Information Technology and the Forest Sector

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The emergence of digital information and communication technology (ICT) has created new challenges and opportunities for the global forest sector. This report – the first systematic and extensive assessment of ICT impacts on the forest sector – analyzes how ICT has affected the global forest sector to date and discusses the driving forces shaping ICT development and its implications for the sector's future. The report also proposes research and policy strategies to help the forest sector adjust to the changes brought about by ICT development.

Perhaps the most significant impacts of ICT development thus far have related to productivity increases and the greater demand for paper products. ICT has enhanced productivity and reduced production costs both in the forest industry and in forestry itself. Paper consumption has increased markedly as a result of modern office technology (personal computers, photocopiers, printers). The introduction of global positioning systems and satellite photography have revolutionized the monitoring and management of forest resources. These and many other examples, as well as their implications, are discussed in this report.

Will the current trends in ICT development continue? What are the emerging new trends? The report suggests that impacts are likely to be more significant in the future than in the past and, in many cases, qualitatively different or even unexpected. A systematic consideration of the topic, which this report seeks to provide, can thus assist the forest sector in making the relevant – and inevitable – adjustments.

The forest sector has only just begun to grasp the likely long-term impacts of ICT and to understand their potential magnitude. Views on the characteristics, number, and the timing of these impacts tend to differ significantly throughout the forest sector. Such differing views can be partly attributed to the lack of scientific research on the topic and the lack of relevant data. Thus ICT is providing new challenges not only to the global forest sector but to forest research. Indeed, a number of issues meriting further research are indicated in the report.

Lauri Hetemäki is a senior researcher at the Finnish Forest Research Institute (Metla) and Sten Nilsson is the Deputy Director of the International Institute for Applied Systems Analysis (IIASA).

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Edited by
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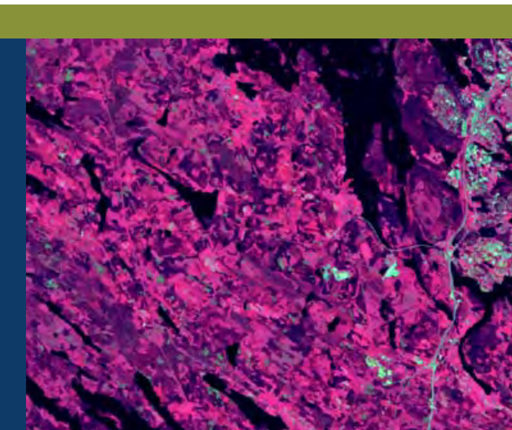

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Preface

This volume in the International Union of Forest Research Organizations (IUFRO) World Series presents the final report of the IUFRO Task Force on Information Technology and the Forest Sector. The Task Force was established by Lauri Hetemäki (Metla), Sten Nilsson (IIASA), and Michael Obersteiner (IIASA) in 2002, with Sten Nilsson as chairman. The work was coordinated by IIASA. The objectives of the Task Force were 1) to establish an operational network to identify and coordinate research and activities on the topic of information technology and the forest sector and 2) to produce a Task Force report.

We would like to thank Risto Seppälä, the President of IUFRO, whose idea it was to establish the Task Force. We also thank IIASA, Metla, and the home institutions of the Task Force members for their contribution to the success of this work. We are first and foremost indebted to the authors of the chapters included in this volume. Special thanks go to IIASA's Forestry Program for organizing and hosting the Task Force workshops and for handling and funding the production of the report.

Technical editing of the report was carried out by Kathryn Platzer (IIASA); the Task Force administrative work was organized by Cynthia Festin (IIASA); and the Task Force Web pages coordinated by Ian McCallum (IIASA). We are indeed grateful for these crucial contributions to the work of the Task Force.

The Editors
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Chapter 1. Introduction

Lauri Hetemäki and Sten Nilsson

> When reading the accounts of the 1870s and 1880s written by those who lived through them, one is inevitably struck by the similarities between the evolution of compound engines and ships and that of chips and computers, between the process of generation of a world economy through transcontinental transport and telegraph and the present process of globalization through telecommunication and the Internet (Perez, 2002).

1.1 Background

"No topic in publishing and information has been more talked about in recent years than electronic and optical communication technology and its impact on existing media and on the future of paper" (Rennel *et al.*, 1984). This statement is the first line of a book, published over 20 years ago, that considers the impacts of information and communication technology (ICT) on the paper industry and markets.[1] Since then, the world has experienced the spread of new ICT innovations to mass markets such as the Internet, broadband, and mobile phones. While the world forest sector has also been fundamentally changed by the development of ICT, there are still no comprehensive or systematic studies as to how. Nor are there any studies as to how ICT is likely to change the sector in the future. This study aims to fill some of those gaps.

The lack of such studies is perhaps not surprising. Studying the impact of ICT on the forest sector would—in some ways—be like studying the impact of electricity or the internal combustion engine on the forest sector. ICT, like electricity and the engine, belongs to a category known as general purpose technologies: technologies that are basically everywhere and affect everything (Jovanovic and Rousseau, forthcoming). The role of ICT in the development of the forest sector is thus difficult to precisely identify and quantify. Moreover, immediate, short-term changes in general purpose technologies tend to have long-term impacts in terms of organizational, institutional, and cultural changes. Thus, the full impact of ICT will be apparent only after a long time lapse.

As the quotation at the beginning of this chapter indicates, the "ICT revolution" is often understood as having changed and as continuing to change our societies just as the "industrial revolution" did in the late nineteenth century. Today, we know that the industrial revolution caused fundamental changes in the forest sector, for example, the advent of large-scale pulp and paper manufacturing. Similarly, the forest sector has not been immune to ICT, nor will it be immune to the ICT developments predicted to take place in the future. As many of the impacts of ICT on the forest sector are very general, a precise assessment of them is difficult. It is, however, important to try to analyze them.

There are already a number of studies on particular aspects of ICT and their impact on specific forest-sector-related topics. Interest has been most significant and long-standing in the impacts of electronic media on paper consumption. There have also been studies on more contemporary issues, such as the role of global positioning systems (GPS) in forest inventory, e-business in the wood products industry, or radio frequency identification (RFID) labels in packaging, to mention a few.

This publication presents an extensive discussion of ICT impacts on the forest sector—from the forestry industry to the end products in the market. This breadth of discussion has important advantages. First, as issues in the forest sector tend to be linked, it allows useful feedback between the various topics. For example, if ICT changes the consumption of forest products (e.g., paper), there will also be changes in the consumption of wood, and thus in the way we use our forests. It is

[1] For a detailed definition of ICT, see the Appendix.

therefore useful to try to analyze how ICT impacts on forest products "trickle down" to forests. The second advantage of extensive coverage is to provide a discussion about those topics not addressed in detail in the literature. As already mentioned, the main relevance of ICT to the forest sector has historically been seen in terms of its possible impacts on paper consumption. Even today, when one discusses ICT in the context of the forest sector, people's minds immediately turn to such issues as "the paperless office." However, as this publication shows, this is too narrow a view. ICT has affected and is still affecting the global forest sector in many other ways, and these are fundamentally changing how things are being done or not being done anymore.

Many of the impacts of ICT on the forest sector are relatively new or still on the horizon. This is quite simply because some of the major ICT innovations tend to be of recent origin themselves. For example, in 1995, the first year of widespread use of the Internet, there were still only about 16 million users in the world. Ten years later, there are about one billion. Given the speed at which the Internet is currently spreading, there may well be two billion by 2010. More important than the number of users, of course, are the changes that such trends are bringing with them. Economic, social, political, and cultural activities across the globe are being structured by and around the Internet, computers, and mobile communication networks. Castells (2001, p. 3) has stated that, "exclusion from these networks is one of the most damaging forms of exclusion in our economy and in our culture."

To sum up, the study rests on the view that the ICT revolution that started in the late twentieth century is causing fundamental transformations in the global forest sector and that anyone interested in knowing what is happening to the global forest sector in the coming decades also needs to be familiar with how ICT is changing our societies. The need for an analytical evaluation of the impacts of ICT on the global forest sector is thus obvious.

1.2 What Do We Wish to Accomplish?

ICT is not only about new technology; it is also about new ways of doing things. ICT can be seen as having three interlocking themes: 1) new developments in the technologies themselves, 2) new innovations, developments within organizations, and developments in sectoral working/business practices, and 3) how quickly and how widely these developments are being taken up in society. The details of the technology are less important than the changes that ICT is bringing to the basic structures of society. For example, ICT has important implications for the ways societies organize work and create economic wealth and for how people spend their leisure time. It helps to interconnect people, economies, and societies in new ways—the words *globalization* and *networking* are often used in this context. Thus, the analysis in this study emphasizes the *impacts* of ICT rather than the technology itself.

The impacts of ICT on the global forest sector can be seen in contrasting ways. For example, in countries where the forest sector has played an important role (e.g., Canada, Finland, Sweden, and parts of the United States), it is not uncommon to contrast the new "knowledge society" or "ICT society" with mature "smokestack" sectors such as the forest industry. While the former is viewed as representing the future and hope, the latter is seen as something belonging to the past, in short, *passé*. Indeed, in many of the countries just mentioned, this *passé* image is making it increasingly difficult to attract new generations to study forest-industry-related subjects or to work in the forest industry. Although this stereotype may appear to be a superficial image problem, it is nevertheless an important factor affecting the sector. Interestingly, the opposite seems to be happening in a number of economically less-advanced countries. For example, the forest industry is attracting increasing investment, employment, and interest in countries such as Brazil, Chile, China, Indonesia, Poland, and Russia.

The image of the forest industry as a smokestack sector tends to obscure the possibility that ICT could become a source of new opportunities and a new image. As has happened in so many other sectors, ICT can enable new inventions and greater prosperity. As such opportunities are not necessarily inherent in existing forest-sector structures, new and innovative ways of combining ICT and forest-based materials or services must be sought. Another purpose of this study is to point out such opportunities.

As well as the macro-level developments mentioned above, a large number of more specific and fundamental changes are also taking place in various subsectors of the forest industry. Indeed, it is difficult to think of issues in forest sector that are not affected by ICT. On the other hand, the global forest sector is such a large entity that ICT cannot have a uniform and simultaneous impact on every part of it. For many subsectors, ICT appears to provide a new engine for progress and opportunity. For others, it can be a disruptive or even “killer” technology. In many instances too, ICT impacts cannot yet be clearly seen. Moreover, the speed at which these influences affect the sector is likely to vary among different geographical locations and subsectors. We hope the present study succeeds in reflecting this heterogeneity.

It is important to stress that ICT impacts that are slow and gradual can be as significant as immediate “disruptive” changes, principally because of the inherently long-term character of the forest sector. For example, trees planted today in natural boreal forests may not reach their optimal harvesting age for 70 to 100 years. Similarly, after a forest is clear cut, it may take hundreds of years for it to return to its original state. Forest industry investments are typically made on the basis of a 15–30 year time horizon. Thus, forest-sector issues—wood production, forest-product markets, forest conservation, and biodiversity—require a long-term view. That is why analysis of the slow, gradual trends caused by ICT is so important. Assessments and projections of these trends will draw attention to emerging problems, indicate the likely impact of interventions, and guide the development of investments and other resource-allocation decisions.

The new and changing operating environment caused by ICT also creates important challenges for forest-sector research. In basic research, new or updated models and methods may be required. In applied research, new empirical results are needed to quantify ICT impacts on the forest sector. From the applied research perspective, however, such research has important limitations with respect to future development.

There is thus a need to seek new ways of envisioning the nature of future development. Consequently, in this study, various qualitative approaches are used, along with data analysis, to try to predict the future impacts of ICT on the forest sector. Indeed, the emphasis in most of the chapters is of a qualitative rather than quantitative nature.

Here, the starting point for the qualitative approach is that the future cannot be treated as an objective fact but needs to be thought of as emerging and only partially knowable. In that sense, it should not be treated as an empirical reality but rather as a set of only partially viewable alternatives that describe future possibilities. Consequently, we present scenarios, or rather visions, of the future impacts of ICT on the forest sector. These are not intended to predict the future but rather are tools for thinking about the future. They acknowledge that the future may be unlike the past and that it is shaped by human choice and action. They also acknowledge that while the future cannot be foreseen, exploring future possibilities can inform decisions being made now. Basically, this type of approach involves rational analysis and subjective judgment. Its danger is that it may produce banal superficiality as opposed to insight. We hope that this study has succeeded in avoiding this pitfall—but this we must leave to the judgment of the reader.

History also shows that predictions and scenarios related to technological development and innovations tend to be children of their time. When the public first become aware of new innovations, their optimism is high; they think new systems or services will revolutionize society and do everything short of mixing the perfect martini. After the initial hype comes the hangover, which shows that expectations were excessive or that a too-rapid development was anticipated. This is what supposedly happened, for example, with the so-called information economy bubble at the turn of this century. It was like an “ICT tsunami” that created high and bullish markets; but when reality hit, hopes were destroyed and the resulting economic slowdown wiped out many new businesses.

Thus, the history of technological development tends to be associated with waves of great expectations followed by a rapid deflation of those expectations (Perez, 2002). And when our expectations are deflated, disappointment tends to make us believe—wrongly—that nothing of any significance will result from the new developments. In short, *technological forecasting tends to overestimate short-term impacts and underestimate long-term impacts*. It is the failure to anticipate the gradual, long-term trends, however, that can turn out to be the most fatal for many policies and businesses, in that, because of their slowness, action may not be taken until it is too late.

This study does not aim to provide instant rules and formulas for reacting to ICT changes in the forest sector; its goal is to help the reader recognize patterns and interpret the meaning of the changes caused by ICT and to promote understanding of how ICT and the forest sector intersect. As the topic of ICT impacts in the forest sector is still greatly neglected in forest research, it is imperative to draw attention to its importance, not least because—as indicated earlier—this study appears to be the first comprehensive analysis of this topic. The research task is a challenging one because the subject matter seems to develop and change much faster than research can hope to keep pace with. Moreover, the ways in which ICT will affect our societies and the forest sector in the future are likely to cause surprises. As Castells (2001, p. 195) has pointed out, "The wonderful thing about technology is that people end up doing with it something different from what was originally intended." The present study can therefore be seen as indicative of a need for further and more-detailed analysis of the impact of ICT in many of the topic areas referred to in this book.

The study is intended not only for researchers but for a much wider forest-sector readership. It thus also addresses the strategic and policy implications of ICT changes in the forest sector. The reasons for providing this type of analysis vary in terms of the topic under discussion. Even if clear strategic and policy implications do not emerge, the analysis can be helpful in decision making. Often, the first stage of a decision process is pattern recognition; being able to systematically analyze a topic, draw attention to the major trends, and identify the important patterns may be the most we can hope to do. If only this were achieved, it would be a significant step on the road to informed decision making.

1.3 The Scope and Outline of the Study

This study is not an exhaustive one. Its purpose is to cover the issues more deeply than merely providing an introduction. Covering all possible issues would have led to a work of encyclopedic proportions—ICT has too many direct and indirect effects for them all to be covered in just one study. For example, the potential impacts of ICT on firewood and charcoal or wood energy are not discussed—even though the latter account for over 50% of total world wood utilization. The relationship between ICT and firewood is just too tenuous. Moreover, although ICT is a central enabler of, for example, biotechnology and nanotechnology development, we do not consider the impacts of the latter technologies on the forest sector. They are topics worthy of their own study.

The outline of the study is as follows. Chapter 2 places the topic in context, summarizing the main impacts of ICT in the forest sector to date. The chapter provides a historical background for the rest of the book, explaining how the relationship between ICT and the forest sector has developed thus far and how ICT is likely to affect the forest sector in the future.

Chapter 3 discusses past successes and failures in making projections and building future scenarios regarding the impacts of new innovations. It provides a cautionary reminder of our limited ability to make long-term projections. Looking back at history, we see that new innovations can have unexpected consequences and that projections can also go wrong. There is room for optimism, however, for in the past, people have been able to anticipate future developments with surprising accuracy. Clearly, some issues are easier to anticipate than others.

Chapter 4 gives an overview of e-commerce in general and its applications to the forest sector. Future scenarios and policy implications are also discussed. Chapter 5 is closely related to Chapter 4 in that it discusses the possibilities that ICT provides for forest business in terms of increasing operational productivity and efficiency.

Chapter 6 addresses one important forest products category—communication papers. The chapter discusses and foresees how ICT is likely to impact on newsprint, magazine paper, and office paper consumption and prices. It also assesses the ICT implications for the paper industry operating environment, such as the geographical location of future investments.

Chapter 7 extends the discussion of Chapter 6 to the paperboard and packaging markets. The approach taken also provides new insights into how ICT development could change the strategies of the forest industry. In that sense, the chapter has a larger relevance than the sector that it addresses.

Chapter 8 considers ICT impacts on the wood products industry. Here, as in Chapter 7, the major issues relate not to ICT impacts on the consumption of the products but on how the sector can utilize ICT to increase productivity and improve marketing. It also discusses how ICT development could be integrated into the wood products sector and into the infrastructure supporting the utilization of these products.

Chapter 9 reviews how ICT development has affected, and is likely to affect, the way in which forests are managed for the purposes of wood production and conservation.

Chapter 10 moves the focus of the study from the direct forest sector connection to a more general level. It addresses the cultural and social impacts of ICT on our societies that, in turn, will have impacts on the forest sector. One major theme raised by the chapter is the "digital divide" issue.

Chapter 11 considers the policy and governance dimension of ICT development. It asks how ICT has affected, and is likely to affect, the governance of forest policy and forest issues.

Chapter 12 provides a summary of the study and discusses the strategy and policy implications of the findings.

Appendix

Box 1.1. What Do We Mean by ICT?

The acronyms ICT (information and communication technology) or IT (information technology) have entered our everyday language in the last decade and tend to be used interchangeably, with ICT recently seeming to have become the more popular.

A number of different definitions of ICT have been established by international organizations such as the Organisation for Economic Co-operation and Development (OECD), the World Bank, and different national statistical authorities. The OECD definition of ICT is also endorsed by the United Nations Statistical Office (UNSO) and used by a number of national statistical institutes (NSIs). All the definitions tend to characterize ICT as including both hardware and software used to store, process, and transport information in digital form.

The OECD Committee for Information, Computer and Communications Policy (ICCP) established an Ad Hoc Statistical Panel to address the issue of indicators for the Information Society in 1997. The Panel recognized that the ICT sector should be defined as an industrial sector formed by bringing together business units (establishments, enterprises, or enterprise groups) that had common ICT activities. It was felt that the industrial classification ISIC Rev. 3 was the best option available for collecting indicators on an internationally comparable basis. In September 1998 the OECD definition of ICT was released.

The OECD definition

The principles underlying the choice of the activities included in the ICT sector definition:

For manufacturing industries, the products of a candidate industry:

- Must be intended to fulfill the function of information processing and communication, including transmission and display; or
- Must use electronic processing to detect, measure, and/or record physical phenomena or to control a physical process.

For services industries, the products of a candidate industry:

- Must be intended to enable the function of information processing and communication by electronic means.

The ISIC industries included in the ICT Sector:

Manufacturing:

3000: Office, accounting, and computing machinery
3130: Insulated wire cable
3210: Electronic valves and tubes, and other electronic components
3220: Television and radio transmitters, and apparatus for line telephony and line telegraphy
3230: Television and radio receivers, sound or video recording, or reproducing apparatus and associated goods
3312: Instruments and appliances for measuring, checking, testing, navigating, and other purposes, except industrial process equipment
3313: Industrial process equipment

Services:

5150: Wholesale of machinery, equipment, and supplies (part only, where possible)
6420: Telecommunications
7123: Renting of office machinery and equipment (including computers)
72: Computer-related activities

Source: OECD (1998), DSTI/ICCP/AH/M(98)1/REV1

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Chapter 2. ICT and the Forest Sector: The History and the Present

Lauri Hetemäki, Anders Q. Nyrud, and Kevin Boston[*]

2.1 Background

The image of the forest sector tends to be that of a natural-resource-intensive and mature sector. This view obscures the fact that, throughout its history, the forest sector has adjusted to new inventions such as electronics. For example, telegraphy and telephones were already being widely used in the sector during the late nineteenth century. Moreover, the large increases in productivity in the forest sector after World War II would clearly have been impossible without the automation achieved by the increasing use of electronics, including computers.

The purpose of this chapter is to present a historical overview of information and communication technology (ICT) utilization in the forest sector and to assess how ICT has impacted the sector's operating environment, for example, product development and markets. We do not seek to provide a complete historical assessment; we focus rather on the period from about the late 1970s to the present when modern ICT began to have profound impacts—from the introduction of microchips and personal computers (PCs) to the spread of the Internet and mobile communications. For forestry, the launch of the first global positioning system (GPS) satellite in 1978 also turned out to be a significant milestone.

To date, the discussion of the impact of ICT on the forest sector has tended to concentrate on possible changes in the consumption of communication paper products (the "paperless office" debate). This is not surprising, as the possible impacts of ICT have been most clearly identified, and are perhaps most significant, for these products. But the impacts of ICT on the forest-products markets is only one dimension of the issue. It is equally important to analyze, for example, how the sector itself has used ICT to enhance productivity and increase service quality. When ICT impacts are viewed from this perspective, it becomes clear that significant changes have taken place in all forest industry sectors. For example, the use of ICT in raw-material procurement, logistics, production processes, and marketing has had important implications not only for communication papers but also for the paperboard and packaging industry and for the wood products industry. ICT has also played a crucial role in the monitoring and managing of forest resources, with geographic information systems (GIS) now being the cornerstone of most forest management information systems. The use of forests for many types of services, such as recreation, biodiversity, and carbon sequestration, has also been influenced by modern ICT. It is evident, therefore, that ICT is having wide impacts on the forest sector, from silviculture to the marketing of forest products and the recreational use of forests.

The outline of the chapter is as follows. First, we analyze the impact of ICT on the communication paper sector and comment very briefly on the relationship between ICT and the paperboard and packaging sector (the latter topic is taken up in more detail in Chapter 7). Next, we turn to the wood products sector, and then move on to discuss the impact of ICT on forest management. We conclude by briefly analyzing how ICT has influenced the various services generated by forests.

2.2 Communication Paper Products

By communication papers we mean *printing and writing papers* and *newsprint*. Printing and writing papers can be classified according to end use into the following groups: *office papers* (photocopying, printing, envelopes, stationery), *magazine papers and catalogues*, and *other print products* (books,

[*]Hetemäki is responsible for sections 2.1–2.3, and 2.6; Nyrud for 2.4; and Boston for 2.5. Hetemäki would like to thank Tuija Sievänen and Ashley Selby of the Finnish Forest Research Institute (Metla) for their comments.

inserts, flyers, directories, lower-print-quality magazines and catalogues). In 2003 total world communication paper production was 135 million tons, which amounted to 41% of total world paper and paperboard production (Source: FAO database). In terms of value, exports of communication papers were US$41.6 billion (i.e., 57% of the total value of paper and paperboard exports). In the paper and paperboard sector, the production of communication papers uses the largest share of wood fibers (pulpwood, chips, and recovered paper). The impacts of ICT on communication papers are thus of major interest to the whole forest sector.

2.2.1 The paperless office—The development of a myth

What can be said about the development of ICT and communication papers in the past two decades? If one approaches the question from the perspective of the early 1980s, a natural starting point is the introduction of the idea of the "paperless office." Sellen and Harper (2001, p. 2) believe that it is quite difficult to track down where and when this term entered common parlance. They also note that as early as 1895 a pair of French satirists were predicting that the record player would bring "the end of the book"; that, around the turn of the century, Jules Verne doubted there would be novels in 50 to 100 years' time; and that by the 1960s Marshall McLuhan (1962) was writing as though *The Gutenberg Galaxy* would collapse into a black hole. However, an important landmark in identifying the source of the paperless office idea was the foundation of the Xerox Palo Alto Research Center (PARC) in 1970. PARC is a research unit established to develop innovative products to help to create the "office of the future" in which electronics would replace paper. Consequently, PARC's "office of the future" vision also became labeled as the "paperless office" vision.

As we know, the vision of the paperless office has not yet been realized. But during the early 1980s, when microchip development advanced significantly and personal computers started to enter consumer markets, some analysts predicted that these and other developments in electronic communications could have a drastic impact on paper use.

Studies by the U.S. Congress (1983) and Rennel *et al.* (1984) provide a perspective of how the role of ICT and communication paper products was seen in the 1980s. The U.S. Congress (1983) study was commissioned by the Congress Office of Technology Assessment to analyze the role of technology in the forest products industry. The chapter, Competition from Electronic Technologies, summarizes the existing literature on the topic and provides a good overview of the subject as seen in the early 1980s. The study makes reference to a number of publications that point to the potential impacts of the substitution of ICT for paper. Many of these articles forecast a major shift away from the use of paper toward increased reliance on electronic media.[1] The U.S. Congress (1983, p. 77) study, however, also notes that "uncertainties regarding the rate of commercialization and public acceptance and forecasts of its impacts on paper must be considered speculative. While there is little disagreement among analysts that electronic communications may ultimately displace the need for some writing and printing papers, the timing and extent of the impacts are subjects of debate." The study also notes that, in the short term, the proliferation of word processors and office copiers seems to have increased the demand for printing and writing paper. It anticipates that the future impact of electronic media on paper demand is likely to depend on the attitudes of a generation of children accustomed to the partial substitution of electronics for paper. The U.S. Congress (1983, p. 79) study concludes by stating that "although current technology limits the use of electronic communication to desktop consoles and large computer and word-processing installations, the development of handheld portable devices with readable screens—and microelectronic processors capable of storing entire

[1] For example, in 1980 Euro-Data Analysts, a British-based market consulting group, projected: "Over the long term, Euro-Data considers it likely that the developed countries will achieve a nearly paperless society as the rate of commercialization of electronic communications accelerates. Euro-Data forecasts that during the current decade, paper will lose a share of the market to the electronic media through video telephone, telex, video books, video newspapers, consumer magazines, and electronic funds transfers" (quoted in U.S. Congress, 1983, p. 77).

books and magazines—could have a significant impact on the substitution of electronic media for print."

Rennel *et al.* (1984) is a detailed study of the future of paper in the "telematics world," written by pulp and paper engineers. Although it tends to emphasize the technical aspects of the issue, it acknowledges the importance of its economic and social dimensions. The general tone and view of the study is more "professional" than the U.S. Congress (1983) study and many similar studies of the late 1970s and early 1980s. Furthermore, its analysis has turned out to be quite accurate. First, it argues that the impact of electronic media such as the use of videotex for news, shopping, and banking will be evolutionary rather than revolutionary. This is partly because "Consumers' acceptance of the new electronic media is deeply rooted in both economic and social patterns. Changes in patterns will only occur when it proves profitable to provide new outlets to meet changing consumer demand" (Rennel *et al.,* 1984, p. 226). Second, the study concludes that the demand for printing and writing papers is likely to increase with the use of electronics such as PCs, word processors, and office copiers. Nevertheless, as Rennel *et al.* (1984) acknowledge, although new electronic technologies will introduce new communication possibilities that, for the most part, will enhance the use of paper, these will in some cases be a substitute for paper. The authors do anticipate, however, that the negative impacts will take a very long time to be of great significance to the paper industry.

The main emphasis in early studies on the impacts of ICT in the paper industry was on the consumption of communication paper products. Discussion about the possible benefits of ICT utilization for productivity or for the other forest sectors (paperboard, the wood industry, and forestry) was limited or nonexistent.

Once the "paperless office" debate was aroused, the discussion never totally vanished, but it did lose its momentum, and studies focusing only on this topic more or less disappeared. One of the most important reasons for this was the rapid spread of electronic communication and electronic office equipment, which increased the demand for communication papers rather than replaced it.[2] This development is summarized in *Figure 2.1*, which shows the world consumption of communication papers and the development of some important ICT equipment and services.[3] *Figure 2.1* indicates that the consumption of printing and writing papers and newsprint has increased significantly despite the introduction of the new digital media and services. Indeed, the consumption of some paper grades such as cut-size or A4 papers has undoubtedly increased because of PCs, printers, and copy machines. Similarly, copy machines, printers, and fax machines exist only because of paper. Thus, in today's office, paper is an electronics-intensive product, and vice versa.

In the late 1990s there was renewed interest in the debate on the impact of ICT on communication papers (see, e.g., Boston Consulting Group, 1999; Hetemäki, 1999; Electronic Document System Foundation, 2001; Smyth and Birkenshaw, 2001; CAP Ventures, 2003). This revival was spurred mainly by the rapid development of the Internet and new communications technology (e.g., mobile phones and electronic books). However, the "two waves" of debates, separated by nearly two decades, had some important qualitative differences. In particular, the increasing use of ICT and electronic commerce was seen as a new way of enhancing productivity in business-to-business operations, logistics, marketing processes, the paper-production process, and the forest sector in general. It was anticipated that the new ICT would also create demand for new paper products, such as digital color paper grades. Some of the studies also pointed to the impact of ICT on the real prices of paper products (Hetemäki, 1999). In Chapter 6, there is a more detailed discussion of the recent studies on ICT and communication papers.

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[2] In fact, some paper products did actually vanish because of ICT: *carbon paper* for copying and *punch-card paper* for computer commands.

[3] Chapter 6 discusses in more detail what conclusions can be reached for the future, based on *Figure 2.1*.

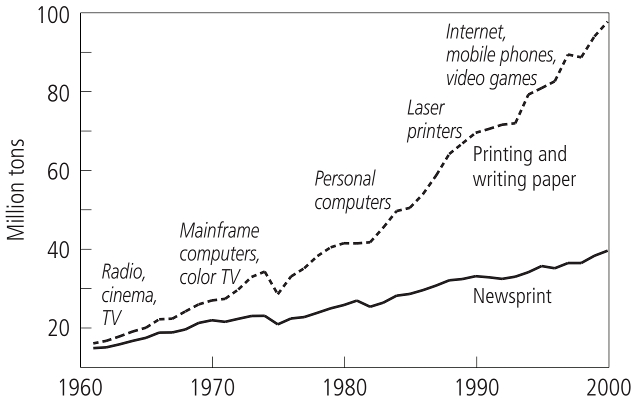

Figure 2.1. World communication paper consumption and ICT development, 1960–2000.

2.2.2 ICT, productivity, and globalization

Today, in many countries of the Organisation for Economic Co-operation and Development (OECD), paper industry output per labor hour is significantly higher than in the 1970s (e.g., in the United States it is twice as high as in 1970). One important factor behind this rapid increase in productivity has been the increasing use of ICT. Indeed, ICT development has been essential for the viability of the sector. First, ICT has increased the productivity of the actual production process through automation. Second, it has made the internal handling of business within companies more efficient. Third, ICT has increased productivity in the paper products industry at the raw-material procurement, logistics, and marketing stages. Indeed, today, the paper industry likes to promote its image as an ICT-intensive industry (Krogerström, 1998).

In recent years, business-to-business communication and e-commerce have revolutionized raw-material procurement and the marketing of end products in the paper industry. One important development has been the launching of papiNet in 1999 (http://www.papinet.org). papiNet is the global initiative to develop, maintain, and promote the implementation of electronic transaction standards to facilitate the flow of information and facilitate computer-to-computer communications among all parties engaged in the buying, selling, and distribution of forest, paper, and wood products. It enables forest products companies to reduce costs, enhance relationships, and improve decisions through the use of a secure, industry-specific, transaction-processing network. It also improves the quality of customer service (for more details, see chapters 4 and 5).

Some ICT impacts are rather difficult to quantify. For example, ICT is likely to change organizational structures and working practices. ICT development has, however, been essential to the globalization of the paper industry by facilitating and lowering the costs of company mergers and foreign investments. Usually, the more global a paper company is, the more important the role of ICT in it. Indeed, it is difficult to envisage global paper companies with production and marketing facilities in over 20 countries not having the possibility of real-time communication and information transfer.

2.3 Paperboard and Packaging Paper Products

The paperboard and packaging papers group consists of various paper types. First, *kraft papers* are used primarily as wrappers or packaging materials (e.g., grocers' bags, envelopes, multiwall sacks, tire wraps, and butchers' wraps); *boxboard* is a general term designating the paperboard used for fabricating boxes; and *containerboard* is used in the manufacture of shipping containers and other corrugated-board products. The share of paperboard and packaging papers in the total world consumption of paper and paperboard is around 40%.

The history of ICT in the paperboard and packaging sector has some important differences from that of ICT in the communication papers sector. There were no fears that the development of ICT would cause a decline in the consumption of paperboard and packaging papers, as ICT cannot produce direct substitutes for these. Instead, interest in the paperboard and packaging sector has centered on how ICT could enhance the sector's productivity and business strategies, as well as on opportunities for combining ICT with packaging products (e.g., bar codes and so-called intelligent packaging).

There appear to be no comprehensive and systematic studies on the impact of ICT on the paperboard and packaging sector. An overview of the topic is presented in Chapter 7, as are insights into possible future developments in the industry.

2.4 Wood Products

Wood is available to most cultures as a versatile, naturally replenishable resource of raw material. It has traditionally been used for purposes such as toolmaking, housing and shelter, and the creation of art and religious symbols. Wood products can be produced using fairly simple technologies, but modern production techniques frequently utilize advanced, capital-intensive technology. Both traditional and modern manufacturing techniques are reflected in current production. Many of the tools and techniques of carpentry perfected since the Middle Ages have changed little, and traditional techniques are frequently reflected in contemporary wood products. But new and advanced wood products are also continuously being developed (e.g., particle board being made into designer furniture).

In the wood products industry, solid and composite wood products are manufactured through the mechanical processing of either industrial roundwood or derivates from other wood industries. Primary wood processing involves the processing of logs (i.e., sawmilling and manufacture of wood-based panels), while secondary processing adds value to primary products through, for example, the industrial manufacture of furniture, woodworking, or construction. The industry is heterogeneous, both with respect to size and location of the production units. The units producing primary goods mainly use roundwood of local origin, and the processing is usually carried out close to the raw material—in forested regions. Wood-processing mills may even control raw material supply through the ownership of forests.

In 2002 the total world production of wood-based panels was nearly 185 million cubic meters, and lumber production was 390 million cubic meters (Source: FAO database). The total consumption of sawlogs and veneer logs was 930 million cubic meters. Approximately one-third of wood-based panels and one-quarter of lumber production were traded across borders. The export value of the wood-based panels was $16 billion and of the sawn wood $22 billion.

2.4.1 ICT in the production process: The transformation of the sawmilling industry

Since the 1960s the sawmilling industry has used ICT in production, thus transforming formerly labor-intensive practices into a capital-intensive, automated production process. The sawmilling industry serves as a good example of how ICT has impacted on the wood industry. Today, ICT is applied in all aspects of the wood products industry (manufacture of sawnwood, panels, and boards, furniture, packaging, woodworking, millwork, and construction).

In sawmills, logs are split into rough-squared sections, planks, and boards. As the cost of raw material accounts for approximately 60% of total production cost, producers usually attempt to maximize output using the raw material available. Their key objective is to determine the best sawing pattern—or optimal breakdown—for the logs (primary breakdown) or to cut sawnwood to the best width and length and to saw or resaw cants and slabs into boards (secondary breakdown).

Williston (1976) points out that the basic requirements for determining the optimal breakdown of a log are the ability to measure its geometry and grade, including taper and seep, to calculate the correct sawing position, and then to move and hold the log in that position. Traditionally, the mill operator or head sawyer would make these calculations based on a visual inspection of the log and his own experience. The optimization can also be made through application of the Pythagorus theorem, and if there are proper measuring devices, can be performed by computer.

The development of (laser and X-ray) scanners has enabled the diameter, length, and shape of the log to be measured and the log geometry information to be stored (see Bowe *et al.,* 2002). The information obtained can be used to sort and grade logs to provide a graphical representation before sawing and as inputs to calculate optimal breakdown patterns. Improvements in scanning and computer technology have made it possible to fit the headrig of a saw with a computerized scanner, facilitating the measurement of logs as they are fed into the headrig; this has represented a breakthrough in sawnwood production and has resulted in faster and more efficient production (see Bowyer *et al.,* 2003).

The introduction of ICT has provided the computing power needed to conduct the geometrical optimization required to determine the optimal sawing patterns for individual logs. Geometrical optimization has been carried out mostly through the adaptation of numerical techniques such as simulation, linear programming, and dynamic programming. The first digital optimization applications were introduced in the late 1960s, among them the Swedish simulation program developed by Riikonen in 1962. Williston (1979) at that time surveyed the state of the art in sawnwood manufacturing, pointing out that computerized optimization and automation applications were already in use in Sweden and the United States. Similar applications for performing secondary breakdown and canting and cutting of sawnwood were also developed and integrated with headrigs in production.

ICT has also impacted the treatment of sawnwood. ICT applications have been used to measure the length and width of planks and boards (Bowyer *et al.,* 2003) and, through the use of tools such as picture analysis, to determine surface properties (e.g., knots and color) (Vienonen *et al.,* 2002), thus improving the sorting and grading of sawnwood. Methods have also been introduced to control the drying process and to measure physical strength and reveal possible defects, for example, through stress and deformation testing or acoustic tests (see Marchal and Jacques, 1999).

Computing systems are usually integrated into modern log scanners to provide, for example, optimal breakdown patterns, edging and trimming, and visualization. Computerized production methods have resulted in increased production efficiency. Aune and Lefevre (1974) compared manually and computer-controlled chipper-canters and found the saw yield (lumber recovery factor) to be higher for the computer-controlled system. Specific efficiency estimates as a result of the introduction of ICT are hardly ever reported, but Robinson (1975), Greber and White (1982), and Baardsen (1998) all report improved efficiency in both United States (U.S.) and Norwegian sawmilling after ICT was introduced into the industry.

2.4.2 Impact of the Internet

Most wood industries have seen developments similar to those in sawmilling, and ICT is now used for a wide range of purposes—from design and product development through to supply chain management, promotion, and sales. Since the Internet was made available to the public, e-business has gained importance in the wood industry. E-business is the application of Internet-based technologies to business activities and includes e-commerce (transaction activities) and business-oriented applications such as logistics, order entry, information sharing, and transmission of information between exchange partners (see chapters 4, 5, and 8).

Currently, companies in the wood products industry use e-business solutions in many tasks. A company intranet provides a means of internal communication, for example, between management and employees. ICT-supported supply chain management and logistics—with respect both to production inputs and deliveries of outputs to customers—are becoming increasingly common, as is the use of ICT for financial transactions, for transferring information among business contacts, for communication with consumers, and for marketing, sales, and product deliveries.

The experience of Norwegian furniture manufacturers in the early 1990s shows that the implementation of e-business solutions can provide considerable benefits in the wood industry (Ministry of Transport and Communications, 1996). The Norwegian furniture industry has developed common computer systems for financial management, ordering, and production. A local network was introduced to small-scale furniture manufacturers, facilitating information sharing and coordination of business activities. This resulted in considerable savings, with the 20 participating companies reporting annual savings of approximately NOK 30–50 million. The network also improved competitiveness and increased value creation in the companies. Moodley (2002) highlights the link between Internet connectivity and access to global markets. He reports that e-commerce technologies are becoming increasingly important for South African wood furniture producers, integrating them into global value chains and thus exposing them to the demands of more sophisticated markets.

Studies have indicated that e-business solutions have already been generally adopted in the wood products industries. The use of e-business solutions depends on factors such as market segment, customer base, and value-added to product and company size. In 2001 more than half the members of the U.S. Hardwood Lumber Association were using the Internet for business purposes (Vlosky and Smith, 2003). The use of the Internet was even higher among exporters of primary wood products in the United States. In 1999 approximately 80% were using the Web, mainly for promotional activities (Pitis and Vlosky, 2000a; Pitis and Vlosky, 2000b). Shook *et al.* (2002) found the use of e-business solutions for secondary forest products manufacturers in the Pacific Northwest to be independent of geographical location but correlated with manufacturing plant size. In the Canadian wood products industry, Internet use for business purposes exceeds that of the U.S. industry (Vlosky and Pitis, 2001); and according to surveys conducted by the OECD, this is also the case in other industrialized countries (OECD, 2003).

Dupuy and Vlosky (2000) conducted a mail survey investigating electronic data interchange (EDI) use by forest products manufacturers (primary solid wood/pulp and paper) in Canada and the United States. They found that only 16% of their respondents were using EDI, that EDI implementation was highly correlated to company size, and that the main reason for implementation was requests from customers.

A study conducted in 1999 concluded that in the U.S. home-center business the number of companies with a Web site was almost three times higher than among forest products manufacturers (Vlosky and Westbrook, 2002). The use of other Internet-based technologies (e-mail, EDI, and Web sites) was also higher than the industry average, being a substitute for regular mail and fax, for example. This indicates that the home-center industry and retailers already conducting e-commerce are also more likely to adopt other e-business strategies.

2.5 Forest Management Use of ICT

Recknagel (1913) describes the information required to prepare forest management plans: soil type, topography, wildlife, growth and yield, and marketing data. These information requirements have remained near constants for over 90 years, but the tools used to collect and manage the information have changed dramatically, with ICT development assisting the rapid assessment and integration of data from multiple sources.

Geographic information systems (GISs) are now the cornerstone of most forest management information systems. They have evolved from the simple mapping systems for computer graphics developed at the Harvard Graduate School of Design’s laboratory into the sophisticated systems of today (Burrough and McDonnell, 1998). They now allow for the integration of both raster and vector data and perform advanced modeling procedures using arithmetical and Boolean functions that involve both tabular and spatial data. The development of a relational database further enhances the user’s ability to perform complex queries using natural language tools. Advances in computer hardware technology leading to the development of low-cost and reliable mass-storage devices, graphic terminals, and digitizing and scanning devices, have made data more affordable. GISs will play a more important role in the future as they become further integrated into enterprise-resource-planning systems. These systems manage forest operations as well as maintaining much of the documentation required by certification organizations.

As well as the development of and advances in GIS technology, there have been considerable developments in the ability to collect spatial and tabular data for seamless integration into GISs. Currently, handheld computers with global positioning system (GPS) capabilities can display, record, and annotate maps directly in the field. Additional gains are being made in the rapid transfer of positional data to mapping systems using handheld laser technology coupled to field-data collectors (Peet *et al.*, 1997; Liu, 2002).

Remote sensing has played a significant role in forestry since the integration of aerial photography into forest inventory in Canada in the 1920s. The first aerial photos were black and white, but now foresters have a choice between black and white, black and white infrared, color, and color infrared photography (Paine and Kiser, 2003). The photos can now be adjusted to specific needs (e.g., black and white photography can provide a better image resolution, whereas infrared photography can more easily detect areas with high moisture content or stressed or dying vegetation). Although digital photography is changing small-format photography, it must overcome the problem of the large number of pixels required to produce high-resolution pictures in large-format cameras. The development of image compression technology, such as the Foveon X3 detector, can reduce the memory required while improving the image resolution (Paine and Kiser, 2003).

Remote sensing has advanced with the space programs. The first spaced-based images were taken by hand-held cameras during the Mercury, Gemini, and Apollo space programs. The Skylab was one of the first multiple-sensor, space-based, remote-sensing systems (Lillesand and Kiefer, 2000). Many consider the launch of the Landsat program, Landsat-1, in 1972 as being the first space-based, remote-sensing system, with five further successful launches taking place. These systems contained multiple sensors, such as return beam vidicon, multispectral scanners, thematic mapper, enhanced thematic mapper, and enhanced thematic mapper plus (Lillesand and Kiefer, 2000). Space-based platforms have been established not only by the United States but by other countries. France, India, Russia, and private corporations are now offering space-based remote sensing.

Recently, there has been a significant increase in the use of the microwave portion of the electromagnetic spectrum. The advantages of using these frequencies is their greater ability to penetrate atmospheric conditions such as clouds or rain. Light detection and ranging (LIDAR) has been used to measure the canopy heights of forests (Lillesand and Kiefer, 2000).

A culmination of GIS and remote sensing is the development of stand-delineation and tree-counting algorithms. These procedures use several remote-sensing features, such as the location of areas of maximums combined with contrast-detecting techniques that identify the likely location of the trees (Leckie *et al.,* 2003). This technology has the potential to significantly improve forest assessment. The continual improvement in data-capture and data-management technology will allow forest plans to be developed with more and higher-quality information that will allow for the development of improved forest plans.

This technology has emphasized the ability to collect more high-quality data with increased efficiency, often to support improved decision support systems. Forestry has a rich tradition of developing decision-support tools using a combination of simulation and optimization techniques. Some of the first linear-programming applications were developed to determine harvest levels for large forest areas (Johnson and Scheurman, 1977; Garcia, 1984). In the last 30 years, there has been an increase in the number of discrete harvest-scheduling algorithms. Initially, systems linked silvicultural and transportation decision making with a view to improving the financial returns from forestry investments (Weintraub and Navon, 1976; Kirby *et al.,* 1980; and Kirby *et al.,* 1981). With increasing awareness of the importance of the spatial pattern on many ecosystem functions, new planning techniques were developed to integrate ecosystem and economic goals. Bettinger *et al.* (2002) describe a variety of heuristic techniques that can be used to solve these increasingly difficult spatial forest-planning problems. The increase in computer storage and processing speeds now allows larger data sets to be collected. Decision-support tools are shifting from single-ownership planning models to regional models. These models are emphasizing spatial processes across ownerships. An example of such a model is the two-million-hectare model being completed in western Oregon where commodity production and wildlife habitats are modeled for a variety of ownership classes (Bettinger *et al.,* 2005).

2.5.1 Chain of custody

Although there have been significant improvements in the development and use of ICT in forest assessment, there have not been similar gains in the technology used to maintain the chain of custody of forest products. Historically, logs were branded with the hammer, and the driver carried a multisheet docket containing information about the origin and ownership of the wood. Duplicate pages from these books were distributed to all elements of the primary log-supply chain, and these receipts were used as the basis of log security, payments for logging, hauling services, and invoicing customers for the delivery of goods. Computers have replaced the written ledgers, but much of the manual process is still used by many forest operations today.

The new emphasis in supply chain management is the changing of procedures. Accurate delivery of product and information through the supply chain has encouraged organizations to apply new technology to improve log tracking from the forest to the customers. In the tropics, to reduce the illegal log trade, the emphasis is placed on log identification. New techniques include identifying the log source with tags, paint, or chemical compounds that can be read by a detection device. The amount of information contained in these tags can vary from identification of the source to more-detailed measurements including diameter, felling date, and the volume of wood contained in the logs.

Paint, often combined with fluorescent or magnetic tracers, has frequently been used in association with log branding to identify ownership. The U.S. Department of Agriculture has used fluorescent tracers for over 20 years to detect log theft. Recently, microtaggant tracers that can be encoded to provide a tamper-proof method of declaring ownership of the logs have been used. The information contained in microtaggant paint must be read manually and is appropriate for describing individual log features (Dykstra *et al.,* 2002).

Bar codes have been attached to consumer products for well over 20 years and have been applied in forestry for over 10 years (Olsen *et al.,* 1977). These tags can hold a variety of information and are commonly used in the log export trade. Tags need to be manually attached to each log and remain attached until the log is consumed. The tag must be visible so that it can be read by scanners. The problem is that many of the materials used to create a durable tag interfere with pulping operations.

A more recent method for identification is the radio-frequency-identification (RFID) tag. The RFID tag responds when the correct radio frequency is encountered and does not need to be visible to a scanner, as the card then transmits the stored information (Palmer, 1995). The tags can contain from as little as one byte of information to several thousand bytes. Their drawbacks are their cost—a tag can cost around 30 cents—and the technical expertise required to program the information on to the tags. Smart cards with embedded microprocessors can be used to hold cargo manifests; these are more suitable for the transportation of batches of logs by truck, rail, or vessel than for the individual log (Dykstra *et al.,* 2002). There is still a need for a new tagging technology that allows log identification without interfering with pulping operations.

2.6 Forest Services and the Social Context of Forests

The importance of environmental and other services related to forestry have increased, and some new services have been introduced during the past decades (Pagiola *et al.,* 2002). There is a great diversity of forest services, for example, recreation, forest-related tourism, conservation, biodiversity, carbon sequestration, regulation of hydrological flows, mushroom and berry picking, hunting, forest fire prevention, and "virtual" forests. Typically, many of these services are considered as nonmarket services; however, some, for example, tourism and mushroom picking, do have markets that function well. ICT has had important implications for all these services. Some of these are related to the fact that ICT has changed the way societies view or value forests. This societal perspective will become clearer when we discuss the environmental issues related to forests.

Forest-related services are a vast topic, and not all can be covered here. The analysis is restricted to topics relating to environmental issues, recreation and tourism, and virtual forests; these serve to illustrate the many-sided impacts that ICT has already had on forest issues.

2.6.1 Environmental issues and ICT

The electronic media helps to make us aware of the forest-related environmental issues taking place on the other side of the world. Thus, people in Europe can be alerted, for instance, to a campaign currently being run by Greenpeace to save rain forests on the other side of the globe, for example, in Pará State in the Amazon region of Brazil. According to Greenpeace, Pará has lost an area of rainforest the size of Austria, the Netherlands, Portugal, and Switzerland combined. We can learn of this campaign through the Internet and the Greenpeace Web page (http://www.greenpeace.org). The campaign immediately brings to mind pictures of clear-cut rainforest in Amazon, logging machines, and environmental activists chaining themselves to trees. We may never have had first-hand experience of these activities, but we will have seen such images many times before—on television. Television puts the issue into words and pictures and thus makes it more concrete. Irrespective of whether the facts and views provided by the media are objective, they catch our attention.

This story serves to illustrate how ICT has been an essential driving force in putting across the message of the environmental movement and in internationalizing forest-related environmental issues. It seems appropriate to assume that, with the help of electronic media and the Internet, issues such as the spotted owl conflict in the U.S. Pacific Northwest in the 1980s and 1990s or the rainforest deforestation issue in the Amazon region, did manage to gain much wider attention than would have been possible through conventional print media. This trend has also had implications for forest industry operations, as the following example will show.

In September 1997 the third-largest paper company in the world, UPM, based in Finland, announced an alliance with the Indonesian pulp manufacturer APRIL, the aim being to integrate the fine-paper operations of the two companies in Asia. UPM’s involvement with APRIL drew immediate fire from environmental groups because of the Indonesian company's logging of old-growth forests and questions of workers’ rights. Environmental groups mobilized international action against the plan in the media and on the Internet. This pressure from environmental groups was influential to the extent that in September 1999, UPM announced its withdrawal from a proposed broad international alliance with APRIL. In today’s world, where rapid communication and the linking of different pressure groups around the world is possible (e.g., through the Internet and e-mail), forest industry companies have to take much greater account of the potential effects of their operations.

To summarize, environmental groups have actively utilized the opportunities provided by the electronic media and the Internet to promote their issues. Their campaign strategy is to gain large media coverage to attract public attention to their issues—and also to collect financial resources. For example, Greenpeace is advertising the chance to become a Greenpeace cyberactivist member, receive occasional emergency campaign alerts, participate in online discussions, and even maintain a personal home page (http://www.greenpeace.org/; last accessed December 2004).

Environmental groups are, of course, not the only interest groups to have used ICT to promote their own forest-related issues. Similar strategies are utilized, for example, by the forest industry, but perhaps with less success. The side-effects of this may be that the media tend to play a central role in exacerbating forest-related environmental issues (Nie, 2003). Drama, conflict, and polarization are often prerequisites for getting the message across through the media. According to Nie (2003), interest groups frame an issue in the most polarizing way possible to get media attention, or the media take an environmental issue and polarize it as much as possible to “infotain” their customers.

In the present context, it is significant that the tool enabling all this is ICT. Today, people can react immediately to forest issues raised on the other side of the world. Consequently, the operations of forest industry companies and forestry practices regarding environmental issues have both tended to become more similar in different continents. In principle, in today's Information Society the same rules have to be followed wherever the companies operate.

2.6.2 Recreation and tourism

ICT, as this study shows, has changed the societies in which we live and our everyday lives in many ways. Recreation and nature tourism cannot escape these changes. Technology has always had important implications for recreation and tourism—as in the role of the automobile. In the twentieth century, allowing cars into nature parks directly led to increased public support for parks, a boom in outdoor recreation, and the creation of additional parks (Shultis, 2001). Of course, there have been downsides to this development, such as increased congestion, environmental impacts, and commercialization of the parks. What have been the major impacts of ICT on forest-related recreation and tourism?

Forest tourism has started to play an increasingly important role in the rural areas of many countries, and in some cases it may even be the main economic activity. This type of tourism can be either mass tourism, for example, to a well-known national park, or it can be mainly orientated toward individual needs, for example, renting a cabin in a remote area. The providers of these services vary from individuals or family-based firms to large multinational companies. All have found ICT of benefit to their business and services. Small recreation providers can particularly benefit from ICT. Their problem used to be limited resources in comparison with those of mass or industrial tourism providers. Small companies were then traditionally unable to pay for advertising, making it difficult to supply information to customers (particularly those in other countries) about the availability of recreation. Using the Internet and e-mail has turned out to be an effective tool, and communities have also found it beneficial to attract tourists via the Internet. A typical example is the *New Forest Tourism Guide* (http://www.new-forest-tourism.com/), the Internet site that provides information on the attractions of forests in the county of Hampshire in southern England. The menus on the Web page allow viewers to navigate around the tourist sites related to forests in that area.

The increasing number of people using the Internet and computers has also affected the services that organizations involved in forest-related recreation and tourism provide. National parks, for example, use Internet pages to advertise and to inform visitors about various issues related to the parks (see, for example, http://www.nps.gov/; http://www.outdoors.fi). They also use ICT, for example, to monitor visitor activity. Melville and Ruohonen (2004) describe how a system based on GSM communications is used for visitor counting on one of the 170 national nature reserves in England. A prime requirement of the system was that it should involve a minimal amount of field staff time to harvest the data. In general, ICT increasingly provides the necessary tools for the efficient planning and management of natural parks. *Table 2.1* illustrates some of the ICT-based impacts on national park managers (Shultis, 2001).

While most recreation seekers use technology to visit the backcountry, an increasing number visit the backcountry to use their technology (Shultis, 2001). For example, a mobile phone, handheld computer, or computer clock with, for example, GPS, compass, altitude and weather monitor, and heart rate monitor, may motivate people to visit areas where such equipment can be used to its full advantage. One often-expressed negative example, with no direct ICT content, is the off-road use of four-wheel-drive jeeps (SUVs) to visit remote locations not reachable with conventional cars. Another side-effect of ICT in this context is the tendency of some people to rely too heavily on the technology rather than their own personal resources, with expensive repercussions if the technology fails and, for example, search parties having to be sent out.

Table 2.1. Categories of ICT impacts on park management.

Category	Examples	Impacts	Major implications/issues
Communication	Radio, cellular, and digital phones, GIS, GPS, datalink watches, handheld computers	More rapid linkages to other groups; expectation that trips to remote backcountry can stay "connected" to outside world	Increased safety and planning capability; expectations that information and ability to "connect in" will be available (e.g., park radio frequencies, avalanche warnings at the site); more demand for search and rescue
Information	TV, Internet, videos	Increased awareness, use, and appreciation; more informed public; increased options and opportunities	Primarily external-driven messages: managers will be forced to respond to images portrayed by commercial interests and provide their own
Tools for planning and management	Visitor and wildlife monitoring	Better information on visitors and wildlife	More efficient and less-costly management

Adapted and modified from Shultis (2001).

2.6.3 Virtual forests

"Let your screen take you away to a quiet place in the forest. Watch the little peaceful bugs and ants running about their business. A funny little spider making a web. Dew drops on the leaves. Birds twittering somewhere in the branches above… This screensaver will immerse you into the peaceful environment of the forest life that will make you forget about all your problems! Allow yourself to experience the sense of calm serenity that comes from disconnecting from the feeling that you have to "do" something." This quotation is from the advertisement of the three-dimensional computer screensaver "*Forest Life 3D*" (http://www.astrogemini.com/forest.html). The example illustrates the fact that ICT can be used to generate "forest-like" virtual experiences.

According to Levi and Kocher (1999), in the future, virtual reality technology will allow people to experience nature in a simulated environment—virtual nature. The authors have in mind computer-generated virtual environments, where people can also simulate activities. However, this is already happening today (e.g., with three-dimensional and interactive video games). Searching Google with the words "virtual forest" results in a large number of Internet pages detailing where virtual forests can be experienced in various parts of the world. Moreover, nature films have already been with us for decades, providing visual virtual journeys to forests all over the world, without the viewer ever needing to leave the couch. What have been the implications of such virtual possibilities for forests, if any?

Levi and Kocher (1999) study how the increased use of information technology affects people's relationship with the natural environment. Among the issues studied are:

- What effect will the use of virtual nature have on people and their relationship with nature? Will it cause people to devalue *real* nature?
- What effect will the use of this technology have on natural environments and the way we treat them?

Before discussing their findings, it is helpful to outline why these questions may be relevant and important.

There is apparently a concern that modern information technology could cause people to lose interest in real nature. The argument typically goes that nature films, commercials, and photographs (e.g., on the Internet or in nature calendars) present images of exceptional or monumental landscapes, such as giant redwoods and colorful rain forests with exotic fauna, often in a spectacular light setting. Such exposure to very beautiful natural environments is believed to cause people to devalue nonspectacular natural environments (Knighton, 1993; McKibben, 1996). The “more normal” woodlots may appear bland and uninteresting in comparison, and people may not enjoy them or care what happens to them because they fail to live up to their expectations. Why should one visit natural environments that are less beautiful than the simulated ones you can experience at home—without the mosquitoes? Knighton (1993) describes this effect as “nature pornography.” Moreover, television commercials, for example, may influence the way people utilize forests. Instead of forests being a place for hiking and nature, they become just one more place to enjoy a Coke. According to McKibben (1996), the expanded use of information technology of all kinds exacerbates these phenomena.

Virtual nature could also be beneficial for forests. For example, it may raise people’s awareness of endangered species and programs to save forests, as with environmental groups’ utilization of ICT. Virtual nature could also be used to solve problems regarding habitat preservation programs, such as how to allow people to experience environmental preserves without damaging their resources. For example, it could allow people to stay in cities rather than travel to the countryside, cutting down on traffic and air pollution and preserving the natural environment. For some people virtual forests could be an environmentally friendly substitute for visits to real forests. Moreover, as Lee *et al.* (2003) note, for older adults experiencing gradual physical decline and other age-related problems, visits to a virtual forest may maintain connectivity to “nature” and promote psychological well-being.

From a survey conducted among students at Cal Poly, California, Levi and Kocher (1999) found that enjoyment of the electronic media’s depiction of nature correlates positively with support for the preservation and maintenance of national parks and forests but negatively with the preservation and acquisition of local natural areas. They found that this devaluing effect would be likely to increase as new, virtual-reality technologies become commercially available. Overall, the results suggest that there are some dangers in the increasing use of information technology to simulate environments. The authors stress, however, that their study has a number of limitations; their findings should be interpreted as indicating a possibility of “ordinary” nature being devalued rather than providing strong empirical evidence of it.

To summarize, it appears that ICT has already influenced how some people view forests. To a degree, it resembles the issue of choosing between a plastic or real Christmas tree—something that has already impacted the Christmas tree market and people’s purchasing habits. It seems safe to assume that, with the development of ICT, the impacts of virtual forests will become ever more important.

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Chapter 3. Surprising Futures

Trina Innes, Carol Green, and Alan Thomson

3.1 Introduction

This chapter presents a cautionary tale about our ability to predict the future impacts of ICT on the forest sector. In succeeding chapters, the authors use their experience and research to forecast how information technology may change the future of forestry. Our chapter puts those visions into perspective. We ask: how can the past help us understand what to expect from future innovations?

Innovation is different from invention. Invention is the creation of a new idea, product, or concept (Cook and Mayes, 1996). Innovation implies a change in what was being done before. It is taking an idea, product, or process, and adapting it to fit either a new situation or one that is perceived as new by the adopter. Adaptation may involve the transfer of technology from one domain to another or the evolution of an idea.

The Centre for Innovation Studies (2004) identifies three types of innovations:

- *Incremental Innovations* are described as small improvements. They represent continuous improvements and can often be predicted with confidence. They generally cause little disruption to existing activities and generally build on existing products or ideas (e.g., Moore's Law).
- *Radical Innovations* represent new technologies or ideas that completely displace existing approaches or require extensive changes in business practices. These changes are discontinuous and disrupt the traditional way of doing things.
- *General Purpose Technologies* are huge innovations that cause foundational and far-reaching changes in the world. The waterwheel, steam power, electricity, internal combustion engine, railways, and the Internet are among the most prominent general purpose innovations. They share four characteristics:

  –Wide scope for improvement and elaboration;
  –Wide range of uses;
  –Potential for use in a wide range of products and processes; and
  –Strong complementarity with other technologies.

Josty (2001) suggests that no one can predict radical innovations but that it is possible to predict incremental innovations. In 1965 George Moore of Intel predicted that the number of transistors on a silicon chip would double every 18 to 24 months (Statistics Canada, 2004). This prediction has held true because it is based on a single technology—photolithography. When the nature of the technology changes, the algorithm or methods used for forecasting may no longer be valid.

The computer industry is full of casual predictions that underestimated the impact of computing technology. In 1943 Thomas J Watson, the chairman of IBM, is said to have predicted a world market of five computers (Wikipedia, 2004). Today, computers are atop the desk of almost every business in the world and becoming a common fixture in many homes.

Forecasting the future is risky (see *Box 3.1*), but even predictions that fail to come true can help steer us away from negative consequences. Innovations do not always produce their intended effect. Some innovations develop faster than expected; others produce unintended results. We may not know enough to anticipate the impacts of innovation or the cumulative effect that many small changes may cause. Results can be far removed from the initial innovation and are often hard to track. In this and other ways, it is fair to assume that technology is shaping our future (Gaines, 1991).

Seddon (1989) suggests:

> The preoccupation with the present which arises because history is neglected means that the relationship between past, present and future is taken-for-granted. The links between past, present and future remain unexplored and the processes by which change occurs over time are insufficiently analysed.

In the past some suggested that drilling into the ground for oil was crazy, that movies didn't need sound, and that everything had already been invented. After examining hundreds of technology forecasts, Schnaars (1989) found that most people exhibit a myopia that causes them to focus on the future in terms of present conditions. The results often make fools of the forecasters (see *Box 3.1*) (Schnaars, 1989).

Box 3.1. Forecasting the future is risky

"Drill for oil? You mean drill into the ground to try and find oil? You're crazy."
--Drillers whom Edwin L. Drake tried to enlist to his project to drill for oil in 1859.

"This 'telephone' has too many shortcomings to be seriously considered as a means of communication. The device is inherently of no value to us."
--Western Union internal memo, 1876.

"Everything that can be invented has been invented."
--Commissioner, U.S. Office of Patents, 1899.

"Who the hell wants to hear actors talk?"
--Warner Brothers, 1927.

"But what ... is it good for?"
--Engineer at the Advanced Computing Systems Division of IBM, 1968, commenting on the microchip.

"There is no reason anyone would want a computer in their home."
--President, Chairman and Founder of Digital Equipment Corp., 1977

In evaluating predictions such as those in *Box 3.1*, it must be borne in mind that some statements may be made in an attempt to maintain competitive advantage or for tactical policy purposes. For example, a mainframe computer maker in the 1970s could have had tactical reasons to downplay the role of desktop computers. On the other hand, developers of new technology tend to overestimate the impacts, as illustrated by some early projections for remote sensing and artificial intelligence.

In spite of the failures illustrated in *Box 3.1*, there have been notable successes in ICT forecasting, such as the "infostructure" proposed by Bush (1945), which might be seen as a precursor to hypertext, the Internet, and the World Wide Web. Subsequent predictions by Greenberger (1964), who paid tribute to "the remarkable clarity of Dr. Bush's vision," were equally perceptive. Similarly, Kahn and Wiener (1967) presented their list of "One Hundred Technical Innovations Very Likely in the Last Third of the Twentieth Century." Panelists judged that 80% of the forecasts relating to computers and communications had occurred by the end of the century (Albright, 2002). Only 18% of the innovations forecast for aerospace were judged to have occurred. Ranked by a selection of panelists, the ten best forecasts as recorded by Albright (2002) are:

1. Inexpensive high-capacity, worldwide, regional, and local (home and business) communication (perhaps using satellites, lasers, and light pipes);
2. Pervasive business use of computers;

3. Direct broadcasts from satellites to home receivers;
4. Multiple applications for lasers and masers for sensing, measuring, communication, cutting, welding, power transmission, illumination, and destructive (defensive) use;
5. Extensive use of high-altitude cameras for mapping, prospecting, census, and geological investigations;
6. Extensive and intensive centralization (or automatic interconnection) of current and past personal and business information in high-speed data processors;
7. Other widespread use of computers for intellectual and professional assistance (translation, traffic control, literature search, design, and analysis);
8. Personal "pagers" (perhaps even two-way pocket phones);
9. Simple inexpensive home video recording and playing; and
10. Practical home and business use of "wired" video communication for both telephone and television (possibly including retrieval of taped material from libraries) and rapid transmission and reception of facsimiles.

Predictions are possible when there are trends in underlying technology. Albright (2002) suggests that semiconductors, computing, storage, and optics will continue to grow into the future. Forecasts based on these technologies will likely yield more predictable innovations.

We have chosen to use Rogers' innovation diffusion theory as a framework for our discussion. Rogers (1995) suggests that an innovation is "an idea, practice or objective that is perceived as new to an individual or another unit of adoption." Innovations in the forest industry can be classified as a product, a process, or a business system innovation (Hovgaard and Hansen, 2004). Process includes technologies; business systems include new ideas.

Following a brief introduction to diffusion theory, we present three case studies. Each case study examines the situation leading up to the innovation, how the innovation was adopted, and both the predictable consequences and unintended impacts of the innovation. We focus on the chainsaw (product), Internet (process), and sustainable development (idea).

3.2 Innovation

3.2.1 Innovation diffusion theory

The innovation diffusion theory is well suited to forestry studies. In his classic text on diffusion of innovations, Rogers (1995) indicates that many of the key studies in innovation use agricultural examples. The adoption of innovations in forestry is attributed to the highly successful role of the agricultural extension services in the United States. In recent years, innovation diffusion theory was applied to several areas of forestry—forest fire prevention (Hodgson, 2000), pulp export (Dalcomuni, 1998), participatory forestry extension (Kessy and Mtumbi, 1996), and wood product use (Fell *et al.*, 1997). In environmental settings, innovation diffusion theory was also applied to environmental policy (Kern *et al.*, 2001).

Rogers (1995) defines diffusion as "the process by which an innovation is communicated through certain channels over time among members of a social system." He identifies four key elements affecting diffusion of an innovation: the innovation itself, communication channels, time, and a social system. Rogers applies the term "diffusion" to both the planned and unplanned (surprising) spread of innovations, primarily with respect to new technology. Reinvention (modification of intended use) often occurs during the process of adoption and implementation and plays a significant role in some of the case studies.

People interact with five principal attributes of innovation.

- *Advantage* is often financial, although social prestige, convenience, and satisfaction may also be of benefit. Advantage is the degree to which an innovation is perceived as better or worse than the existing way of doing things. Most important is that individuals perceive the innovation as advantageous. In many case studies, surprises are related to changes in the perception of relative advantage.
- *Compatibility* is the degree to which the innovation is attuned to the values, experiences, and needs of potential adopters, and surprises can also occur in relation to compatibility.
- *Complexity* is the extent to which the innovation is perceived as difficult to understand or use.
- *Trialability* measures the ease with which people can try out the innovation. One that can be tried on an "installment plan" (adopted in parts) is more likely to be adopted. This may reflect an individual's attitude toward risk.
- *Observability* is the degree to which others can examine the innovation in use, and the results of its use.

People exist within social systems and fall into five main categories of innovativeness (Rogers, 1995). True innovators or pioneers comprise less than 3% of the population. The rest of the population is made up of 13% early adopters, 34% early majority, 34% late majority, and the remaining 16% laggards. The adoption of innovations, therefore, follows a characteristic bell-shaped (cumulative S-shaped) curve over time and approaches normality.

When innovations are introduced, people are often uncertain of their value. Given this level of uncertainty, it is only pioneers who are willing to take the chance to master something new. This is also the period during which the technology may show poorer performance than anticipated and when problems facing the technology are being improved.

As the pioneers gain insight and share their experience, early adopters realize that the innovation is within their reach. During this period, technology advances as people "learn by doing" and share their feedback with others. The early majority are quick to realize that many others are receiving benefits from the innovation. As the innovation becomes more commonplace, the late majority adopt the technology, leaving the laggards who may never adopt the innovation for personal, financial, or philosophical reasons. Eventually, technology may change or be usurped by new innovations, causing the cycle to begin again.

An innovation can be desirable for one potential adopter and not for another. The rate of adoption of a new idea is affected by the old idea it replaces; thus, a highly compatible initial innovation can pave the way for less-compatible innovations, and negative experience with one innovation can impede the adoption of others. Preventive innovations diffuse particularly slowly, as relative advantage may be far in the future and difficult to perceive (Rogers, 1995).

Kondratieff (1935) studied nineteenth-century economic, social, and cultural aspects of our life, which, he believed, could be used to predict future economic developments. He observed world economic expansions and contractions and predicted that a cycle of economic depression, recovery, growth, and maturity would be about 54 years in length. This is known as the Kondratieff Cycle.

Kondratieff detailed the number of years that the economy expanded and contracted during each part of the half-century-long cycle. He outlined which industries suffer the most during the downwave and how technology plays a role in leading out of the contraction into the next upwave. Often, upwave movements tied into the clustering of new technologies.

The concept of the "technology cluster" is an important one for evaluating surprises in innovation adoption. The diffusion of innovative technology clusters plays a major role in moving economies out of depression (The Centre for Innovation Studies, 2004). *Table 3.1* provides an outline of major technological innovations and clustering since the 1700s.

Table 3.1. Innovations resulting from clustering of technologies.

Timing	Features	Transport/ communications	Energy systems	Key factors
First 1780s–1840s	Industrial revolution	Canals, roads	Water power	Cotton
Second 1840s–1890s	Steam power and railways	Railways (iron), telegraph	Steam power	Coal, iron
Third 1890s–1940s	Electricity and steel	Railway (steel) telephone	Electricity	Steel
Fourth 1940s–1990s	Mass production	Highways, radio and TV, airlines	Oil	Oil, plastics
Fifth 1990s	Microelectronics and computer networks	Digital networks	Gas/oil	Microelectronics

(Source: Freeman and Soete, 1997)

Many products require the confluence of a number of separate innovations for a breakthrough to occur. This is a major thread running through our case studies.

3.2.2 Forecasting advantage

While the later adopters can often observe the advantage conferred on early adopters of an innovation, the pioneers must perceive advantage by some form of forecasting. There are a variety of methods for forecasting the future impacts of a product, process, or idea. Some people use quantitative approaches for modeling the future. Others use qualitative methods that synthesize the experience and knowledge of experts, or even personal intuition.

Many people believe that models are reliable predictors of the future, much like the laws of physics. However, human behavior and technology adoption are both influenced by many factors, leading to unpredictable outcomes. These factors generate erroneous forecasts. Regardless, forecasts can provide insights into how things might unfold, which helps us to better manage the future (Koomey, 2000).

Other methods of forecasting include S-curve analysis, which provides a logical predictor akin to the diffusion theory. Analogies and metaphors are generated based on historical developments. Timelines supported by assumptions can estimate how things will develop in the future. Often, it is the assumptions that prove to be flawed. “Future stories” or backcasting is especially relevant to our case-history approach: one imagines oneself in a future situation—a possible, probable, or desirable future. Using this as a starting point, a “history of the future” leading up to this situation is then written. This can be done systematically, step-by-step, or intuitively. Our case studies offer a variation of the backcasting approach.

Evaluation of the history of adoption in the case studies illustrates that the nature of the adopted product, practice, or idea changes with time. Later adopters may be responding to very different conditions than early adopters. It is a combination of these conditions and other events that results in surprising outcomes.

One way to ensure greater forecasting accuracy is to use more than one forecasting method. Schwartz (1996) and Koomey (2000) recommend using a set of forecasts or scenarios for exploring the future. Koomey clearly notes that the choices of today affect tomorrow. The work we do today to forecast future forest conditions can help us make decisions that will reflect on better forest management in the future—and result in technologies to support this management.

3.2.3 Abandonment

The rate of abandonment of an innovation can be as important as the rate of adoption in determining the level of use. Discontinuance often relates to a “surprise” related to perceived advantage or compatibility. This is best illustrated by a brief example—use and abandonment of DDT (Dichloro-diphenyl-trichloroethane).

DDT was first synthesized in 1874. Researchers could not forecast the impact or predict the use of DDT. Its effectiveness as an insecticide was discovered only in 1939. Widespread adoption of DDT occurred because it presented adopters with high relative advantage—reasonable cost, effectiveness, persistence, and versatility—at a time when the world was at war and insect-borne disease was prevalent. Following the war, many agricultural and forestry applications for DDT were developed.

The relative advantage of persistence became the relative disadvantage of adoption. The chemical accumulated and concentrated and passed up the food chain. Recognition of the magnification in the food chain resulting in high toxicity to nontarget organisms culminated in the 1962 publication of Rachel Carson's book, *Silent Spring* (Carson, 1962). DDT's compatibility with environmental values decreased. Moreover, the second surprising result was that target organisms developed resistance to the pesticide, resulting in decreased control. This negatively affected the relative advantage.

As a consequence of these two surprising outcomes, DDT use was abandoned in much of the world. DDT is still used in some countries to control disease, in particular to target malaria-carrying mosquitoes, and resumption of use of DDT is currently being explored. This resumed interest in turn is a "surprising future" for DDT. It is due to the rapid resurgence of malaria, especially in sub-Saharan Africa, as well as to changed modes of use that give better relative advantage. DDT is used only within households where a very low dose can repel mosquitoes; widespread application for mosquito control is not carried out, avoiding environmental contamination. (Raloff, 2000; Greenwood and Mutabingwa, 2002).

3.2.4 Drivers and outcomes of innovation

The supply-push/demand-pull model, in which innovation is driven by a balance between customer demand ("demand pull") and desire to market in-house developments ("supply push"), is commonly used as the basis of studies on drivers of innovation. Ruttan (2002) discusses other theories such as induced innovation, evolutionary theory, and path dependence. Different forces (push-predominating or pull-predominating) can operate at different stages of the diffusion process, and political, technological, economic, and social restraining factors can also be significant (Tan and Teo, 1999).

Outcomes of innovation can include increased efficiency, higher productivity, reduced costs, increased profits, and reduced employment. Selection among possible innovations can involve trade-offs of capital and labor costs and lies in economic theories such as Schumpeter's theory of innovation (Ruttan, 2002). Schumpeter argued that innovation leads to a state of "creative destruction," where innovations cause old products, skills, and processes to become obsolete, destroying established enterprises and creating new ones.

3.3 Case Studies

3.3.1 Product case study—Chainsaw

3.3.1.1 Historical Background

Chainsaws were a radical invention. They replaced the traditional way of working in the woods. For most of human existence, animal and human power and hand tools were used to perform work in the forest. To move logs, European foresters used many of the same methods as ancient Greeks, including levers, ropes, gravity, water, the wheel and axle, the pulley, the inclined plane or wedge, and animals (Silversides, 1997). Loggers later cut and moved logs using axes, saws, and pike poles.

Cutting down trees is termed "felling" by woodsmen. The first method of felling was the axe. The crosscut saw, needing two men to operate, was introduced in the second part of the nineteenth century. The demand for timber increased in the early nineteenth century in Great Britain to meet naval requirements and the need for square timbers (Stanton, 1976), and with the development of the pulp and paper industry around the world. After modern steelmaking techniques were developed in the 1830s, the use of saws became more widespread. During the first decades of the twentieth century, a one-man crosscut saw was created. With the development of a debarking tool, the axe was supplanted by saws and was soon used only for removing branches from trees.

Early forest workers often supplied their own tools, each of varying design and quality. They chose how to work, what kinds of tools to use, and the time of day they worked. The work hours were long and the labor hard, with forest workers often being paid piecework wages. The stage was set for the innovation of a product that would reduce the intensity of labor and increase wages.

Steam, electric, and internal combustion engines were all adapted for use with tools that made woodcutting easier and more efficient. Many of these efforts were focused on early mill operations. Rosenburg *et al.*, (1990) quote Scherer (1982) who "found that the forest products industry was heavily dependent upon outside sources of technological change." The chainsaw is one of the earliest examples.

The chainsaw has its origins in the field of orthopedics. Seufert (1980) reports that the German, Bernard Heine, a master of prosthetics, created the osteotome in 1830. The osteotome made it easy to cut through bone while avoiding the jarring impacts of the hammer and chisel and thus splinters. The osteotome was the precursor of today's chainsaw. While manufacturers claim to have invented the first chainsaw in the 1920s, the 1830 osteotome predates the invention by almost a hundred years.

An early chainsaw created by California inventor R. L. Muir required a crane for operation, limiting its commercial success. In 1861 the Hamilton saw was created; it was hand-cranked by one or two men and looked like a spinning wheel. In the 1880s the Americans produced a riding saw; it looked like a rowing machine that cutters could sit on. None of these products was commercially successful.

3.3.1.2 Adoption of the Product

The world experienced a time lag of one century between the "idea" of a power saw and its successful innovation. This was partly because of the lack of technology development. World War I and World War II created clustering of various technologies, making new innovations possible. Light metal technology made it possible to use aluminum and magnesium. War researchers also created the light, gasoline-powered, air-cooled engine. Separately, these two technologies provided the foundational requirements for the modern chainsaw.

Andreas Stihl, a German mechanical engineer, patented the "Cutoff Chain Saw for Electric Power" in 1926. He is credited with the invention of the modern chainsaw; he patented the first gasoline-powered chainsaw in 1929, calling it the tree-felling machine.

Chainsaws evolved from two-man units to lighter-weight, one-man units. Diecast aluminum and magnesium components reduced saw weight. More powerful direct-drive engines speeded cutting using a new "chipper" type chain that is still in use today. This illustrates that significant innovations can occur in different aspects of the same device or process.

According to Hjelm (1991), the introduction of the chainsaw can be examined from two perspectives—how the innovation changed the process of logging and its associated labor and how the workers themselves adjusted to the technical change. He examines the adoption of chainsaws in Sweden, where it was not the industry that demanded the chainsaw, but forest workers.

Workers adopting the chainsaw obtained a relative advantage over other workers. Chainsaws offered opportunities to reduce the intensity of work in the forest and to increase financial returns. In the early years, social status was tied to owning a chainsaw, although early chainsaws were heavy, cumbersome, and unreliable, decreasing their compatibility with the existing forest practices. As the technology developed, chainsaws became lighter and easier to use and maintain. They became more affordable and gained broader acceptance by workers who could observe them in action.

The rate and level of diffusion of chainsaw technology was influenced largely by the evolution of the technology itself. Hjelm (1991) researched the reason why forest workers in Sweden adopted the chainsaw, an innovation that was available only at a cost twenty times that of a one-man crosscut saw. In interviews with elderly forest workers, he learned:

- Early two-man chainsaws were heavy, clumsy, and not very reliable. Forest companies owned the early machines and demonstrated their use to workers. Few were satisfied with the performance of early chainsaws and continued to prefer the one-man crosscut saw.
- Early buyers were pioneers, having rarely seen a chainsaw prior to their purchase. Pioneers were attracted by the fact it would replace muscle power; they helped increase awareness of the chainsaw and the negative aspects that reduced its rate of adoption. The technology brought issues that weighed on the worker. Would the chainsaw start in the morning? Would they be able to maintain it? Information was shared by word of mouth and the decision was an individual one.
- In the 1950s, the reputation of chainsaws improved. People were more pleased with the technology; this, in combination with persuasive advertising, made more workers think of buying one. They purchased the chainsaw because they hoped to decrease their physical work and increase their wages.

Not surprisingly, as chainsaws became lighter and easier to use, the level of adoption increased. In Australia, chainsaws increased the productivity of fellers, changed the structure of logging work, and introduced new hazards. The 1940s and 1950s saw their greatest growth. Chainsaws have undergone improvements in design and weight reduction. The chainsaw is now an indispensable tool in the logging industry and a common domestic tool (Crowe, 1983). That said, the larger harvesting machines introduced in the 1970s and 1980s have replaced many forestry workers; the chainsaw is now limited to environments that are too hazardous or too difficult for harvesting machinery.

3.3.1.3 Predictable Consequences and Unintended Results

One of the major principles in defining innovation is making changes to maintain or improve competitiveness (North and Smallbone, 2000). Chainsaws were a product innovation developed to improve the competitiveness of individual loggers. Developed for the forest industry, the chainsaw has been adopted by the agricultural and construction industries, as well as by individual users.

Futurists often predict the future by extrapolating from the technology of the present. In the 1800s, anyone predicting the future would have thought in terms of machines being powered by steam. There were no gasoline engines then. What was surprising in the 1800s would not be surprising in the 1900s. Gasoline-powered chainsaws were not a surprise after the creation of the gasoline engine. Many leaps in innovation occur as different technologies merge. In 1830 the concept for a chainsaw was proposed, but it was a hundred years before technology permitted the concept to be realized, and it was years later that chainsaws were commonly used.

The diffusion of innovations can experience a lag until the technology catches up with the improvements that made an innovation useful. When the technology is widely adopted, there can be other consequences. One of the surprises of chainsaws was the deforestation of the Amazon. Without the chainsaw and the associated large-scale deforestation of the Amazon, would the world have experienced the sustainable development movement?

The adoption of chainsaws also saw unintended consequences. There were increases in unintended injuries and in the severity of forest worker injuries (Crowe, 1983). Full-time users of chainsaws were subjected to the hazards of noise and vibration, causing loss of hearing and "vibration-induced white finger" or numbness. The loss of sensation in fingers and palms of forest workers was especially prevalent in colder areas of operation (Crowe, 1983). Carrying chainsaws over long periods created back problems, and the gasoline-powered tool also increased the risk of forest fire.

Evolution in the forest industry has seen human and animal energy replaced by the machine. Like the chainsaw, which was largely replaced by large harvesting equipment, the horse was replaced by the tractor, and the river was replaced by the truck. All these innovations have increase the efficiency of forest operations but have had unintended consequences, including increased soil compaction, reduced number of forest workers, and increased road traffic.

3.3.2 Process case study—The Internet

3.3.2.1 Historical Background

While computers were developed in the 1960s, it was the clustering of innovations in the 1990s that led to the rapid evolution and adoption of information and communication technology. Here we refer to ICT comprising all forms of technology used to create, store, share, and use information.

ICT innovations brought to fruition many of the predictions of early computing pioneers such as Bush and Greenberger. Key to this evolution was a clustering of electronics, software, and browsers that resulted in a suite of innovations. As the number of computers used increased, the rate of adoption of ICT increased exponentially. Nowhere is this growth more obvious than the Internet.

The Internet is a general purpose innovation and belongs to both product and process innovation categories (Prescott and Van Slyke, 1997). As a product, the Internet is an innovative tool for managing, sharing, and processing information. As a process, the Internet is a major driver of change in business. It has enabled broad changes in the way organizations market products, conduct sales, and reach clients and customers. The Internet is also a “nested innovation.”

The origins of the today’s Internet were in 1969, with the connection of two computers to form a network called ARPANET (Advanced Research Projects Agency Net). Like the computer, ARPANET had military origins and was a closed, secure system designed to protect national security in the United States during the Cold War. It broke information into small packages, making interception by others difficult and thus protecting the flow of information between military installations. Soon anyone with a computer capable of running TCP/IP (Transmission Control Protocol/Internet Protocol)— software available in the public domain—could connect to the Internet. The military thus abandoned ARPANET in 1983, and it ceased to exist in 1990—a victim of its own success.

The Internet is one of the most radical innovations ever created. It differs from previous innovations in that it offers a common platform upon which numerous incremental innovations can be built. Electronic mail (e-mail) was created in 1971 to send messages across the network. In 1972 telnet permitted the remote control of a computer. File transfer protocol (FTP) was created in 1973 to allow bulk transfer of information from one computer to another (Bellis, 2003). Domain name servers (DNS) were introduced in 1984 to better manage the names and lists of Internet addresses as more and more people connected to the Internet.

Twenty-two years after the creation of the Internet, the World Wide Web was created in 1991, the same year the public was allowed access to the Internet. Web browsers provided a graphical, point-and-click interface. The Internet enabled the connection of remote computers, and the Web enabled users to connect to information. The Web worked because programs that link computers made it possible for people with no computer knowledge to connect to information.

3.3.2.2 Adoption of the Process

> The Internet's pace of adoption eclipses all other technologies that preceded it. Radio was in existence 38 years before 50 million people tuned in; TV took 13 years to reach that benchmark. Sixteen years after the first PC kit came out, 50 million people

were using one. Once it was opened to the general public, the Internet crossed that line in four years (Margherio *et al.,* 1998).

The diffusion of the Internet can be examined from varying perspectives and scales— individual, organizational, national, and global. Where we are in the adoption cycle depends on location [e.g., urban or rural (Greenstein and Prince, 2005)], the size of the group, and a specific Internet innovation. For example, e-mail laggards in North America can become early adopters on a global scale. In the early 1990s, people using dial-up access to the Internet were considered innovative. Newer, faster methods of connecting are now widely available. Instead of being a late adopter of dial-up connection, a person can become an early adopter of satellite connection.

During the early years, ARPANET was tightly controlled, with access limited to universities and government institutions and with few tools and products of interest (i.e., complexity was high, while relative advantage, compatibility, and trialability were low). Innovative users of the Internet were well-educated students and researchers who were willing and able to accept the risks associated with using a new technology. Early adopters of computers were young with above-average incomes (Lin, 1995). In the early years there was a gender bias, with males leading the adoption of the Internet (James and Wotring, 1995). The gender bias has virtually disappeared in countries experiencing a high diffusion of the technology.

In 1991 new software called Mosaic was developed, making the Internet easier to use through the Web. Two years later, Netscape and Internet Explorer were released. This release of browsers coincided with the 1993 lifting of ARPANET's research-oriented "acceptable use" policy—making the Internet available to the public. Increasing trialability (Bellis, 2003) and decreasing complexity, while providing users with numerous benefits (increased relative advantage—see *Box 3.2*), led to exponential growth (see http://www.isc.org/index.pl?/ops/ds/).

Box 3.2. Increased relative advantage

"The Internet has relative advantages along many dimensions. It provides written communication faster than postal mail, allows for purchases online without driving to the store, and dramatically increases the speed of information gathering. The Internet is also easy to try (perhaps on a friend's PC or at work), easy to observe, and compatible with many consumer needs (information gathering, fast communication); and its complexity has been decreasing consistently. All of these attributes have contributed toward increasing Americans' propensity to adopt" (Greenstein and Prince, 2005).

While most radical innovations experience slow acceptance, the growth of the Internet has been staggering. From four hosts based in the United States in 1969, the Internet has grown to almost 172 million hosts, based in almost every country of the world. The Worldwatch Institute (2003) indicates that the Internet attracted new users at double-digit rates in 2002. In 1992 only 1 in 778 people used the Internet; in 2002 that number had soared to 1 in 10. There was a 16.5% increase in host computers in 2002 (171.6 million) drawing more than 600 million people regularly online.

Early adopters of the Internet were concentrated in a few countries. By the mid-1990s, over 90% of Internet hosts were found in North America and Western Europe. Asia had only 3% of global Internet hosts (Lottor, 1995). Approximately 90% of nations now have Internet access. (Worldwatch Institute, 2003). Xiaoming and Kay (2004) state that "Internet penetration is related to a country's wealth, telecommunication infrastructure, urbanization and stability of the government, but is not related to the literacy level, political freedom and English proficiency." Gastle (2003) suggests that the pace of innovation is increasing in the knowledge-based economy. He also suggests that fear of being left behind is driving the adoption of technology in developing countries.

IT is a business tool. It is used to help organizations develop their business models and manage business activities (Vlosky, 1999). The decision to adopt IT and the Internet is influenced by internal and external factors. Internal factors include the attitude to and knowledge of the Internet possessed by the owner or manager, the availability of resources, and the attitude to and knowledge and acceptance of technology by employees. Externally, the decision to adopt the Internet is influenced by an organization's need or opportunities to interact with suppliers, customers, and competitors. Market pressures may demand that a company embrace the Internet or it will risk losing competitive advantage (e.g., become incompatible with suppliers or inaccessible to clients).

Tamplin *et. al* (2002) suggest that companies working in the field of telecommunications, electronics, and computers are the most innovative users of the Internet and associated tools. Sarosa and Zowghi (2003) suggest that smaller companies are slower to adopt information technology because incorrect decisions will more quickly impact their bottom line.

The adoption of the Internet and any information technology can be voluntary or nonvoluntary. Some organizations mandate the use of the Internet. Organizations provide training to reduce its complexity and increase the number of people trying the technology (Prescott and Van Slyke, 1997). By mandating its use, more users are able to realize its benefit, which may in turn influence their adoption of the technology outside the workplace.

Hansen (1996) documents that ICT offers foresters an advantage—one that increases their productivity and competitiveness and a company's bottom line. Foresters were quick to take advantage of the Internet using e-mail and sharing information through the World Wide Web. It was identified as an excellent way for foresters to communicate with the public. According to Burk (1995): "Computers are, and will remain, as much a part of forestry as tree-measurement devices."

3.3.2.3 Predictable Consequences and Unintended Results

Over 34 years ago, researchers knew their work on ARPANET was exciting, but they could never have predicted the proliferation of innovations arising from their activities (Bellis, 2003). ICT has brought new information and services, new forms of information delivery, improved efficiencies, worldwide linkages, and the transformation of personal and business practices. Originally developed for communicating research information, the Internet is now also a source of entertainment, news, and information. It has radically changed the way people think and operate.

The Internet is achieving its original goal—improving communication and access to information. It ensures that scientists have easier access to data, permits NGOs to respond to emergencies and launch farther-reaching campaigns, and makes it easer for people to share ideas and collaborate—all activities that benefit society (O'Meara, 2000). Scientists are using the Internet more than the telephone for remote communications (Schweig *et al.,* 2001). They are replacing visits to libraries by using search engines to find information. (Lawrence and Giles, 1999). Individuals make more purchases of investment products using the Internet than the telephone. "Breaking down the government walls" using Internet-based geographic information systems is increasing the public's access to information in the form of maps (Wilson, 1999).

The forest industries, like other businesses, now have to grapple with problems that arise because of differences between their technological capabilities and those of their clients. While the industry may be able to afford the technology and to use it, we still need to address the fact that clients may not have similar capabilities (Blank, 1995). In addition, Burk (1995) noted that "computer-connected foresters" can communicate with immediacy; with that speed comes a general expectation of immediate feedback from the public and an added stress for the forest worker.

There is some concern that the Internet is not equalizing the accessibility of information. Lawrence and Giles (1999) indicate that search engines are using popularity as a method for ranking the relevance of content. This could cause popular pages to become more popular and other pages to be more difficult to find using Web-based technology.

The Internet has caused radical changes to business models, forcing some organizations to change the way they market and sell to suppliers and customers and generally communicate with them. It has increased the ability of organizations to compete in a global market. With the rapid increase in the sharing of information has come an increase in the pace of new innovations. Surprisingly, this has often meant that competitive advantage is eroding faster—companies must run harder just to stand still (Gastle, 2003). Organizations are also facing new challenges when it comes to recruiting the talent needed to manage Internet-based solutions for their organization.

The Internet has resulted in information overload. Users are bombarded with too much information and unsolicited information. Handling this information overload has created a new workplace stress. Workers are increasingly expected to deliver an immediate response to e-mails and other requests for information. To address this problem, new innovations are being developed so that users can customize the information they receive.

Unfortunately, as O'Meara (2000) also indicates, technology allows those with less-honorable intentions to have access to information, putting them in a better position to exploit information and inhibiting our ability to manage our businesses or the environment. To combat uses that are detrimental to society, organizations have to implement security protocols and technologies to protect their privacy and restrict access to information.

3.3.3 Idea case study—Sustainable development

Innovative ideas that diffuse through a culture can be as important to cultural change as technical innovations. Whether ideas are the result of discoveries made by empirical research or solutions to social and political problems, they can have far-reaching effects. As an idea or concept, sustainable development represents a radical innovation when compared to earlier views of social, economic, and environmental management. Over the past 30 years, sustainable development has become a favorite integrating concept for policymakers and educators and in international agreements (Mebratu, 1998; Robinson, 2004). Spangenberg (2004) calls it a "new paradigm." However, as with technical innovations, conceptual ideas must be adopted to be effective and may be adapted and reinterpreted. As ideas diffuse within society, there is much debate over what they mean. The term "sustainable development" is often used interchangeably with "sustainability." Sometimes this is only a semantic difference, but some consider the two terms conceptually different (Robinson, 2004) .

The literature on sustainable development is enormous. A 1997 bibliography by Pezzoli (1997a and 1997b) lists 25 pages of references covering 10 different subject categories. In this discussion we trace the development and definition of the concept of sustainable development as it appears in the published documents of selected international conferences and summit meetings. We use these documents to illustrate how the idea of sustainable development diffused around the world. The language of these documents represents the expansion and adoption of the concept as an international idea, in spite of the many concerns regarding definition and scope that have appeared in the literature over time.

3.3.3.1 Historical Background

Sustainability relates to the physical limits of renewable resources such as forests. For example, a "maximum sustainable cut" is a harvest rate that does not exceed normal growth rates. Going beyond that maximum endangers the future of the resource (Dixon and Fallon, 1989). As early as 1664, John Evelyn's *Silva, or a Discourse on Forest Trees* raised concerns regarding forest practices and their effect on the future resource, thereby becoming "the first science that explicitly incorporated concerns about safeguarding natural resources for future generations" (Evelyn, 1776; Wiersum, 1995, p. 322). Later expressed in policies such as sustained yield and multiple use, this concern culminates in today's emphasis on biodiversity and ecosystem-based research in sustainable forest management.

The modern environmental movement dates to the late nineteenth century in the United States. As the movement grew, it progressed from the ideas of early conservationists and preservationists to more recent concerns such as the decline of tropical forests (Kimmins, 1993), climate change (Cohen *et al.*, 1998), and energy shortages (Hall, 2004).[1] In the 1960s and 1970s the environmental movement grew more widespread and active. During the same period, the concept of sustainability expanded from only a natural resource issue to one that incorporated economic issues and the relationship between development projects and the environment, hence “sustainable development” (O’Riordan, 1988; Wiersum, 1995; Hens and Nath, 2003). The first Earth Day occurred in 1970 in the United States (Nelson, 2004), and it does not seem to be a coincidence that one of the first important international environmental meetings was held in 1972: the Stockholm Conference on the Human Environment. While the expansion of the idea of sustainable development was influenced by many factors, it was pushed along by the developing “environmental revolution” (Kimmins, 1993, p. 285).

Literature relating to the concept of sustainable development regularly refers to the Brundtland Report as offering the first significant definition of the term. Commissioned by the United Nations in 1983, and chaired by Gro Harlem Brundtland of Norway, the World Commission on Environment and Development (WCED) was asked to “propose long-term environmental strategies for achieving sustainable development by the year 2000 and beyond.” The report defined sustainable development as meeting “the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987, p. 23). While being critiqued and/or amended extensively, this definition generally serves as a starting point for discussion (Wiersum, 1995; Mebratu, 1998; Elliott, 1999; Carvalho, 2001; Hens and Nath, 2003).

The Brundtland Report popularized the idea that economic development and environmental conservation are intertwined—that they must be considered together when implementing international projects and policies. Prior to this time, development and conservation were considered incompatible (Elliott, 1999, p. 22). Robinson (2004) calls this combining of ideas a “radical innovation,” but there were many critics, as will be discussed later. As a result of the Commission and its report, the concept that sustainable development included both environmental and economic issues was generally adopted by most international policymakers. Moffatt (1996, p. 15) asserts that after the Brundtland Report was published, governments, environmental organizations, and industry “would not view the environment as an externality to economic matters.” The concept became part of national and international policies, and it continued to show up over time in the language of international agreements regarding the environment.

The Stockholm Conference on the Human Environment (1972) and the World Conservation Strategy (1980) had previously discussed the influence of development on the environment, but they did not see the two issues as interdependent (IUCN, 1980; Thibodeau and Fields, 1984; Moffatt, 1996; Panjabi, 1997). The World Conservation Strategy recognized only “the need for global strategies both for development and for conservation of nature and natural resources” but concentrated primarily on conservation issues (IUCN, 1980). The Brundtland Report added the recognition that both developing and developed countries had work to do:

> A new development path was required, one that sustained human progress not in just a few places for a few years, but for the entire planet into the distant future. Thus “sustainable development” became a goal, not just for the “developing nations” but for industrial ones as well (WCED, 1987, p. 4).

The concept that sustainable development involved both economic development and environmental conservation and required attention by both developing and developed countries was soon promoted at the international level. The issue of social equity or justice was hinted at: “Our inability to promote the common interest in sustainable development is often a product of the relative neglect of economic and social justice within and amongst nations” (WCED, 1987, p. 49).

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[1] See the National Park Service historical survey for a more complete literature review at http://www.cr.nps.gov/history/hisnps/PSThinking/nps-oah.htm.

By 1992 at the United Nations Conference on Environment and Development (i.e., the Earth Summit) in Rio de Janeiro, the interconnection of economics and the environment as necessary to sustainable development was assumed. Social justice and equity issues were also being incorporated into the concept. “Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature” (UNCED, 1992; Principle 1, Rio Declaration) (Panjabi, 1997). Agenda 21, the document arising from this meeting, identified the close link between environmental and economic development and delineated action plans to solve some of the world’s problems (Moffatt, 1996).

The documents of two recent international summits, the World Summit on Sustainable Development (WSSD, 2002) and the World Summit on the Information Society (WSIS, 2003a and 2003b) illustrate a later evolution in the concept of sustainable development. The language of these summits assumes the interdependency of environmental issues, economic development, and social justice.

In 2002 UN Secretary-General Kofi Annan observed that the Earth Summit in Rio did not result in much progress toward sustainable development and that environmental degradation and poverty had only increased in the ten years since 1992 [WSSD, 2003 (Foreword)]. In his preface to the Johannesburg Declaration, Annan goes on to assert that during the Summit the “general understanding of sustainable development was broadened and strengthened, particularly the important linkages between economic and social development and the conservation of natural resources” (WSSD, 2003, p. 5). By this time, there was a clear assumption that sustainable development required attention to economics, to the environment, and also to social issues in order to be successful. It was also clear that sustainability was of concern to both developed and developing countries—often expressed as a need to both curb consumption and protect resources.

The WSIS (2003) documents regularly mention sustainability of information and communication technologies (ICT) without specifically defining what sustainability means in this context. They also suggest that environmental, economic, and social issues have benefited from the increasing use and expansion of ICT. The World Summit on the Information Society pledged to continue to expand the declarations made in earlier summits and made a “laundry list” of hopeful outcomes. All the strands that make up the current concept are mentioned here:

> Our challenge is to harness the potential of information and communication technology to promote the development goals of the Millennium Declaration, namely, the eradication of extreme poverty and hunger; achievement of universal primary education; promotion of gender equality and empowerment of women; reduction of child mortality; improvement of maternal health; to combat HIV/AIDS, malaria and other diseases; ensuring environmental sustainability; and developing global partnerships for development and the attainment of a more peaceful, just and prosperous world. We also reiterate our commitment to the achievement of sustainable development and agreed development goals as contained in the Johannesburg Declaration and Plan of Implementation and the Monterrey Consensus, and other outcomes of relevant United Nations Summits (WSIS, 2003a, p. 1).

3.3.3.2 Adoption of the Idea

International meetings over the past 30 years show a gradual acceptance of the concept of sustainable development as a means of improving economic, environmental, and social conditions in the world. Sustainable forest management is a key component of the concept (see *Table 3.2*). But how widely has this integrated definition of sustainable development been accepted? How well does its adoption fit with diffusion theory? As stated earlier in this chapter, the successful diffusion of an innovative idea is affected by its recognized advantage to potential adopters, by its compatibility with their values, by its complexity, and by its ability to be tried and observed.

Table 3.2. Sustainable development events and their forest-related components.

Year	Event	Impact/contribution	Forestry focus
1972	United Nations Conference on the Human Environment in Stockholm	Declared that economic development without regard for the environment was wasteful and unsustainable, but did not solidly integrate the two concepts (Moffatt, 1996; Panjabi, 1997).	*Declaration Principle #2*: "Natural ecosystems must be safeguarded for the benefit of present and future generations" (Panjabi, 1997, Appendix 1).
1980	World Conservation Strategy	Considered the first comprehensive policy statement on the link between conservation and development. Suggested that development can be used as one means of achieving conservation goals rather than as an obstruction (Elliott, 1999). In response, 40 countries developed national strategies toward the development of conservation priorities and actions (Moffatt, 1996).	The three objectives of the strategy include the maintenance of essential ecological processes and life-support systems, the preservation of genetic diversity, and the sustainable utilization of species and ecosystems (including forests). (http://www.sdinfo.gc.ca/historical_path/index_e.cfm?id=108; IUCN, 1980)
1983–1987	United Nations World Commission on Environment and Development, chaired by Gro Harlem Brundtland of Norway. Published *Our Common Future.*	Stressed the need to overcome poverty, to meet human basic needs, and to integrate the environment into economic decision making (Elliott, 1999). Popularized the concept and made it politically acceptable. Established a definition for sustainable development that has formed the basis for subsequent discussion.	*Species and Ecosystems: Resources for Development* (WCED, 1987, Chapter 3). Discusses the problem of species extinction and deforestation.
1992	United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro—the "Earth Summit."	Published the *Rio Declaration on Environment and Development*, a nonbinding set of principles that integrated environmental concerns with the development process and social issues. Included agreements on climate and forestry and biodiversity statements. Established *Agenda 21* as a set of actions to clean up the environment.	Non-Legally Binding Authoritative Statement of Principles for a Global Consensus on the Management, Conservation and Sustainable Development of All Types of Forests (Forest Principles; Agenda 21 Annex III, Chapter 11). Combating Deforestation. (UNCED, 1992)
1993–1995	Montreal Process	Developed a set of *Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests.* Emphasized that criteria are focused at the national level and will be evaluated according to the needs and conditions in a particular country. Subsequent initiatives have been or are in development for countries in Africa, Asia, South America, Central America, and the Near East.	Established tools for describing, monitoring, and evaluating progress in sustainable forest management (Montreal Process, 1995).

Table 3.2. continued.

Year	Event	Impact/contribution	Forestry focus
2000	United Nations Forum on Forests (UNFF[2])	Established under Agenda 21 as the main international forum for "the management, conservation and sustainable development of all types of forests and to strengthen long-term political commitment to this end."	Based on the *Rio Declaration*, the *Forest Principles* (Agenda 21, Chapter 11) and other international agreements and policies.
2002	United Nations Millennium Declaration	Affirmed earlier declarations on the need for sustainable development in concert with the preservation of living species and natural resources with an effort to change "current unsustainable patterns of production and consumption" (United Nations, 2000).	*Declaration #23:* "We resolve: To intensify our collective effort for the management, conservation and sustainable development of all types of forests" (United Nations, 2000).
2002	United Nations World Summit on Sustainable Development, (WSSD) held in Johannesburg	Reaffirmed the commitment to Agenda 21 as a program of action for sustainable development incorporating economic, social and environmental and political policies and programs. The concept had become the underlying basis for action.	*Declaration #45*: "Sustainable forest management of both natural and planted forests and for timber and non-timber products is essential to achieving sustainable development." Followed by nine action items (WSSD, 2003).

If their concluding reports are any evidence, international conferences and summits have found an advantage in the concept of sustainable development. From the Stockholm Conference of 1972, through to the Johannesburg Declaration of 2002 and the World Summit on the Information Society of 2003, the concept has served as a rallying principle. These summits urged better stewardship of the world's natural resources while also recognizing that economic development is vital to developing countries. But there has not been universal acceptance of an integrated view of sustainable development. The complexity of the concept limits its complete adoption.

Definitions of sustainable development are vague, variable, and frequently critiqued (O'Riordan, 1988; Dixon and Fallon, 1989; Shearman, 1990; Goodland, 1995; Wiersum, 1995; Moffatt, 1996; Mebratu, 1998; Carvalho, 2001; Robinson, 2004; Williams and Millington, 2004). The vagueness of the definitions is viewed as a defect by many authors who see use of the term as unproven and perhaps hypocritical or deceptive. A critique of the documents resulting from Johannesburg in 2002 shows that a number of authors believe sustainable development to have become a rhetorical buzzword without clear meaning and without any political will behind it (Urquidi, 2002; Hens and Nath, 2003; Pallemaerts, 2003).

Statements of agreement with the concept have been made for 30 years, but development projects still result in environmental degradation. Clark (1995) takes the view that economic development—which he equates with continuous growth—and conservation are mutually exclusive. Goodland (1995) feels that environmental sustainability "does not allow economic growth, much less sustainable economic growth," because the goal of development is human well-being, while the goal of environmental sustainability is "the unimpaired maintenance of human life-support systems." Hall (2004) implies that the term "sustainable development" is an oxymoron, a combination of two conflicting concepts and therefore of no practical use. In critiquing the Johannesburg Declaration of

[2] See www.un.org/esa/forests/about.html (Last accessed 9 May 2005).

2002, Pallemaerts (2003, p. 295) states: “Sustainable development, far from becoming ‘a central guiding principle,’ seems doomed to remain nothing but a ‘collective hope’.”

The differences between the needs and values of developing countries versus the needs and values of developed countries loom large over the global acceptance of the concept, creating a North/South split. The developed North has found advantage in adopting an integrated definition of sustainable development, believing that nations can both grow and protect the environment at the same time. Consequently, many countries have included the concept in their environmental policies (Moffatt, 1996; Mebratu, 2004).

Developing countries (the South) have not always been as eager to accept the integration of environmental conservation initiatives with economic development. They fear being forced by wealthier countries to implement environmental policies that will hamper their economic growth or negatively affect the livelihoods and survival of local peoples (Carvalho, 2001; Upton, 2002). As an example, efforts to conserve endangered species such as elephants or the great apes are seen to be in conflict with the needs of subsistence hunters and local markets (BCTF, 2002; De Alessi, 2003). Farmers in Jamaica are forced by economic and political pressures to turn forest lands into coffee agriculture in order to prosper, thereby increasing deforestation of their island (Weis, 2000). Consequently, some developing countries and communities are not eager to agree to the integrated definition of sustainable development. As a result, international conferences often choose ambiguous language in the face of these concerns, and the progress of international agreements is slow (Moffatt, 1996; Panjabi, 1997).

As noted above, sustainable development can be considered as a radical innovation (Robinson, 2004). In keeping with diffusion theory, radical innovations are adopted slowly because they require intensive changes of practice. Changes in political structures, attitudes, and policies are needed to implement successful sustainable development, and these are hard to achieve (Dodds, 1997; Carvalho, 2001). Implementation also requires attention to multiple issues: globalization, poverty eradication, retention of biodiversity, protection of natural resources including forests, overpopulation, and political instability (Hens and Nath, 2003).

Ethical, religious, and political agendas also affect adoption. Rogers (1995) says that adoption of an idea is supported when it agrees with the value systems of the adopters and may not be adopted if it does not agree with their values and concepts.

Overpopulation is often cited as a contributing factor to environmental degradation, but population control is both an ethical and political issue in most countries. The Rio Declaration has been criticized for not making a clear statement of the relationship between overpopulation and the environment. Panjabi (1997) indicates that this may be because of lobbying by various religious and national interests. Changing ethics and social values can also influence adoption (Caldwell, 1984; Shearman, 1990). The value placed on the environment by the public has changed radically over the past 30 years, complicating adoption of sustainable practices and policies. WSIS documents (WSIS, 2003) attest to the inequity of ICT technology and access, which contributes to the lack of success in solving both economic and environmental problems.

Applying the concept of sustainable development to the development of specific policies has proved difficult (Wiersum, 1995). Shearman (1990) argues that sustainability can be defined only in relation to a specific social, economic, or environmental context. The only way the concept can be tested is through specific policies and implementation practices. The complexity mentioned above makes it difficult to see the whole picture. Consequently, only pieces of the concept can be evaluated at any one time. The “installment plan” of adoption is probably more relevant when one is considering the diffusion of this concept, because it seems easier to anticipate the effects of small incremental changes, although sometimes even small incremental changes can have large and unpredictable effects, as described by chaos theory (Gleick, 1987). In fact, attempts to apply new ideas sometimes backfire.

For example, the *Northwest Forest Plan* was an attempt to force governmental agencies in the United States to work together and with the public to solve the impasse between environmental values and development values during the 1980s and early 1990s. The initial surprise was that it was a nontimber resource that triggered the controversy and the resulting changes in forest policy and practice. The Endangered Species Law, the spotted owl, and the marbled murrelet forced the creation of new regulations and legislation mandating the adoption of sustainable forestry practices—the recognition that there must be a "new equilibrium" between the economy and the environment (Tuchmann and Brooks, 1996). However, the same rules that were developed to save endangered species and solve the problem of unsustainable forestry practice have apparently inhibited creative solutions.

As an example, adaptive management was adopted as an innovative tool to train people in new and better forest practice. This strategy requires risk taking and experimentation. Stankey *et al.* (2003) report that the application of adaptive management principles was hampered because rules requiring assurance of "no harm" to wildlife set an impossible standard. According to Stankey *et al.* (2003): "Actions judged to pose a risk to endangered species generally are opposed, even when the efficacy of precautionary approaches is poorly understood." The fear of undesirable consequences (too much risk) prevented testing of alternatives.

> The irony here is that while continuation of policies that have not worked seems to ensure continued failure, undertaking actions where outcomes are uncertain is resisted because of the inability to ensure that unwanted effects will not result (Stankey *et al*., 2003).

When dealing with innovations like the chainsaw or the Internet, most people can easily observe how the innovation works and can determine its advantage or disadvantage to their lives. Even though the results of adoption may not be clear or realized until later in the future, the effects are relatively easy to track. Adopters can see a tangible outcome of using the product or process. Change resulting from an idea is harder to see. Adoption and implementation are gradual processes with varying results, depending on the situation. The success of the concept can be judged only by looking at individual projects, local efforts, and the cumulative effects over time. Agreement on performance measurement is needed to track possible improvements.

Within the forest sector, the development of criteria and indicators is one method of improving the evaluation of sustainable management efforts. The Montreal Process, the International Tropical Timber Organization, and the European Union through the Helsinki Process are all engaged in efforts to establish methods of evaluation that relate to specific countries and conditions (MacCleery, 2001; Albee, 2003; McDonald and Lane, 2004).

Forest certification schemes such as the Sustainable Forest Initiative (SFI) of the American Forest and Paper Association and the Forest Stewardship Council Certification (FSC) are developing objectives and performance measures to encourage sustainable forest practices. These efforts combine social, economic, and environmental considerations. They promote biodiversity, water quality, healthy ecosystems, and other environmental goals (Washburn and Block, 2001). Perhaps over time, the results of these efforts will be observable in improved ecosystems and less environmental damage. With demonstrable success these efforts will encourage wider adoption of sustainable forest management and sustainable development practices.

3.3.3.3 Predictable Consequences and Unintended Results

Sustainable development is a huge concept, a radical innovation that could have a significant impact on the environment. However, the vagueness of the concept, resulting from both inexact and variable definitions, poses a major barrier to its adoption and implementation. The term can be interpreted and used to fit one's own needs. While sustainable development can be a mediating term between opposing parties, the more the concept is politicized, the more it may be devalued. Although the following statement comes from an early period in the discussion, it reflects an unintended consequence of the adoption of the concept.

> Developers now realize that under the guise of sustainability almost any environmentally sensitive programme can be justified. They thereby seek to exploit the very ambiguities that give sustainability its staying power. Similarly, environmentalists abuse sustainability by demanding safeguards and compensatory investments that are not always economically efficient or socially just (O'Riordan, 1988).

However the concept is defined, success in implementing sustainable practice and policies on a broad level has been slow. Each new summit has acknowledged the lack of progress in solving international environmental and social issues but has vowed to keep working on the problem. While hailed as an important document in 1992, Agenda 21 was not legally binding internationally, unlikely to be read by the general public or paid attention to by many governments. [According to Panjabi (1997), *The Times* of London described Agenda 21 as a "750-page document of unsurpassed UN verbosity."]

Given the complexity of the concept, the number of issues and problems that must be addressed, the difficulties in changing economic and social policies and practice, and the general uncertainty surrounding the real meaning behind the concept, the unexpected consequence may be that the concept has gained so much power within the international community. Regardless of its practical effect, the idea of sustainable development continues to inform and guide international efforts to solve the world's environmental, social, and development problems.

Sustainable development as a concept that attempts to see development as more than economic growth and recognizes both the finite nature of the natural world and the needs of human society has been adopted as a guiding principle, but problems of implementation remain.

3.4 Key Findings

> If we do not take the time to review the past we shall not have sufficient insight to understand the present or command the future: for the past never leaves us and the future is here already (Mumford, 1974, p. 13).

New ideas and processes do not always have intended effects: some innovations develop faster than expected, and others take unintended paths. An examination of case studies of innovations with which we are currently familiar provides a lens through which we can view our projections of the future. Innovations fall into three categories: products, processes, and ideas, and Rogers' (1995) theory of innovation diffusion provides a unifying framework for their evaluation through the five principal attributes of advantage, compatibility, complexity, trialability, and observability.

Adopters of innovations fall into five main categories: innovators or pioneers, early adopters, early majority, late majority, and laggards, with adoption of innovations following a characteristic bell-shaped (cumulative S-shaped) curve over time. The "technology cluster" concept is an important one for evaluating surprises in innovation adoption, with many products requiring the confluence of a number of separate innovations for a breakthrough to occur. Preventive innovations diffuse particularly slowly, as relative advantage may be far in the future and difficult to perceive. Many surprises are related to abandonment of innovations, as illustrated by the history of DDT use.

The chainsaw case study (a product) illustrates the long period of time between an initial concept (a chain-based saw) and today's widely used, reliable, portable gasoline-powered devices based on lightweight materials. A significant, surprising outcome was widespread deforestation, made possible by chainsaws. Health hazards from prolonged chainsaw use were also unexpected.

The Internet is becoming the primary method for sharing information, including natural resource information. The forest industry uses the Internet to communicate with clients, share information about products, and support other business activities (Poku, 2003). Poku (2003) suggests that the majority of forest companies in the United States have adopted ICT technologies to help them conduct business and meet the needs of their clients. E-mail and Web pages are the most popular, supported by nonformal training in the workplace. ICT and the Internet illustrate both product- and process-type innovation, all of which serve to increases productivity, competitiveness, and a company's bottom line. Traditionally, foresters used plot sheets, diameter tapes, compasses, and clinometers to gather information about the forest and shared results through paper reports. ICT is now required to efficiently manage the ecology and economy of the forest (Hansen, 1996). It has changed the way we inventory the forest, model forest conditions, and share the results with others. It has affected how we measure the height and diameter of trees, how we capture information on maps, and how we make forest management decisions.

ICT has changed how we share forestry information and gather input from stakeholders. We are experiencing the unexpected consequences of demands for more and faster services, changing public expectations, and a sometimes-limiting expectation of technological literacy. The early developers of the Internet never forecasted the unprecedented rate of adoption of ICT.

The idea of sustainable development has a long history, but it has not achieved its anticipated impact because of ambiguities in the concept and because of complexities in implementation. Many interpretations are possible, and everyone can assert that they are "for" sustainable development without really being committed to change; a North/South split between developed and developing countries exacerbates this situation, and the term is often misused, especially in political arenas, exploiting the ambiguities in the concept.

Predictions are often colored by issues such as attempts to maintain competitive advantage or tactical policy purposes. The principal finding of this chapter strikes a cautionary note: even with the best of intentions, events can turn out very differently from predictions.

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Chapter 4. E-Commerce

Anders Q. Nyrud and Åsa Devine

4.1. Introduction

E-commerce is defined as business where orders are placed and/or received through electronic networks. The Organisation of Economic Co-operation and Development (OECD) (OECD, 2002) distinguishes between Internet transactions (conducted over the Internet) and electronic transactions conducted over computer-mediated networks (see *Table 4.1)*.

Information and Communication Technology (ICT) is applied by businesses for a variety of purposes. Business processes that are conducted over networks—not only buying and selling but also servicing customers and collaborating with businesses partners—are referred to as electronic business (or e-business). E-business comprises e-commerce, consumer relationship management (CRM), and supply chain management (SCM). The sole focus of this chapter will be e-commerce. The chapter provides an overview of e-commerce in general, e-commerce applications in forestry, and future trends and scenarios, and policy implications. SCM is treated separately in Chapter 5.

Table 4.1. The Organisation of Economic Co-operation and Development (OECD) definition of electronic commerce transactions and guidelines for their application (from OECD, 1999).

E-commerce transactions	OECD definitions
BROAD definition	An *electronic transaction* is the sale or purchase of goods or services, whether between businesses, households, individuals, governments, and other public or private organizations, conducted over *computer mediated networks*. The goods and services are ordered over those networks, but the payment and the ultimate delivery of the good or service may be conducted on or off-line.
NARROW definition	An *Internet transaction* is the sale or purchase of goods or services, whether between businesses, households, individuals, governments, and other public or private organizations, conducted over the *Internet*. The goods and services are ordered over those networks, but the payment and the ultimate delivery of the good or service may be conducted on or off-line.

4.1.1 Digital infrastructure and electronic commerce

Since the advent of electronic networks, the importance of e-commerce has been growing rapidly. For example, during the period 2000–2003, U.S. retail e-commerce increased by approximately 25% annually (total retail sales grew by less than 5% annually). There are no credible estimates for the total value of global e-commerce transactions, but according to the figures reported by the U.S. Census Bureau (2005), the total value of e-commerce (value of shipments, sales, or revenue) in the United States was US$1,679 billion in 2003, with business-to-business commerce accounting for 94% of this figure. Eurostat reported that the value of Internet-based e-commerce, conducted by enterprises located in the European Union (EU), amounted to €95.6 billion in 2001 (EUROSTAT, 2004), adding that this number probably represented only 20% of the total EU e-commerce sales.

The decisive factor as far as e-commerce is concerned is the number of individuals online: infrastructure must be in place, and businesses and individuals must know how to operate computers and use electronic networks. At the time of writing, there are approximately one billion individual Internet users (Computer Industry Almanac: www.c-i-a.com; see *Figure 4.1*). North America is the region with the largest share of Internet users per capita (see *Figure 4.2)*. A global assessment of

Internet infrastructure and use is provided in the World Economic Forum's Network Readiness Report (Dutta and Jain, 2004). The report provides a global Networked Readiness Index that evaluates ICT environment, readiness, and usage in 102 countries. The countries with the highest networked readiness scores are located in North America, northern and western Europe (including Israel), and along the Pacific Rim (including Malaysia, Singapore, and Taiwan). The countries achieving the lowest scores are located in Africa, Central Asia, the Middle East, southeastern Europe, and South America. Countries where the public investment in ICT infrastructure has been high (in particular, Korea, Malaysia, and Taiwan) are also achieving high scores on individual Internet usage and e-business environment (market environment, business readiness, and business usage).

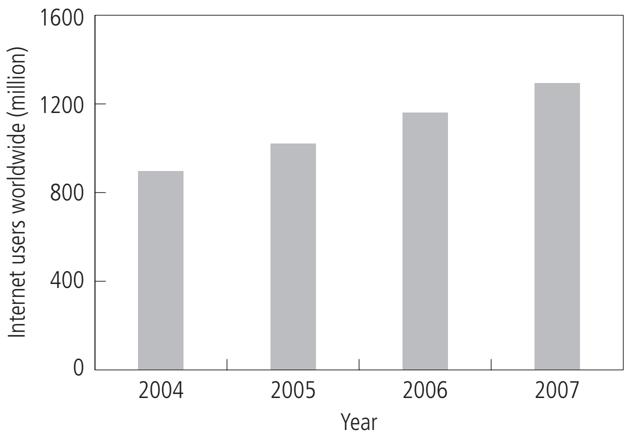

Figure 4.1. Worldwide Internet population 2004 and projections for 2005, 2006, and 2007.
Source: Computer Industry Almanac (2004).

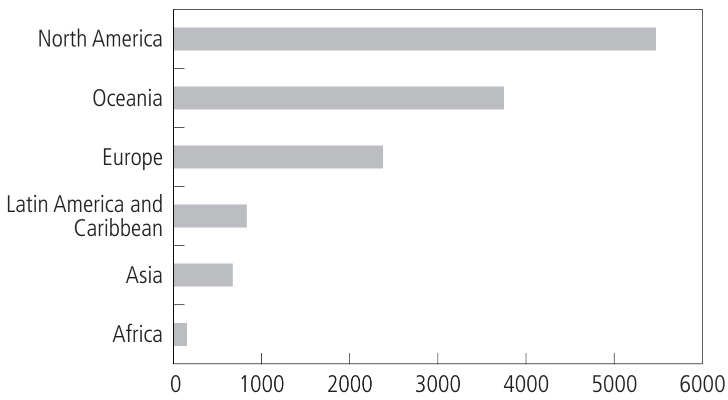

Figure 4.2. Internet users per 10,000 people.
Source: United Nations (2004).

A look at the actual numbers of networked individuals provides a somewhat different picture. In 2003 Asia was the continent with the highest number of Internet users, and the two single countries with the most Internet users were the United States and China (186 million and 100 million respectively (Computer Industry Almanac, 2004). The United States was ranked number one in the 2004 Networked Readiness Index (Dutta and Jain, 2004), whereas China ranked only 51. Singapore, Finland, Sweden, and Denmark—the countries ranked 2, 3, 4, and 5 by the 2004 Networked Readiness Index—altogether accounted for 16 million Internet users. While China, India, and Russia accounted for 6 million (2002), 18.5 million (2003), and 94 million (2004) Internet users respectively, all are ranked in the middle segment of the Networked Readiness Index. Asia is likely to maintain its position as the continent with the most networked individuals, and the growth potential there is considerable.

Asia, Europe, and North America are the dominant regions with respect to forestry, forest industry, and consumption of forest products. According to the Food and Agriculture Organization (FAO), 70% of global roundwood production, almost 94% of global paper production, and almost 90% of global sawnwood production is conducted in Asia, Europe, or North and Central America. The three regions Asia–Pacific, Europe, and the United States account for 77% of the total value of the global paper and forest products industry (Datamonitor, 2005).

The number of individuals and businesses using the Internet is correlated with the number of individuals ordering goods over the Internet as well as businesses receiving orders. OECD data on Internet e-commerce are presented in *Figure 4.3* and *Figure 4.4*. OECD members are in general achieving higher scores than non-OECD countries, and OECD statistics are therefore not representative of the global ICT situation. *Figure 4.5* provides estimates of the relative value of e-commerce for selected countries in 2000; transactions between businesses are clearly the most important aspect of e-commerce.

4.1.2 Types of electronic commerce

According to estimates, business-to-business (B2B) e-commerce accounts for approximately 80% of the total value of all e-commerce (see OECD, 1999). B2B e-commerce involves electronic infrastructure, software, hosting, procurement, ad serving, CRM, consulting, messaging, and customer loyalty related to automated processes between trading partners—network-facilitated information exchange. Information can be transmitted through intranets (networks internal to the firm) and intranets that are expanded to business partners (extranets). B2B e-commerce can be implemented in an effort to reduce (transaction) costs; it is often implemented at business partners' insistence (for example, when large businesses demand that their suppliers link into their e-commerce system) or as a defensive reaction to competitors engaging in e-commerce.

Electronic data interchange (EDI) is a hardware-independent data format developed in the 1970s. EDI provides a generic standard for conveying business information in an efficient manner, for example, ordering, invoicing, and shipping services. EDI messages can be transmitted via e-mail, HTTP, and FTP; but originally—before the Internet—data was transmitted through Value-Added Networks (VANs) operated over leased telephone lines.

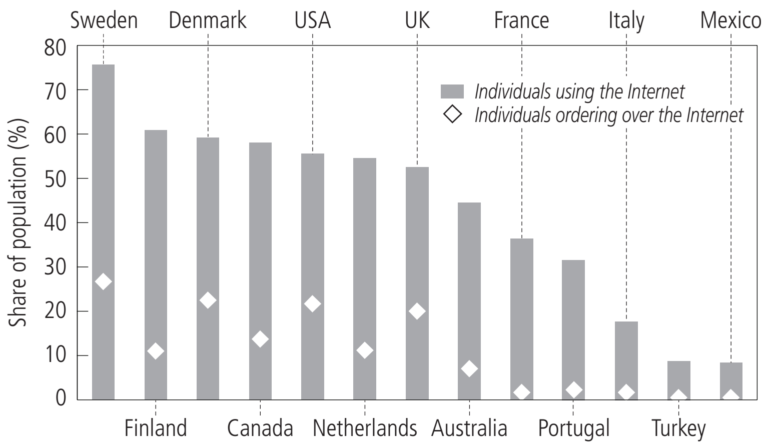

Figure 4.3. Individuals purchasing over the Internet: 2001 or latest available year.
Source: OECD, 2004.

Notes: (1) Finland, Denmark and the United Kingdom: 2002 instead of 2001. (2) Canada, Italy, Turkey: 2000 instead of 2001. (3) Turkey: individuals belonging to households in urban areas.

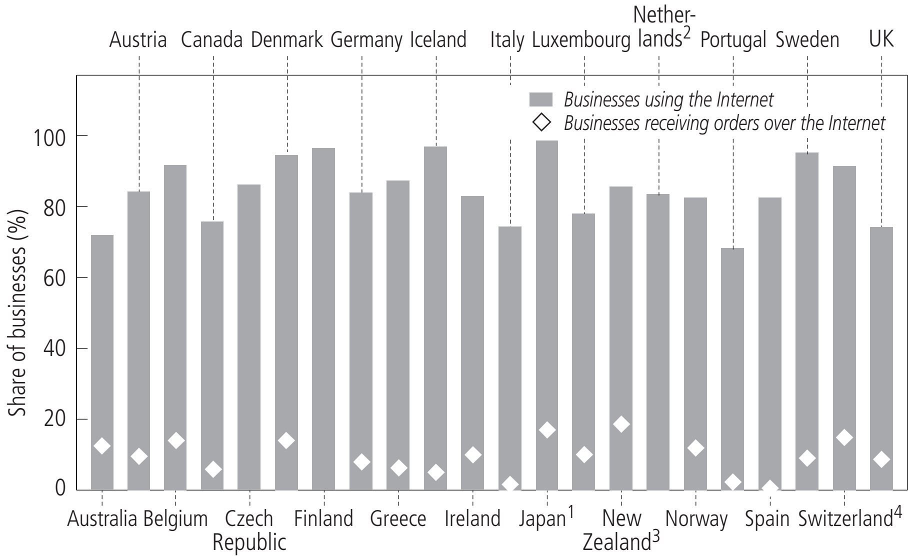

Figure 4.4. Businesses using the Internet and businesses receiving orders over the Internet: Percentage of businesses with ten or more employees, 2002 and 2003, or latest available year. Source: OECD (2004).

Notes: Japan[1]: Data refer to enterprises with 100 or more employees; agriculture, forestry, fisheries, and mining are excluded. Netherlands[2]: Use, orders received and placed, refers to Internet and other computer-mediated networks. New Zeeland[3]: Data refer to 2001 and include enterprises in all industries except electricity, gas, and water, government administration and defense, and personnel and other services. Switzerland[4]: Data refer to the manufacturing, construction, and services sectors; 2003 data are estimates; data for businesses receiving orders over Internet refer to 2001.

Broader ↑	Web commerce	Internet commerce	Electronic commerce → Broader
Business	2.00% (Sweden)	1.08% (UK) 0.40% (Canada) 0.40% (Australia, 1999–2000)	5.20% (UK) 13.30% (Sweden)
Business sector (excl. financial sector)	0.90% (Sweden) 0.70% (Finland)	0.94% (UK) 0.40% (Italy)	5.95% (UK)
Retail sector	0.10% (France)	0.95% (USA, Q3 2001) 1.09% (USA, Q4 2000) 1.39% (UK)	0.95% (USA, Q3 2001) 1.09% (USA, Q4 2000) 1.39% (UK)

Figure 4.5. OECD estimates of Web, Internet, and electronic commerce transactions. Percentage of total sales and revenues, 2000.
Source: OECD (2002).

Another format for transferring business data that has been introduced more recently is the Extensible Markup Language (XML). The benefits of using message-transfer standards such as EDI and XML are: reduced procurement and inventory costs, reduced document delivery time, shortened lead times, elimination of clerical tasks and errors, communication across industry sectors (common standards), the customization of forms to meet a company's needs and those of its trading partners, and complete auditing, billing, and security functions. A recent study conducted by the European Commission (2004) investigated European e-business activities in ten sectors and reported that although 60% of all companies asked were exchanging standardized data, many companies did not know which standard they were actually using.

Business-to-consumer electronic commerce (B2C) relates to businesses selling products and services directly to consumers. In B2C, end users and retailers are linked via the Internet; B2C can involve activities such as Internet access, portals, retail, auctions, build to order, banking, brokerage, and ticketing. In its simplest form, B2C e-commerce is the electronic version of the retail model. A variety of goods and services can be sold by B2C e-commerce, both intangible products (electronic products and services: entertainment, travel, newspapers/magazines, financial services, and e-mail) and tangible products (e-commerce retail: dominant so far are electronics and software, books, and music). Goods and services sold in B2C e-commerce can be categorized as (i) search products—the search can be evaluated from externally provided information, with typical search products being books and toys; (ii) experience products, for example, clothing, perfume, or cell phones, for which consumers commonly demand more than just information to be provided online; and (iii) credence products, for example, health products such as vitamin products that are difficult to assess even after purchase. Experience and credence products are not necessarily sold online, but recent business studies have emphasized that e-commerce can be of considerable importance for consumers when they are making the decision to purchase an item or a service—even though the product may not be purchased online (cf., European Commission, 2004).

In addition to B2B and B2C, a few other types of e-commerce can be identified. B2E (business-to-employee) e-commerce involves the use of intranets or the Internet for services such as directory (personnel, project), benefits (retirement, health), travel and expenses, and dissemination of information (corporate/industry news, projects, key contacts). B2G (business-to-government) e-commerce involves transactions between businesses and government, such as online administration and contract management of federal and state government projects. And finally, P2P (person-to-person) e-commerce is the interrelation between nonprofessional, private individuals on the Internet.

4.1.3 Business models in electronic commerce

Timmers (1998) used a systematic approach to identify architectures for business models. He described eleven different e-commerce business models and classified these with respect to two dimensions: innovation and integration of business functions. The business models included e-retail services (e-shop, e-procurement, e-mall), customization (e-auction, value chain service provider, information broker, trust service) and market makers (third-party marketplace, virtual communities, value chain integrator, collaboration platform) as shown in *Figure 4.6*. Other similar taxonomies are,

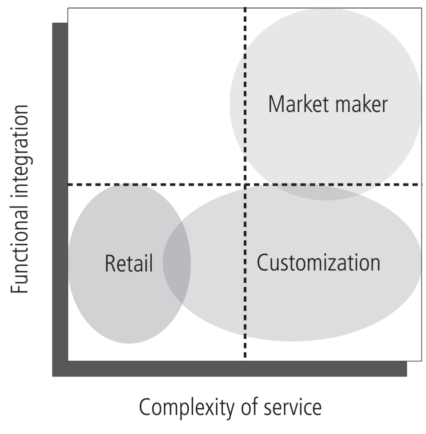

Figure 4.6. E-commerce business models ranked according to functional integration and complexity of service (after Timmers, 1998).

for example, provided by Rappa, 2003 (nine models) and Turban *et al.*, 2004 (19 models). A critical discussion and review of the business model concept is provided by Hedman and Kalling (2003).

In the subsequent text, the three main groups described in Timmers' (1998) model will be used. These can be evaluated according to the functional integration and complexity of service—for example, innovation and value-added—of the business model (see *Figure 4.6)*. Simple retailers are located in the lower-left-hand corner of the figure, while integrated value networks, using the e-commerce service to add value to the products sold, are located in the upper-right-hand corner of the figure. Increasing functional integration and complexity provide diversified e-commerce solutions.

4.1.4 Electronic commerce in the forest sector

The use of e-commerce solutions in the forest sector, both B2B and B2C, depends on factors such as market segment, customer base, value-added in production, and company size. North American studies indicate that forest products manufacturers, primarily of solid wood and pulp and paper, long ago integrated Internet in their daily business (Vlosky and Pitis, 2001; Vlosky and Smith, 2003). Toivonen (1999) evaluated marketing information systems strategies in the Finnish forest sector and found that although marketing information systems were in use, they were not fully utilized in existing information systems. The use of specialized e-commerce applications, such as EDI, is still low (16% of businesses in 1999, with 28% stating that their company planned to conduct EDI by the year 2002) and depends on company size (Dupuy and Vlosky, 2000). A study conducted on home-center business in 1999 concluded that the number of companies using Internet-based technologies (e-mail, EDI, and Web sites) was higher than the forest industry average (Roadcap *et al.*, 2000).

Business practices and expectations regarding e-commerce in Canadian and U.S. solid wood companies were surveyed in 1999 by Pitis and Vlosky (2000a and 2000b). The respondents reported that the application of ICT had already resulted in changes in business and that further changes were anticipated. ICT was used for marketing purposes, and the companies reported that they had obtained new customers and generated more sales than could have been generated without an Internet presence. ("We put pictures on the Internet showing how we make our products better. Customers 1,000 miles away can take a "virtual tour" of our company and see who they are dealing with.") Market share had increased, for example, through B2B data interchange and online customer inventory management.

Logistics functions had also improved: the purchase of items from vendors had become easier and was carried out faster; inventories had been reduced by broadcasting available stock to customers via the Internet; and inventory control had improved because of better information about inbound product locations. Firms reported shorter lead times, and responses to customers' inquiries were faster. Savings in labor costs were also reported— "customers can look up order and shipment status online reducing phone calls to reps and freeing them to handle orders rather than inquiries"—and there had been savings on communication costs, for example, overseas or long-distance telephone charges.

This implies that e-commerce solutions are used both for B2B and B2C e-commerce in the forest sector. The survey indicated that businesses were enthusiastic about e-commerce and that cheap and easy access to market and customer information was considered the major advantage of applying it. But higher production efficiency and lower production costs were also anticipated. According to the respondents, the introduction of ICT had boosted productivity and reduced costs. There was little evidence that information technology had been applied to create product innovation, and there were no plans for this in the future. The results corresponded to previous analyses in other sectors and industries.

4.1.5 Strategies: The Internet and competitive advantages

In his 2001 article, *Strategies and the Internet*, Michael Porter (2001) discusses the impacts of Internet and e-commerce on businesses, based on his five forces model. He concludes that the Internet will have mostly negative effects on firms' competitive strategies and considers the Internet to be a threat rather than an opportunity (see *Table 4.2*). Improved access to market information via the Internet will lead to increased industry rivalry; in particular, in low-cost production, industry rivals are able to quickly imitate competitive advantages; differences between producers and products evaporate; and products become standardized. Furthermore, producers are able to market their products globally, and this will increase rivalry within the industry from both entrants and substitutes.

Table 4.2. Porter's (2001) five forces applied on businesses and the Internet.

Force		Positive effect		Negative effect
Customers	+	Eliminates powerful distribution channels	–	Shifts bargaining power to end customers, hurting firm profitability
	+	Improves bargaining power over traditional distribution channels	–	Reduces switching costs and intensifying competition
Suppliers	±	Raises firm’s bargaining power over suppliers, but also gives suppliers access to new customers		
			–	Provides a new channel for suppliers to reach end users, reducing the leverage of intermediaries
			–	Gravitates procurement to standardized products that reduce differentiation
			–	Lowers barriers to entry, and proliferation of competitors shifts power to suppliers
Entrants			–	Lowers barriers to entry such as large sales force, access to distribution channels, and physical assets
			–	Creates a flood of new entrants in many industries
Substitutes	±	Expands market size by making the industry more efficient		
			–	Creates new substitution threats
Industry rivalry			–	Reduces differences among competitors as offerings are more difficult to keep proprietary
			–	Migrates the basis of competition to price
			–	More competitors emerge because markets get geographically larger
			–	Decreasing variable costs relative to fixed costs increases pressure for price discounting

Porter (2001) also comments on what is usually considered the “sixth competitive force”—complements—and suggests that firms can create competitive advantages by using Internet services to complement existing operations. The Internet will provide advantages for existing industries that have been constrained by the high costs of communicating, gathering information, or performing transactions. The fundamentals of competition are unchanged: firms should integrate ICT and e-business into their strategy and focus on creating real values through production, rather than directing all their focus toward applying new technologies in sales and marketing. According to Porter (2001), the only true indicators of value creation are related to industry structure and companies’ ability to create sustainable competitive advantages (the simple market fundamentals). Successful firms are those that use the Internet to complement their traditional modes of business rather than as a substitute for established operations.

Porter’s views did not go uncontested. In an article entitled *Rethinking Strategy in a Networked World (or Why Michael Porter is Wrong about the Internet),* Tapscott (2001) argues that the Internet would indeed provide new, valuable business opportunities. Success is determined by businesses’ ability to adjust to business networks and Internet strategies. The Internet dramatically reduces search, coordination, contracting, and other transaction costs among firms, and because of this “a myriad of new business models have emerged that are different from the industrial-age template” (see the business models presented under the last subheading). Tapscott (2001) argues that new technologies have provided new possibilities that can be utilized to create new business opportunities and product innovation in terms of information access, communication potential, and flexibility, instead of just being a complement to the ongoing businesses. But he also foresees new challenges for future businesses: the new technology would lead, he says, to a new generation of consumers that are smarter, more active, and more independent. In the future, businesses must therefore focus even more strongly on their customers.

Nicholas Carr (2003 and 2004) elaborates on this debate along the lines of Porter (2001). He argues that standardization and commoditization of ICT erodes firms’ possible competitive advantages and leads to fiercer competition and reduced revenues. It is not the implementation of ICT, the Internet, or e-commerce in itself that matters but how the technology is used. As Varian (2004) states in the book review of Carr (2004): “The standardization and commoditization of technology does not necessarily mean that innovation stops; it might even boost innovation and provide competitive advantages due to cheap and easily accessible ICT.”

4.1.6 The Internet, competitive advantages, and the forest sector

Internet-based e-commerce in the forest sector has undergone considerable development since the World Wide Web was opened for commercial purposes. Early forest sector adaptations of Internet e-commerce were mostly e-retail services—dotcoms with the sole business idea of using the Internet to sell wood products to customers. According to Porter (2001), the downfall of most dotcoms was of their own making, as they were based on business ideas with little innovation, little value-added, and practically no functional integration. However, as pointed out by Shook *et al.* (2004), there were also a number of B2B e-commerce exchanges established in the forest sector in the late 1990s that failed because forest industries were simply unprepared for the adoption of large-scale technology and did not participate—in spite of the fact that such businesses would probably have increased market efficiency and eliminated inefficiencies in the supply chain.

Other early but more successful e-commerce initiatives started out with a strategy of differentiation and the provision of customized solutions to their clients. Information brokers (e.g., PaperLoop.com and ForestWeb.com) have been offering Web-based information services about the forest business and acting as a forest-sector business-news service since the late 1990s. There are Web-based marketplaces (e.g., www.PaperExchange.com) that have been mediating forest products trade, creating contacts between buyers and sellers of raw material and industrial wood products for almost ten years.

At present, the emergence of more specialized forest products e-commerce sites is gaining momentum—market makers with a high degree of functional integration, innovation, and value-added for the customers: virtual communities, value-chain service providers, value-chain integrators and third-party marketplaces and collaborative platforms, linking the buyers and sellers. PapiNet (which merged with WoodX in 2004) is a joint industry effort to provide an international e-business standard for the forest sector (see Chapter 7). It offers an e-business platform for the forest sector where business information is transmitted by means of XML. “PapiNet is a set of standard electronic documents that facilitates the flow of information among parties engaged in the buying, selling, and distribution if paper and forest products” (www.papinet.com, 2004). Two other examples of this kind of forest sector VAN are ForestExpress.com and Expressopaper.com. Both platforms provide services that link the business systems of buyers and sellers of paper, but they also offer additional services such as business consultancy and raw material supply.

There has apparently been a development from autonomous dotcom services to large, ubiquitous, forest sector e-commerce platforms. The autonomous Web sites have apparently prevailed, and even though many experienced trouble after the IT bubble burst, they now coexist with the larger platforms. The platforms provide services with increased integration, innovation, and value-added-enhancing interoperability, and may develop into larger forest industry hubs.

4.2 Trends and Scenarios

The rapid growth of e-commerce is expected to be maintained. While B2B e-commerce will remain the dominant use of e-commerce (the future development of B2B e-commerce is treated in more detail in Chapter 5 which deals with supply chain management), B2C e-commerce is expected to gain momentum in specific markets. For example, according to an EU study, the latest boom market in B2C e-commerce has been e-tourism (European Commission, 2004). At present, several topics, technologies, and business ideas are receiving considerable attention. The trends described in this chapter are mainly related to customer trust, operability, and technological developments for accessing networks. In this section some trends in e-commerce are highlighted and commented on, and some speculative scenarios are presented.

4.2.1 Trends

The trustworthiness of the Internet is a key issue for all involved in e-commerce transactions. If businesses and customers lose trust in e-commerce, for example, because they are afraid of having their identity stolen or because they consider the payment methods inadequate, they will simply refrain from using online services. In a year 2000 survey conducted by the World Information Technology and Services Alliance (WITSA, 2000), public trust related to e-commerce—in particular, security of payments—was rated the most significant barrier facing the electronic commerce industry (47% of the respondents rated lack of trust or familiarity with electronic commerce and lack of understanding of electronic commerce as the most significant barriers facing the e-commerce industry).

Security issues involve both B2B and B2C e-commerce and relate to issues such as safety of payments and monetary transactions, treatment of personal and corporate information, liability questions regarding fraud, and fear of being hacked. As e-commerce is becoming global and users must deal with unknown and anonymous individuals and companies, the risk of consumers refraining from e-commerce will increase. *Figure 4.7* provides a survey of Web shoppers' expectations of online security and indicates that Web shoppers are optimistic about online security.

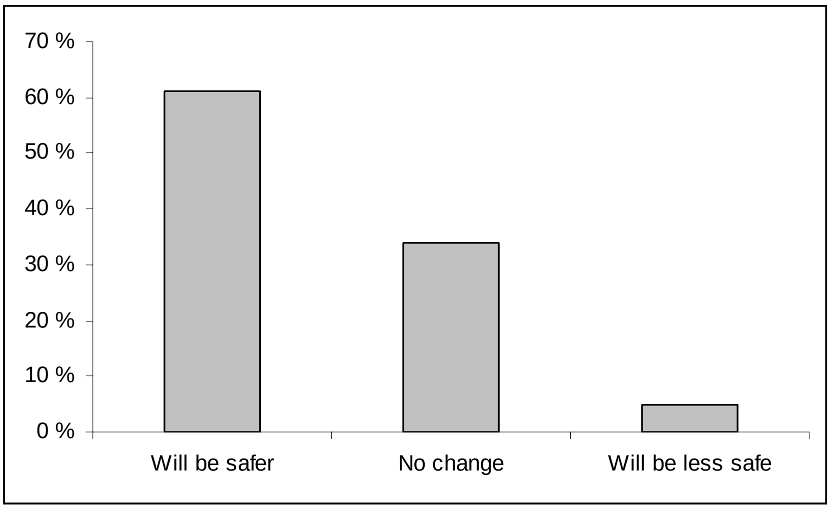

Figure 4.7. Web shoppers' opinions about online security in 2004.
Source: AC Nielsen (March 2004), as reported in epaynews.com/statistics/index.html

Another issue that has received substantial attention in recent years is the emerging wireless technology (i.e., technologies that allow the use of online applications without being physically connected to a network). This includes broadband connections with limited range (UWB, Wi-Fi, WiMAX, 3G, and 4G standards) and also long-range and nonvoice technologies (mobile technology). Such technologies are already in use both for private and businesses applications; wireless networks for personal computers are now frequently used in the workplace, universities, schools, and public places, as well as in homes.

The next step in wireless technology is generally considered the introduction of alternative devices (other than personal computers) for accessing the networks: technology that allows networks to be accessed irrespective of the location of the user or the physical connection, for example, the next generation of cell phones, so-called smart phones. The use of wireless applications is expected to grow rapidly in the near future, and wireless technology will probably have the largest impact on B2B e-commerce, improving information access as well as quality; businesses will be able to utilize wireless equipment, for instance, for internal communications (being connected to intranets), order handling, allowing longer hours of operation, or to develop new products and services. Wireless technologies can be used to track production or customers. *Figure 4.8* provides predictions of the share of wireless Internet users.

New inventions are, as discussed in Chapter 3, notoriously hard to predict, but one obvious impact of improved wireless technologies is that they provide easy online access both for businesses and customers. Increased accessibility is very likely to result in increased use of e-commerce services and probably in increased sales/purchases. A key element in the innovation in wireless services is payment methods. For e-commerce to expand further, safe and easy methods of transacting payments must be developed. A response to this is micropayments, transactions of small amounts (less than $10) using networks.

A serviceable micropayment standard will provide a convenient alternative to cash, and implementation of this technology will lead to increased purchasing flexibility and probably increased purchasing speed. Micropayments can be used for paying for digital goods and services, ticketing, retail services, vendoring, and P2P transactions. Technologies suggested for micropayment range from standard Internet applications to mobile commerce or m-commerce (mobile, nonvoice applications) with applications such as prepayment and subscription, aggregation and billing, or stored value (Costello, 2003). *Table 4.3* provides a revenue projection for m-commerce in 2009.

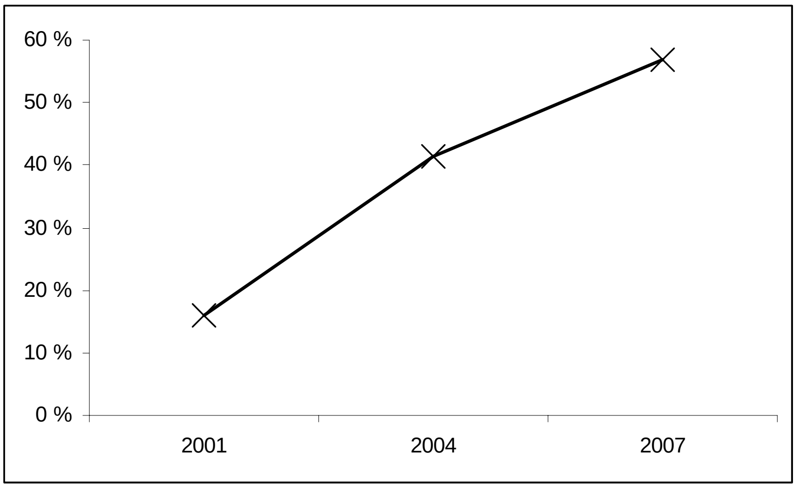

Figure 4.8. Global wireless users, 2001, 2004, and 2007.
Source: eMarketer (March 2002), as reported in epaynews.com/statistics/index.html

Table 4.3. Global m-commerce revenue projections for 2009. Source: Juniper Research (August 2004), as reported in epaynews.com/statistics/index.html.

Category	Value ($US billion)
Global revenues	88
Ticket purchases	39
Phone-based retail POS sales	299

4.2.2 Scenarios

The following scenarios are provided so that the future prospects of e-commerce in the forest sector can be discussed and then educated guesswork used to provide examples of how e-commerce may develop. Shortly after the introduction of e-commerce, the OECD (1999) conducted a study on the issue and attempted to come up with predictions about the impacts of e-commerce, suggesting that e-commerce would:

- Lead to reduced production costs and result in improved profits; improve incomes and employment;
- Result in more widely distributed income across populations; and
- Reduce the brain drain, as it would provide job opportunities for educated citizens. (The opposite of brain drain—“brain repatriation”—was suggested in countries investing in ICT).

Micropayment and Wireless Technologies

Micropayment services facilitate the transaction of small sums of money and therefore provide an opportunity for businesses to market and sell lower-priced products and services than is currently usual in e-commerce. This allows entrepreneurs to invent, market, and sell products and services that were previously too cheap to sell online—and probably start charging money for formerly free products and services. All kinds of products—search, experience, and credence—can be sold, ranging from entertainment, ticketing, and vendoring to contributions to NGOs and P2P money transactions. In fact, e-commerce based on micropayment has already impacted the forest sector in situations where digital information sources have become substitutes for newspapers (see Chapter 6). Given that customers have trust in these payment methods, the number of payments and total value of micropayment-enhanced e-commerce is likely to increase substantially (see *Table 4.3*).

Coupled with wireless technology, instant money transactions can be made from anywhere that has overage for a cell phone or other wireless device. This can also make way for new and inventive products and services being sold in the forest sector. For example, nongovernmental organizations (NGOs) in many countries are already receiving contributions from individuals via cell phone. Landowners can use wireless micropayment applications (mobile payment, m-payment) to charge anglers and hunters for fishing and hunting licenses—and also trace or monitor their movements—or provide tourist adventures (charging hikers, for example, directly for services). Although wireless technologies have already substantially impacted B2B, they still have great potential, for example, in tracking and improving EDI services, and micropayment applications will increase B2B integration even further.

It is likely that micropayment will be the catalyst for a number of new goods and services. However, business ideas and technology will probably be easy to copy and, as Porter (2001) warns, the rivalry within industries and the threat of imitations will increase. Still, wireless micropayment can provide sustainable competitive advantages if the product marketed and sold is based on exclusive knowledge or rights, for example, if it is location-based, tied to enforceable property rights, a patent, or brand. This will result in situations such as the market fragmentation scenario discussed in Chapter 7.

The Frictionless Economy and the Forest Industry Hub

In a connected economy practically everything can be marketed and sold using e-commerce. It can be argued that e-commerce solutions are bound to become a substitute for traditional shops and stores, perhaps resulting in large, generic units (Web-based platforms or hubs) where, for example, trade in forest or wood products will take place. Suppliers will simply be able to offer their products through large generic Internet retail stores (to some extent, this is already happening in the sense that big-box retailing has gone online) or through value-integrating market makers that integrate the wood-based value chain, including B2B and B2C e-commerce. For example, ForestExpress is providing not only timber (raw material) for industry but also business consultancy services. In a globally integrated market, information will be practically perfect, and the cost of information will therefore be negligible. Trade will be frictionless, constrained only by the cost of physically transporting products from the supplier to the purchaser; and the forest products hub may even be superseded by a commodity hub, encompassing all kinds of building materials and/or commodities.

On the other hand, many wood products are experience products—the purchaser is interested in comparing products with respect to quality and may also need some kind of customization (for example, raw material for the furniture industry)—and these products cannot be sold through generic portals. This problem can be solved by the implementation of product standards (which might be the outcome of PapiNet's efforts to create an industry-wide, e-business standard; also note comments on Industry Function Classes, and aecXML in Chapter 8). Product standardization can result in commoditization: products that previously were diversified may become standardized commodities, resulting in increased industry rivalry, competition, and threats from substitutes (as long as the transport costs are reasonable). The result will be a focus on production efficiency and cost leadership (cf., the cost-saving scenario discussed in Chapter 7.) Producer surplus will diminish and consumers will be better off.

The Closing Digital Divide

As reported in Dutta and Jain (2004), networked readiness is high in the developed economies in North America, Western Europe, and along the Pacific Rim. Currently, most e-commerce takes place in these countries. However, the 2003–2004 global information technology report (Dutta and Jain, 2004) suggests that the situation is changing—the digital divide is closing. China already has the second largest population of Internet users in the world, and other countries with large populations are developing rapidly; in the near future most of the new Internet users going online will be from the so-called developing world. This will change the center of gravity in the virtual society both with respect to demographics and geographic origin, and will, of course, have an impact on the current state of e-commerce.

The impact of low-cost countries entering e-commerce will affect the competitive environment both in B2B and B2C forest industry markets. Traditional forest industries are frequently raw-material- and/or labor-intensive, and producers that maintain cost leadership will have a competitive advantage. Capital-intensive industries and industries that depend on highly skilled labor are probably subject to less-fierce competition. Still, e-commerce will probably lead to increased industry rivalry, and fiercer competition for many forest industries and cost-cutting strategies are likely to be important in the future (cf., the cost-saving scenario discussed in Chapter 7). This may result in cash flows toward low-cost regions and therefore redistribution of income toward developing countries. Many developing (low-cost) countries are already exploring the opportunity offered by e-commerce to market and sell products worldwide. Moodley (2002a and 2000b) reports that the South African wooden furniture industry is using e-commerce to reach into new markets.

With the standard of living improving in large parts of Asia and more people going online, the implication is that global demand will grow (cf., the market-expansion scenario in Chapter 7). On the other hand, for some products, global trade is restricted because the price of transport is high relative to product price. Factors such as transport costs, tastes, and consumer preferences may result in regional segmentation of forest products markets.

The Failure of Electronic Commerce

There is also the possibility that e-commerce reaches a limit or is simply abandoned because of lack of interest on the part of businesses and/or consumers. Not all products can be marketed and/or sold online; e-commerce is not well suited to market credence products, and there can be constraints to using e-commerce. Costs or substantial inconveniences related to e-commerce transactions (such as collecting market information, carrying out online purchases, paying the purchase and long-distance shipping) may exceed the price difference between online and products sold domestically. Furthermore, taxation of Internet transactions, for example, the much-debated Tobin tax on financial transactions, can place limitations on e-commerce

User trust in online applications is also a key issue. Consumers and businesses may be reluctant to start using e-commerce because they do not understand the medium or because of security flaws, viruses, or spam. The information available online must also be trustworthy. Information can be distorted or fragmented as the massive amount of information available can make businesses and customers lose their overview of markets. Or information can be distorted on purpose because this suits a company as, for example, in the early days of e-commerce when discounts and special offers were used to gain market access and shares.

4.3 Policy Implications

Computer Literacy and ICT Infrastructure Investments

Computer literacy and ICT infrastructure are of great importance, as they directly affect ICT use, both with respect to customers and businesses. Policy efforts should therefore focus on developing and investing in telecommunications infrastructure, thereby providing affordable access to the Internet. Infrastructure must be in compliance with international standards. Experience from South Korea shows that investments in ICT infrastructure pays off; after considerable public investment in infrastructure that country is now among the most networked societies in the world.

Security and Privacy of Transactions

Digital technology and networks must be safe to use, and data flows must be protected. This can be enhanced through improving technology, enforcing national legislation, and through international standards and agreements.

Free Trade, Legal, and Regulatory Frameworks

E-commerce is increasingly dependent on cross-border transactions, and free-trade agreements are thus prime prerequisites for the adoption of e-commerce. The fundamental principles of international trade law (national treatment and nondiscrimination, Most-Favored Nation (MFN) treatment, transparency as well as notification, review, and consultation) should be maintained. Forest products are currently among the commodities subject to the lowest trade restrictions in the world. Under the Work Programme on Electronic Commerce (WTO, 1998), adopted by the General Council of the World Trade Organization (WTO), existing WTO obligations, rules, disciplines, and commitments—including the General Agreement on Tariffs and Trade (GATT), the General Agreement on Trade in Services (GATS), and the Agreement on Trade-related Aspects of Intellectual Property Protection (TRIPs) agreements—are technology neutral.

4.4 Conclusions

E-commerce applications are increasingly a prerequisite for marketing and selling products; the commercial actors in the forest sector should focus on creating value-added in their main business area and attempt to invent new electronic business models only if the business model adds real value. ICT can be used to support old business practices, or new, inventive e-commerce ideas should focus on adding value for consumers through functional integration and innovation. Value-added to products will provide diversified businesses opportunities that are most likely to result in sustainable competitive advantages. Policies must focus on providing the necessary know-how and infrastructure for the businesses to operate and develop competitive e-businesses.

For forest products trade, however, there is the question of how far a product can be transported. The combination of bulky, low-value products that are expensive to transport will, for some products, mean that the product can only be sold within a limited distance from the producer. Even though e-commerce provides a global market for goods, high transport costs may limit the selling of the goods on the global market.

Increased international trade is frequently taken as a proof of globalization. There is no doubt that ICT and e-business have enhanced global information and trade flows, but it is a misconception that globalization is a result of new ICTs. Globalization has rather been enhanced by ICT, for example, through the introduction of e-business.

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Chapter 5. ICT in Forest Business

Kevin Boston

5.1 Introduction

The forestry business is one of the oldest continuously operating businesses in the world, with companies like Stora of Sweden first being incorporated in the thirteenth century. Forestry has adapted to many changes in the world, such as the development of steel and plastics. Now, the forest industry needs to adopt its practices to the information age. The forest industry has several unique characteristics when compared with other businesses, and ICT applications must address these unique characteristics if they are to contribute to forestry business growth.

Forestry has one of the longest cycles of any business supply chain. Even the shortest rotation for tropical hardwoods, approximately five years, can exceed the strategic planning horizon for many other business types. As the usual plantation-forest rotation lengths for most temperate forests are 25 to 50 years—and thus much longer than the tenure of employees—additional decision-support and information-management tools are needed to account for the long time frames encountered from planting to harvest. The maintenance of knowledge is thus a key role for ICT systems.

Forestry is a decoupling business; lumber is sawn from the larger logs that are bucked from the even larger tree stem. Thus, a variety of coproducts are produced as part of the separation of the larger item into the smaller components. For example, if the customer wants a pruned log, the remainder of the log grades contained in the tree will be produced when the tree is felled and bucked. This coproduction of goods from the decoupling activities makes the forestry business significantly different from the more common assembly industries where the smaller parts used in a variety of finished consumer goods are combined into larger products. Coproduction prevents the forest business from relying exclusively on customer demand to drive the business, as it is unusual to have a balanced demand for all products lines at the same time. The business must combine customer demand for a portion of its product line with the ability to aggressively market to potential customers the coproducts resulting from the decoupling activities.

Wood is a natural material and has a significant amount of variability in its material properties, which makes it difficult to reliably predict what products can be manufactured from it. For example, the number of logs required to fulfill a customer order for a desired amount of machine-stressed graded lumber cannot be predicted because of the variability in the modulus of elasticity in wood which is often unknown until after the lumber is produced. Thus, another role for ICT is to be able to continually monitor the manufacturing process to ensure that customer orders are met.

Computers have been used in business since the 1950s, when General Electric first installed one to perform commercial applications (London, 2003). They are now found on nearly every desk, replacing the adding machine and typewriter. The hope has always been of an ICT revolution that would dramatically increase production. In fact, many businesses have recently begun to question the effectiveness of their ICT investments (Farrell *et al.*, 2003). A study in the early 1990s showed that managers from all businesses obtained two-thirds of their information from telephone conversations rather than from their ICT systems (Davenport, 1994). Forest business, like most industries, has adopted computer technology to automate much of its core accounting and human-resources functions, but it has been slow to invest in analytical and decision-support tools to support the broader business; this is often because of the long time horizons and decoupling processes involved in forestry. Forestry has been a slow adopter of advanced ICT. A PriceWaterhouseCoopers' survey of the Web sites of the top 100 global forest and paper companies shows that only five Web sites were considered best-in-class, while 37% received low scores of less than 50 out of a possible 100 (Kallioranta and Vlosky, 2002). This does not mean that ICT investments are unimportant. ICT can improve the performance of a business in three broad ways: automation of a process, thus saving labor costs; facilitation of process reengineering to align procedures with the company's strategy; and assisting companies to cross business boundaries to form collaborative, interorganizational relationships that will benefit all businesses concerned (Ravarini *et al.*, 2000).

ICT investments cannot be made in isolation and must take into account the overall strategy of the company. The strategy for a successful business can take one of two broad directions: one is to become a cost leader by producing goods at a lower cost than competitors; the other is to offer higher value for its goods than the competitors can offer (Porter, 1985). Investment in ICT technology can be used to help implement either of these broad strategic directions. Current ICT applications have been categorized into six areas that represent the core components of most forest business and that, when properly implemented, can lead to both cost savings and improved customer service. They are:

1. Long-term forecasting and market intelligence;
2. Collaborative forecasting systems;
3. Customer relationship management systems;
4. Manufacturing operations management;
5. Logistics management; and
6. Industrial forest management.

5.2 Long-term Forecasts and Market Intelligence

Long-term forecasting and market intelligence aim to provide the forest business with information regarding the price of or demand for their products. This is especially important in the forest business, given forestry's long rotation periods, and therefore long time horizons, and the limited ability to change forest operations quickly, with roads, for instance, often having to be built a year before they are available for use.

The usual market intelligence reports describe past market performances and predict future conditions. Examples include those produced by Resource Information Systems Inc. (RISI) that have developed econometric models able to predict prices and demand for various forest products for a variety of world market segments; these forecasts can be accessed via the Internet.

Jaakko Pöyry produces *World Fibre Outlook Studies.* These reports describe the market conditions for a variety of products for many of the forestry regions of the world. Other market intelligence services, such as *Random Length and Crows,* produce a weekly market analysis, aimed primarily at the North American markets. These reports can be quite expensive, exceeding US$10,000 per copy, but a business can easily locate and purchase them over the Internet.

Some organizations do not charge for their information. The International Tropical Timber Organization (ITTO) provides free-of-charge market information, primarily for tropical forest products from over 400 countries. The Food and Agricultural Organization (FAO) report *State of the Worlds Forests* is also available free of charge. Many of these reports were available prior to the development of the Internet. This information can now be accessed with ease. Thus, the long-term competitive advantage derived just from access to information no longer exists. The advantage now lies in firms' ability to use such information to develop their strategic plans regarding long-term demand for forest products and thus improve forest investment decision making.

5.3 Collaborative Forecasting Systems

Forestry will primarily use market intelligence and long-term forecasting for strategic investment decisions; but short-term forecasts are needed to plan and schedule annual, monthly, and weekly operations, especially in logging, sawmilling, or pulp and paper-making businesses. Collaborative forecasting brings the consumers and producers together to develop a forecast that supports all the businesses involved.

There are usually two approaches to collaborative forecasting. One approach is where one of the organizations generates a reference forecast and the partner organization updates portions of it from its own market intelligence. For example, a sawmill may share its lumber-demand figures with nonindustrial owners who supply the bulk of logs to that mill—the sawmill may have better access to market intelligence and can thus provide the best information regarding the price and demand for products than the individual landowners who may own timberland as just one part of their investment portfolios. The other approach involves each organization preparing its own forecasts separately; the forecasts are then compared and the differences discussed, with each firm contributing its own market intelligence (McCarthy and Golicic, 2001). A pulp mill and a paper mill each have equal access to market information and may be capable of generating demands for their own products; together, however, they can produce a superior forecast that will increase the profitability of both businesses. ICT is used to facilitate development, comparisons, and collaboration until an agreed demand has been reached. Both firms will use the collaborative forecasts to estimate the demand needed for their business. The benefits of collaborative forecasting can be significant. It can be used to align production to demand and save the additional products that could likely be placed into inventory if demand were less than production. There is also the opportunity to improve the service among customers as they begin to better understand each other's business. This is the formation of collaborative business relationships described by Ravarini et al. (2000) as one of the transformations created by ICT. But these benefits can be difficult to quantify (for example, in terms of increasing customer responsiveness and maintaining product availability to the customer while optimizing inventory levels). Firms involved in collaborative forecasting can achieve a reduction in costs while improving customer service, which allows them to compete using both price and value differentiations, and this results in increased revenues for both firms (McCarthy and Golicic, 2001).

5.4 Customer Relationship Management Systems

Customer relationship management (CRM) systems are difficult to define precisely. The generally accepted definition is that CRMs are systems in which customers can interact with businesses. The goal of the CRM system is to tailor marketing strategies to each customer to maximize their value to the business (Thompson *et al.*, 2000). CRM systems capture and analyze customer transaction data collected from a general ledger or customer-order capture system; their goal is to identify buying patterns that can be used to prioritize a customer's importance to the business. Once customer prioritization is complete, a campaign-management component of the CRM system will allow the marketing group to develop a marketing strategy for particular customers. The final component of the CRM system is a communication tool that can link marketing with operations to support order fulfillment (Thompson *et al.*, 2000).

When properly applied, CRM systems are able to describe those customers and products that are most profitable to the business. Unprofitable products can be dropped, thus simplifying the company's product line; this can result in a more efficient business with lower inventory and set-up costs. Unfortunately, these systems have a history of poor performance, with only 16% producing any measurable benefits after implementation (Leach, 2003).

CRM may, however, help the forest business determine the most profitable customers to ensure their demand is met, while less-profitable customers may be targeted to purchase the grades of lumber or logs that are coproduced as part of the decoupling process. In an industry such as forestry with its coproduction of products, a CRM will allow the firm to develop a demand function for its high-value products and determine the volume of what will be coproduced in meeting this demand. Using the pruned wood example again, marketing may develop a strategy to maximize the value of clearwood production but use a different strategy when selling the unpruned cores that are a coproduct of the sawing process. The CRM can be used to determine the pricing requirements necessary to sell this volume. The result is an economic analysis of the likely return from any harvest or milling decision.

5.5 Manufacturing Operations Management

An enterprise resource planning (ERP) system is an ICT application that identifies the resources needed to manufacture and transport products to customers (Sheikh, 2003). ERPs combine transactional data with production-planning and scheduling models to determine the manufacturing capacity and raw-material requirements to meet market orders. Additionally, ERPs can track all types of inventory, including the supply of raw materials, work in progress, and finished-goods inventory to allow for real-time reporting regarding progress toward fulfilling a customer order and the resulting financial data to be reported to the company. Work centers and personal and plant maintenance are scheduled to improve capital efficiency (Kapp *et al.*, 1999). ICT is an enabling technology for the implementation of ERPs; to be successful, however, ERPs depend on the ability of the business to define and adhere to a strict set of business procedures regarding how an order is processed and scheduled in the manufacturing centers and then shipped to the customer. They are often criticized for the inflexibility they can create in the business, as the processes are deeply imbedded in the ICT systems.

ERP systems are now being deployed primarily in manufacturing plants throughout the forestry sector. Mead Corporation has deployed an ERP system at a cost of US$125 million in all eight of its paper divisions in the United States. Their ERP system controls all materials used in the paper-making process, except for raw material supply. Mead Corporation believes that the largest gain from their project was being able to redefine their business processes—the second category of ICT benefits described by Ravarini et al. (2003). However, some customers are struggling with the changes (Shaw, 2000). SAPPI Fine Paper Europe have adopted an ERP in their European division that includes Web-based customer ordering and allows for a centralized logistics services (Jewitt, 2002). Madison Paper Industries have also developed an ERP application to help manage their operations; they state that they now have the capability of running their business with access to real-time data and that they can have an overview of their financial performance at any time during the month (Shaw, 2003) instead of at month's end once accounting has completed its analysis.

5.6 ICT Uses in Logistics

Logistics involves the storage and transfer of freight. In commercial forestry, there are two large logistics components. One is the movement of consumer products from the manufacturing centers to markets, while the other involves the movement of raw materials from the forest to the manufacturing centers. The movement of logs to manufacturing centers can account for 50% of the wood costs in the southeastern United States (McDonald *et al.*, 2001). In New Zealand's forest industry, log transportation accounts for 20% to 30% of the seedling-to-mill-door discounted costs (Murphy, 2003). The result is that improvements in transportation can significantly improve a company's competitiveness in world markets. Neuman *et al.* (2000) describe the best practices found among leading logistics service providers for all industries, showing the importance of ICT in the logistics portion of forestry business. They include:

1. 75% used detail planning and scheduling systems to efficiently schedule their logistics fleets;
2. 80% of all freight has product tracking capabilities;
3. 79% provide detailed order management software that allows customers to track the progress of their shipments; and
4. 83% have online bookings (or e-business bookings).

One would seek these characteristics in a large logistics service provider, but a significant component of the total transportation costs in the forest business involves the shipping of primary wood products, logs, or wood chips on specialized trucks with limited backhaul opportunities. Frequently, this fleet is composed of small transportation companies or owner-operators of an individual truck who are often contracted to a particular harvesting operation. This results in hauling fleets that are poorly controlled, leading to inefficient transportation solutions. ICT applications that have been implemented have produced significant gains. Weintraub *et al.* (1996) demonstrate cost savings of between 12% and 35% with reduction in the size of the truck fleet by 29% to 35% for the Chilean forest industry with the adoption of the advanced logistics system, Asicam. This system has been applied throughout South America and has recently been adopted by firms in South Africa. Other logistics planning systems have been developed, such as Distribution Management Systems (DMS) in New Zealand, which has developed paperless dockets to further improve the operational efficiency and data quality associated with the movement of primary forest products: instead of log receipts being entered manually by teams of data-entry clerks, data is entered through onboard terminals. Further developments in logistics are needed to produce log identification tags to support chain of custody requirements and facilitate improved supply chain management that can both withstand the harsh environment and not interfere with downstream processing such as pulping.

The forest products industry is one of the few industries, along with mining, that is required to develop and maintain much of its own transportation infrastructure. Maintenance, typically grading of unbound-aggregate roads, can consume a significant portion of the total transportation costs. Tools, such as Opti-Grade developed by FERIC in Canada, combines a road profilometer with a global positioning system (GPS) receiver. When installed on a logging truck, this system can continually measure the road roughness during hauling operations. Data are then periodically collected from the trucks using smart card technology and are used to schedule only those road segments that require grading (Turcotte, 2003). Opti-Grade has been installed in more than 20 locations in Canada and has been able to reduce grading costs by 30% (Turcotte, 2003).

5.7 ICT Uses in Commercial Forest Management

The goal of the ICT applications developed for commercial forest management is to assist in the organization of the forest to provide products and services in a sustainable manner that will maximize their value to the owner. Vertically integrated forest products firms may have a slightly different goal and seek to maximize the value obtained from the entire supply chain. ICT systems are enablers of these goals through their ability to assist in the collection, storage, analysis, and communication of forest management data required to develop the long-range-strategic to weekly order-fulfillment schedules that are prepared in the forest industry.

Much of the development in ICT technology in forestry has been to aid in the refinement of forest assessment. In the last 40 years, there has been a rapid development in remote-sensing capabilities. These data can be captured from satellite, fixed-winged aircraft, helicopter, and terrestrial platforms using a variety of electromagnetic bands and have allowed forest managers to quickly obtain a current assessment of the property. The resolution of these products has been constantly improving. There are now technologies such as Light Detection and Ranging (LIDAR) that can pick out a single tree from an image and may assist in reducing the uncertainty of what products can potentially be produced in the forest. Future research is needed to determine how to develop log-bucking or log-scanning simulation models from this detailed data that will support an improved understanding of the decoupling process. Many of these products can be purchased over the Internet; they can be downloaded immediately to the user's computer—there is no need now to wait for data to be written to tapes, then mailed, and loaded on to the company's computer system. These technologies are able to provide information that can characterize the forested area, the health of the forest, or the volume that is available for harvest. They can dramatically improve the development of sustainable forest-management plans.

Geographic information systems (GIS) are the cornerstone of the commercial forest management organization, able to easily integrate both raster and vector spatial data and the associated tabular data into a single system. These data are now the foundation of the forest planning process; they form the basis of many forest planning systems, enabling the forest to be organized to meet the owners' goals. Epstein *et al.* (1996) describe the detailed planning tools, PLANEX, being used to improve the economic returns in the Chilean industry. Planex uses a variety of GIS data layers to optimize logging-unit design. These tools, combined with the logistics system Asicam, are reported by members of the Chilean forest industry to have resulted in savings of US$20 million annually (Epstein *et al.*, 1996).

Fletcher *et al*. (1996) describe the use of remote-sensing and GIS technologies in organizing the harvest schedules for Pacific Lumber in the California redwood region. GIS technology was used to classify the approximately 81,000-hectare (200,000-acre) forest into various land-use categories, describing habitat quality for the myriad of sensitive species. This allowed the development of management scenarios using mathematical programming approaches that considered the characterizations of each management unit. The result was a plan that increased the current net worth by over US$105 million for the 120-year planning horizon, when compared with the original set of no-action alternatives. GIS tools can easily provide the data for economic-based, decision-support tools and growth-and-yield systems to allow for the evaluation of efficient silvicultural regimes to meet a wide range of market and nonmarket goods. The technology allows for increased flexibility in the preparation of forest plans, thus improving the quality of forest management.

The use of ICT is not limited to improving the efficiency and accuracy of developing and organizing data for forest planning projects. It can be used to improve the efficiency of operations. Just as ICT is changing agriculture with the adoption of precision agriculture techniques, it can also significantly improve the efficiency of many silvicultural operations used in commercial forestry. Treatments, such as fertilization or herbicide treatments, are customized to smaller portions of the field instead of an average treatment being applied to the entire field. The economic gains from these site-specific applications of chemical treatments have been well understood. Knowe (2001) describes an economic threshold model to support decision making regarding treatment of competing hardwood vegetation in pine plantation forests in the southeastern United States. These hardwood competition indices currently use basal-area measurements, but they could easily be modified to use remotely sensed data to estimate the competition using percentage canopy measures of various species groups. Treatments could then be applied to portions of the stand where this is economically justified. Advances in satellite navigation can be used to guide aerial operation to deliver these treatments to the locations where positive economic returns can be made, resulting in improved financial returns for the landowner and reducing the often-controversial use of chemical treatments in forestry.

The other area where ICT is changing forest operations is harvesting. Modern harvesters are now equipped with GPS tracking systems and GIS terminals to allow operators to display their location and prevent harvesting in areas designated for protection, such as sensitive soils or riparian preserves. Onboard communication systems using cellar phones or satellite phones allow market information to be communicated directly to the harvester. This information can be combined with maps of the remaining inventory to develop harvesting instructions based on market prices. Such developments are moving organization closer to the goal of a factory forest model with a real-time inventory system for all products. It can further enhance the relationship between harvesting and sawmilling operations to improve customer service by providing the logs necessary to meet demand. There has been very little research on the sector-level impacts of precision farming and even less for the forestry sector, but this may be an area where deployment of ICT can improve the profits from forestry through increased automation of existing processes and elimination of waste. Further research is needed to determine better methods of utilizing this information.

5.8 Fully Integrated Forestry Supply Chain

These ICT applications have predominately focused on individual segments of the forestry business supply chain. The future of ICT development will be to deploy ICTs to support the execution of the entire supply chain where all segments—customer demand, logistics, manufacturing centers, and forest operations—are integrated into an efficient supply chain network. This will support the efficiency gained from within the organization, force a firm to identify and refine its business process, and begin the creation of collaborative business relationships. Long-term forecasting is used to plan capital investments and to select silvicultural regimes to create the desirable raw materials to support these future markets. In the short term, customers who were prioritized in the CRM system on the basis of their profitability and requirements are obtained using collaborative forecasting systems that are reliant on ICT systems. Once the demand for lumber and paper is determined, it will need to be converted into demand by log type using decision-support technologies that can translate the decoupling processes from lumber and pulp back to logs. The forestry group will query its GIS system and other decision-support tools to select logging units that best meet the demand. Once these stands have been identified, the total yield for all products will be predicted and this information transmitted to the rest of the supply chain to allow the various organizations to seek markets for all the material that will be produced. Harvesting operations will be controlled using cellular and satellite phones that will allow cutting instructions to be modified and harvesting crews to produce the best mix of logs demanded by sawmills and pulp mills with real-time inventory control. Manufacturing centers will adopt procedures to best allocate their manufacturing capacity using ERP applications that allow them to process a customer order quickly through the efficient planning of their operations. Product tracking using ICT for all products—lumber, paper, and logs—will allow customers to check the status of the orders. The proposed system will use real-time data with flexible manufacturing systems within the log-making, sawmilling, and pulp and paper processes to improve decision making (Janssen *et al.*, 2004).

The benefits of such a system can be significant. Bryan and McDougall (1998) propose that a fully optimized supply chain has the potential to increase sales revenues significantly, but there are few examples of a fully optimized supply chain in forestry. Portions of the supply chain have been optimized, and the results have been significant. Examples include models to improve the log allocation to sawmills. Temple-Inland Group in eastern Texas (United States) have helped firms increase their annual profits by US$5 million (Wagner *et al.*, 1996). Similar results have been reported for the Weyerhaeuser Company in nearby Arkansas (Hay and Dahl, 1984). Weyerhaeuser developed a similar decision support system to evaluate small-log sawmilling operations for its western North American operations. Their initial test showed a return on investment exceeding 40%. Jones (1999) estimates that improved supply execution can result in a 15% to 60% reduction in inventory and a 20% to 30% improvement in delivery performance, leading to an overall cost reduction for the supply chain of between 20% and 30% for New Zealand companies. Hecker *et al.* (2000) describe savings of US$8.00 per cubic meter from inventory reductions in Germany. Kapp *et al.* (1999) estimate that a fully optimized supply chain for the South African sawmilling industry would be between 2% and 7%. This type of integrated system would not only impact the type of logs supplied to a customer but also the way these would be milled, thus connecting the customer, the fundamental element of the forestry business, to the forest (Light, 2002).

5.9 Valuing ICT Investments

Most visions of the future show the importance of ICT to business, and forest business is no exception, as ICT drivers are three of the eleven most commonly cited science and technology drivers for future conditions. They include:

- Increased technological globalization, as computing sophistication grows;
- Increased access to technology, but this could create a potential technology gap between rich and poor nations; and
- Increased reliance on the use of ICT in business (EFILWC, 2003).

The forest industry will operate in a world with increased technological sophistication where there is a greater reliance on the use of ICT to operate the business. However, investment in ICT alone does not guarantee a successful business, for there have been many failures of the components described in the previous sections. Firms seeking to remain competitive should evaluate their ICT investments with the same care as they would evaluate other large capital investments. The decision to invest in ICT begins with the larger problem of defining the company’s strategy. For example, a firm that adopts a strategy to increase market share may seek to develop ICT that supports e-business so that it can access a wider range of markets; another firm that seeks to lower its production costs may choose to adopt a new ERP system or develop an integrated logistics systems that will reduce the cost of producing or shipping its goods. A firm that wishes to increase customer service may seek to implement a CRM system and eventually develop a collaborative forecasting system with its high-profit customers. The ICT investment must match the strategic goal of the firm.

The lack of good quantitative measures of the impact of ICT on productivity has frustrated many. There are a limited number of reports describing productivity gains in all business, but none in forestry. Studies have shown a positive correlation between ICT expenditures and productivity gains, but there is a significant variability associated with the correlation between ICT investments and productivity, with some firms showing a negative correlation between ICT expenditures and productivity, that is, where ICT investments resulted in the company being less profitable (Brynjolfsson and Hitt, 2000).

Dempsey *et al.* (1998) recommend a total-value-of-ownership approach to determine the suitability of ICT investments. This approach requires a detailed business plan that includes the traditional costs of hardware and software plus implementation costs (including consultancy fees, training costs, and the transition cost of running dual systems during implementation). Benefits include savings from automation and incremental revenue generation. Additionally, the less well defined benefits include increased market share, or productivity measurements are estimated. Finally, the nonquantifiable benefits such as an improved competitive position or increased customer satisfaction need to be calculated (Dempsey *et al.*, 1998). Besides just estimating the cost and the range of well-quantified and unquantified benefits, the business plan will include a description of how the investment will be measured and what sort of time frame is involved to achieve the expected returns on the investment. Scenarios are developed that include estimating the cost if key components fail. Finally, the business plan will describe the flexibility of the software and the ability of the vendors to maintain their products as best-in-class (Dempsey *et al.*, 1998).

A firm will confirm that its strategy defines its ICT needs through this ICT-valuation approach. The company will have full ownership of the changes necessary to implement the hardware and software, but more importantly, the company will have ownership of the process changes caused by the new ICT application. The result will be ICT investments that can be adopted by the business and that are flexible for its future growth. Successful implementation of ICT solutions will show an initial productivity growth that will be equal to investment in the first year, but the productivity will increase by a factor of 2 to 8 for longer terms, as business capabilities increase in effectiveness with the adoption of the new processes (Brynjolfsson and Hitt, 2000).

5.10 Impacts of ICT on Mergers and Acquisitions

There has been an overall consolidation of the forest products industry through numerous mergers and acquisitions such as those listed here: Stora and Enso, Weyerhaeuser and Willamette Industries, International Paper acquiring both Union Camp and Champion International, and the Meade and Westvaco merger. The increasing use of ICT in all aspects of the business may make many of the mergers more complex, as the legacy systems will need to be aligned. Companies may have developed systems with a different definition of such basic units as a customer—is this a single mill or should one define a customer as all the mills from an individual company? Another example is the definition of a stand. Is a stand defined as a single unit created upon planting or a unit that has evolved through a collection of cultural activities? The result is that these definitions of the data will limit the compatibility of systems as much as a hardware or ICT infrastructure limitation. The company will need to consider recoding all data in the models to match their original model, developing a new system, or managing multiple systems and processes. Internet and e-mail providers may also need to be changed.

The Smart Paper company is a good example of the difficulties inherent in mergers regarding ICT applications. This group of investors purchased the International Paper mill in Hamilton, Ohio (United States), that had previously been owned by Champion International. During the sale of the mill it became obvious that the ICT systems would need to be replaced. The original legacy system was developed by Champion International prior to its acquisition by International Paper. This ICT application remained in operation while International Paper installed its own Internet provider and e-mail. When Smart Paper gained control of the plant, however, they had to invest nearly US$4 million in upgrading and integrating the ICT systems in this facility to align them with their other facilities (Shaw, 2003). With costs such as these, the ICT systems need to be considered as a major criterion when a merger of two or more business units is being considered.

5.11 Structure of Markets

There are many challenges needing to be faced by both the industry and the actors (e.g., centers of expertise, universities, and software providers) involved in providing innovative solutions. ICT in general, and e-business in particular, should have a long-term impact on the structure of the industry. The future of forest business is one of increased competition and globalization, with the development of an extensive plantation forest in the southern hemisphere and the development of the Russian forestry sector. Additional competition comes from other building materials such as masonry and steel products.

Describing the future is difficult, but at one extreme, the industry will accelerate its consolidation, eliminating all but the largest vertically integrated companies. Production and investment will shift from high- to low-cost producing areas. The industry will be made up of larger firms, with their internally integrated supply chains leveraging their economies of scale and controlling the production capacity (Juslin and Hansen, 2002). This scenario will result in an increased transfer of production from the North to the South, as the cost of production is emphasized. At the other extreme, the forest products industry will be made up of smaller companies that have developed multiple-firm supply chain networks emphasizing collaborative relationships and using ICT tools to allow these firms to quickly respond to changes in customer demand. The multiple sources of supply, manufacturing, and logistics supply chain networks will emphasize customer service. Competitive advantage becomes a function of the degree of cooperation within these multiple-firm supply chains. This structure will delay the shift from low- to high-cost production areas, as it will focus on existing customer relationships and consistency of service. However, the forest products industry seems rather reluctant to adopt e-business or other ICT technologies to promote the inter-firm collaborations. Indeed, in a context where companies' competitiveness is threatened as long as they keep on producing commodity products (as is currently the case), it seems rather safe to think that ICT adoption in the forest products industry should look like a tidal wave (at least with large companies): once the benefit is clearly demonstrated, every company should adopt it rather quickly. The industry structure will shift the bulk of commodity production to low-cost producing areas.

In the different context of value-added production, the adoption of e-business should have a different pattern. As companies' competitiveness should be less threatened because of the relatively small number of large players, ICT adoption should be somewhat slower, at least as long as companies can efficiently service their customers without it. From the industry structure point of view, e-business will certainly allow companies producing small value-added products to create new networked structures of business partners to fulfill customer needs that are larger and more complicated than they could fulfill in isolation. These companies may limit themselves to the largest markets to minimize the complexity of their supply chains. This networked business structure can allow firms operating in high-production-cost areas to continue to produce goods for niche markets or customized orders that cannot be fulfilled cost-effectively with the larger production units. Indeed, if companies have the ability to quickly satisfy a large customer base with a large product line, then a dominant factor of success is the use of ICT to enable organizational agility; this should, in turn, delay, or perhaps stop, such a shift from its current location to low-cost-producing regions.

The likely scenario will be a shift in commodity production to areas of low cost; fewer companies will supply the largest demand centers, but integrated networks emphasizing customer service will remain in the current areas of production. It is more difficult to tell whether ICT will have an effect or not, even though ICT progress should facilitate the improved integration of systems when compared to the heterogeneous legacy systems.

5.12 Future Development of ICT

The forest business will encounter increasing demands from its customers who will expect 24-hour customer service, with orders placed by phone, Web, or wireless connections. They will demand that orders be delivered as promised with real-time order tracking. Other customers may want to visit a variety of vendors or be able to purchase supplies via an e-auction site at the lowest prices. Additionally, customers will want seamless transfer of transactional and operational data from both suppliers and customers to support their operations. There will be an increased public demand for improved environmental performance, and customers will require assurance that the products they consume meet the high environmental standards often set by NGOs through various certification schemes. The forest products industry will need to shift its focus from attempting just to lower production costs to increasing customer service while lowering its production costs.

The largest gains that can be made by deploying ICT systems are through business transformation and the development of collaborative business relationships among various suppliers—logistics service providers, harvesting operations, as well as manufacturing centers—through integrated supply chain networks. This will allow for increased economic efficiency and customer service through collaborative processes that share information among levels in the supply chain.

This sharing of data is not without its problems, as sharing may violate antitrust regulations if, for example, firms use information to calculate a supplier's costs or set their prices so as to limit competition or prevent firms from entering the market place. Sharing of information can be further complicated when firms operate in multiple countries that may have different interpretations as to what constitutes violating antitrust laws. Companies will need to educate their employees regarding acceptable practices when using information from collaborative sources.

ICT is not a panacea for forest business success but an enabler of processes that must be defined and managed by people within firms. Successful companies will continually focus on refining their strategies to develop the processes that will allow them to operate their business profitably. Once that is completed, ICT investments can be properly deployed to implement these new methods of doing business.

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Chapter 6. ICT and Communication Paper Markets

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6.1 Background

In the past, ICTs increased consumption of communication paper products and brought about a significant growth in the productivity of the communication paper industry. Will these trends continue in the future, or are new trends emerging? These topics are the focus of the current chapter, the main emphasis of which is the impacts of ICT on the demand for and prices of communication papers. We also look at the changes such as globalization and new investment that ICT is likely to bring to the operating environment of this sector.

Two different approaches are taken. First, a data analysis is carried out to evaluate recent consumption patterns for communication papers in a number of countries of the Organisation for Economic Co-operation and Development (OECD). This analysis forms the basis of an assessment of possible structural changes in the demand for communication paper brought about by ICT. To supplement the quantitative data analysis, we also carry out a qualitative analysis by identifying the major driving forces likely to shape the future relationship between ICT and communication papers. Next, we make assumptions, based mainly on recent literature, as to how these forces will develop in the future and what their implications will be for that relationship.

The objective of the chapter is to increase awareness of the many ways in which information technology is already affecting the global communication paper markets today and will increasingly affect them tomorrow. The framework presented aims to help clarify the diverse and complex issues involved. The chapter concludes with an analysis of some of the implications of ICT for future forest research and policy.

The chapter is organized as follows. First, recent statistics on consumption and prices of communication paper are presented, and there is an analysis of whether any of the structural changes in consumption patterns in some OECD countries could be due to ICT. Differences between OECD and non-OECD countries in this respect are also considered. In the second section, the driving forces likely to shape the future development of ICT and the communication paper sector are analyzed. The third section discusses how these forces might affect the future development of ICT and communication papers. Finally, the implications of likely future developments in the forest sector are considered. In the Appendix, there is an analysis of how ICT may change the models used by forest economists to make long-term projections for the communication paper market.

6.2 Market Scenarios

World consumption of printing and writing paper and newsprint increased significantly from 1960 to 2000, despite various innovations in ICT equipment and services (see *Figure 2.1* in Chapter 2). In fact, on average, the world communication paper market seems today to be essentially like yesterday's, with trends, such as growth, continuing. However, when we perform a more detailed analysis of the statistics of different countries in terms of paper grades and of the data from the mid-1990s onward, a more diverse picture emerges.

6.2.1 Is there a structural change in consumption because of ICT?

For decades, forest economists have been publishing long-term projections on the consumption and prices of forest products, including communication papers. For example, the Food and Agriculture Organization (FAO) has been making long-term projections since the beginning of the 1960s, the most recent being the FAO (1999) Global Outlook Study and the European Forest Sector Outlook

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Study (EFSOS, 2005). The basic features of these studies, and a number of other projections for communication paper demand (e.g., the recent Jaakko Pöyry projections; see Tarvainen, 2003; Korpeinen and Ainamo, 2003) and the United States (U.S.) Forest Service projections (see Haynes, 2002), are very similar. Future consumption and prices are expected to develop more or less along the same lines as in the past. For newsprint, the growth rates in North America and in European Union (EU) countries are expected to be somewhat lower than in the past, but no major structural changes are foreseen. Some studies explicitly state that ICT will not have any important negative impact on consumption in the near future. For example, Korpeinen and Ainamo (2003, p. 9) state: "Statistics show that new media such as radio, television, and the Internet are no substitutes for paper. In fact, growth in the consumption of paper has coevolved with new information and communications technologies." On similar lines, Kangas and Baudin (2003, p. 45), on which the EFSOS (2004) communication paper projections are based, conclude: "The position of paper as the fastest growing category of forest products is often seen as being at risk due to a continuous fear of replacement by electronic solutions in the information sector. Replacement has not taken place and development of office technology has been more or less mutually beneficial for the producers of printing and writing paper." Thus, tomorrow will greatly resemble yesterday.

One of the central assumptions behind these projections is that per capita consumption of paper products is directly and positively related to per capita income (GDP) and negatively related to the price of the paper product (Chasamil and Buongiorno, 2000; Simangunsong and Buongiorno, 2001). This relationship is seen as valid across countries and over time. However, some recent studies have started to question the general validity of these assumptions (Hetemäki, 1999; Hetemäki and Obersteiner, 2001; Bolkesjø *et al.*, 2002). For example, according to Hetemäki (1999) and Hetemäki and Obersteiner (2001), it is evident that the long-term relationship between newsprint consumption and GDP in the United States has changed and that the projections based essentially on extrapolation of past trends are likely to be erroneous.

It seems apparent that ICT impacts on communication paper products differ among the various paper grades, across countries, and over time. For example, the consumption patterns and drivers for newsprint and cut-size (e.g., A4) papers are likely to be different. Moreover, the possibility of ICT having major impacts on these paper grades differs greatly among countries (e.g., the United States and India). Because of the rapid development of ICT in recent decades, it is also probable that the impacts, or their magnitude, have changed within any given country over time.

To provide a picture of the current state of the markets, an analysis of recent consumption data for different paper grades in a number of OECD countries is presented. This will shed light on whether there is evidence of significant changes in consumption patterns that could possibly be due to ICT. The discussion starts with the most intensively researched paper grade and country, namely, U.S. newsprint.

6.2.2 The U.S. newsprint market

The U.S. newsprint market is an interesting case study because of the United States' advanced ICT use and major role in the world newsprint markets—its share of the world newsprint consumption is about one-quarter. However, for the present study, the most compelling reason to study the U.S. newsprint market is that statistics show a clear structural break in the consumption pattern of U.S. newsprint in the late 1980s, and the evidence indicates that ICT was a major cause of this.

In *Figure 6.1*, consumption of U.S. newsprint from 1975 to 2004 is shown, along with the projections by FAO (1999), Hetemäki and Obersteiner (2001), and the U.S. Forest Service (Haynes, 2002). We first consider the FAO projection and its implications, as this helps to illustrate the potentially significant role that structural breaks can play in projections. The FAO projection starts from 1995; it shows that newsprint consumption will increase from 11.9 million tons in 1994 to 15.3 tons in 2004 and 16.4 tons in 2010. However, as the line showing actual consumption indicates, newsprint consumption has been declining since 1987, reaching 9.9 million tons in 2004. That is, it has reached a level last experienced in the late 1970s. The difference between the FAO projection and actual consumption in 2004 is 5.4 million tons. Viewing this “projection error” from the industry perspective, it equals the annual production of approximately 35 newsprint mills in North America (the total number of mills is 52).[1] In terms of pulpwood use, the difference between the projected and actual figure represents approximately 7.4 million cubic meters less pulpwood consumption.[2] Finally, the “projection error” represents about 14% of the world annual production of newsprint in 2004. To sum up, had actions been taken according to the FAO projection, serious miscalculations regarding newsprint investments and forestry operations would have resulted. What are the reasons behind this erroneous FAO projection?

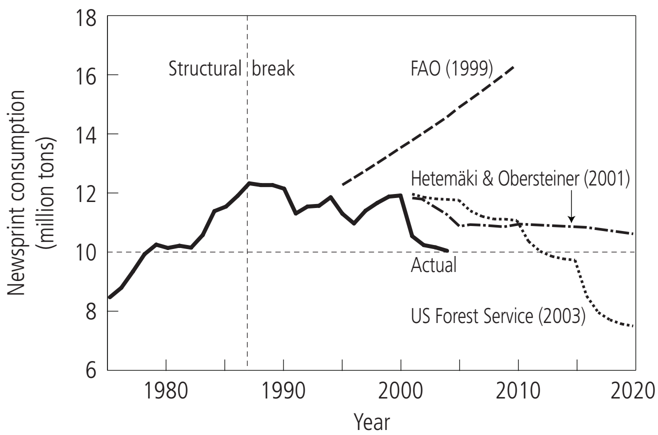

Figure 6.1. U.S. newsprint consumption 1975–2004, and projections to 2020. [U.S. Forest Service (2003) refers to the study edited by Haynes (2002)].

First, it is important to stress that the FAO projection is not exceptional. On the contrary, it is based on an approach and model that can be regarded as a standard or *classical approach*. Similar models and assumptions have been used by forest economists in general, as well as in industry consultants’ projections, for example, by Resource Information Systems Inc. (RISI) and Jaakko Pöyry. The models and assumptions are based on paper consumption reacting positively to changes in economic and population growth and negatively to paper prices. The FAO model computes the projections on the basis that, for example, a 10% increase in GDP (typically achieved in 3–4 years in the United States) would cause an 8.2% increase in newsprint consumption. However, newsprint consumption has been declining since 1987 (i.e., for 17 years) despite an average annual GDP growth rate of 2.9% per annum. The newsprint per capita consumption in relation to GDP per capita declined by 52% from 1987 to 2004. The explanation for this decline cannot be found in the newsprint price—the real price has been declining at an average annual rate of 2.5% since 1987. Finally, the population has increased on average by almost 1% annually since 1987. Consequently, instead of all the typical determinants used by experts for projecting newsprint consumption that point toward increasing consumption, the actual consumption has declined. Why?

There are a number of reasons for the structural change in the U.S. newsprint market, but it is difficult to quantify their individual effects. For example, the following factors have been important: commercial printers using newsprint have switched from newsprint to other paper grades (SC paper); the weight of newsprint has declined from 60 mg to 48 mg; there have been changes from broadsheet

[1] In North America, the size of newsprint machines varies from 60,000 tons to 290,000 tons, with the average size being 150,000 tons (Source: North American Newsprint Association).

[2] Assuming that 50% of the newsprint production is based on virgin fiber, and assuming that in mechanical pulp production the wood utilization multiplier is 2.8 (i.e., per ton of pulp), 2.8 cubic meters of pulpwood are required.

to tabloid newspaper formats; there have been improvements in technical processes. However, the most important factor appears to be that fewer people are reading newspapers, and newspaper circulation has thus declined markedly. Statistics from the Newspaper Association of America (NAA) show that in 1980 daily newspapers were read regularly by 67% of all Americans but in 2004 by only 53%. Similarly, the circulation of daily newspapers has been declining since 1988 (see *Figure 6.2*). In addition, U.S. daily newspaper advertising expenditures in real terms have stayed on more or less the same level since 1988, although with strong variability. Newspaper advertising expenditures in relation to real GDP, which indicate the relative competitiveness of newspapers as advertisement outlets, declined from 1988 to 2004.

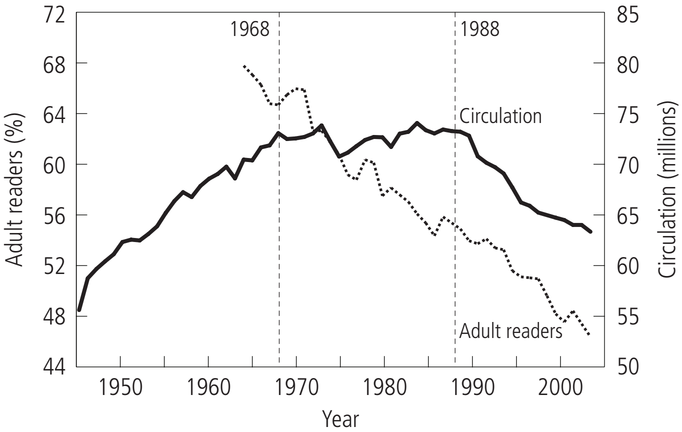

Figure 6.2. U.S. newspaper circulation and readership, 1945–2004.

What then explains declining readership and circulation trends? NAA (2001, p. 4) surveyed the media behavior of a nationally representative sample of 4003 adults. According to the study: "The first and perhaps most significant finding of the study is the decline in penetration of traditional media including newspapers, TV and radio and the concurrent rise in the use of the Internet as a source of news and information." The study also reports evidence that the increasing use of the Internet is accelerating the decline in newspaper readership. This finding is also supported by other recent media surveys (e.g., Digital Future Report, 2004), and by the U.S. Census Bureau findings (see *Table 6.1*). To sum up, people, especially the younger generations, read fewer newspapers, (magazines, and books). As the younger generations move to older age cohorts, they no longer pick up newspaper reading to the extent that happened in the past.

The above considerations point to a need for a new interpretation of the relationship between newsprint consumption and GDP in the United States. This issue is elaborated in more detail in the Appendix.

A few comments about the other two projections in *Figure 6.1*. are required. The U.S. Forest Service projection is part of the National Timber Assessment, regularly conducted by the Forest Service in accordance with the Resource Planning Act. The most recent Timber Assessment study (Haynes, 2002) provides an outlook from 1996 to 2050. The basic model used for the projection of newsprint consumption is the classical type described above (see also Appendix) but modified according to the model used by Zhang and Buongirono (1997). Thus, the model also includes a print-media price index, and television, radio, and computer price index, capturing the possible substitution impacts of electronic media. The estimated income and price-elasticity parameters have the same signs as the FAO equation, but the absolute values are greater. The model also introduces the *demand dummy calibration variable* to make adjustments so that the actual stagnating-demand growth in the period 1986–2000 can be traced. That is, the model itself cannot track recent stagnation but needs this artificial "tuning" to track the actual pattern known at the time of the projection. The dummy variable is also used to dampen newsprint demand in the first few years of the projection period (beyond 2000) to reflect the current recession in the U.S. economy. In the long run (after 2020), the dummy reflects the assumed gradual substitution of electronic media for newsprint (reducing the rate of change in newsprint consumption to 70% of what would otherwise have been predicted by the econometric formula). To sum up, the U.S. Forest Service projection acknowledges the stagnation in newsprint consumption but still uses the old model and assumptions to make future projections.

Table 6.1. Media use by U.S. consumers and projections to 2007 (hours spent annually).

Media	1990e hours	2000 hours	2007p hours	%-change 1990–2007p
1. Newspaper	208	180	168	-19
2. Magazines	146	135	119	-19
3. Books	117	109	108	-8
4. TV	1,470	1,640	1,785	+21
5. Radio	919	945	1,098	+20
6. Videos, video games, movies	57	130	226	+296
7. Internet	1	107	216	+21,500
Total	2,918	3,246	3,720	+27

Sources: Statistical Abstract of the United States, U.S. Census Bureau. Figures for 2000 and 2007p are based on the 2004–2005 issue; figures for 1990e are based on estimates using issues for 1997, 1999, 2002, and 2004–2005. The estimates for 1990 have to be used, as the reported statistics in various issues are not directly comparable.

The Hetemäki and Obersteiner (2001) projection for U.S. newsprint consumption is based not on the classical model but on a model in which newspaper circulation is used to explain newsprint consumption. Hetemäki and Obersteiner (2001) argue that the classical model is no longer valid for explaining recent U.S. newsprint consumption and should therefore not be used for long-term projections. According to these authors, after the 1987 structural break, the long-term GDP elasticity of demand for newsprint is likely to be negative. However, during the business cycle (short term), GDP is nevertheless still likely to have its conventional impact (i.e., the higher the GDP, the higher the newsprint consumption; see the Appendix for more details). According to the projection, newsprint consumption declines rather steadily up to 2010, after which the speed of decline increases. The model forecasts that in 2020 newsprint consumption will be 7.6 million tons, which is equivalent to the level last experienced in the mid-1960s.

The structural break in the U.S. newsprint market is of historic significance. It is the first major example of a communication paper market, where the long-term positive relationship between paper consumption and economic growth no longer holds. The breakdown of this “law-like” relationship has significant implications for the models used by forest economists (see the Appendix). However, it is the practical implications that, in the end, count the most. The U.S. newsprint market example points to the possibility of similar structural breaks happening in newsprint consumption in other countries and also in other communication paper grades.

6.2.3 Other newsprint markets

Ongoing research at the Finnish Forest Research Institute (Metla) analyzes the following questions: Can we observe similar structural breaks in newsprint consumption in countries other than the United States? Have there been structural breaks in other paper grades? If there have been structural breaks, what role has ICT played in them? Finally, what are the likely future developments in world communication paper markets up to 2020, and what is the role of ICT in those developments? The research project studies these questions using data on the newsprint, office paper, and magazine paper markets for 30 different countries during the period 1976–2003. Currently, these countries account for about 84% to 88% of the world consumption of these paper grades and about 90% of production.[3] Although the research is ongoing, analysis of the data has already produced some interesting results. The following discussion is based on the findings so far.[4]

Starting with the newsprint markets, consider *Figure 6.3* which shows newsprint consumption per capita and GDP per capita for Australia, Canada, Denmark, Finland, Norway, and Sweden (mean values across the countries). The six countries are similar in terms of the level and development of their GDP and newsprint per capita levels, and they all score high in terms of ICT utilization. The figure shows that for the period 1998–2003, newsprint consumption stagnated or declined. This could be an indication of a structural change in the newsprint market in these countries:[5] a change similar to the one in the United States, albeit with a time lag.

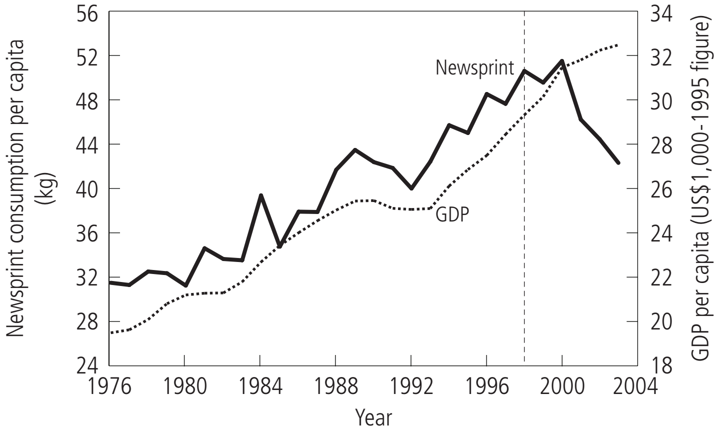

Figure 6.3. Newsprint consumption per capita and GDP per capita: Mean values for Australia, Canada, Denmark, Finland, Norway, and Sweden, 1976–2003.

According to the European Commission (2004a, p. 101), increasing use of the Internet is seen as a threat in the European newspaper industry. This study reports: "At present, less time is spent using the Internet than reading newspapers, but these relationships are changing all the time. The increasing use of broadband Internet access by consumers is making the experience easier, more attractive and cheaper in many EU member countries, and many commentators believe that it will lead to more use of online news services as a substitute for newspaper purchase."

The various issues of World Press Trends shows that newspaper circulation and advertising revenues have been declining in a number of OECD countries since about the mid-1990s (e.g., WAN, 2004). This also has a direct impact on newsprint demand. Currently, the high-GDP, high-ICT OECD countries consume approximately 75% of world newsprint production (22 OECD countries from a total of 30). Although the research to date cannot show unambiguously that ICT is a major cause of lower growth or stagnating and declining newsprint consumption in these countries, this could well be the case. On the other hand, the pattern of newsprint consumption in non-OECD countries tends to be very different. Metla research indicates that, for the bulk of the countries

[3] The countries are grouped in to three categories: (1) *High-GDP, High-ICT*: Australia, Canada, Denmark, Finland, Japan, Netherlands, Norway, Sweden, UK, and USA; (2) *High-GDP, Medium-ICT*: France, Germany, Israel, Italy, New Zealand, and Spain, and (3) *Low-GDP, Low-ICT*: Argentina, Brazil, Chile, China, Czech Republic, Egypt, Hungary, India, Indonesia, Malaysia, Mexico, Poland, Russia, and Turkey.

[4] The Metla research is based on paper consumption data obtained both from FAO and Paperloop. It is evident that for some countries and some years, the original data for both sources have errors. The Metla research has corrected/estimated the data for obvious errors (outliers), but there are still bound to be errors left. However, the overall patterns presented here should be robust.

[5] The same pattern holds for each of the six countries separately.

consuming the remaining 25% of the world production, newsprint consumption is growing rapidly—for some, for example, China, at a very high percentage rate.

6.2.4 Office and magazine paper markets

Figure 6.4 shows the per capita and total office paper consumption and per capita GDP for the United States. The term "office paper" is used here as a synonym for the paper grade known as uncoated wood-free papers (or uncoated free-sheet papers). These paper grades are used for office and business printing (copiers, computer printers, facsimiles), business forms and envelopes, on-demand publishing (mostly text reports and trade books), and commercial printing and writing (stationery). Office papers represented 45% of total printing and writing consumption in the United States in 2003. Looking at the figure, it is evident that the per capita consumption of office paper started to stagnate in 1988 and that it is no longer in line with general economic growth. From 1994 onward, consumption has actually been declining.

It is interesting to note the somewhat different pattern of the *per capita* and *total* office paper consumption. The differences suggest that population growth no longer increases office paper consumption. The specific reasons are unclear and could partly be that many of the new immigrants are working in sectors that are not "office paper intensive." Nevertheless, the clear message from *Figure 6.4* is that a structural break took place in office paper consumption in the 1990s. What are the reasons for this?

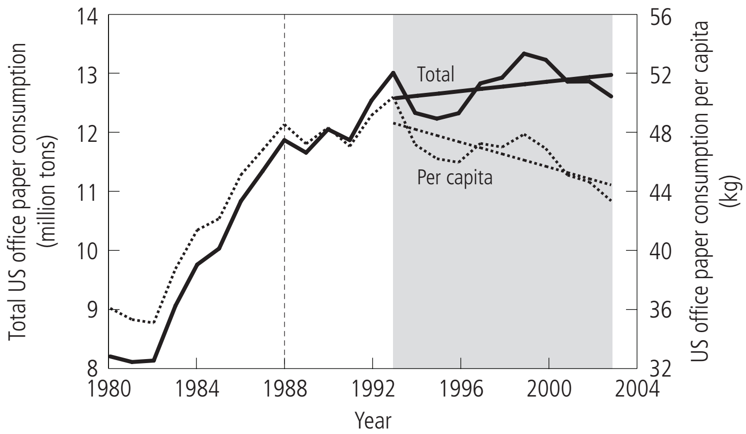

Figure 6.4. United States: Total and per capita office paper consumption in 1980–2003 (*with estimated trends computed for the period 1993-2003*).

Apparently, there are no studies of this phenomenon, which is surprising given that the stagnation/decline has been going on for 15 years and is due to the major importance of office paper in the communication paper sector. However, there are a number of ad hoc analyses and opinions by consultants and industry people. An article by Cody (2003) provides one industry analyst's view of the issue: "A key factor is that uncoated free-sheet papers have probably been affected more than any grade by recent technological trends." Cody (2003) bases this argument on the statistical demand for the components of uncoated wood-free papers—cut-size (A4) papers, offset, envelopes, forms, and other papers—for the period 1986–2002. The statistics shows that cut-size-paper consumption is still increasing, offset papers and envelopes are stagnating, and forms and "others" are declining. Shifts caused by the Internet and personal computer technology, such as electronic bill paying, e-mail communication, and Internet-related impacts on advertising, are seen to have caused slippage in demand, for example, for envelope, forms-bond, carbonless, tablet, text, and cover papers. On the other hand, the increase in demand for cut-size paper is driven by cheaper ICT equipment and printing costs that result in increasing usage of printers and copy machines. It thus appears that ICT has had both negative and positive impacts on office-paper consumption in the United States, while the net effect has been negative.

Besides office paper, the other big paper grade in the printing and writing paper category is *magazine and catalogue paper*, used not only for magazines and catalogues but also for inserts, flyers, directories, and books. In this chapter, we refer to all these paper grades as magazine papers.[6] *Figure 6.5* shows per capita magazine paper consumption and GDP per capita for the United States. Unlike newsprint and office paper, there is no indication of a clear structural break in the consumption pattern. Magazine paper consumption continues to increase, albeit with a somewhat lower growth rate since the mid-1990s.

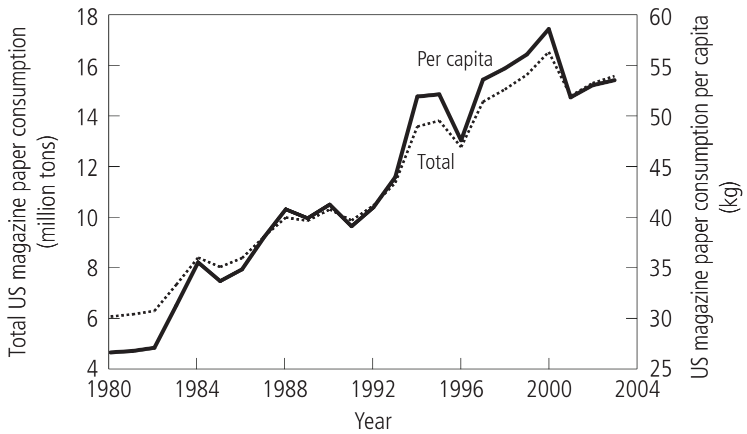

Figure 6.5. U.S. total and per capita magazine paper consumption, 1980–2003.

It is difficult to say what role ICT has played in magazine paper consumption in the United States. Household media statistics and surveys indicate that ICT may have reduced the time spent on reading magazines (see *Table 6.1*). According to the Digital Future Report (2004), Internet users in the United States spent on average two hours per week reading magazines; those not using the Internet spent 3.1 hours reading magazines. On the other hand, ICT has created a supply of many new ICT-related magazines, and the ICT industry is also an important magazine advertiser.

Turning to other OECD countries, *Figure 6.6* shows the office and magazine paper consumption per capita for a group of 10 OECD countries. The figure indicates a stagnation and decline in the per capita consumption of office paper in the last four years. Since 1998 magazine paper consumption has also stagnated. However, during this period GDP growth was slower than the average for 2001–2003. Thus, it is too early to say whether a structural break is taking place in office and magazine paper consumption or whether there is only a temporary slowdown. Some media studies point to the possibility of a structural change. For example, increasing use of the Internet has been seen as a threat to magazine reading in Europe—“26% of Internet users said that they have reduced time spent on reading magazines” (European Commission (2004b, p. 66). At present in Europe, more time is already being spent on the Internet than on reading magazines. The European Commission (2004b) report projects that increasing use of broadband access by consumers will increase Internet use in the future at the cost of reading magazines, among other media.

[6] Technically, the "magazine paper" consumption data used here was obtained by subtracting the uncoated woodfree paper consumption from the total printing and writing paper consumption (Source: Paperloop).

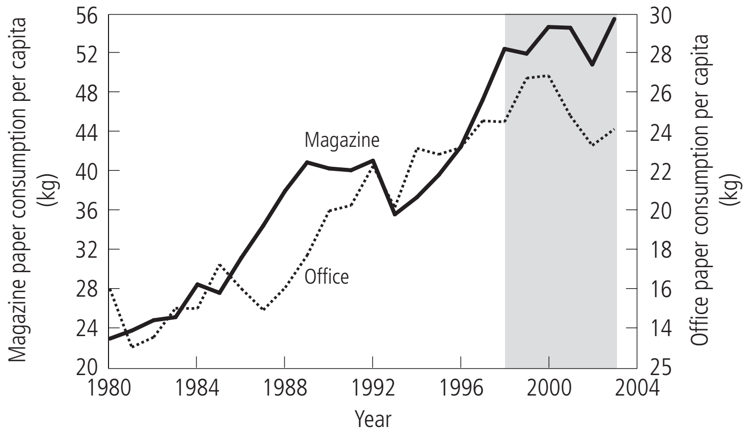

Figure 6.6. Office and magazine paper consumption per capita: Mean values for Canada, Denmark, Finland, France, Germany, Italy, Japan, Norway, Sweden, and the United Kingdom, 1980–2003.

Despite the above facts, the paper industry still tends to view the future optimistically, with the Internet and print media being seen mainly as mutually beneficial.[7] However, the attitude in the newspaper publishing industry tends to differ from that in the paper industry. For example, Arthur Sulzberger Jr., chairman and publisher of The New York Times Company, states: "If we're going to define ourselves by our history, then we deserve to go out of business. Newspapers cannot be defined by the second word—paper. They've got to be defined by the first—news. We've got to be as powerful online, as powerful in TV and broadcasting, as we are powerful in newsprint. I do not care when we print our last newsprint edition."[8] The differing views undoubtedly reflect differing interests. For the paper industry, print is the business, whereas for the publishing industry it is content (news, information, entertainment).

6.3 Future Driving Forces

Past historical data and trend analysis only provide a background against which to build future scenarios of the relationship between communication paper markets and ICT. Indeed, the drawback of many existing projections is that they typically tend to form future visions heavily based on what happened in the past. For example, the figure showing the past coexistence of print and electronic media (see Chapter 2) is very often used to argue that a similar relationship is bound to continue in the future (e.g., Korpeinen and Ainamo, 2003). This view is understandable, as the history of the world communication paper market has been one of continuous growth in tandem with economic growth (GDP). This long history, together with the theories forest economists use, leads us to believe that the positive relationship between paper consumption and GDP is written in stone (see Appendix). However, when a structural break occurs in the markets and new determinants of market development emerge, or if there is a change in the role played by existing determinants, the historical trends are unlikely to continue. Here, we have argued that such a structural break has taken place, or could be taking place, in many OECD communication paper markets.

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[7] For example, the Swedish Association of Pulp and Paper Engineers (SPCI) magazine states: "It's no secret that the printed word is facing increasing competition today, with much focus on the Internet. Yet even now, the Internet only takes just over 1% of all advertising revenues. To date, it has not competed significantly, and it has stimulated considerable demand for print through new magazine titles and companies advertising the existence of their websites. So, at a time of emergence from a period of recession, and despite the difficulties and the changing marketplace, it appears that print in Europe has a solid future" (SCPI, 2004, p.18).

[8] Cited in Gates, 2002.

The above considerations inevitably suggest the need for a closer analysis of the driving forces shaping the future of communication paper markets in the coming decades. The object should be to try to identify the most important driving forces shaping this relationship and to make educated judgments about their development in the long run. This, in turn, allows scenarios to be created of the probable impacts of ICT on communication paper markets. We now turn to such an analysis.

Following Hetemäki (1999), the major driving forces determining the relationship between ICT and communication paper development are identified as (1) economic factors, (2) consumer preferences, (3) technology, and (4) environmental concerns. These driving forces are interlinked, and, in practice, it may be difficult to separate them. However, this taxonomy is useful for expositional purposes.

6.3.1 Economics

The rapid spread of information technology is to a significant degree the result of economies of information. For example, the average annual rate of decline in the prices of personal desktop and mobile computers between 1993 and 2003 was approximately 42% (Berndt and Rappaport, 2003). There appears to be no end to this development on the horizon. Besides the hardware, the costs of computer-operating systems and information transmission and reception, such as broadband services, are decreasing rapidly. Rational consumers and producers respond to these changes by increasing the use of the relatively cheaper ICT equipment and services.

The above trend, and other economic incentives and market advantages, will work toward increasing electronic publishing. The contents of many of the intangible goods, whose value does not rely on a physical form (e.g., newspaper and magazine articles, airline tickets, bank transfers, letters) are increasingly communicated in digital form over the Internet, mobile phones, and personal digital assistants (PDAs). One essential characteristic of the digital information market is that information production is relatively costly (although not as costly as print production), while reproduction and delivery are cheap, or even essentially cost-free. To illustrate this, consider the example of costs associated with online and printed newspaper production and delivery to customers.

For a printed newspaper, the production costs comprise news production and back-office operation expenses (including information-collecting costs, administration expenses, and remuneration for reporters, editors, and management), printing and delivery costs (newsprint, transportation, labor), and fixed-assets costs (office buildings and equipment, printing-related premises and equipment, delivery vehicles). The technical production and distribution costs are typically of the order of 50% of total production costs.[9] For the online newspaper, the costs are similar except that the technical production and distribution costs are insignificant. (Online production does not require newsprint and printing facilities.) The cost difference of distributing one or 100,000 newspapers via the Internet is also insignificant (i.e., the marginal distribution costs are close to zero). With printed newspapers (magazines and books), actual demand is difficult to project, and the costs of unsold copies at newsstands have to be taken into account. For electronic online publishing, documents are printed (by the consumer) only when they are needed and in the quantity needed (*print on demand*).

On the revenue side, advertising expenditures are of central importance to newspaper and magazine publishers. For example, in the United States, 85%–90% of a newspaper's revenues are generated by advertising, and only 10%–15% comes from sales. In Germany, the United Kingdom, and Japan, advertising revenues play a smaller role but still account for from 40%–70% of income. Television, radio, and the Internet increasingly compete for this revenue. The less advertising, the fewer pages there are in the newspaper or magazine and the more fragile the economic viability of the publication. *Figure 6.7* illustrates how the share of total media advertising revenue of newspapers

[9] According to the *Finnish Newspaper Association*, the production costs for Finnish printed daily newspapers in 2002 consisted of following major items (share in total costs in parenthesis): technical editing (29%), editing (26%), administration and marketing (24%), and distribution (21%).

and magazines has been declining in the United States for the last two decades, the major reason being the increasing share of electronic media.

Currently, the main threat for print-media advertising revenue is that the Internet is attracting classified advertisements from newspapers. In future, Internet advertising is also likely to have an important effect on other types of advertising. For the high-GDP, high-ICT, OECD countries, Internet advertising expenditure still accounts for less than 5% of total advertising expenditure. Thus, there is still a huge potential for increasing this share in the future.

The economics of information production and consumption have another dimension, not discussed above, namely, the lower the costs of producing and retrieving information, the more information will tend to be available to consumers. Thus, both the supply of and demand for information is likely to increase. Much of this information will also be printed and copied on paper, making the consumption of high-quality printing and copying paper likely to increase in the near future. The further we look, however, and the more user-friendly the ways of retrieving and saving digital information become, the less likely we will be to print the information (see below).

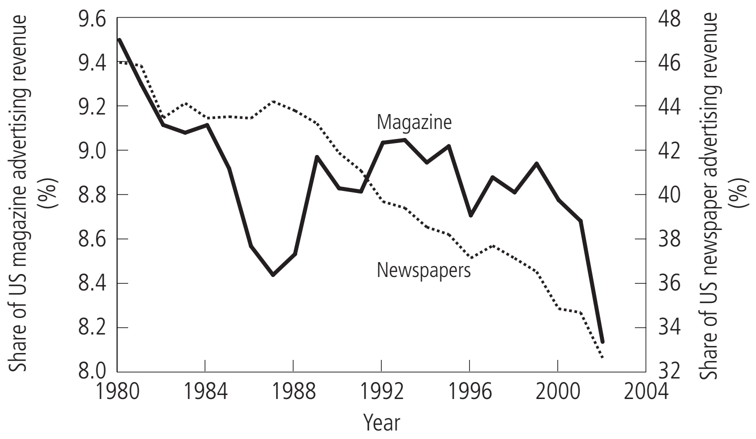

Figure 6.7. Share of U.S. magazine and newspaper advertising revenue in total U.S. advertising revenue, 1980–2002.
Source: http://www.mediainfocenter.org/compare/adrevenue/

6.3.2 Consumer preferences

The total amount of time (and capacity) consumers can spend on information or entertainment is finite—24 hours a day. As Nobel laureate economist Herbert A. Simon puts it: “What information consumes is rather obvious: it consumes the attention of its recipients. Hence, a wealth of information creates a poverty of attention, and a need to allocate that attention efficiently among the overabundance of information sources that might consume it” (cited in Varian, 1995). The growth of a new information medium, such as the Internet and wireless communication, will inevitably result in choices being made between the different information and entertainment media.

Each consumer's willingness to use a particular piece of technology, such as the Internet, depends strongly on the number of other users. This is the so-called bandwagon effect (Shapiro and Varian, 1999). Internet surveys show an exponential growth in the number of people using the Internet. According to recent statistics, the number of people with online access in the world in March 2005 was 13.9% or 889 million (http://www.internetworldstats.com/stats.htm, 31 March 2005). However, regionally, the number is unequally distributed: North America 67.4%, Europe 35.5%, Latin America 10.3%, Asia 8.4%, and Africa 1.5%.

With new technologies, new modes of consumption will also evolve. Print newspapers present yesterday’s news, and customers increasingly want to have news on what is happening now. The most up-to-date news is delivered by the Internet or by mobile communication tools. Moreover, a document is no longer just a piece of paper but can include, for example, images, spreadsheet and presentation files, electronic mail, and video. The advantages of a digital medium is that it allows diverse, interactive, productive, and innovative uses, many of which remain to be invented. Reference CDs, dictionaries, encyclopedias, directories, and databases have proliferated simply because CDs offer better methods of searching, indexing, clipping, and cross-referencing—a lesson learned, for example, by the Encyclopaedia Britannica. With new developments, such as third-generation mobile phones and wireless communication, these trends will accelerate. This type of development tends to push information from paper to electronic media. According to the HMI (2003) study, 92% of new information in 2002 was stored on magnetic media, primarily hard disks. Paper represents only 0.01% of new information storage. The HMI (2003) project has estimated that new stored information grew by about 30% a year between 1999 and 2002. The study also shows that the amount of information printed on paper is still increasing but that the vast majority of original information on paper is produced by individuals in office documents and postal mail, not in formally published titles such as books, newspapers, and journals.

Consumer preference for electronic rather than print media is also likely to strengthen in the future because of the generational factor. The younger generations are increasingly using the Internet and computers as their primary source of information and entertainment, rather than books, newspapers, and magazines. As time goes by, these new habits will start to replace the older ones with ever-increasing force. The Digital Future Project's most recent study (September 2004) identifies ten major trends that characterized the Internet's impact on people in the United States. According to the study, Internet users continue to "buy" their time to go online from hours previously spent viewing television and print media. The younger the consumer, the more likely he/she is to go with this trend.

6.3.3 Technological development

For the issue at hand, it is important to understand that paper can be viewed as a *technology*. Paper is to words and pictures what a film is to photography—a technology that allows content to be stored and delivered to consumers. That consumers and producers have seen fit to move from film to digital photography has had a dramatic impact on the consumption of film and film cameras. In principle, a similar movement could be possible between print and digital media because of technological development. We now consider this possibility in more detail.

Technology responds to incentives, just like everything else. When technology exists but the incentives for using it are missing, not much will happen. Technology starts to change economies, institutions, everyday life, and societies only when people have the incentive to adopt new technologies.[10] As new technologies first appear in a crude embryonic state with only a few specific uses, these incentives typically increase over time. Improvements and diffusion then occur simultaneously, as the technology is made more efficient and is adapted for use over an increasingly wide range of applications through a series of complementary innovations. This held true for computers. The famous and overworked quote by Thomas Watson, the chairman of IBM, in 1943: "I think there is a world market for maybe five computers," probably reflected the fact that, at that time, even a person working in the technology industry could not envisage the various uses computers could be put to, nor the way mainframe computers would evolve to PCs and handheld computers. Even today, computers are still evolving and are used for new purposes. Computers have long been sold into households as machines that can turn a home into an office, but they are increasingly used

[10] The electric engine is one example of slow initial diffusion, followed by a very rapid period of adaptation of the technology. Easterly (2002, p.179) points out: "As late as 1910, only 25% of American industry was electrified, although Edison had invented the central electricity generating station in 1881." However, by 1930, 80% of the industry was electrified. Thus, once the incentives for adaptation of the new technology are strong enough, the diffusion of the technology can be very rapid.

in bedrooms and kitchens as e-mail terminals, as hubs for playing music, for storing and editing photos, and as stations for navigating the Web.

The above examples illustrates how computers have been successfully developed and adapted to new uses. But if we consider computers as substitutes for printed paper, they have important disadvantages. Particularly, the quality of displays makes it very tiring to read things on the screen; computers are not as portable as paper, and they consume electricity. However, there is currently a rapid development taking place in "paper-like displays" and "electronic-paper" technologies that could deal with such disadvantages (Kleper, 2002; Wilson, 2003). These technologies enable digital information to be displayed on paper-like devices, such as e-paper or smart paper, or on new types of displays, such as those based on organic light-emitting diode (OLED) technology.

These technologies are targeted to a large range of applications—from microdisplays for mobile phones to very large panels for electronic billboards. They are expected to have a major impact on our future personal and business lives, as they will enable new products and applications that cannot be served by current paper-based and electronics technologies. Significant investments have recently been put into developing paper-like displays (e.g., by Xerox, IBM, Sony, and Philips). Interestingly, the world's third largest paper company, UPM, has just launched a new venture to develop a remotely updatable display and manufacturing process for the high-volume manufacturing of these displays (see: http://akseli.tekes.fi/Resource.phx/tivi/elmo/en/z-08224075.htx). In general, research on so-called *hybrid media* (the integration of wood-fiber products with digital media to develop new interactive communication tools) is rapidly expanding (see http://www.media.hut.fi/hybridmedia/).[11]

Another rapidly developing digital technology is mobile and wireless technology. According to De Freitas and Levene (2003), we are confronted with a third wave of novel ICT technologies of mobile and wearable computing, the first wave being PCs and the second the Internet. This new wave offers many communication opportunities and is thus likely to have an impact on conventional communication technologies, such as print. The convergence of a variety of electronic devices and technologies, such as cell phones with pull-out flexible displays and PDAs with display-screen projection, will also challenge conventional printing technologies (Kleper, 2002).

ICT development is also an important driving force behind the improvement in printing technology. A great many paper-based documents are created on the computer (HIM, 2003) and ICT has also enabled more people to do their own printing at home. A major trend in printing technology is digital printing at the cost of conventional technologies, such as offset (PIRA, 2004; CAP, 2003). Color printing is also a strong trend both in newspaper publishing and office printing. These trends are likely to make printing technologies more attractive and less costly to consumers and therefore to increase demand for new paper products suitable for new printing technologies. Typically, these types of papers will contain less wood fiber and more chemicals (pigments) than the conventional paper printing papers.

To sum up, technological development is likely to have two opposing effects on the demand for printed media: it will increase the opportunities for substituting digital media for printed media; and cheaper and more advanced digital and printing technology will tend to lead to an increased demand for printed media. The Boston Consulting Group (1999) projects that the effects of substitution will outweigh the complementary effects: in other words, the increase in paper use because of Internet printing and office copying will be smaller than the amount of paper products being replaced by digital media.

[11] One modern application is to put electronic currents into paper. Metal fragments embedded in the paper fibers carry a message that can be picked up at the other end, like a sophisticated bar code. Data can be carried from one database to another on pieces of paper (CEE, 2003).

6.3.4 Environment

Environmental issues are also likely to play an important role in the development of the global forest sector in the future. According to Mastny (2003), societies are interested in "shifting spending away from goods and services that cause environmental and social harm, and towards products that are more environmentally sound and socially just." This is, in essence, what has been labeled "green purchasing." In the paper and printing sector, the green purchasing trend can be summed up with the question: How can the services provided by paper be delivered to consumers with minimal resource use and pollution?

Environmental pressure groups and researchers have already started to question whether the environmental impact of electronic versions of newspapers, magazines, and books could place a smaller burden on the environment than the printed versions (Romm *et al.*, 1999; Paper Project, 2001; Strigel and Meine, 2001; Clarke and Hetemäki, 2005). In 2002 over 50 not-for-profit organizations in the United States working on paper, recycling, and forestry drafted a common vision for achieving an environmentally and socially sustainable paper industry (See www.conservatree.com). Their mission is to protect natural forests, reduce waste, and generally minimize the environmental impacts of the forest industry. They have argued that decreasing the consumption of paper and adopting ICT as an alternative to paper communication could offer a possible solution. Their concerns can be seen as a natural evolution of the debate that started decades ago on the recycling of newspapers.

The environmental pressure group's arguments are challenged by the forest industry lobby groups, such as national and international paper industry associations, as well as by more specific groups like the PaperCom Alliance (http://www.papercom.org/index.html). The latter is the voice of the paper-based communications industry in the United States whose mission is to promote paper-based products and services in the face of the challenge from electronic communication and commerce.

Important players in the issue are also paper industry customers. The paper industry exists only as a service to other industries, such as newspaper, magazine, and book publishing, and businesses using office papers (e.g., banks and insurance companies). How these sectors respond to environmental issues and ICT development will also primarily determine the impacts on the paper industry. Recent evidence indicates that environmental lobby groups may have succeeded in influencing the corporate sector to take actions. For example, a number of major commercial banks in the United States and Europe have announced paper-procurement policies that aim to reduce paper consumption so as to better fulfill the environmental sustainability criteria of their businesses (Bank of America, 2005; Citygroup, 2005; HVB, Group 2004).[12] These banks are major office paper consumers; thus such policies will have significant impacts on the office paper markets.

However, the life-cycle environmental impacts of electronics are also significant, as, for example, the recent study by Kuehr and Williams (2003) indicates. As these authors point out, the continuous updating and short life span of ICT equipment are also major causes of environmental side-effects. Depending on which information format turns out to be environmentally more friendly—printed or digital—the pressures of producing and consuming it will increase. This result aside, the environmental pressures to decrease paper wastage will also increase. For example, the landfill problems related to information production and consumption have to be addressed in one way or another. This is going to be an increasingly important issue, not least because of economic development, which will increase the demand for newspapers in non-OECD countries.

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[12] Bank of America (2005) announced on 1 April 2005 that: "The bank will minimize the volume, by weight, of paper products it purchases, where cost, quality, and general business needs allow. This will be achieved via procurement best practices, such as light weighting; internal operations initiatives, such as business process digitization; and customer product offerings, such as providing online banking customers with the option of receiving electronic statements in place of paper statements."

The per capita consumption of communication papers in the two most populous countries, China and India, was 12 kg and 3 kg in 2003, respectively. The world's highest per capita consumption is in Finland, where it was 159 kg in 2003 (United States, 132 kg). If we predict that per capita consumption of communication papers in China, India, and other non-OECD countries will reach a per capita consumption level that is only one-third that currently of Finland's, an enormous global landfill problem will be created.[13] Increasing paper recovery can mitigate but does not solve this problem, and there are technical and practical limits to using recovered paper. Moreover, recovered paper will also inevitably end up in the landfill. Besides the landfill problem, there are all the other environmental consequences, such as increasing greenhouse gas (GHG) emissions. Such problems will mean increasing incentives in the future to use digital media to reduce environmental problems related to print media services and products.

Technological development will also determine the extent to which print and digital media will cause environmental impacts, as technological development will affect factors such as energy consumption and effluents. Laitner (2003) argues that technology has played a positive role in energy consumption—new software and electronic technologies have tended to allow more efficient energy use in almost all equipment and appliances. On the other hand, technological development is leading to the integration of various electronic devices, for example, television sets, video recorders, and PCs, which are very likely to emerge as single desktop machines. This would tend to cut material wastage, and probably net energy use, compared with the current situation.

Technological development can, and undoubtedly will, also help to reduce material wastage and the environmental side-effects of paper production and consumption. The main and unavoidable problem with print products and media, however, will be their dependence upon heavy hardware technology (pulp and paper mills, machinery). Moreover, the production and delivery of print media will always involve a large amount of transportation at all stages of the product life cycle. Despite the advances in cleaner production processes, environmental side-effects related to production and transportation are very difficult to avoid. It is also often forgotten that the pulp and paper industry are heavy ICT users at practically every stage of the paper life cycle, from silviculture to recycling. Indeed, the paper industry has promoted the image of its sector as an ICT-intensive industry, for example, by stating that a modern paper mill has more computer equipment than a Boeing 747.[14] Similarly, printed information production, such as phone directories or newsprint, is also a technology-intensive process. Thus, in life-cycle analyses (LCAs) regarding print products, it is essential to take into account the ICT-related impacts, for the print sector is also faced with problems related to ICT wastage.

Technological development is also likely to play an indirect role in the environmental issues related to the question of print versus digital media. The trend of technological development is to make digital media more user-friendly (cf., the size, capabilities, and screens of PCs 20 years ago). When consumers see that paper-like displays or smart paper are as easy to use and as good quality as print media, and that they come at mass-market prices, then the environmental perspective (green purchasing) becomes much more relevant. The more consumers accept electronic media as a substitute for printed media, the easier it is for politicians and environmental authorities to regulate media that are environmentally more damaging. The regulations requiring recycled paper to be substituted for virgin fiber is an earlier example of this type of development.

Wastage is also a major *economic problem* in the newspaper, magazine, and book-publishing sectors, as it causes additional production costs (PIRA, 2004). The drive to reduce waste is related both to financial costs (to the publisher and other supply chain elements) and the environmental costs

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[13] If the per capita consumption of communication papers in China and India reached one-third that of Finland (53 kg), this would imply, *ceteris paribus*, an approximate increase of 110 million tons of communication papers in the world. This is equal to almost 80% of world consumption in 2003 (142 million tons).

[14] "It takes 25 different computer systems to keep a Boeing 747 in the air, whereas more than 100 computer systems are need to run an ultra-modern paper machine" (Krogerström, 1998, pp.12–13**).**

(to society as a whole). The environmental aspects will also affect the relative costs of the different media. For example, environmental regulation will add a cost to the environmentally more damaging media form, and this increased cost will, in the end, be paid for by the consumer. Thus, the environmental "battle" between print and digital media also boils down to economics.

6.4 The Future Outlook

What type of scenarios can be anticipated for communication paper markets? Clearly, only general, subjective remarks—not precise quantitative estimates—are possible. We first consider the impacts on paper consumption, then discuss the price issues, and conclude with a few remarks on the paper industry operating environment.

6.4.1 Paper demand

The top graph in *Figure 6.8* shows the mean values for per capita newsprint consumption in 15 OECD countries that accounted for about 75% of world consumption from 1976 to 2003, as well as trend projections to 2020. If future developments followed the 1995–2003 trend, there would be a slight decline in per capita newsprint consumption. If it followed the 1999–2003 trend, there would be a significant decline. In 2020 the level would be similar to that of the early 1980s. However, the discussion above about the driving forces shaping the relationship between print and ICT seems to suggest that newsprint demand is unlikely to follow recent trends. The ICT impacts on newsprint consumption in OECD countries up to 2020 are likely to be even stronger than in the recent past. Thus, the future could be even more bleak for the newsprint industry than *Figure 6.8* suggests. The further in the future we look, the more likely it is for print media to face an increasing challenge from electronic media.

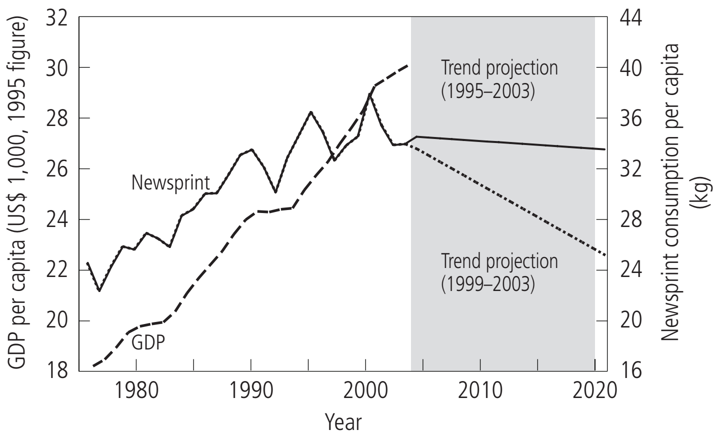

Figure 6.8. Newsprint per capita consumption and GDP per capita in OECD countries (mean values across countries) and trend projections to 2020.[15]

There are likely to be differences in the patterns of development across paper grades. ICT development is having both negative and positive impacts on the demand for communication papers, with some grades more affected than others. However, over time, the relative size of these effects is changing. For example, the most important office paper grade, the cut-size (A4) paper, is mainly used for computer printing and photocopying. The trend of declining costs for computers and photocopying/printing machines also seems to be a continuing one in the coming decades, with copy

[15] The OECD here includes the following 15 countries: Australia, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, New Zealand, Norway, Spain, Sweden, the United Kingdom, and the United States.

and printing machines increasingly being used in the home. While declining real prices usually generate more demand for printing and copying machines, technological developments make each generation of machines more efficient (quicker) and of better quality than previous ones—and thus more attractive to the user. This will result in more printing and photocopying and an increasing demand for cut-size paper.

How long this development will last is questionable, as opposing trends are now emerging. Not only are copy machines and printers becoming cheaper, but so are all the other ICT equipment and services that could be used for same purposes as cut-size papers (i.e., reading, transferring, and archiving information). We have already seen the movement of airline tickets and bank transfers to electronic format. Because of cheaper and better computers, office work is also moving increasingly online. For example, in 2004 a county board in Finland (Kaarina) decided to move completely to electronic rather than paper-based handling of its administration. Each county board member has a laptop and broadband connection, and these are used to circulate all administrative messages and documents. This is currently an exception, but for how long?

As the technology of computer and paper-like displays develops, electricity requirements decrease and costs decline, and there are increasing incentives to move from office paper printing to electronic communication. The environmental issues, as argued above, are also likely to favor the latter. These trends do not necessarily imply that electronic communication is, without question, the future choice over print communication, simply that every day the incentives for using electronic media seem to grow. But it is difficult to say when electronic communication actually starts to become a significant substitute for cut-size paper. We can predict increasingly confidently that this will happen sooner in OECD countries than in non-OECD countries for the reasons discussed above in relation to newsprint.

As far as the magazine paper market is concerned, the net impact of ICT development is also somewhat ambiguous. In recent years, ICT development has appeared to increase the number of magazines. For example, many ICT-related specialist magazines have come on to the market. This trend has naturally led to increasing demand for magazine paper. More generally, ICT development to date does not seem to have dampened consumers' thirst for magazines to the extent that it has for newspapers. However, consumer media surveys point toward increasing substitution of electronic media for magazine reading. In terms of economic, consumer, technological, and environmental driving forces, it is difficult to avoid the conclusion that, in the next 10 to 15 years, electronic media will win out over books and magazines

As stated earlier, the above communication paper demand scenarios are unavoidably subjective. However, many of the other recent studies on communication paper markets tend to come to similar conclusions, although there are differences in the details (Boston Consulting Group, 1999; CAP, 2003; PIRA, 2004). To sum up, to date, the complementarity of ICT and communication papers has been the dominant impact, but this is unlikely to remain constant—the substitution impact will become stronger over time.

6.4.2 Communication paper prices

Most of the discussion about the impact of ICT on the paper sector has dealt with paper consumption—almost nothing has been said about possible price impacts. *Figure 6.9* shows recent historic price development for newsprint and printing and writing papers in the OECD. To the end of 1980s, real prices were increasing, since when they have declined for over 10 years. How will ICT affect these trends in the future?

ICT is likely to affect communication paper prices indirectly in three main ways. First, ICT increases productivity in the paper industry. As argued in Chapter 8, the industry has an incentive to use ICT on an increasing basis to enhance productivity, which, in turn, will result in lower prices for communication paper products. Second, ICT development will strengthen the competition between electronic and print media, giving consumers more opportunity to choose where they will read news or magazine articles and how they will spend their leisure time (printed versions, television, Internet, mobile phones, multimedia handheld computers). Thus, the different media platforms will compete with each other even more, and pressures to cut prices to stay competitive will increase. Finally, ICT is to globalization what a common language (increasingly English) is to communication—the one supports and enables the other. That is, ICT helps increase globalization. In the paper industry, this means, among other things, closer interconnection between geographically different communication paper markets, with both companies and their customers increasingly seeing global paper markets as one big uniform market. This, in turn, tends to increase competition and reduce prices.

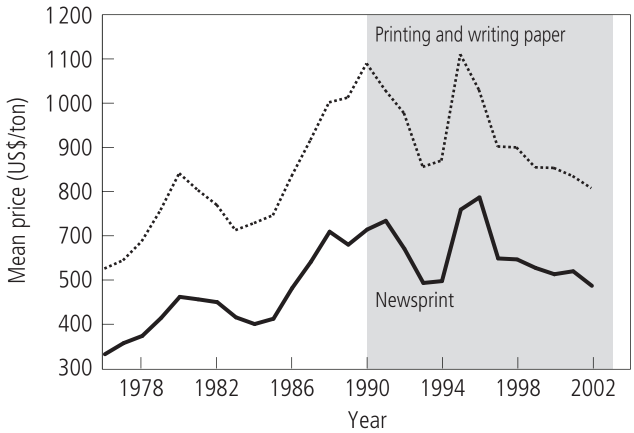

Figure 6.9. Newsprint and printing and writing paper prices (real 1995) in the OECD.

To sum up, ICT development will strengthen the current trend of declining communication paper prices. The price impact of ICT could be of great significance to the paper industry and, of course, to consumers. For example, the 2003 annual report of the Finnish-based company UPM—the third largest in the world communication paper sector in terms of output—shows that a 10% change in the product prices will have the following impact on its annual operating profits (in million €): magazine paper –310; fine paper –160; and newsprint –130 (i.e., total of €600 million). In 2003 UPM's total profits were €784 million (including the wood-working industry profits). Thus, a 10% price change can typically affect total annual profits to the tune of 70%–80%. Moreover, a price change has double the impact on profits that the same percentage change in sales has. As is often observed, paper industry revenues may be declining, despite increasing output volumes, and this is another reason why continuous cost reduction is a basic feature of the paper business.

Thus, when discussing the potential impact of ICT on communication paper markets, it is important to acknowledge the impacts of product price shifts and not just of shifts in demand, which is what usually happens. The practical problem is that the impacts of ICT development on prices are probably even more difficult to analyze and measure than the impacts of ICT on demand, and are thus easily overlooked.

6.4.3 Implications for operating environment

Besides the impacts on communication paper consumption and prices, ICT will also change the operating environment of the global paper industry and the forest sector in general.

One major impact is that ICT enhances a trend that is already taking place for other reasons, for example, relocating the paper industry from OECD countries to non-OECD countries. As indicated above, ICT can be expected to decrease the demand for communication papers in OECD countries. In the non-OECD countries, however, consumption continues, and in many countries, continues to grow. Incentives to invest in these countries are therefore greater, while at the same time, OECD countries become less attractive investment locations. Other ICT-related impacts only enhance this problem. ICT is an enabler for global companies with operations in various continents and makes investment in non-OECD countries easier. ICT also increases the possibility of paper company mergers, both in OECD or non-OECD countries. In short, the changes caused by ICT tend to strengthen the "outsourcing" of communication paper demand and production from OECD to non-OECD countries. For countries whose economies rely heavily on the paper industry and forestry (e.g., Canada, Finland, and Sweden), this development will also have significant economic and societal impacts. The changes in the paper industry and in communication paper markets are also likely to have important implications for forestry, perhaps resulting in structural and locational changes in roundwood demand that may be reflected in changes in forest use.

Considering the long-term nature of the forest industry and forestry investments and the significant likely impacts of ICT on the forest sector, there is clearly a need for more research and policy dialog on this topic. It is important to stress that ICT does not necessarily imply a diminished role for the forest sector in the future—the importance of forests in our societies does not disappear with the development of ICT. Instead, ICT may bring in structural changes and new priorities within the sector. In the OECD countries at least, the recent increasing importance of environmental and ecosystem benefits, tourism, and other forest-related services will probably strengthen even more, while conventional industrial wood-production activities will decrease (Di Castri, 2001). However, ICT development will also help in the utilization of new wood-based businesses opportunities, such as those related to biorefinery (Thorp and Raymond, 2004). Policymakers and institutions should reflect on this development.

6.4.4 Differences between OECD and non-OECD countries

In principle, the driving forces discussed above are universal. However, as *Figure 6.10* shows, newsprint demand has grown at an increasing speed in non-OECD countries, despite the increasing use of ICT in these countries. Why the difference between the OECD and non-OECD newsprint consumption pattern?

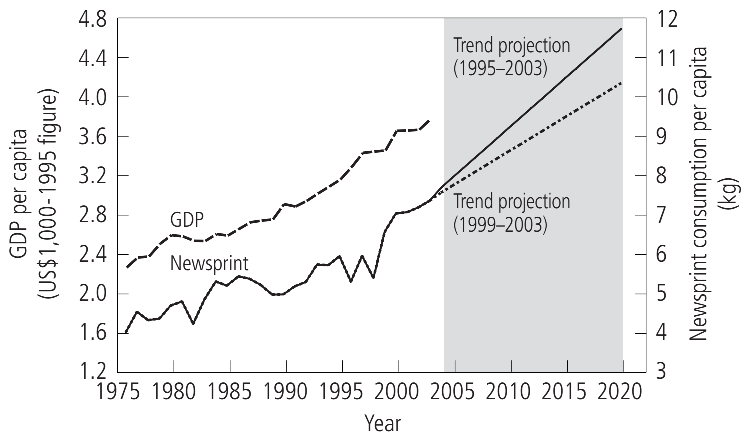

Figure 6.10. Per capita consumption of newsprint and GDP per capita in non-OECD countries (mean values across countries) and trend projections to 2020.[16]

There appear to be two main causes. First, the per capita consumption level of newsprint and printing and writing paper in OECD and non-OECD countries is very different. In non-OECD countries it is five times lower than in OECD countries (7 kg versus 35 kg in 2003). Should the non-OECD countries follow a pattern similar to that of the OECD countries, the newsprint consumption

[16] The non-OECD includes the following 14 countries: Argentina, Brazil, Chile, China, Czech Republic, Egypt, Hungary, India, Indonesia, Malaysia, Mexico, Poland, Russia, and Turkey (Note: Czech Republic, Hungary, Mexico, and Turkey are actually members of the OECD).

level will still be far from saturation point. As non-OECD countries advance economically, this cap will tend to grow smaller and newsprint consumption will increase. Second, the level of ICT use in non-OECD countries is far lower than in OECD countries (see *Table 6.2*). For example, according to the ICT index used in Metla research to measure the spread and use of ICT equipment and services, the 2002 index for the non-OECD and OECD countries, respectively, was 835 and 2,303.[17] The highest figure was for Sweden (2,806), which is over 27 times bigger than the lowest figure [India (102)].

Table 6.2. Population, communication paper consumption, and ICT rankings in 2002.

	Population (million)	Newsprint per capita (kg)	Print. and Writ. per capita (kg)	ICT* index average
Western Europe	340	34	68	2,348
CHP** + Russia	203	7	22	1,335
North America	320	35	94	2,351
Asia	2,565	5	6	508
Japan	127	30	86	2,252
Australia & New Zealand	23	33	60	2,243
Latin America	329	4	10	805
Egypt, Israel, Turkey	142	12	7	1,023
Total	4,026	8	22	

*ICT index = (Internet users + mobile phones + PCs + TVs)/1000 people.

Note: In the data set, the continents include the most important paper consuming/producing countries, not all countries. **CHP refers to Czech Republic, Hungary, Poland.
Source: Metla data set.

As regards the future impact of ICT in non-OECD countries, big uncertainties loom. Are these countries following the pattern of current OECD countries? Will they ever reach the level—or even half the level—of the per capita communication paper consumption currently observed in OECD countries? Or could they—would they—leapfrog to the "ICT society" and never go through the high level of print-media consumption? If so, what sort of timetable are we looking at?

Other examples point to the relevance of the above question, for example, the leapfrogging in the adoption of mobile phone technology without the intermediate step of land-line technology. A large part of the African population has not had, nor is ever likely to have, access to land-line phones, but does have access to mobile phones. In other words, much of Africa will perhaps never be covered by cable-based, land-line information, and communication technology because of the high cost of land-line technology and the rapidly falling costs of mobile technology. Mobile phones are also used in many new and innovative ways in Africa to reduce transaction costs (*Economist*, 2005). In principle, similar leapfrogging could take place in media. If economic and consumer incentives to move to electronic instead of print media are strong enough, some developing countries are unlikely ever to experience communication paper consumption patterns similar to those of the industrialized countries. Never having had the old technology on a mass-market basis could even be advantageous to them.

Currently, even though there are apparently many incentives for non-OECD countries to increase their ICT use, in practice, cultural and economic factors seem to favor gradual development, at least in the coming decade or so. The ICT substitution effect in non-OECD countries is not strong enough, now or in the near future, to stop the growth in communication paper consumption. However, the

[17] The Metla ICT index country classification is almost identical to that of the International Telecommunication Union (ITU) index, introduced in 2003 (http://www.itu.int/home/index.html).

further we look into the future, the more likely it is that non-OECD countries will follow the pattern of OECD countries (i.e., a gradual slowdown in communication paper consumption).

In the coming five to ten years, the increasing communication paper consumption in the non-OECD countries is likely to be larger than the decline in consumption in the OECD countries. The net effect is that world communication paper consumption will increase in the coming decade. The closer we come to 2020, however, the more likely it is to decline.

6.5 Conclusions

In 1854 *The Times of London* offered to pay £1,000 to anyone who could develop a method of using rags as the raw material in papermaking. While the announcement did not produce the desired result, it clearly demonstrated the need to resolve the shortage of raw materials that was causing such problems for papermakers and their customers. Today, 150 years later, the big challenge in the paper industry is not raw materials but that paper may no longer be needed to transmit information. In the present chapter, we have tried to outline the potential challenges of ICT for the communication paper sector.

First, we argued that a structural break has either taken place or can be expected to take place in communication paper markets in many OECD countries. The historical relationship between economic growth and growth in the demand for paper seems to have broken down (e.g., in North America and the Nordic countries). This is most evident in the case of newsprint, but indications, albeit less strong, are also present for office paper grade. Magazine papers do still seem to be following the historical pattern more closely. It was also argued that ICT development is an important factor in these structural breaks, although this is still an open issue in the literature.

Many paper industry analysts have become so sure that there is a continuous positive relationship between paper consumption and GDP growth that they still claim it to be valid, even in markets where there is ample evidence that this is no longer the case. In this climate of seemingly ever-rising economic growth and paper consumption, it is no wonder that some recent paper-demand projections (basically, extrapolations from past trends) have failed badly to track the actual pattern. One message of this chapter is that we should be alert to potential market changes when making projections about future consumption, as extrapolations from the past are likely to be poor indicators of future patterns. Moreover, a clearer distinction needs to be made between the short-term and long-term impacts of economic growth. As argued in the Appendix, during the business cycle the relationship between newsprint consumption and GDP can still be positive, although in the long run it may be negative.

It was also stressed that ICT, in addition to its impacts on the consumption of communication paper, can have important implications for prices. ICT tends to increase competition in paper markets in various ways and thus increase the pressure to lower prices.

It was argued that economics, consumer preferences, technological development, and environmental considerations will be the major driving forces to shape the relationship between print and ICT in the future. We built scenarios, or rather visions, of the likely development of these driving forces and how they would affect the future development of the communication paper sector and the forest sector in general. The major conclusions follow.

In the near future, say, in the next 10 years, development in OECD and non-OECD countries is likely to be very different. In OECD countries, the trend will be toward favoring electronic media/communication at the cost of print media/communication. For print newspapers, this will mean declining readership and thus declining newsprint consumption. For office papers and magazine papers the outlook is more complex, with both positive and negative impacts. Substitution effects will strengthen with time. In principle, the impacts should be similar for all countries—and may well be. However, in non-OECD countries, because of the significantly lower level of per capita communication paper consumption, lower economic wealth, and a low ICT utilization level, the net effect will be a growing communication paper market, at least in the coming decade or so. This growth in demand will more than offset the declining and stagnating pattern of communication paper consumption in OECD countries. Thus, the net effect for world communication paper demand is currently still positive. However, over time, there is an increasing likelihood of declining communication paper markets in non-OECD countries. The timing of this impact is the great uncertainty looming on the horizon of world communication paper markets and thus of the global forest sector.

While technological development creates new technologies, it has an inherent tendency to destroy old ones. The history of technology provides plenty of examples. As Easterly (2002, p. 177) noted: “Beyond the happy façade of technological creation are some technologies and goods that are being destroyed. Economic growth is not simply more of the same, producing larger and larger quantities of the same old goods. It is more often a process of replacing old goods with new goods. People who were producing the old goods may well lose their jobs, even as new jobs—probably for other people than the people who lost their jobs—are created producing the new goods.” So far, at the global level, ICT has not yet replaced communication papers or industry jobs and the sectors linked to them. But while paper is still being made in larger and larger quantities, this may be changing, at least in a number of OECD countries—the U.S. newsprint market being the most significant example.

Where new and old technologies and the industries and services built around them, still coexist, conflicts may arise. According to Easterly (2002, p. 177): “Vested interests wedded to the old technology may want to block new technologies.” Moreover, a society that has established countless routines and habits, norms, policies, and regulations to fit the conditions of the existing technology does not find it easy to assimilate the new technology. The successful diffusion of the new technology and the opportunities it brings may be possible only after what has been called “institutional creative destruction,” where old institutions are gradually replaced by new ones (Perez, 2002). The new situation is particularly challenging for countries heavily dependent on the paper industry and forest sector, such as Canada, Finland, and Sweden. These countries have big stakes and vested interests in the old communication paper sector and, understandably, are not interested in giving these up.

Hence, the increased importance of new strategies in such countries. Policy-wise, there would appear to be a need for increased physical and intellectual investment (R&D). First, more research is needed to study the actual phenomenon (i.e., what are the implications of ICT development in the forest sector?). Second, with the potential decline of the communication paper industry and related forest sector operations, what new opportunities are there for forest-based businesses? These could be increasingly forest-related services rather than wood production as such. However, wood utilization could also be increased in areas such as biorefineries (e.g., substituting wood-fiber-based energy for fossil-fuel energy) and pulp derivatives (e.g., health and food products, textiles). Policies are also needed to make the adjustment from the old to the new technology as smooth as possible, for example, creating new opportunities and “safety networks” for people working in the old technology sectors.

Still, the most immediate and important challenge in these countries is to acknowledge that the forest sector is facing a *structural change*. Past history suggests that societies tend to have difficulties in accepting structural changes before these start to have serious side-effects. It is, however, essential to start coming up with strategies now against the time when communication paper products no longer provide a livelihood for the forest sector (e.g., in North America and the Nordic countries). That day may be 10 or 20 years hence, but it will be too late to start thinking about new opportunities once it has arrived.

Appendix: ICT, Paper Demand Models and Projections

This chapter shows that there has been a structural break in newsprint markets and, to a lesser extent also, in office paper markets in a number of OECD countries. It has been argued that ICT development has been an important factor in this. The structural break is characterized, among other things, by the fact that the relationship between GDP and consumption has changed from positive to negative. This issue appears to have first been raised in the context of U.S. newsprint markets in Hetemäki (1999), and was later studied in Hetemäki and Obersteiner (2001). The finding is very challenging for forest economics from the methodological point of view, as shown below. Here, we discuss these challenges and their implications for research.

Classical Approach

The basic structure of the econometric models used to project forest products demand has not changed significantly over time (see e.g., McKillop, 1967; Kallio *et al.*, 1987; Solberg and Moiseyev, 1997; Simangunsong and Buongiorno, 2001). Typically, the theoretical background of the models is production theory, according to which the forest product enters as an intermediate input in the production function along with other inputs. Let us assume that a behavioral hypothesis, for example, cost minimization, allows the formulation of an optimization problem from which the demand for the forest product can be derived. Typically, this setting produces a demand function, such as that in the Global Forest Products Model (FAO, 1999) and in Simangunsong and Buongiorno (2001), and expressed as equation (1)

$$C_{ik} = a_{ik} P_{ik}^{\sigma_{ik}} Y_{ik}^{a_{\sigma_{ik}}} C_{ik,-1}^{\eta_{ik}}, \qquad (1)$$

where C_{ik} is the consumption in *i*th country for commodity *k*, C_{-1} is demand in the previous year, *P* is the price of the commodity, *Y* is a proxy for economic activity or income (usually GDP), and σ, a, η are the elasticities with respect to price, income, and past demand. The empirical model corresponding to (1), after taking a logarithmic transformation and using empirical data corresponding to the theoretical variables, can be written as

$$c_{k,t} = a_0 + \beta_1 GDP_{i,t} + \beta_2 p_{k,t} + \beta_3 c_{k,t-1} + \varepsilon_t, \qquad (2)$$

where the small letters denote natural logarithms, $c_{k,t}$ is the quantity of forest product consumption, GDP_t is gross domestic product, p_t is the real price of forest product *k*, $c_{k,t-1}$ is the lagged dependent variable capturing the possibility that in the short term, demand may adjust only partially, ε_t is the error term, and *t* is a subscript denoting the time period. As the variables are in logarithmic form, the β-parameters can be interpreted directly as elasticities. Typically, the studies assume that the signs of the elasticities are known a priori. For example, Simangunsong and Buongiorno (2001, p. 161) state that on the basis of the universality of the economic laws of demand, "one would expect the price elasticity of demand to be non-positive and the GDP elasticity to be non-negative." To guarantee that the elasticities are assigned correct signs and magnitudes, they can be restricted or directed in empirical estimation to fulfill this objective. Indeed, Simangunsong and Buongiorno (2001) use the so-called Stein-rule shrinkage estimator for this purpose.

The model (2), and its variations, have been the most common models used by forest economists for decades to generate long-term outlooks for forest-product consumption (e.g., by FAO, U.S. Forest Service, Jaakko Pöyry, RISI). It is thus appropriate to label it the classical model. For example, FAO (1999) estimated the model for newsprint consumption of 26 high-income countries (including the United States), using annual data for 1961–1994, and obtained the following estimates,

newsprint consumption = -0.02 newsprint price + 0.45GDP + 0.46 newsprint cons.$_{t-1}$

The equation had a good fit, explaining 98% of the historic variations in newsprint consumption. The long-term price and GDP elasticities derived from the above equation are –0.03 and +0.82, respectively. These are in accordance with earlier elasticity results obtained in the literature (see review in Simangunsong and Buongiorno, 2001). The FAO used the model to compute projections for newsprint consumption for the period 1995–2010 (projections for the United States are shown in *Figure 6.1*).

For the purpose of this Appendix, the GDP and price elasticities for U.S. newsprint consumption were estimated. The estimations were carried out separately for the period before and after the structural break (1987) and using both annual and quarterly data. A number of static and dynamic specifications were also estimated. The summary of the elasticity results is shown in *Table A.1*. The results are in line with those found by Hetemäki and Obersteiner (2001). During the pre-1987 period, a 1% change in GDP would have resulted in a 0.63%–0.98% increase in newsprint consumption, depending on the specification chosen. However, after 1988, a 1% change in GDP would have resulted in a 0.22%–0.44% decline in newsprint consumption. Clearly, the results are very different from those used by the FAO (1999) for U.S. newsprint.

Table A.1. The long-term GDP and price elasticities for U.S. newsprint consumption.

Period	GDP (t-values in parentheses)	Price (t-values in parentheses)
Annual data	+0.63 – +0.69	-1.20 – 0.37
1961–1987	(3.86 – 31.9)	-1.20 – -0.37
1988–2004	-0.44 – -0.24	(1.39 – 4.16)
	(1.39 – 4.16)	(0.30 – 3.33)
Quarterly data	+0.96 – +0.98	-0.06 – -0.05
1979:1–1987:4	(5.48 – 23.20)	(0.09 – 1.70)
1988:1–2002:4	-0.36 – -0.22	-0.04 – +0.003
	(1.06 – 5.01)	(0.09 – 2.06)

Note: The scales show the range of values obtained for the coefficient estimates and t-values in the different specifications.

For forest-economics research, the most important implication of the results is that the classical assumptions of positive GDP elasticity and negative price elasticity are not supported. The relationships seem to be exactly the opposite. However, the price variable seems to lose explanatory power and no longer seems to be the relevant variable explaining the long-term pattern of newsprint consumption.

We also estimated the short-term elasticities for the two periods using quarterly data. The estimations were carried out by first removing the long-term trend from the data using the Hodrick–Prescott filter (Hodrick and Prescott, 1997). The results showed that, in the short term, both GDP and price variables are still significant explanatory variables. Moreover, they have conventional impacts (i.e., positive GDP elasticity and negative price elasticity). What does this imply?

The higher-economic-activity level (GDP) still increases cyclically, for example, newspaper advertising (more classified ads), perhaps even circulation, and therefore also newsprint consumption. Moreover, newspaper publishers clearly care about the cyclical newsprint price changes. These short-term results stress the importance of being able to clearly distinguish short-term and long-term elasticities in forest-products-demand models. However, the way forest economists typically estimate and compute short-term and long-term elasticities may not allow these two impacts to be sufficiently distinguished. [18]

[18] The short- and long-term elasticities are typically estimated from the same data, from the same model, and using the same estimated parameters. For example, estimations from equation (2) provide the short-term elasticities directly, and the long-term elasticities are generated by dividing the GDP and price parameters by

The above results raise the important questions: what is the reason for qualitatively different short-term and long-term GDP elasticities for newsprint consumption and how may these be interpreted? As these questions have not yet been explicitly studied, no conclusive answer can be given. However, an explanation and interpretation are put forward that seem worthy of further analysis and testing.

As indicated in this chapter, recent data and studies on U.S. media behavior show people to be reading fewer newspapers while simultaneously increasing their consumption of electronic media, especially the Internet (NAA, 2001; Digital Future Report, 2004). Economic wealth (i.e., GDP) is apparently one of the factors that allow this substitution to take place. The higher the GDP, the more wealth households have at their disposal to buy relatively expensive multimedia services (PCs, Internet accounts, broadband services, televisions video games). Society as whole also has more money to invest in new electronic media and innovate new services and products, which implies increasing opportunities for electronic media to be substituted for print newspapers. These types of structural changes tend to be slow and gradual and can be clearly identified only over periods that are longer than the typical business cycles. Such impacts can thus be captured only by the long-term GDP elasticities, whereas the short-term GDP elasticities tend to reflect the cyclical economic impacts.

Besides the structural impacts of ICT, the negative long-term GDP elasticity could also be partly due to saturation of newsprint consumption. The higher the GDP and newsprint consumption per capita in a country, the more likely it is that newsprint consumption is reaching saturation level, after which further GDP growth no longer leads to increases in newsprint consumption. Evidence from the intercountry comparisons, however, indicates that the latter seem to be of less importance. For example, newsprint consumption has started stagnating or declining at different per capita levels in different countries. As discussed, this conclusion also seems to be supported by various media studies conducted in recent years in a number of OECD countries.

To summarize, GDP can still be a useful indicator for forecasting changes in short-term consumption, even in OECD countries. However, in the long run, GDP growth is likely to have a negative impact on newsprint demand in these countries. That is, it will enhance the possibility of other media and activities being substituted for newspaper reading and/or taking advertising revenue. Therefore, the nature of newsprint as a product becomes what one economist has called an *inferior good*. [19]

Implications for Research

Above, it was argued that the GDP variable in the classical model may need a new interpretation. Indeed, the usefulness of the classical model for modeling and projecting the markets faced with the type of structural change mentioned above has been questioned, as it is no longer capable of tracking recent behavior in these markets.[20] The newsprint price variable also seems to have a low or insignificant importance in explaining the long-term development of newsprint consumption.

$(1-\beta_3)$. How well this allows the short-term and long-term impacts to be separated is questionable. A more useful method would probably be to use two different additional data sets to generate the two elasticities. For the short-term elasticities, one could use detrended data, preferably quarterly or monthly data. On the other hand, for the long-term elasticities, one should use annual and nondetrended data, and perhaps in addition transform the data using 3–4 period moving averages.

[19] A good for which an increase in income causes a decrease in demand, or a good with a negative income elasticity of demand (leftward shift in the demand curve). Public transportation is an example—as people's incomes rise, they stop traveling by bus and use their own cars.

[20] The classical model is still very useful and has the conventional interpretation for probably most non-OECD countries. It is also valid in many OECD countries for a number of paper grades.

Clearly, there is a need to innovate the modeling of OECD newsprint markets that have experienced or are facing a structural break. In building these models, it may be more productive to start by modeling consumers' media behavior rather than representative firms' production processes, as is done in the classical model. To this extent, variables and data on, for example, newspaper readership and circulation in different age categories over time is likely to be important. Hetemäki and Obersteiner (2001) suggest a new model for projections of U.S. newsprint consumption, based on using the newspaper circulation variable to explain newsprint demand. The development of newspaper advertising (expenditure or advertising volume in pages) would also probably be a useful variable.

There are also more fundamental lessons to be learned. The long-term-outlook studies published by forest economists have tended to be more concerned about the theoretical consistency rather than the forecasting ability of their models. The guiding principle here, however, should be that one is looking not for a theoretically well-defined model but for a good projection model. If the structural patterns in the markets change, the projection models will probably also need changes, and these do not necessarily fit well with existing theories. Indeed, the forecasting literature does not appear to support the belief that a greater reliance on economic-theory-based models will help forecasting (Hendry and Clements, 2003; Stock and Watson, 2003; Hetemäki and Mikkola, 2005). This does not mean that theory could not be a useful starting point for a forecasting model—even for the final model. However, theory should not be a straitjacket.

In general, there needs to be a greater understanding of the type of structural changes that ICT and other factors are playing in global forest products markets and how we need to change our models as a result of these. Historic trends are unlikely to continue.

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Chapter 7. ICT and the Paperboard and Packaging Industry

Peter Ince, Sanna Kallioranta, and Richard Vlosky

7.1 Introduction

The purpose of this chapter is to describe the reasons for the development of ICT and e-business systems in the paper and paperboard packaging industry and to discuss future scenarios that may serve to guide forest-sector research in this topical area. The paper and paperboard packaging industry encompasses producers of primary paper and paperboard packaging materials (paper and paperboard mills) plus secondary producers who convert paper or paperboard into packaging products, such as corrugated containers, boxes, sacks, or other forms of paper or paperboard packaging. Some firms in the industry are vertically integrated, being both primary paper or paperboard producers and secondary converters.

Beyond general reasons for the development of ICT and e-business systems, the chapter focuses on ICT and e-business developments that are unique to the packaging industry, for instance, the ongoing development of "active" or "intelligent" packaging systems. Several hypotheses are explored regarding the market consequences of ICT developments for primary paper or paperboard producers, leading to a set of speculative future scenarios. Forest sector research needs are identified in relation to those market scenarios, including the need for 1) economic models to evaluate market impacts of ICT and e-business developments and 2) research on how to identify and take full advantage of ICT and e-business applications in the context of competitive corporate strategies.

7.2 Background

An overview of ICT and e-business developments in the paper and paperboard packaging industry reveals that some ICT developments are fairly unique to the sector, whereas other ICT developments are shared generally with other business sectors but have unique impacts within the sector. One unique ongoing ICT development is that of active and intelligent packaging ("interactive" packaging). Along with increased use of paper and paperboard packaging in display advertising, interactive packaging offers expanded future markets and applications for paper and paperboard packaging. Other ICT developments shared generally with other business sectors include virtual supply chain integration and collaboration, online product sales and ordering, and business-to-business market exchanges, which have general and also unique benefits and consequences within the paper and paperboard packaging sector. Most of these developments appear to share a common set of motives or drivers, including the goals of greater cost competitiveness, operational efficiency, and exploitation of new market opportunities, linked to business strategies.

7.2.1 General strategic drivers of ICT and e-business development

The goal of competitive advantage is one of the general strategic drivers of ICT and e-business development within the paper and paperboard sector. An industry survey by Vlosky (2000) revealed that gaining competitive advantage, making the company more responsive to customers, and attracting and retaining customers were the most important reasons for implementing Internet business technologies (e-business) in the United States (U.S.) paper industry. Moore (2002) also noted that among United Kingdom paper businesses, the motivators for e-business were competitive pressure and changing customer needs.

Armstrong and Sambamurthy (1999) argued that the effective application of ICT supports, shapes, and enables the firm's business strategy and value chain activities. According to Varadarajan and Yadav (2002), e-business technologies can potentially influence the competitive market strategy of a business and the efficiency of its operations. Chan and Davis (2000) stressed that the decision to implement e-business solutions should be derived from business or market strategies.

The prevailing business strategy for many primary paper or paperboard manufacturers has been to become a low-cost producer of fairly standard commodity products, such as standard grades of paper or paperboard, focusing primarily on tonnage produced and cost-efficiency (Klass, 1999). This particular business strategy (the cost-leader strategy) leads to corresponding expectations for ICT and e-business. The expectations of the cost-leader strategy can be compared and contrasted with expectations of other business strategies according to Porter's (1985) generic strategy types (*Table 7.1*).

Table 7.1. Expected contributions of ICT development among Porter's (1985) generic business-strategy types.

Strategy type	Expected utilization and contribution of ICT
Cost-leader	Efficient operations Reduced transaction costs Standardized and efficient customer service
Differentiation	- Value-added services Differentiated exchange experience Tailored solutions Mass customization
Focus	- Improved relationships Entry barriers
Broad-scope	- Cost-effective to offer customization to a broad scope of partners
"Stuck-in-the-middle"	- Repeat offline business processes Imitate competitors

The cost-leader strategy has also been a driving force behind consolidation and cost-reduction trends in the paper and paperboard industry, and e-business implementation is seen as another opportunity to enhance cost leadership by decreasing transaction costs, increasing process standardization, and improving efficiency. These potential cost savings are very important, both for the paper and paperboard industry in general and for the emergence of e-business within the industry. Stundza (1999) argued that many industry executives in commodity sectors such as the paper and paperboard sector are hesitant to commit large capital expenditures for ICT or e-business until they see enhanced profits ("bottom-line results") by lead adopters.

Pursuant to the cost-leader strategy, the primary paper and paperboard industry has also focused on maximizing product output or capacity utilization (sometimes called the "production-push" strategy); but a recognized challenge for paper or paperboard companies that wish to be successful is to broaden their focus from production volume and efficiency to market needs and customers. Interestingly, ICT and e-business can support company efforts to move from production orientation toward market orientation, giving ICT the potential to offer intangible market-oriented benefits for the paper, paperboard, and packaging industries.

For example, e-business via an extranet[1] (external network) can serve to deepen business partnerships and collaboration (Anandarajan *et al.*, 1998). Companies can also engage supply chain

[1] Extranet—The extension of a company's intranet out on to the Internet (e.g., to allow selected customers, suppliers, and mobile workers to access the company's private data and applications via the World Wide Web). This is in contrast, and usually in addition, to the company's public Web site that is accessible to everyone. The difference can be somewhat blurred, but generally an extranet implies real-time access through a firewall of some kind. Such facilities require very careful attention to security but are becoming an increasingly important means of delivering services and communicating efficiently with customers. Source: hyperdictionary (http://www.hyperdictionary.com/dictionary/Extranet).

partners more broadly in joint product development and intelligence sharing (McCune, 1998). Furthermore, ICT and e-business investment allow businesses to pursue a market differentiation strategy by securing unique relationships, such as through improved service quality and their ability to respond quickly to market shifts (Baharadwaj *et al.*, 1993). In addition, Anandarajan *et al.* (1998) argue that having an extranet may lead directly or indirectly to enhancing corporate image. Vlosky (2000) also found support for that argument in the paper industry.

Overall, ICT and e-business success will derive from the ability of individual companies and their business partners to take full advantage of Internet marketing opportunities addressing market segmentation, promotion, distribution, pricing, information management, and customer satisfaction (Vlosky, 2000). For the paper and paperboard packaging industry, this implies that future development of ICT and e-business will expand the expected contributions of ICT and e-business beyond the narrow expectations of the cost-leader strategy and perhaps shift expectations toward other contributions, such as more efficient and value-added exchange-support services.

Table 7.2. Dominant problems in supply chain or value chain management, and potential benefits of e-business.

Value chain activity	Problem	Potential benefits of e-business
Inbound logistics and procurement	- Long lead time - Incompatible IT systems - Supplier selection	- Increased collaboration - Reduced order cycle - Reduced search cost - JIT (just-in-time) inventory - Responsive supply - Small and frequent purchases
Production and operations	- Inaccurate demand forecast - "Bullwhip" effect - Excess inventory	- Sharing supply and demand information - Use of timely and accurate data in planning - Better demand forecasting - Reduced "bullwhip" effect - Reduced inventory
Outbound logistics and distribution	- Multiple intermediaries - Delivery costs	- Elimination of intermediaries - Electronic delivery - Accurate shipment - Availability of tracking information
Marketing and sales	- Costly and difficult market information attainment	- Improved market and customer information - Faster documentation process - Faster payment cycle - Lower communication costs - Improved relationship
Service (during and after)	- Response time - Costly customized information	- 24/7 information access - Faster response - Customized service at lower cost

From: Porter, 1985; Anandarajan *et al.*, 1998; Chan and Davis, 2000; Tan *et al.*, 2000; Vlosky *et al.*, 2000; Ling and Yen, 2001; Lin *et al.*, 2002; Moore, 2002.

Of course, the potential contribution of operational efficiencies achieved through ICT and e-business development [for example, reduced transaction costs via e-marketplaces, extranet, and electronic data interchange (EDI)[2]] will remain strong drivers for ICT and e-business within the paper and paperboard sector. A broad array of potential operational efficiencies through e-business adoption can be anticipated in terms of Porter's (1985) value chain (*Table 7.2*). Paper and paperboard packaging producers confront an array of problems in managing the material supply or value chain, but in that context they can take advantage of numerous benefits conveyed by e-business to streamline their supply chain (*Table 7.2*). Paper and paperboard packaging firms can integrate their supply chain systems with those of trading partners to achieve a more efficient product and information flow.

Beyond general drivers of operational efficiency and competitive advantage, ICT also holds a promise of expanding product applications for paper and paperboard packaging. Real prices for paper and paperboard bulk commodities have generally been declining in recent decades, partly as a result of productivity gains, efficiency gains, and cost cutting throughout the industry. In this context, the industry recognizes the need to develop new value-added products and expand packaging markets to improve industry revenues and profits. That objective is connected to a set of unique motives for the development and application of ICT in the paper and paperboard packaging industry, as discussed in the next section.

7.2.2 Unique motives for ICT and e-business in paper and paperboard packaging

In addition to general drivers of ICT and e-business development, some motives for ICT development are fairly unique to the paper and paperboard packaging industry. The twenty-first century arrived with significant changes already taking place in the way that paper and paperboard were being purchased, consumed, and utilized. Drivers for change in the packaging industry include ongoing changes in retailing, changes in channels of distribution, changes in packaging expectations (with an expanded information-transfer role), and increased time pressure for moving products into the marketplace (Klass, 1999).

A shift in recent decades toward larger retail stores and mass distribution of products has helped to expand the function of packaging from traditional product containment and protection functions to sales and marketing functions. With larger retail stores and mass merchandizing, reliance on knowledgeable salespeople to assist customers with product information has declined. Instead, reliance on product packaging to advertise and inform customers about product contents and uses has increased. This trend was facilitated by technological shifts in paper and paperboard packaging materials, such as development of better printable packaging materials suitable for color printing or graphic displays, which helped packaging to assume expanded sales and marketing functions.

The impact of these trends in recent decades has been to expand markets for printable paper and paperboard packaging materials, and competition has led to a demand for higher-quality color graphics in packaging and the creation of new requirements for high-quality packaging materials (Klass, 1999). However, that development was just one phase of a broader information-technology revolution unique to packaging. Other developments, such as bar coding and the subsequent development of active and intelligent packaging in the 1990s, have expanded the outlook for packaging functions in the future. Active packaging is packaging specifically designed to change or control the condition of the packaged product, chiefly to extend shelf life, improve safety, or enhance sensory properties. Intelligent packaging is packaging designed to use electronic sensors or chemical indicators 1) to sense or transmit information about the environment, shipping conditions, or other product information and 2) to convey information to managers or to the product user. In the long run, these developments are paving the way for the emergence of packaging as a new medium of product-information transfer and enhancement of product use.

[2] EDI—the exchange of standardized document forms between computer systems for business use. EDI is part of electronic commerce and is most often used between different companies ("trading partners"). It uses some variation of the ANSI X12 standard (USA) or EDIFACT (UN-sponsored global standard). Source: hyperdictionary (http://www.hyperdictionary.com/ dictionary/Electronic+Data+Interchange).

Development of active and intelligent (interactive) packaging is an emerging market development closely linked to ICT and e-business; it is fairly unique to the packaging sector and therefore perhaps the best example of how ICT and e-business may uniquely impact the paper and paperboard packaging industry. Paper or paperboard packaging that includes inexpensive electronic transmitters to keep track of product shelf life, inventory data, or other detailed product specifications, or that helps customers understand how to use the product efficiently, offers broad potential for product innovation and expanded market development within the paper and paperboard packaging sector.

"Packaging is easily overlooked as fulfillment/distribution operations are planned and constructed and, yet, packaging materials and methods can have significant positive or negative impact on productivity, transportation costs, and damage/loss claims."[3] This statement is likely to be all the more prophetic with the emergence of interactive packaging systems. In the global economy, many emerging companies have little expertise in "back-end fulfillment" (procurement, distribution, global inventory management, and logistics); thus, interactive packaging provides the packaging industry with an opportunity to become the provider of new packaging system solutions, while helping customers to develop more effective packaging strategies. Indeed, the extent to which paper and paperboard producers can participate in packaging system development may largely influence the industry's future growth or market outlook, as discussed subsequently in this chapter.

Other changes in the business environment driven by e-commerce have also influenced demands for packaging materials. For example, because of smaller order sizes, direct online ordering tends to reduce the demand for wood pallets while creating increased demand for smaller paperboard shipping containers. The shift from mass retail to direct customer delivery of smaller orders through online sales has also increased the demand for protective packaging materials to ensure the safe arrival of goods. The growth of online sales thus offers new market opportunities for the packaging industry.

The most significant industry challenges that global paper manufacturers have faced in recent years are consolidation, globalization, downsizing, and overcapacity (Juslin and Hansen, 2002; *Pulp and Paper North American Fact Book 1998–1999*, 1998). Cyclical demand patterns, high inventories, and variable lead times characterize not only the primary paper and paperboard sector in general but also the paper and paperboard packaging industry because of inefficiencies inherent in the supply chain (Juslin and Hansen, 2002). These inefficiencies are only exacerbated by manual transaction processing and inefficient use of ICT resources.

Economic globalization (partly facilitated by the global Internet) has also been associated with broad structural changes, such as a decline in growth for U.S. manufacturing and expanded growth in goods production abroad (where lower-cost labor or other comparative advantages offer more-efficient production possibilities). The movement of manufacturing capacity abroad (facilitated in part by global management via the Internet and other ICT developments) has tended to reduce local U.S. demand for packaging and local production of paperboard packaging in recent years. For example, U.S. production of paperboard declined in tandem with declining growth in industrial production from the late 1990s to 2001 (*Figure 7.1)*; [Sources: American Forest & Paper Association (AF&PA) and U.S. Federal Reserve].

Providing cost-effective packaging strategies matched to customer needs requires enhanced cooperation and communication between packaging manufacturers and buyers. ICT and e-commerce applications, such as extranets, enable such an improved information flow between global suppliers and buyers and may be used as a platform for more efficient and effective joint product development in packaging and distribution systems. The need to streamline the supply chain and maintain good

[3] Statement attributed to Mack Green, president, Orion Packaging Systems (Anonymous, 2000).

control over operations has become evident throughout the paper industry. Greater integration between primary paper and paperboard packaging manufacturers and their customers further along the supply chain has become of paramount importance, and e-business/e-commerce solutions are available to assist in improving many of these inefficiencies.

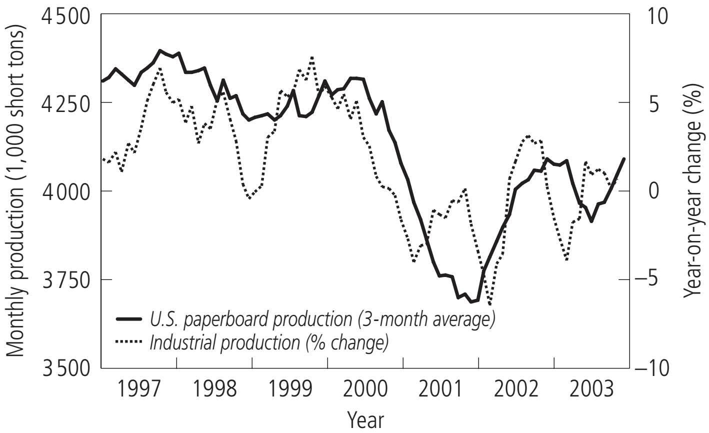

Figure 7.1. U.S. paperboard production and industrial production index (year-on-year growth), 1997–2003.

The Internet also offers a new arena for exchange through online bidding and reverse electronic auctions. Several customer industries of the packaging industry have implemented or tested online bidding. A concern that packaging manufacturers have, however, is their potential to drive down prices and profit margins (Anonymous, 2000). Despite the packaging industry's hesitancy about online bidding, projections indicate that online bidding for packaging products will continue to grow (Toland, 2003). The paper and paperboard packaging industry, as well as any industry facing online bidding in the future, needs to prepare and develop strategies to address business challenges resulting from it. Furthermore, companies that are invited by customers to an online auction will need to develop a strategy for incorporating this activity into existing sales processes.

7.2.3 Opportunities with interactive packaging

Active and intelligent (interactive) packaging is the latest wave of technological advance in the ongoing evolution of paper and paperboard packaging, an evolution in which the opportunity for product differentiation and market development has generally expanded. Paper and paperboard packaging serves a range of functions, including basic functions of containment, protection, or convenience in product handling, as well as more advanced functions, such as providing product information or convenience in product use. In general, paper and paperboard packaging has been evolving for decades from a medium that served only to contain or protect goods in shipment (the traditional functions of sacks, cartons, and boxes) toward a medium that now also provides for distribution of market and product information, and, ultimately, is a means of monitoring the status of product inventory in storage and transit and/or guiding final product use by consumers.

As mentioned previously, this trend owes much of its early impetus to the emergence, in recent decades, of paper and paperboard packaging as an advertising and display medium, with its expanded use of color print and graphic displays. Development of packaging as an advertising or display medium has firmly established a broader role for it in retail marketing. The advent of bar coding on packaging in recent decades has also greatly extended the role of packaging in facilitating transactions and in tracking product inventory, pricing, and sales. However, even decades before the widespread use of color graphics and bar codes, the U.S. military made wide use of packaging for information transfer, commonly printing packages in World War II with detailed instructions for soldiers on how to use or deploy their contents.[4]

Corrugated containers made from paperboard are the dominant vehicle for shipping goods to market, and most paperboard produced for corrugated containers is still ordinary unbleached (brown stock) that is not intended for color printing or advertising. However, a sizable and expanding market has emerged in recent decades for printed containers suitable for retail display. Thus, the market has already expanded for surface-coated (white-top) linerboard to enable better printing and graphic images on corrugated containers. This development has afforded the opportunity for product-market development and differentiation in the linerboard industry.[5] Similarly, new information technologies are being developed at the present time that are applicable to paper or paperboard packaging, including electronic surveillance, radio frequency identification (RFID)[6], "smart inks," product diagnostics, and polymer or laminar electronics for packaging applications. These technologies also afford new avenues for product development and innovation.

The development of RFID, for example, is rapidly gaining widespread attention in the packaging industry and among large retailers; RFID affords an entirely new and more automated means of inventory tracking and product control. The RFID device is typically a small and inexpensive electronic responder that contains (and may transmit) data on the product contents or other relevant inventory information. With small and inexpensive RFID devices embedded in paper or paperboard packaging materials, product inventories can be quickly assessed and monitored automatically as packages move in and out of warehouses. Some of the larger retail stores in North America have already expressed a desire to switch over to RFID packaging systems.

Wal-Mart has announced its initial RFID implementation rollout to cover shipments from its top 100 suppliers to its six distribution centers and 250 Wal-Mart stores and Sam's Club locations by June 2005; it plans to follow these with more distribution centers and store locations by October 2005, and the next top 200 suppliers are to be included in the RFID implementation plan by January 2006 (Meadows, 2004). According to a Packaging Strategies and Cap Gemini Ernst & Young 2004 survey, more than half (54%) of the surveyed global packaging industry companies believe that Wal-Mart's supplier mandates will be a catalyst for RFID adoption in the industry. Accordingly, half of the respondents (51%) indicated that they are planning RFID implementation programs in 2004 (Patterson, 2004). An example of the packaging industry's response is the cooperation between Stora Enso, a world leader in consumer goods packaging, and Stockway, a specialist Finnish software provider, to develop RFID-based smart-packaging solutions to create added value for customers through improved logistics, better product safety, and online control over the supply chain (Stora Enso, 2004).

Other examples of commercially developed active packaging are food containers that can control moisture content, scavenge oxygen, or otherwise inhibit microbial growth (Brody, 2002). More

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[4] With instructions printed on packages, it was possible for soldiers to accomplish fairly complex and unfamiliar tasks, such as the processing and development of color photographic film, a type of film that was not in widespread civilian use but became available to military photographers during the war.

[5] Linerboard is the facing material that is combined with corrugating medium (the fluted material) to produce corrugated containerboard for shipping containers and boxes. Linerboard represents a large share of the paperboard industry and is the largest single paper or paperboard product produced in the United States (18 million metric tons of linerboard and 9 million tons of corrugating medium were produced for domestic use in 2001, and several million tons of linerboard were exported) (Source: AF&PA).

[6] RFID is a form of identification that does not require line of sight (unlike bar codes). The RFID system usually includes an antenna (coils), reader transceiver with decoder, and transponder (tag). In operation, the reader sends out a signal, which activates the tag and allows data to come into or leave the transponder's memory. When a tag is within range, the signal from the receiver is sensed and information from the transponder is sent to the receiver. As with most developing "standards," there are several implementations of RFID. See http://www.cknow.com/ckinfo/index.htm

recently, interactive or intelligent packaging has been designed with time–temperature indicators to monitor freshness of food products, electronic sensors to monitor temperature history and shelf life, or chemical indicators to monitor freshness of perishable food (Ahvenainen, 2003). Another example of intelligent packaging is food packaging designed to work with Intelligent Microwave Oven (IMWO) technology, a multipurpose kitchen appliance with product bar code scanning and Internet connection, capable of reading information from a food package to help guide food preparation and cooking (Yam, 2000).

Interactive packaging—which includes active packaging, intelligent packaging, and sensory packaging—takes packaging beyond the realm of enhanced paper or paperboard graphics and into a realm of more-immediate product definition (Dallmeyer, 2003). This kind of packaging can identify, categorize, and sensitize the package in ways that directly connect it to the product for the benefit of the consumer and the consumer-product manufacturer (Dallmeyer, 2003).

Many technological features of interactive packaging have been available for years, but these features are becoming increasingly affordable and applicable with refinements in electronic technology that have recently been the subject of industry trade shows and conferences. Only recently have retailers and producers become poised to exploit these technologies in their supply chain and retail distribution. Developers of interactive packaging technology continue to work on making the technology more commercially viable and cost-effective. It is possible to envision in the not-too-distant future that packages in a retail store will "talk" to the customer, provide the customer with accurate information about product freshness, such as past temperature exposure, allow product purchase without waiting in a checkout line, and also help to ensure that the product is used properly after purchase (such as providing guidance to a customer on how to cook and prepare the contents of a food package with all the perfection of a master chef). However, this vision also implies that the paper and paperboard packaging industry has the potential to evolve from a commodity-oriented industry (like the "containerboard industry") into an industry with products that are more systematically customized and tailored to specific needs (an industry that may become known as the "packaging system industry").

The advance of packaging system technology in the direction of interactive packaging thus affords new opportunities for market development and product differentiation, just as development of enhanced printability and graphic capabilities did in the past; but exploiting that opportunity will depend on how the industry can respond to the challenge of developing entirely new packaging systems. Historically, the industry played a large role in transforming packaging systems through innovations in primary commodity products, such as the development of paperboard technologies that allowed corrugated containers to become the principal medium of goods packaging worldwide. Similarly, the development of printable packaging was chiefly dependent on primary manufacturing and commodity innovations (such as improved print technology, multiply linerboard, sheet-coating technology, and use of more bleached pulp for surface plies). However, the new market-development opportunities afforded by interactive packaging may be more in the areas of secondary system services and end-user support functions (much more of a packaging system service function than a strictly commodity manufacturing function). Thus, the market implications of interactive packaging for the paper and paperboard packaging industry may depend on the extent to which the industry assumes a broader service function and system-development role beyond its more traditional commodity-manufacturing role.

7.2.4 Other e-business developments in paper and paperboard

Apart from the development and application of ICT in packaging, e-business also provides some unique and more general development opportunities in the paper and paperboard packaging industry. The advent of e-business and Internet commerce is seen as promising a range of benefits in manufacturing, particularly in the paper and paperboard sector. However, despite the general enthusiasm, promises, and claims surrounding e-business, a recent survey by consultants PricewaterhouseCoopers revealed that the majority of packaging producers do not yet actually appear to believe that e-business or e-commerce has transformed their industry, although they do believe that it will do so to some extent in the future (in Toland, 2003). Estimates have been made that e-commerce has a potential to reduce paper industry costs overall by 15% to 20%, the second-highest percentage reduction anticipated among 17 industries studied in 2000 (Fazio, 2000). It would thus appear that the opportunity spectrum for information technology sophistication and e-business development in the paper and paperboard packaging industry is relatively wide. Indeed, some companies within the sector have already established and begun to implement e-business strategies, using fairly sophisticated Internet concepts in their operations. On the other hand, some companies are still rather hesitant to adapt Internet or e-commerce technologies (Shook *et al.*, 2003).

According to PricewaterhouseCoopers (in Toland, 2003), a large majority (82%) of recently surveyed paper companies had an Internet presence. However, their Internet Web sites were primarily informational rather than transactional. As of 2000, only 6% of the companies had product-availability data online and only 3% offered order-status information through their Web pages (pponline.com, 2000; Cubine and Smith, 2001). Among packaging and converting companies, 20% said they offered products and services online, according to a 1999 survey by Packaging Business (Stundza, 1999). The survey also found, however, that a much smaller share of the packaging buyers actually used online sourcing in their purchasing process. The packaging buyers indicated that they preferred dealing with packaging suppliers in traditional ways because of the perceived complexity of their packaging transactions. Another study by PricewaterhouseCoopers found that although two-thirds of packaging-sector companies in the United Kingdom had a Web site and conducted some business through external e-mail, more sophisticated e-business practices remained in their infancy (in Toland, 2003). The study also found that despite 40% of these packaging companies using their Web site to capture customer information, only 14% are actually analyzing it (for example, reviewing purchasing behavior) (Toland, 2003). On the other hand, some case studies have indicated that customer requests were a driving force behind the establishment of online ordering in the paper industry (Friedman, 2000).

Historically, well before the launch of the commercial Internet, paper companies were already reaching out using ICT beyond their organizational limits to create a process of electronic information exchange between vendors and customers. During the 1970s and 1980s, many companies extended ICT beyond the company walls by exchanging data in the form of electronic documents between supply chain partners using system-to-system computer connections over networks and proprietary systems (Chan and Davis, 2000). Since the early 1990s, the paper industry has used an industry-specific message standard for EDI called EDIPAP—Electronic Data Interchange for the Paper Industry (CEPI, 2000). In North America in 2001, approximately 16% of paper-purchase transactions were handled through EDI (Dupuy and Vlosky, 2000). PricewaterhouseCoopers found that 32% of United Kingdom packaging companies used EDI in 2001 (Toland, 2003). The expense, complexity, lack of flexibility, and limited functional scope of EDI implementation has confined its use to large enterprises with large transaction volumes and adequate financial resources (Acly, 2000). The next logical step beyond traditional EDI is the use of the Internet as a modern system-to-system connection platform, eliminating expensive cabling and maintenance costs (Acly, 2000).

Extensible Markup Language (XML) is an emerging Internet standard for sharing data between computer applications that uses the Internet as its platform. The paper industry has made an industry-wide joint effort to develop a set of unified XML messaging standards for business transactions for the buying, selling, and distribution of paper products. This paper-industry-specific messaging standard project is called papiNet (papiNet, 2003). The goal of papiNet is a single set of unified, international XML-based, e-business standards designed to improve the efficiency and accuracy of transactions throughout the paper-supply chain, while reducing the cost of operations (papiNet, 2003). Development of industry standards that will enable efficient transactions between customers and suppliers, and prevent fragmented and costly e-commerce infrastructure, is a critical part of the foundation for e-business (CEPI, 2000).

Paper industry vertical business-to-business (B2B) exchanges, also called e-marketplaces, were established to help the industry decrease inefficiencies in their supply chains and better cope with the cyclical nature of industry markets through better visibility. There has been a positioning of e-marketplaces in the supply chain by firms' claiming to offer the opportunity of lowering the transaction costs of identifying, negotiating, and purchasing from multiple suppliers, as well as providing access to consolidated pricing and industry demand/supply information. As users are able to browse suppliers' or buyers' aggregated inventories and/or production schedules, they can improve production planning, reduce inventory, and implement dynamic pricing arrangements.

As was the case in other industries, the paper and paperboard packaging industry saw the emergence of e-marketplaces around the dawn of the new millennium. In 2000 more than 50 "dotcoms"—Internet enterprises—were competing to capture market share of paper industry revenues (Hayhurst, 2001). Certain characteristics of the paper and paperboard packaging industry, such as the high degree of fragmentation, highly cyclical and unpredictable supply and demand, and multiple distribution steps, almost guaranteed the suitability of e-marketplace development for the industry (Moore, 2002). Thus, according to the PricewaterhouseCoopers 2001 Global Forest & Paper Practice estimates, 25% of U.S. forest product industry revenues were expected to be transacted over the Internet and 12% in e-marketplace sales by 2004 (*ForestExpress*, 2001). However, despite the positive prospects, B2B exchanges were unable to achieve that kind of success. After the economic slowdown and the dotcom crash in 2002, only a few vertical e-marketplaces for paper remained in business (Kallioranta, 2003). Yet, in 2001, 25% of surveyed United Kingdom packaging manufacturers claimed access to a B2B e-marketplace (Toland, 2003).

While the market has witnessed the demise of third-party e-marketplaces (dotcoms), it has experienced a growing interest in private exchanges and "extranet" solutions. Extranets started to gain interest and enthusiasm among businesses in the later half of the 1990s. In 1998, 13% of the companies surveyed in a cross-industrial study by ActivMedia Inc., said they had implemented an extranet (McCune, 1998). In the same year, 10% of forest-industry companies surveyed in North America indicated extranet implementation (Vlosky and Punches, 1999). Less than 10% of packaging producers claimed to have their own extranet in the United Kingdom in 2001 (Toland, 2003).

7.3 Alternative Hypotheses and Future Scenarios

The following sections discuss several alternative hypotheses regarding the broad impacts of ICT and e-business in the paper and paperboard packaging industry. The hypotheses lead to several speculative scenarios regarding impacts of ICT on paper or paperboard commodity markets. The idea is to generalize discussion of ICT and e-business development: 1) by considering what could happen to primary paper or paperboard commodity markets as ICT developments expand in the future, and 2) to provide a basis for speculative discussion of broader implications for the forest sector.

Currently available data on ICT developments cover only a relatively short time frame. Nevertheless, using a market model framework as a basis for discussion, it is possible to discuss different hypotheses in some detail in terms of speculative market scenarios. Discussion of hypotheses and scenarios leads to some recommendations regarding the research needed to fill knowledge gaps, how to improve existing market models in order to evaluate ICT impacts, needs for alternative models and market interpretations, and suggestions for research on how to identify and take full advantage of ICT and e-business applications in the context of competitive corporate strategies

7.3.1 Market-expansion scenario

One broad hypothesis is that the emergence of interactive packaging systems coupled with widespread use of e-commerce offers potential for expansion of packaging markets through development of new electronic packaging systems. Just as evolution of paper and paperboard packaging from basic container functionality to print-and-display functionality has led to new demands for packaging in recent decades (to communicate and provide more product information to customers), so too could the evolution from printed information on the package to electronic information in the package.

Trends in interactive packaging technology suggest that future packaging systems will be able to convey a much wider array of product information to customers and thus enhance the utility of packaged goods, courtesy of inexpensive electronic components embedded within the packaging itself. Several decades ago, the role of packaging was mainly limited to functions such as delivery of goods to stores in brown corrugated boxes. Today, much more colorful packaging containers serve also to provide customers with vital product information, often with pictures or printed instructions on how to handle or use a product. Not long from now, interactive packaging may “talk” to customers, telling them more about the condition of the product or how long it has been on the shelf, and also providing customers with the latest information on how the product can be used optimally for various purposes, augmented by updated information transmitted to the package from an electronic network.

This hypothesis suggests a scenario in which the packaging industry will expand into value-added markets by developing entirely new packaging services that increase the demand for or the value of packaging in general. The market-expansion scenario envisions that the paper and paperboard packaging industry is entering a new era of market development, with expanded potential because of extended service functions (beyond the traditional roles of packaging) and also because interactive packaging can increase the utility of packaged products. Under this scenario, the utility of paper and paperboard packaging (as well as the packaged products) could be significantly enhanced by interactive packaging systems. The economic value of paper and paperboard packaging could increase if producers capture (at least, in part) the value associated with the development of improved packaging systems. In effect, the paper and paperboard industry of the future may be able to boost demand for packaging materials (as they have in the past) and also capture additional value for new packaging system services (to the extent that they retain a proprietary service role in packaging-system development or maintenance).

Thus, the market-expansion scenario suggests that interactive packaging will expand markets and enhance product value for paper and paperboard packaging, as the industry participates in the advent and exploitation of the new interactive packaging systems of the future. That this outcome will actually occur remains largely speculative, but one purpose of this chapter is to develop speculative scenarios concerning the potential role of ICT and e-business development in the industry.

The short-term impact of the market-expansion scenario can be introduced using a static equilibrium model. One common way of illustrating the market context for primary paper or paperboard packaging producers (for example, the paperboard industry within a particular region) is to plot data on mill capacities and the production costs of mills in ascending order, yielding a marginal production-cost curve (or supply curve) that can be viewed as intersecting a product-demand curve for all producers. *Figure 7.2* is a stylized illustration of this concept of static market equilibrium, where the upward-sloping “capacity–cost” curve (or product-supply curve) intersects the downward-sloping demand curve at equilibrium price (P_1*).

In *Figure 7.2* the letters (A, B, C, etc.) denote individual mills, with production capacity and production cost for each mill indicated by the width and height of each vertical bar. The stepwise upward-sloping “curve” formed by the bar chart of capacity and cost data is the industry marginal cost or product-supply curve (*Figure 7.2*). Assuming that the industry operates in a competitive market and that output capacity is met by product demand, the market equilibrium (the balance between supply and demand) occurs roughly at price P_1*, where marginal costs of production (of the highest-cost producer) equal marginal price (willingness to pay by consumers).

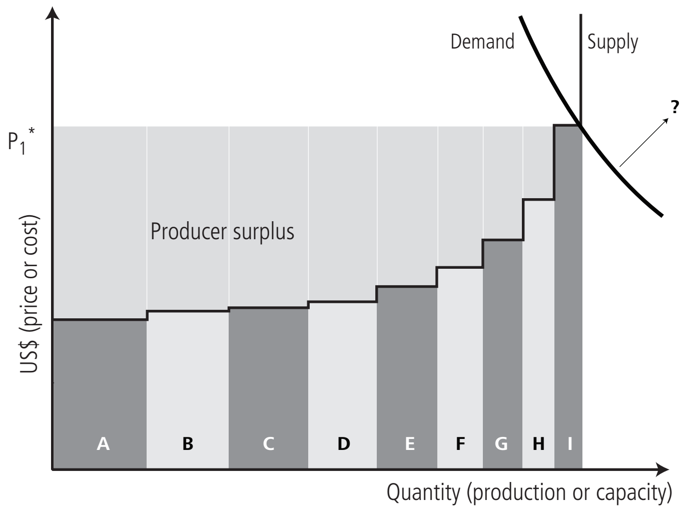

Figure 7.2. Static equilibrium model of the paperboard industry, with individual mills (denoted by letters) having varying capacity (*x* axis) and production costs (*y* axis).

The area between the price line and the industry cost curve is producer surplus (the source of industry profits), with lower-cost producers having generally higher profit margins. In general, the market equilibrium may also settle at a different point, either at a higher price if there is excess demand or at a lower price if there is excess supply (or excess capacity). Thus, price and producer surplus (or industry profit) can vary, depending on cyclical market conditions. However, here it is sufficient to simply recognize that the production costs of various producers, the overall level of product demand, and the willingness to pay for the product (or product services) each play a role in determining the overall market equilibrium and the profits of individual producers.

The market-expansion scenario suggests that interactive packaging systems will boost overall product demand or overall product value, shifting the packaging-demand curve upward or outward and increasing both price and producer surplus for paper and paperboard packaging. That scenario lends a positive or optimistic outlook to the future implications of ICT and e-business development in the paper and paperboard sector. However, precise impacts on demand and prices are at best speculative, and benefits to primary paper and paperboard producers will depend on how successful they are in garnering value from packaging system development. Thus, there is a speculative potential for increased demand, but the precise shift of the demand curve remains a question mark (*Figure 7.2*).

The market-expansion scenario and static equilibrium model suggest some knowledge gaps and future topics for research. The impact of interactive packaging on overall paper or paperboard demand is one obvious question raised by the scenario. Another related question is whether some firms will gain competitive advantages over other firms via ICT development. Carr (2003) argues in his widely debated Harvard Business Review article that investments in ICT are less and less likely to deliver competitive advantage to firms over time as the power, ubiquity, and affordability of information technology grow. His argument was based 1) on the comparison of information technology as a so-called infrastructure technology with a variety of other ubiquitous infrastructure technologies, such as steam engines, railroads, electricity, and telephones, and 2) on the belief that a firm can gain competitive advantage only by having something that rival firms do not have. Carr noted that ICT did provide innovative first-mover companies with many opportunities for competitive advantage early in the ICT "build out" curve, "when it still could be owned like a proprietary technology."

In contrast to Carr's view, others have argued that the competitive advantage rests not in ICT itself but in the firm's capabilities to use it. Although ICT may have become ubiquitous and readily available, the insight and ability required for it to create economic value and competitive advantage are very much in short supply (Stewart *et al.*, 2003). Brown and Hagel (2003) (in Stewart *et al.*, 2003) reason that competitive advantage is based more on the ability to innovate around the continually evolving capabilities of ICT than on technical or business-practice innovation at any point in time.

In the case of interactive packaging, the rate of diminishing returns from ICT investments, suggested by Carr (2003), may depend on whether a firm is vertically integrated or not, or whether a firm is a primary paper or paperboard commodity producer or a secondary converter (a producer of packaging end products). The ongoing development of interactive packaging technology suggests that vertically integrated firms or converters who produce packaging end products will likely have a greater ability or more opportunity to develop new and innovative packaging systems, reaping most of the economic benefits of innovation, whereas those who are only primary paper or paperboard commodity producers may not reap the same immediate benefits from product innovation, apart from a potential for long-term expansion in overall paper and paperboard commodity demand.

The equilibrium model also suggests a need to focus on how ICT will influence competitive advantage and production costs among individual firms or competitors in the industry and the question of what might happen in the market if some firms become leaders in the development of ICT or e-business systems. Those questions lead to the following two additional scenarios related to the potential market impacts of e-business or e-commerce.

7.3.2 Cost-saving scenario

A much more conventional hypothesis concerning e-business systems is that they will reduce overall industry operating costs and therefore increase profitability. This is a reasonable hypothesis (although not entirely certain, as such systems have yet to become fully implemented throughout the industry). By scheduling production orders more efficiently via e-business, normal business and production operations can in theory become more cost-efficient. Another potential cost-saving aspect of RFID tags on packages could be to increase recycling efficiency by helping to automate the sorting of recycled packaging materials (Saar and Thomas, 2003). The general idea that ICT and e-business can enhance production efficiency leads to a "cost-saving scenario," in which packaging production costs of primary paper and paperboard producers and secondary converters decline, as e-business affords a more efficient and instantaneous linkage of customers and overall production scheduling.

In general, a firm that is an early entrant to e-commerce or manages e-business more efficiently than other firms may achieve some short-term market advantages or greater cost savings than other firms. However, in theory, there is no reason not to expect all producers in a particular commodity market, such as paper or paperboard packaging producers, to quickly take full advantage of e-business and all firms to eventually experience similar production efficiencies and cost savings. Carr (2003) would appear to be an advocate for the latter idea. He claims that by the time the market becomes saturated with ICT infrastructure, the opportunity available for individual-firm competitive advantage will largely be dissipated.

Under this interpretation, it seems plausible that wide-scale adoption of e-business would simply result in long-term, across-the-board reductions in costs (cost savings) for all producers in a particular commodity market, such as paper or paperboard packaging. Furthermore, in the long run, gains in production efficiency could result not only in industry-wide cost savings but also in a deflationary reduction in product price, which may ultimately erase temporary gains in producer surplus or gains in profitability for early entrants. On the other hand, research by Strassmann (2003) and other authors in Stewart *et al.* (2003) shows that firms using identical information and communication technologies and demonstrating equivalent ICT spending have great variability in profitability. In addition, Strassmann (2003) points out that profit potential depends on whether firms adopt individual custom combinations of available applications and software offerings instead of installing comprehensive, generic, enterprise solutions.

Market impacts of the "cost-saving scenario" under Carr's interpretation of long-term market outcomes can also be illustrated using the static equilibrium model. The impacts on market equilibrium of an industry-wide (across-the-board) cost reduction are shown in *Figure 7.3*. The cost reduction shown in *Figure 7*.3 is stylized and perhaps exaggerated for illustrative purposes (the precise future cost savings resulting from e-business remains speculative). However, in general, the anticipated outcome under this scenario is that the overall commodity supply curve (cost curve) would be pushed downward because e-business is interpreted as having the long-term effect of overall cost reduction. As long as capacity remains constant (and assuming that demand is at the limits of capacity in this case) the short-term market impact would be to increase overall producer surplus or profitability in the industry. However, according to economic theory, this effect would not last for long, as the market equilibrium price would equilibrate downward toward the lower marginal costs of the marginal producer (the demand curve would deflate downward as competitive buyers learned that products were available at lower costs).

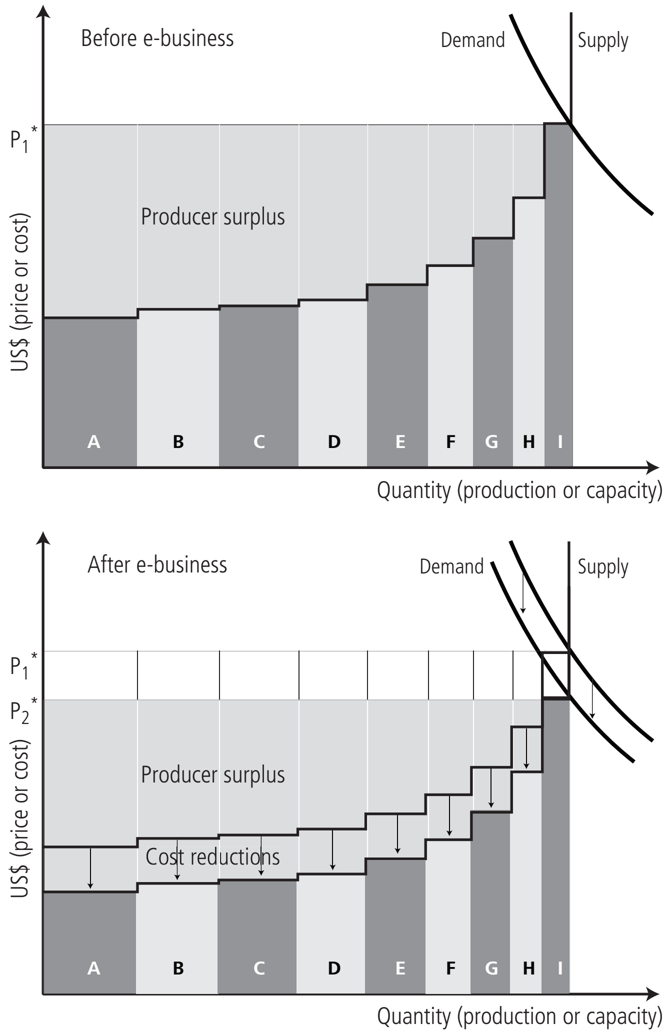

Figure 7.3. Market impacts of e-business in a commodity market, assuming the primary effect is to reduce operating costs.

Thus, as shown in *Figure 7.3*, the net outcome of industry-wide cost reduction is likely to be deflationary (price shifting from P_1* to P_2*), although precise long-term impacts are ambiguous. Impacts on producer surplus or profitability for individual producers will depend on the level of cost reduction afforded by e-business for marginal and efficient producers. For example, if the marginal producer (mill I in *Figure 7.3*) were to achieve greater-than-average cost savings from e-business, the market price could drop significantly and the effect of e-business would be to reduce profitability across the entire sector. The long-term impact on producer profits might be alternatively neutral or even positive, but that would depend on whether cost savings at individual firms outweighed deflationary impacts on market price and also on long-term capacity adjustments. Although the impact across the entire industry on producer surplus or profitability under this scenario is somewhat ambiguous, the market model points to a need for a better understanding of the existing cost structure of the industry and the true cost-savings potential of e-business and e-commerce as necessary elements in appreciating the long-term market impacts of the cost-saving scenario.

In addition, although the static market model (*Figure 7.3*) may be appropriate as a framework for discussing the market impacts of overall reductions in operating costs (such as greater efficiencies in production scheduling or supply chain cost savings), the static model may be a poor framework for illustrating differences in transaction-cost savings among individual firms (such as the effect of more efficient matching of buyers and sellers to individual firms via e-commerce). A more sophisticated market model may be needed to take into account the commercial arbitrage process between buyers and sellers in cases where transaction costs are being reduced by e-commerce, because it is not immediately apparent whether the transaction-cost savings will accrue to the buyer or to the seller. In an extreme case, suggested by the following scenario, not only may buyers obtain significant transaction-cost savings but e-commerce may also conceivably result in market segmentation, which could result in the shift of a considerable amount of producer surplus from sellers (primary producers of paper and paperboard) to buyers (secondary converters or packaging customers).

7.3.3 Market-segmentation scenario

A somewhat different hypothesis concerning the development of e-commerce in the pulp and paper sector is that it will reduce not only production costs but transaction costs in general. Hypothetically, e-commerce may promote a better or more optimal match between secondary converters and primary paper or paperboard producers. For example, paper or paperboard mills typically produce large bulk rolls of paper in various roll widths (so-called trim widths), and converters (buyers of bulk rolls) typically have various roll-width needs and specifications. Paper-roll trim optimization and special invoicing have been cited as advantages of e-commerce in the paper industry.[7] Buyers of finished rolls are converters whose roll-width requirements vary with the requirements of their converting operations and customer needs, while sellers are mill operators who may have to adjust width settings of roll slitters and handle excess trim loss. E-commerce can help match buyers who want a particular trim width with sellers who can most efficiently produce that particular trim width, and vice versa, and thus e-commerce may reduce transaction costs. However, whether the economic surplus generated by such transaction-cost savings in general will accrue to buyers or to sellers in the market remains ambiguous.

An extreme case that illustrates a loss of producer surplus is market segmentation, where primary producers who once shared a common commodity market become segmented into smaller markets with less overall producer surplus. A "market-segmentation scenario" may seem unlikely in the case of commodity packaging grades of paper or paperboard. It could nevertheless occur if e-commerce is able to achieve transaction-cost savings by better matching buyers to sellers according to product parameters, such as paper or paperboard roll width, and thus afford economies to buyers with different sheet-width requirements.

The underlying hypothesis is that transaction costs may decline, as e-business will afford instantaneous linkage and virtual integration between sellers and buyers, while business operations and production scheduling will become more efficient. However, the "market-segmentation scenario" suggests that e-commerce will also bring about a structural shift in purchasing power from sellers to buyers. According to e-commerce experts such as Bradley Rosencrans (see Cody, 2000), the market and the customer will drive transactions in the world of e-business, creating a new business model called "demand-pull" (demonstrated as a business model by the Dell Corporation, for example) as

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[7] See *Pulp & Paper* magazine, February 2000 and August 2003.

opposed to the traditional "production-push" (or cost-leader) business model of the commodity-based pulp and paper sector. In this new model, the effect of e-business will be to redesign business transactions from the customer backward and not from the mill forward, by allowing buyers to identify more efficient transactions via the Internet.[8] According to this hypothesis, new and more-efficient market segments could emerge as a result of e-commerce or e-business.

Using the example of specification of trim width in finished paper or paperboard rolls, it is possible to envision that more efficient markets for buyers may turn out to be more segmented (smaller, more customer-oriented markets, as opposed to larger, mass commodity markets). As suggested earlier, e-business could more efficiently match buyers (converters) who want a particular roll width to those producers (mills) that can most efficiently produce that particular roll width, and vice versa. Whereas, in the past, the transactions of mass commodity brokers have tended to unify commodity markets around standard product grades, the effect of placing individual buyers into direct contact with producers via e-commerce could lead to market segmentation. Apart from transaction-cost savings, better matching of buyers and sellers may result eventually in the segmentation of the market into submarkets, that is, niche markets (according to roll width, for example).

ICT also has the potential to lead to geographically expanded markets as the importance of physical proximity diminishes because of business use of the Internet or other electronic communication technologies. This might contribute to the enhanced profitability of new submarkets or niche markets as well as to expanded global enterprise development. Internet and ICT communication technologies are, for example, helping to advance the outsourcing of production capacity throughout manufacturing to low-cost regions of the world and to facilitate global integration of business relationships. With advanced and instantaneous communication technologies to transmit customer orders and even product design specifications, manufacturers in formerly remote regions of the world, such as China, for example, can readily exploit niche-market opportunities and satisfy custom product orders for clients on the other side of the globe. The opportunity for more customized or segmented niche markets in packaging is thus greater than ever before.

When market segmentation occurs in a previously unified commodity market, the theoretical economic outcome is a net loss of producer surplus. *Figure 7.4* shows a stylized illustration of this effect for an extreme example of market segmentation (or market fragmentation), in which two different markets emerge: one for the products of larger mills and another for the products of smaller mills (for example, mills producing larger rolls and mills producing smaller rolls). The effect of such market fragmentation on producer surplus appears unambiguously negative based on the static equilibrium model.

However, as the shapes of industry capacity–cost curves vary by geographic region around the world, the magnitude of impact could also vary globally (for example, between the more diverse cost structure of mills in the historically more-developed North and the newer and less diverse mills in parts of the developing South). The market model for this scenario suggests the need for a better understanding of the regional cost structure and potential for market segmentation in order to evaluate the market effects of more-efficient e-commerce transactions. It can also be noted that the static equilibrium model discussed in this chapter is a highly simplified representation of market behavior. For example, the static equilibrium model has an implicit but also perhaps questionable assumption of perfectly competitive behavior—producers will produce up to the level of production where marginal revenue equals marginal costs of production. Instead, in the face of lower profits (or reduced producer surplus) producers may simply withdraw production capacity from the market (for example, shut down older or less efficient mills), a behavioral response that would complicate efforts to model the market impacts of transaction-cost savings through e-commerce.

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[8] See *Pulp & Paper* magazine, February 2000.

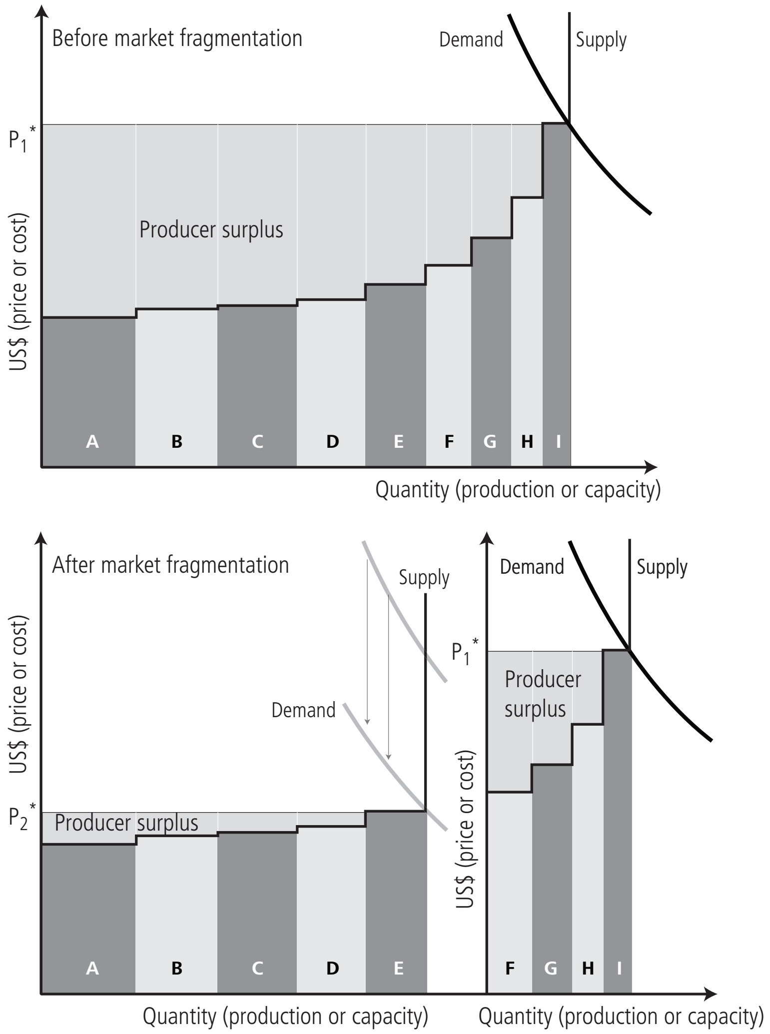

Figure 7.4. Loss of producer surplus in an extreme case of market fragmentation, assuming no change in overall production capacity or consumption levels.

Transaction costs can also be viewed more broadly to encompass challenges in building relationships and trust, and dissemination of knowledge. Accordingly, Pike (2003) contends in Stewart *et al.* (2003) that whereas information technologies gave rise to improvements in productivity in the 1980s and 1990s, information and communication technologies in the new millennium enable suppliers, producers, and customers to integrate their business processes and value chains, acting as if they were one company by sharing information on inventories, production, demand forecasts, and even costs and prices. Thus, ICT may change the way businesses in the paper and paperboard packaging industry work together; and it may have the potential to reduce transaction costs, increase efficiency, and expand markets more broadly.

7.4 Discussion

Three speculative scenarios have been advanced. These are primarily for the purpose of providing some visionary discussion about various hypotheses related to impacts of ICT and e-business development in the commodity-oriented paper and paperboard packaging industry. However, their aim is also to point out knowledge gaps and the need for research in specific topical areas (an objective of the IUFRO Task Force on ICT in the Forest Sector). The three speculative scenarios are summarized as follows:

- Market expansion (via interactive packaging);
- Cost saving (via e-business and more efficient production); and
- Market segmentation (via e-commerce and reduced transaction costs).

The relative likelihood of market outcomes under these scenarios is unknown, and only weak empirical evidence supports such scenarios, indicating to some extent those areas where there are knowledge gaps. An interesting aspect of any discussion is how to fill the knowledge gaps in order to examine whether these scenarios or their underlying hypotheses may be valid or invalid.

The first scenario derives from the hypothesis that ICT and market development associated with new interactive packaging technology will expand markets and increase product demand. Although, conceptually, this appears to be a promising hypothesis that offers a potential for increased product demand or new pathways for paper or paperboard packaging development, only limited experience and largely anecdotal information are available to test the hypothesis over the long run. Although it can be suggested that development of interactive packaging offers the paper and paperboard industry an opportunity to shift their business strategies from the commodity-based, cost-leader strategy to a more market-oriented strategy based on packaging system development, that opportunity is largely speculative (and has yet to be fully exploited). Considerable research and observation of product- and market-development trends will be needed for the ultimate market implications of this development for the paper and paperboard sector to be understood. There is also a fundamental question as to whether the existing commodity-oriented paper and paperboard industry can evolve rapidly enough to assume new service functions or new product-development roles that are implicit in the development of new interactive packaging systems.

The second and third hypotheses (concerning cost reduction and market segmentation) suggest the possibility of a reduction in producer surplus and thus some deflationary or disruptive market impacts in the commodity-based paper and paperboard packaging industry resulting from the advance of ICT and e-commerce. Indeed, the general retreat of independent e-commerce enterprises that has occurred in recent years (the decline of the dotcoms) is sometimes erroneously interpreted to mean that e-commerce may have somewhat less-promising financial benefits than previously anticipated. However, the demise of dotcoms (usually small, independent firms) should not be construed as the demise of ICT itself. ICT had enabled the start-up of many small intermediate dotcom firms in the late 1990s. These, however, were not the sole manifestation of ICT, and indeed, statistics show continued growth in the volume of e-commerce and e-business.

The broad industry interest and headlong advance of e-business and e-commerce in the paper and paperboard industry suggest that decision makers within the industry must anticipate economic advantages that are expected to cancel or offset any potential deflationary or disruptive impacts on markets. Although there are many insights into the motives for ICT and e-business development in the paper and paperboard sector (as discussed previously), significant knowledge gaps remain about collective or long-term market consequences of such development.

7.4.1 Globalization/location implications

ICT, e-commerce, and e-business development has potentially divergent economic implications for globalization and the location of future forest sector development, either accentuating or attenuating shifting patterns of global capacity growth in the paper and paperboard sector. At the broadest level, ICT and the Internet enhance global commerce and global business communication, helping facilitate globalization of commerce and industry. Barriers to trade have fallen rapidly over the past decade along with expansion of e-commerce and ICT. Innovations in communications, computing, production-control systems, and distribution have accelerated the design, production, and delivery of goods on a global scale. Automated production processes have spread rapidly throughout the world. In recent years, economic globalization has contributed to a shift of growth in pulp and paper capacity from developed countries (such as the United States) to other countries, including low-income countries in Asia, such as China. For example, U.S. exports of packaging grades of paperboard to China, once the leading U.S. export destination for paperboard, have declined in recent years, as packaging paperboard production capacity and industrial output have expanded in China. As mentioned previously, U.S. output of paperboard has declined in recent years along with a decline in overall U.S. industrial output (see *Figure 7.1*).

Many factors besides ICT and the Internet are responsible for the expansion of capacity in countries like China (such as low labor costs, expanded growth and foreign investment, and government subsidies). However, the economic experience of the forest sector of the United States during this period of economic globalization provides some empirical evidence of how the forest sector can be impacted negatively by structural change (such as the shift of growth in manufacturing and paperboard production to China), which has been facilitated to some extent by global interconnectedness, the Internet, and ICT.

Under the first scenario, discussed earlier, ICT offers the potential for an expanded and more lucrative market development in packaging (via new interactive packaging systems, for example). Under that scenario, development might be expected to occur most rapidly in regions or countries with the most highly advanced commercial infrastructure and capability (North America, Europe, or Japan, for example), able to readily adopt new electronic packaging systems that can communicate with customers, such as via cell phones. This suggests an advantage under that scenario for paper or paperboard firms in the historically more developed North versus the developing South. Nevertheless, ICT and e-business technologies are easily transferred and readily adopted elsewhere. In China, for example, there are currently more cell phones in use than in any other country. (*United Press International* reported on 25 August 2004 the announcement by China's Ministry of Information that the country had 310 million mobile phone users as of the end of July 2004.)

Under the second scenario, ICT is primarily a cost-saving development with the likelihood that, in the long run, all firms in the industry will eventually exploit the same or similar cost-saving advantages. On the other hand, recent research has shown that firms using identical information and communication technologies and demonstrating equivalent ICT spending have great variability in profitability. Without more specific evidence, whether gains will be higher in one global region or another remains ambiguous. However, it has certainly been observed in recent years that paper and paperboard producers in regions with high-yield wood-fiber plantations (such as Latin America or Asia) or in low-income countries (such as China) have significant manufacturing-cost advantages and high rates of economic growth, both of which have attracted a larger share of global capital investment and capacity expansion. As new plants thus tend to be larger and more efficient in those regions, adoption of the cost-saving advantages of ICT might serve to accentuate their competitive advantages (and certainly e-business and e-commerce systems are widely available on a global scale and just as likely to be adopted by firms in Asia or Latin America as in Europe or North America).

Under the third scenario, ICT may result in market fragmentation, and a significant loss of producer surplus may occur (as illustrated in *Figure 7.4*). That loss is potentially greater in regions where the cost structure of the industry has greater diversity (where there is a wider range of production costs among firms or plants in the industry). The plant infrastructure of the pulp and paper industry in developed regions of the world is typically varied in age and size of production facilities (and therefore more diverse in cost structure). Some older mills in North America or Europe, for example, have been in operation for decades or generations, although a number of leading firms in Europe and North America have a reputation for reinvestment and continuous improvement of existing production facilities.

Conversely, the cost structure of the industry tends to be newer and less diverse in some developing regions (such as some countries in Asia or Latin America), where the plant infrastructure is more modern and there are fewer older mills in operation. In China, however, there is a unique combination of many older and less-efficient mills plus rapid expansion, with many larger and more-efficient mills having been built in recent years. In any case, a market-fragmentation scenario would likely have less economic impact on producer surplus in regions with a preponderance of newer mills with less diversity in cost structure and more economic impact in regions with a more diverse cost structure (a wider range of newer and older, less-efficient mills).

7.4.2 Implications for forestry and forest resources

The three hypothetical scenarios outlined above also have divergent implications for forestry and forest resources. In general, the experience of forest resource development throughout the world in recent decades indicates that forestry and forest sector development becomes more economically feasible and is more likely to be sustainable when the local forest industry infrastructure undergoes stable and prosperous economic development. On the other hand, when producer surplus and profitability decline, forestry and forest-resource development tend to suffer setbacks.

For example, since the mid-1990s, producer surplus and the profitability of the U.S. pulp and paper industry have declined (reaching a cyclical low point in 2002, following the all-time historical peak in 1995). The decline in profitability of the industry, associated in large part with the economic globalization of manufacturing, contributed to a significant historical decline in average U.S. pulpwood prices (real pulpwood prices dropped by about one-third from 1997 to 2002, according to the U.S. Bureau of Labor Statistics' nationwide pulpwood price index). Furthermore, the gross economic output of forestry in the United States peaked in 1994, when U.S. pulpwood receipts peaked, and then subsequently declined by 29% from 1994, as pulpwood receipts and pulpwood prices declined.[9] Clearly, the trends of the past decade indicate that when profitability in forest industry declines (such as in the pulp and paper sector of the United States in recent years), the forest sector and forestry also tend to suffer economically. The number of professional foresters who are members of the Society of American Foresters, for example, has declined by about 15% since the mid-1990s, a decline that roughly matches the decline in pulpwood receipts at U.S. pulp mills since the mid-1990s.

Under the market-development scenario, ICT could lead to a more economically vibrant paper and paperboard sector, with potential outcomes such as increased product value and expanded markets as a result of the development of new interactive packaging systems. Expanded producer surplus in that case could result in increased financial stability and therefore increased capability to support industrial forestry and sustainable forest management; but that outcome, as noted previously, remains speculative.

Moreover, in recent decades, as noted earlier, significant changes were made in paper and paperboard production to facilitate greater use of packaging as a communication and marketing medium, with, for example, increased output of printable (white top) linerboard for corrugated containers or other printable packaging materials (such as increased output of coated boxboard). Those technological developments have had some marginal impacts on roundwood raw material needs in the packaging paper and paperboard sector. Decades ago, unbleached kraft linerboard and boxboard were produced almost exclusively from softwood species (which have longer fibers than hardwoods and provide superior strength properties important in packaging). However, expanded production of printable grades of paperboard coincided with increased use of hardwood fiber (which can provide a good printing surface) and also greater use of surface coatings (e.g., clay coatings or fillers) that have to some extent offset the use of softwood fiber.

The likely long-term impact of interactive packaging technologies on wood-fiber demand is unclear. At present, interactive-packaging and electronic-communication technology is not yet a complete substitute for print communication on packages. However, in contrast to the resource-use trends of recent decades, it is at least conceivable that future interactive-packaging and communication technologies could replace printing as a communication medium in packaging, potentially resulting in a reversion to less use of clay coatings or hardwood fiber in paperboard packaging (materials that improve printability) and increasing the use of softwood fiber (which tends to improve strength).

[9] The gross output of forestry is an element of U.S. GDP (part of the forestry and agriculture component of the U.S. National Income and Product Accounts).

Under the cost-reduction scenario, e-commerce and e-business systems would result primarily in operational cost savings and increased producer surplus in the short run, at least for those firms that are early exploiters of the cost savings derived from ICT or e-commerce and e-business systems. However, theoretically, product prices will eventually equilibrate to lower marginal costs of production if all firms in the industry are able to gain the same benefit from the readily available technology (*Figure 7.3*). The net result in terms of producer surplus in that case is ambiguous, and thus the potential longer-term benefit to forestry or forest sector development is likewise ambiguous under the cost-saving hypothesis.

Under the third scenario, ICT and e-commerce may lead to some segmentation or fragmentation of large unified commodity markets (which were historically characteristic of commodity markets in the paper and paperboard sector). In that case, an unambiguous result would be a reduction in producer surplus and hence a likely reduction in industrial support for forestry or sustainable forest management.

7.4.3 Research tasks

For IUFRO and forest sector researchers who are interested in global forest sector development, forest sector markets, or forest sector modeling, the emerging role of ICT and the hypotheses discussed in this chapter present a set of concrete research tasks. One of those tasks is to assemble data to provide better quantitative measures of the expansion of ICT in the paper and paperboard industry.

For example, there are copious amounts of historical market data on the tonnages of paper and paperboard production, consumption, and trade, as well as data on prices and production capacities. However, there are very scant market data on precisely how much paper or paperboard is used for intelligent or interactive packaging (such as packaging with RFID), how rapidly the market is changing, or how much of a price differential exists for such packaging. As with any new or emerging technology, there are data gaps that need to be filled. Creative research may help in the design of interim measures or proxy indicators for such data. For example, the number of electronic RFID devices produced annually may be known with some certainty, and, if so, an approximation of trends in the volume of interactive packaging output might then be derived.

Once relevant market data are assembled, another research task will be to construct behavioral market models that may eventually be used to test the market hypotheses discussed previously. Many factors have historically influenced structural change in markets for paper and paperboard packaging. For example, shifts in waste-disposal policies and the increased costs of waste disposal in recent decades have helped to make paper recycling more economical and have led to substantial increases in the use of recycled fiber in paper and paperboard packaging. Economic models were designed to evaluate the behavioral response of paper recycling to increasing waste-disposal costs. Widespread introduction of RFID in packaging could further increase efficiency in the recycling industry by affording a more efficient means of automated sorting and handling of recycled packaging materials (Saar and Thomas, 2003). Similarly, economic models can be designed to simulate the market response to the cost advantages or expanding market demands for intelligent or interactive packaging systems.

Perhaps most importantly for the forest sector, researchers can undertake the task of extending such models to examine the business-welfare and forest-resource-value implications of ICT development, testing which of the preceding hypotheses may be rejected and which not, based on more empirical models and behavioral evidence. When such models or evidence become more widely available, it will be possible to better identify the broad market advantages of ICT and, in that context, develop more competitive corporate strategies.

7.5 Conclusion

This review of ICT and e-business developments in the paper and paperboard packaging industry, including the outline of speculative market scenarios, leads to recognition of certain knowledge gaps and recommendations for IUFRO concerning research needs in this topical area. Knowledge gaps include a lack of clear and comprehensive understanding of how ICT and e-business developments will influence markets for paper and paperboard products, such as how the emergence and development of interactive packaging will affect markets for primary paper and paperboard packaging materials and whether it will afford new opportunities for market development. Recommendations include: 1) the development of better empirical market models that more comprehensively evaluate the market impacts of ICT and e-business developments in the paper and paperboard sector, and 2) research on how to identify and take full advantage of ICT and e-business applications in the context of competitive corporate strategies.

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Chapter 8. ICT and the Wood Industry

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8.1 Introduction: The Wood-Processing Industry

The wood-processing industry can generally be characterized by primary and secondary production activities:

Primary production	Secondary production
Sawnwood	Construction (housing, infrastructure, etc.)
Engineered wood products (EWP)	Furniture (home and contract)
	Joinery (windows, doors, etc.)
	Packaging (including pallets)

The traditional view of the primary production sector is that it is a low-tech industry creating low value-added which, to a high degree, results in price competition. Companies are thus considered as focusing on efficient production as well as qualified sorting of raw material. Today, however, there is a more-frequent tendency for companies to try to find unique niches and to supply customers with the products they require through direct communication.

Secondary wood processing uses the output from the primary processing industry to manufacture products with a higher value-added that, in addition to the processing activities, involves design and production development as well as e-commerce.[1]

The main focus of this chapter is to investigate how ICT can be implemented in the wood industry to obtain potential efficiency gains from new technology in relation to raw-material supply, processing, management and control, design and product development, and supply chain management.

The organization of the chapter follows the product flow backwards, starting with competition conditions, market aspects, design of wood products, wood processing, and raw-material supply.

8.2 ICT in the Wood Industry and Sustainable Competitive Advantage

Information and communication technologies (ICTs) are widely used in wood-processing industries, but the degree of utilization differs among firms. A firm can achieve competitive advantages when its actions in an industry or market create economic value and when few competing firms engage in similar actions (Barney, 2001). The generic building blocks of competitive advantage are assumed to be superior in terms of efficiency, innovation, quality, and customer responsiveness (Hill and Jones, 2001). ICTs and their use are under continuous development. The conditions under which investments in ICT in wood-processing firms will yield sustainable competitive advantage are discussed in this section.[2]

To be a source of sustainable competitive advantage, the ICTs—or the products to which they give rise—must be costly to imitate. There are two types of imitation: direct duplication and substitution. Both types of imitation may have cost disadvantages for competitors for a number of reasons: unique historical conditions, causal ambiguity, social complexity, and patent rights (Barney, 2001). Sometimes firms gain certain valuable and rare resources because of conditions specific to a certain time and place. Later, it may be very expensive for other firms to develop the same resources.

[1] The implications of e-commerce are discussed in Chapter 4.

[2] One definition of sustainable competitive advantage is *competitive advantage that can be sustained over time.*

In general, wood-processing industries are easy to imitate and have few barriers to entry. This is also the case for ICTs in wood-processing industries—in most cases, most producers can obtain them easily and inexpensively as long as the appropriate infrastructure (e.g., electric energy and computers) is in place. For basic ICT resources in wood processing, therefore, imitation is simple and cheap.

Thus, for ICTs to be a source of sustainable competitive advantage, Powell and Dent-Micallef (1997) conclude that firms appear to have only three options: (1) reinvent ICT advantages perpetually through continuous, leading-edge ICT innovations; (2) move first and establish hard-to-imitate first-mover advantages; or (3) embed ICTs in organizations in such a way as to produce valuable, sustainable-resource complementarity.

The first two options have proved difficult and uncertain. Some firms have tried to use first-mover advantages, but empirical evidence shows that few firms have been able to gain advantages from this (Powell and Dent-Micallef, 1997). In the forest industry, certain Web-based trading platforms have been claimed to represent such attempts. The third option suggests that for ICTs to be sources of sustainable competitive advantage, they have to be combined with other resources and capabilities of the firm in ways that are costly or impossible for other firms to imitate (Powell and Dent-Micallef, 1997).

In the wood-processing industry it is likely that ICTs alone are not enough to create sustainable competitive advantage, but *by combining ICTs with other resources and capabilities* this may be possible. Possible exploitation of ICT in the wood-processing industry depends on the existing resources and capabilities of companies and on their willingness and ability to change and develop their competence, culture, and organization in order to fully utilize the potential of ICT.

8.3 The Market for Wood Products and ICT

As the most important user of soft sawnwood is the construction sector,[3] the driving forces for construction are thus also relevant for the demand for wood and engineered wood products (EWP). Construction activities, in particular, housing, depend to a large extent on economic factors and demographic development. Key economic indicators are essentially the level and distribution of income, interest rate, inflation rate, and real capital formation. The development of the joinery industry, including the furniture industry, depends generally on the same factors. The third main area for wood use is the packaging industry, including pallets. In some European countries, this sector comprises as much as 20% of wood use. One important driving force for the sector is international trade.

The marketing of wood products and ICT is covered in Chapter 4 in the context of e-commerce. The subject has been discussed by several authors (e.g., Toivonen, 1999).

The demographic factors are essentially population growth, distribution of age classes among the population, the formation of households, and urbanization (Baudin, 2003).

The growing importance of ICT has definite but varying implications for the different parts of the wood-industry sector. The effects of ICT in that sector should, however, be seen in comparison with competing sectors, essentially steel, concrete, and plastics. Can the wood-construction sector gain sustainable competitive advantage with increased use of ICT? A cautious assumption is that ICT in itself cannot be expected to give a competitive edge but that ICT in combination with other factors may do so. This will be discussed later in the chapter.

[3] The construction sector includes also RMI—Repair–Maintenance–Improvement.

8.4 ICT and SCM (Supply Chain Management) in Wood Industries

Material flows in the wood industries, and in particular in the sawmilling industries, are generally characterized by divergence. The introduction of ICT offers a wide range of opportunities for improving the logistics of products. For instance, the sawlog producer is heavily dependent on the variability (quality and dimensions) of timber. The output from sawmills generates a large number of quality assortments and dimensions offered to the next actors in the supply chain, either to agents, importers, wholesalers/retailers or directly to the users—the construction industry and the joinery industry. Additionally, there is interdependence among the manufacturing of different products (Markgren and Lycken, 2001).

It is observed that distributors of wood products tend to be slow with respect to adopting new technologies, unless coerced into it by customers (Dupuy and Vlosky, 2000). This is also likely to be the case for upstream members of supply chains such as sawmills and firms working with wood procurement. As an example, Universal Product Code (UPC) bar coding of individual pieces of lumber is becoming increasingly common. The manufacturer considers this as a service to the customer and does not exploit the possibilities of using the scanned data from UPC bar coding for supply chain planning and inventory management. In other industries, however, huge savings are realized through the use of bar code scanners for inventory management and control (Fisher, 1997).

Another example includes the vendor managed inventory (VMI) introduced by Home Depot, one of America’s largest retail home improvement chains. Under VMI the inventory is held at the customer’s location but owned by the supplier until sold, in this example, in retail stores. Obviously, successful application of VMI requires extensive use of ICT. Canfor Corporation owns and manages the inventory of solid wood products at Home Depot’s distribution centers. Canfor gets access to demand data as an input to forecasting. This arrangement, which originated as a requirement from Home Depot, not only makes Canfor largely dependent on Home Depot but also ensures a more even and predictable demand for Canfor’s products. The visibility of demand from Home Depot enables Canfor to manage its inventories at lower levels.

As another example, the system developed by SkogData, Norway, includes accessibility of all transactional information for each particular business contract for forest owners, forest owner associations, contractors, log hauling companies, third-party logistics providers, and buyers of roundwood. The system also includes order processing and invoicing. The system has significantly improved possibilities for planning across the supply chain. These Web-based solutions should, however, be developed further to include different types of decision support based on optimization and simulation techniques.

An observed trend in many supply chains is the focus on a specific part of the chain—the part that fits best with the competencies of the firm. Operations are increasingly outsourced, leading to a situation where the cost of input material is increasing and the share of the total cost accounted for by value-added operations performed by each member is decreasing (Mattsson, 2000). Organizational changes are facilitated by the use of ICT as a planning tool, for example, optimization models that can be implemented for a large number of members.

The wood-processing industries face major challenges when planning across the supply chain. Some of these challenges are technical and stem from the large degree of divergence in material flows and from the existence of consequence products with limited predictability. ICT solutions are necessary, and they need to be developed further so that firms can reap the benefits of collecting data using bar coding. The wood-processing industries are also tending to move toward closer integration with supply chain members. Even though major challenges will be faced in the years to come, the integration of supply chain processes will benefit from the development and application of ICT solutions and the advanced optimization and planning tools that these solutions will bring across the supply chain.

8.5 Design and Product Development

The rapid introduction of ICT in the construction, furniture, joinery, and packaging industries have been essential to design and production development over the last decades. Many basic software applications like CAD, CAM, word processing, visualization systems, and calculation systems are used to facilitate the production of documents that are used for information flow in or among companies. This section basically focuses on the information flow through the design process and the information generated within it in the construction, furniture, joinery, and packaging industries.

An increasing proportion of information created or used in the design process nowadays is in digital form, and many research and development projects have found solutions for dealing more efficiently with information (Jägbeck, 1998). Tools for both creating and refining information and for standardizing the structure of information have been developed. However, there is still a need for better tools because of the increasing quantity of information in companies, which calls for better ways of sharing and managing information.

8.5.1 ICT and design

ICT may be used at different stages of the design process.[4] In design work, ICT is a tool for documentation, organization, and storing of information, for visualizing and analyzing design alternatives, and for producing drawings and models. Different types of software tools may be used, some of which are described below.

Through *Computer-Aided Design* (CAD) systems, design, construction, and drawing work are handled with support from interactive graphical computer systems. A geometric model of the product, created in the CAD system, is a virtual description of a product's geometric form. The first CAD systems were two-dimensional and in principle based on wire geometry. The greatest benefit of CAD systems versus the drawing board is the ease of electronic transmission of drawings and models between different computer systems and the option of copying and editing. Even 2-D CAD can be included in a company's ICT strategy, as two-dimensional models may be satisfactory for designing products with simple geometry.

CAD, and in particular 3-D solid modeling, has a much greater potential than simply automating the drafting process. According to Wiebe and Summey (1997), "The transition from the use of CAD as drafting tool for producing parts sketches for route sheets to a tool for creating virtual models of complete furniture pieces means a rethinking of how CAD is integrated into product engineering."

The use of 3-D modeling has inspired many advances in different industries, including the furniture, joinery, and building industries. It has facilitated the integration of design and analysis applications or automatic fabrication and assembly, but the industries must still make the transition from paper or electronic drawings to 3-D modeling to realize these benefits (Eastman, 1999).

Computer-Aided Manufacturing (CAM) systems use computer systems to plan, control, and manage manufacturing operations. The most mature area is numerical control (NC), where CAM is used to make programmed instructions to control a machine (Lee, 1999). The machine is then able to follow the operational instructions and, for example, grind, cut, mill, and punch the raw material into a finished product. The geometry of a product created by a CAD system may be used as a basis for displaying the functions in the CAM system. Another CAM function is the programming of robots that may perform tasks such as welding or assembly or carrying equipment or parts (Lee, 1999).

Many companies in the furniture and joinery industry actually use computer numerical control (CNC) machines in their production. It is therefore also common for them to have some variation of a CAM system. CNC machines normally come with an onboard computer system for creating programming instructions, including some CAM components. Quite frequently, however, these are not used (Bronsek, 1997). According to Bronsek (1997) CAM systems are regarded as user-friendly

[4] In this section the concept of ICT is confined to software tools.

tools in wood-based industries and have many benefits. Some CAM systems (for example, MasterCAM) also include applications for woodworking machines.

Calculation systems like the Finite Element Method are often integrated with the CAD system; thus, calculated values can be parameters in the geometric design of the model. In the building industry, technical calculations, related to construction elements such as the ventilation plant, for instance, are generally used by technical consultants (Wikforss, 2003). The use of a calculation system, while more or less standard in the building industry, is not frequently used in the furniture, joinery, or packaging industry.

8.5.2 Presentation and visualization: Virtual prototyping and simulation

As the furniture and joinery design process is still strongly prototype-dependent, an important way of reducing the product-development process is to accelerate the prototyping process. This can be achieved by using CAD data of a product in combination with virtual reality tools to replace or reduce physical prototypes. The result is a virtual prototype or a so-called simulated product that can easily be reproduced, modified, and transported digitally (Dai, 1998). Computer simulations are a way of predicting the appearance of a building or furniture and how it can be experienced (Schmitt, 1999).

Today, some CAD systems include simulation systems, integrated or optional, that make them easy to apply. While not frequently used in the furniture and the joinery industry, however, they are becoming more common there.

Simulation is a precursor to Virtual Reality (VR), and the borderline between them is vague. Simulation could be defined as a computer-generated world: three-dimensional and interactive (Johansson, 2001). VR may simulate reality through the use of interactive devices that send and receive information (e.g., goggles, headsets, gloves, or body suits). VR is gaining acceptance in different kinds of industries, but the display is still expensive (Schmitt, 1999). Schmitt (1999) also believes that architecture is a natural application area for VR. The technique has been applied in architectural design for some time and is now also gradually being accepted by the furniture and joinery industries.

8.5.3 Product models

A product model provides a shared object where multiple participants can store all the information about a product throughout its entire life cycle, thus making the product development of a complex product easier to manage. A product model is a conceptual scheme for describing the product as well as a base of information for storing product data (Johannesson *et al.*, 1996).

Product models have been implemented at various levels in the industry, from simple to complicated systems, such as PDM (product data management). Information management based on product models has changed documentation techniques quite radically. Björk (1995) argues that one prominent element of building data models that compares with traditional building descriptions (for example 2-D drawings) is the explicit modeling of spaces. Product models do not solve all the problems and weaknesses in the construction process, but the transfer of information between actors becomes easier than before. According to Wikforss (2003) an increasing number of companies in the building industry will use building product data models in the future, thus making the design, construction, and production process potentially more efficient.

8.5.4 The design process

The design process is a complex activity that is often integrated with product development. A number of authors have contributed to its development. Andreasen and Hein (1987), Pugh (1990), Hubka and Eder (1992), Roozenburg and Eekels (1995), and Ulrich and Eppinger (2000) are some of the most important publications in the design or product development process. The concept of design process is not obvious; the product development process or the design process is the most common concept in the manufacturing industry; in the construction industry, the construction process is common.

Design or product development may be defined as a process that translates an idea into a product and brings it to the market. It is an interdisciplinary activity between different functions in the organization, but *market, design,* and *manufacturing* are almost always crucial to a product-development project (Ulrich and Eppinger, 2000).

In modern design the paradigm of integrated product development or concurrent engineering is referred to. In integrated product development, the information flow becomes even more important, as all the actors need the information and its status to gain an overview of the project (Löwnertz, 1998).

8.5.5 ICT and design in the construction industry

The construction industry may use ICT to make the design and construction process more efficient so as to obtain better quality buildings. In the last decade, information technology has become increasingly used for this purpose and is today standard in some areas (Björk, 1995). The construction (or building) industry is information-intensive with respect to the following items (Björk, 1995):

- The complexity and size of the end product;
- The need for visualization and technical analysis at the design stage;
- The variety of know-how and materials needed to erect a building; and
- The large number of different participants in a construction project.

As mentioned above, the building design process is carried out in a fairly standardized form, often country-specific (Karhu, 1997). The phases in the product development process are: *Concept Design, System Design, Detailed Design,* and *Production Preparation.* The phases and contents may be adapted to the contract procedure. In the case of early procurement, the contracting procedure is not considered, but the final design phase is the production preparation phase, which is often managed by the contractor after the delivery of detailed design documents (Löwnertz, 1998). For a discussion on these concepts see Karhu (1997), Löwnertz (1998), and Ulrich and Eppinger (2000).

A scenario can be based on the tendency for more integrated approaches. Consider an architect using 3-D CAD to design a complete, thorough, and accurate building data model with full planning information that can be circulated by the computer applications used by all participants involved in the construction process with no loss of information (Kam *et al.,* 2003; Tarandi, 2003). The model can thus be used by engineers estimating the specifications of the materials needed, by contractors ordering the materials, and by the site manager making a project management plan.

Currently, two complementary standards for electronic exchange of architecture, engineering, and construction (AEC) information are available:

- Industry foundation classes (IFC) have been developed to facilitate transaction of data between AEC users; these provide standard representations for construction materials and elements of the planning process.

- aecXML is a common schema of definitions for AEC commodities that can be used for network transactions (e.g., for e-commerce). It is based on the standard XML formatting language.

The International Alliance for Interoperability (IAI) (www. iai-international.org), a not-for-profit division of the International Standards Organization (ISO) administers both IFC and aecXML.

The implementation of IFC enables the testing of competing products and materials within the same model. Various material types can, for example, be tested on the model to evaluate factors such as construction strength, visual aspects, and also cost (*Figure 8.1*). IFC can be used on a wide range of 3-D CAD software systems, and much effort has been devoted to compiling specifications for all objects likely to be encountered in the building industry. The system has been developed for its members—currently around 600—and is implemented globally. The latest version available is IFC2x Edition 2.

From ad hoc, fragmented information to shared standardized data

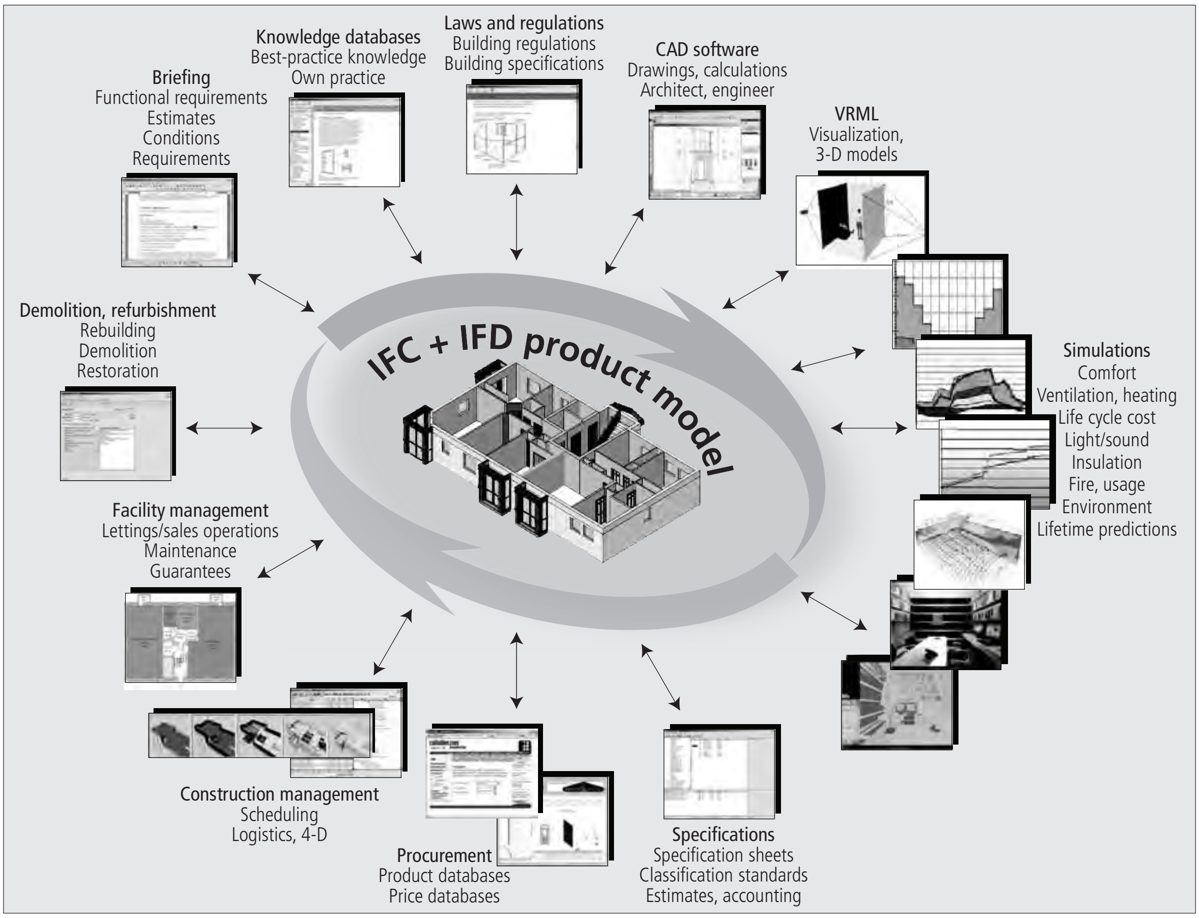

Figure 8.1. The IFC planning process.
Source: Norwegian Building Research Institute (www.byggforsk.no).

Both IFC and aecXML support aspects of industry members' business processes and must be coordinated to achieve the intended overall interoperability—the exchange of information among project participants throughout the life cycle of a facility by direct communication between software applications. Interoperability is achieved by means of a joint project model with common standards coded in a generic language (see *Figure 8.2* below). aecXML is intended to be the transport mechanism by which information can flow seamlessly between applications that are not interoperable, based on IFC compatibility. In many cases aecXML will be used in e-commerce and light payload transactions.

Interoperability in the construction process offers a potential for increased accuracy and efficiency in the construction industry. The construction industry is an important consumer of solid wood products and wood panels, and the implementation of shared project models is therefore likely to affect the demand for products from the wood industry. As the IFC is neutral with respect to choice of material, the increased use of this planning tool will enhance standardization of building materials and thus result in increased industry rivalry both within the wood industry and between wood-industry products and substitutes (cf., Porter, 1980). Producers of wooden building material will be forced to adapt to these standards to stay in business. With homogeneous products, the only possible way of remaining competitive is by maintaining cost leadership (in regional markets). There is probably a (short-lived) first-mover advantage for companies that are able adjust to the new technology quickly, but such a competitive advantage is not sustainable. A possible sustainable competitive advantage may appear if the visual representation of the 3-D models gives wood a competitive edge over substitutes. There are, however, no indications that this is the case.

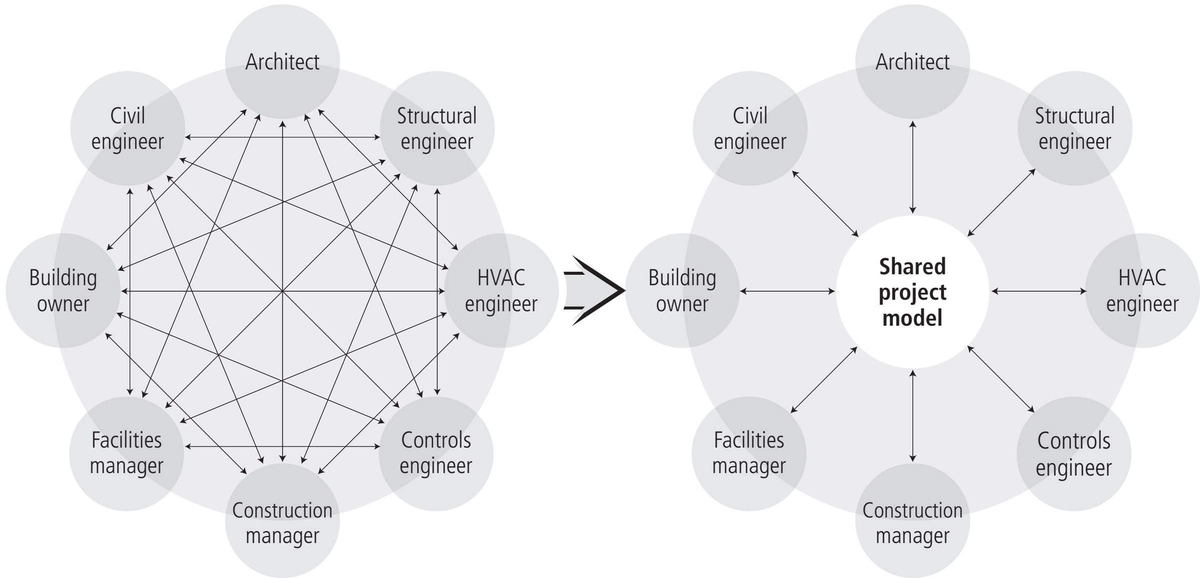

Figure 8.2. The concept of interoperability.
Source: IAI (1999).

8.5.6 ICT and design in the furniture and joinery industries

The proportion of computer-produced documents has grown rapidly during the last years in the furniture and joinery industries and will probably continue to do so. In some areas, such as the detailed design phase, the use of computer support in the form of CAD systems is becoming standard. Most of the software tools used in the furniture and joinery industry are CAD tools. There is, however, very little use of calculation or analysis systems (Olsson and Olsson, 2003). According to Wiebe *et al.* (1998) many of the small to medium-sized companies are in the process of exploring the transition from 2-D CAD systems to 3-D CAD systems interfaced with PDM systems.

To be competitive, the furniture industry has to improve the way it develops products and services. The furniture and joinery design process is still generally a prototype-dependent process. Before a designed product is accepted for production, a full-scale prototype is provided, and tests are generally carried out incurring a large share of the overall cost. One obvious way of improving product development is by using computer-based support tools.

In the design and product development process, almost the same phases as for the building industry apply: *Concept and System Design, Detailed Design,* and *Production Preparation.*

8.6 ICT in Primary Processing

8.6.1 Production management, strategic management, and planning

New information technologies and improved competence have changed the way wood-processing companies operate. Based on the implementation of ICT, new production management and financial control systems, as well as supply chain management systems, have been developed. This section focuses on internal management in individual business units:

- E-mail systems; for communication within and outside the company;
- Internet applications for information and marketing;
- Intranet applications for internal information (i.e., quality systems);
- Administrative management systems for economic transactions and accounting; word processing for, among other things, customer registration; and
- Maintenance systems for registration and scheduling of maintenance work within the plant.

There are several systems whose overall aim is to create an ordered structure to assist in searching for and retrieving documents, for example, EDM (electronic data management). A more advanced system is PDM, which manages data and supports the process of information exchange between different systems and applications (see Section 8.5.3.). Producing documents using computer-supported methods has become common practice in these industries, but managing information/documents is still achieved to a large degree using manual methods. Companies in the furniture and building industries have applied EDM or PDM systems within their organizations or in projects, but introduction to date has been slow.

PDM

The PDM system offers a technology that satisfies the need for managing data related to the product-development life cycle. The need for the system became obvious as sophisticated and automated design tools (e.g., CAD systems) became available and the amount of data accumulated about the designed artifact increased dramatically (Bilgic and Rock, 1997).

A data management system basically stores data about data, which in most cases are files. This concept is usually called metadata. Typical metadata for a file may be the name of the file, where it is located, the type of information in the file, and other useful information, such as who created it and when and where it was created. A PDM system stores data such as 3-D or 2-D drawings, text documents, specifications, bills of materials, geometrical models that describe virtual objects, or sales brochures. The basic functions of a PDM system are:

- *Design Release Management:* the process of controlling design data with check-in/check-out, release level maintenance, access security, and review and approval management.
- *Product Structure Management:* the ability to define, create, modify, and display multiple versions of the product structure;
- *Change Management:* the ability to define and manage data over the life cycle;
- *Classification*: the ability to classify parts by their structure, function, or manufacturing processes;
- *Systems Management:* the use of project-oriented scheduling techniques with work-breakdown structures that should be able to manage any facet of systems design; and
- *Impact Analysis:* the ability to detect the effects of a design change on the overall product design life cycle (Bilgic and Rock, 1997).

Data Exchange

The demand for structuring information results in standards for exchange formats, both for the structure of documents and for the structure of document collection.

Today, companies are more and more oriented toward profitability and value-oriented growth instead of volume-oriented growth, and they attempt to apply differentiation strategies instead of low-cost strategies. Roos *et al.* (2001) discuss the impact of different strategies at sawmills and demonstrate that adding value to products by further processing increases profit margins. Furthermore, to a larger extent than before, companies are identifying customers with special needs (Johansson and Rosling, 2002). Improved management practices and better information on costs in the production process are therefore becoming increasingly important.

Introducing ICT into management has facilitated the implementation of new and more-detailed management systems. The implementation of financial control systems has, to a large degree, been dependent on new information technology; the reduced costs of information technology, coupled with increasing competition, wider product portfolios, and changing cost structures with more indirect costs, has led to the development of Activity Based Cost (ABC) systems (Bjørnenak, 1994; Kaplan and Cooper, 1998). According to Kaplan and Cooper (1998), a company’s cost-management system has three primary functions:

1. Evaluation of inventory and measurement of the cost of goods sold for the purpose of financial reporting;
2. Estimation of the costs of activities, products, services, and customers; and
3. Providing economic feedback to managers and operators about production process efficiency.

The term “activity” has inspired a range of new ABC related terms, such as Activity Based Management (ABM) (see Kaplan and Cooper, 1998; Bjørnenak, 1994), and further grouping into (1) activity accounting, where the focus is activity costs, and (2) process improvements, where the focus is nonfinancial goals. Activity Based Management provides a tool whereby strategic decisions about products and markets and operational decisions about process improvements can be included in a single system (Bjørnenak, 1994).

In Kjesbu *et al.* (2001) the possibility of using ABC in the sawmill industry is demonstrated. The utility of the tool also depends on data availability. As a large proportion of a sawmill’s costs are direct, there is still a question regarding the extent to which a company should use ABC systems. More-detailed data collection must be weighed against the costs. Assuming that ABC systems are more accurate than traditional calculation systems, the probability of adopting ABC systems would be expected to increase with industry competition (Bjørnenak, 1994).

8.6.2 Sorting inputs and outputs

Modern sawmills are specialized and increasingly practice formalized product-, customer-, and company-specific grading (Bjørnenak, 1994). The grading is generally based on local or regional sorting rules. Most of the timber is still graded manually at high speed. The person grading has only a few seconds to make the decision regarding where to cut and the grade of the timber.

Automatic Systems

The introduction of ICT, enhancing information management and computational power, has to some degree resulted in the replacement of manual sorting and inspection systems by automatic systems. The arguments for automatic systems (Åstrand, 1996) are many, for example:

- Decreased labor costs;
- Cutting down on tedious work;
- Speed;
- Accuracy; and
- Flexibility and complexity.

Value can be added to the product by improved sorting and quality control; for example, a board is automatically sorted into a standard grade as the last step in a sawmill, shipped to a customer for secondary processing, and then inspected again, but now with completely different inspection rules. If the complete grading information were supplied together with the board, there would be no need to inspect the board again. The customer may also provide the sawmill with software which—for each board—can provide a calculation of the exact yield and thus of the price of the board. The result can be electronic bidding from several potential customers on each individual board (Åstrand, 1996).

8.6.3 Sawmilling[5]

Even though sawmilling can be carried out as a low-tech application, modern sawmilling and wood-based panel production are increasingly making use of ICT. The main focus of ICT applications adopted by the primary wood-processing industry has so far been the automating of production processes and quality control, improving productivity, and enhancing the standardization and production of homogenous products.

Automatization, Optimization, and Production Efficiency

In industrialized countries, the relatively high cost of raw materials and labor has initiated attempts to integrate automatic optimization procedures into production. To do this, methods have been developed for optimizing output yield on the basis of raw material inputs. These methods are frequently based on quantitative algorithms, either true optimization tools (e.g., linear programming) or simulation models. Input data, including desired outputs, are required to run optimization models, and this calls for a measurement technology that can be integrated into production. At present, several measurement systems are available for applying digital scanning techniques. The process of optimizing production can be broken down into three stages: measuring raw materials and providing inputs for optimization, processing the information and, finally, applying the results from the optimization procedure in production.

The introduction of ICT has spurred the development of a wide range of optimization tools for applications in the wood-processing industry.[6] As a result of increasing computational power and advances in measuring technology, a number of optimization systems are already available. Models designed to determine optimal sawing patterns in lumber production can be purchased from various commercial software suppliers. In sawmilling, most optimization models focus on determining the optimal pattern on the basis of the base area, but increased measurement accuracy and speed have enabled optimization based on the shape of the log as well as the base [cf., technology developed by RemaControl (www.remacontrol.se)]. Another interesting project would be to optimize with respect to prices and qualities of end products (i.e., profit maximization).

True optimization models, such as linear and dynamic programming models, have been used to determine optimal output from production, but to date such tools have gained limited popularity. The models also require a good knowledge of the optimization techniques applied and are often difficult to manipulate and implement in production planning. Discussions on these topics can be found in, for example, Todoroki and Rönnqvist (1997), Todoroki and Rönnqvist (1999), Johansson and Rosling (2002), and Todoroki and Rönnqvist (2002).

Simulation tools have gained substantial popularity in the sawmilling business, and both deterministic and stochastic (Monte Carlo) approaches have been applied. The simulation tools do not provide optimal solutions but rather support for decision making in production. Simulation models are easily manipulated and therefore easily implemented in actual production planning. At present various simulation tools are in use, for example, as described in Occeña *et al.* (1996), Todoroki (1990), and Toverød (2000).

Benchmarking tools may also be used to improve production efficiency. Production in various industrial facilities can be compared, and a best-practice standard for industry performance

[5] The conclusions from this section also apply to engineered wood products (EWP). EWP will be further discussed in Section 8.6.4.

[6] Several optimization systems have been developed for commercial use, and some have been introduced into the Scandinavian market. For example, the Rema Control Wood Saver provides an integrated system for scanning and optimizing production. In Canada, MPM Engineering's Primary Breakdown Optimization, that conducts scanning, simulation, and optimization, is widely applied.

determined. There are various approaches to achieving such tools, for instance, statistical or linear programming approaches.

8.6.4 Engineered wood products (EWP)[7]

Experience of ICT use in the EWP industry is generally based on information from wood-based panel industries around the Baltic Sea. The applied technologies differ among production facilities; older production plants tend to use fewer computer-based systems, and when they do, these are not fully integrated. ICT is widely used in the sector and in a number of company operations. Listed below are some operations that focus on control and measurement systems but do not cover communication or administrative systems:

- Production control systems for the drying, molding, and gluing;
- Production control systems for layup and press line;
- Production control systems for the post work such as sanding or cutting;
- In-line measurement systems;
- Internal control systems; and
- Database systems for storage of internal control records.

Production Control Systems: Drying, Molding, and Gluing

When an ICT system is applied, data are collected, compared to the setting values for the current production, and displayed in a condensed format on a screen.

Layup and Press Line

The part of the production line from layup to the press line is controlled mainly by the belt speed. The press itself is monitored with respect to the press cycle, time, temperature, and pressure in different zones of the press. Near-infrared spectroscopy (NIR) is one system that is available for use here, but it is not yet commonly used. The objective of the system is to control the shape and moisture content of the chips in the process.

Sanding or Cutting

The most common use of ICT in this part of the production process is to optimize systems for cutting schemes. A large proportion of the production is generally sold in customer-adapted sizes. The program is then used to obtain optimal yield in small sizes from a full press-format panel.

In-line Measurement Systems

In-line measurement systems are measuring devices that are not connected to the actual production settings. The layup is monitored by thickness-measuring devices and usually a conveyor belt scale; the devices are not usually connected to the production control system. These systems may include different devices.

- Digital optical glass grid or lasers measure the angle of the reflected laser beam and can be used to measure the thickness. These may be fixed, with transducers covering both the center and the outer side of the layup, or they may move across the total width of the layup.

- X-ray techniques are used in density-profile meters, particularly in the MDF industry.

- Ultrasonic techniques are used as crack indicators and can be connected to the grading equipment; panels showing crack zones can be downgraded.

[7] Engineered wood products constitute a number of products based on wood, veneer, and wood residues (chips or sawdust) as input material. Among the products included in the product group are particle board, plywood, oriented strand board (OSB), laminated veneer lumber (LVL), and parallel strand lumber.

- Mechanical stiffness and strength-measuring devices can be used to estimate the panel strength and stiffness using wave propagation velocity or physical bending.

An enquiry conducted by Baldwin (2000) found that none of the respondents had used in-line data as the final quality test for the panels, although this is permitted under European standards.

Internal Control Systems

The systems control the load cycle, read the test results, create a report of the properties evaluated, and store the results in a database format that makes it possible to compile test data. The systems described above are to some extent combined into one coherent system. These coherent systems, often called MPS systems, are becoming more and more common. The advantages of these systems are better traceability of the products through the production process and a better chance of identifying weak or limiting sections of the process.

The competitiveness of the sector depends on its productivity gains in relation to its substituting materials. The use of ICT in the production process, transport, planning, and sales will be a critical factor for the long-term development of the sector.

8.7 A Scenario: ICT as a Tool to Manage Wood Procurement to the Wood-Processing industry

The sawmill industry is characterized by its fragmented structure. As a result, sawmills have limited opportunities for exerting any authority in the sawnwood supply chain. However, the industry is consolidating, and this may lead to strategic advantages with new possibilities of specialization, for instance, between different mills in a company (Hansen *et al.*, 2002). The need to integrate business processes and information-technology infrastructure among divisions is thus increasing. Managing raw material flows based on market information is a key to a competitive strategy.

To match production with customer requirements, the need for improved integration has increased among different actors in the supply chain. Raw material supply is gradually changing from a push system to a pull system. Baldwin (2000) claims that today’s foresters, procurement managers, and business leaders are spending more money, time, and resources than ever before in securing a timber supply. It is likely that the use of ICT-supported raw material supply systems will increase in the wood-processing industry, even though, to date, few sawmills have developed this option. The reason is possibly a “cultural heritage” based on the traditional way of doing business (Alkbring, 2003).

A mill’s choice of market and production strategy has an impact on the need for information to manage procurement. Today, data generated in the supply chain are mainly used for controlling and sometimes optimizing the subsystems included in the production process (Uusijärvi, 2003). To be competitive in a global market, many companies are implementing modern information technology and decision support systems, including optimization models, for better integration of different actors and processes in the supply chain. Development of standards or easily modifiable systems are necessary to facilitate integration.

Today, the use of ICT differs substantially among wood-processing firms. However, the development of different standards of, for example, Internet communication protocols will make it easier for smaller companies to get access to different applications. For instance, the concept of Extensible Markup Language (XML) makes it cheaper and easier to transfer data: an opportunity to obtain flexible solutions for small and medium-sized companies (Juslin and Hansen, 2002). By developing an e-business structure or Internet-based electronic data interchange (EDI), it is possible to improve information exchange with other companies. The Internet-based solutions offer low-cost data transmission and high availability. Thus, e-business facilitates utilization of resources that can result in cost savings, rationalization, and automation of operations (Juslin and Hansen, 2002). Furthermore, the e-business concept is currently developing into collaborative systems suitable for, for example, procurement. This makes it possible to provide a platform or a portal for exchange of timber and information (Juslin and Hansen, 2002). Enterprise resource planning (ERP) software makes it possible to integrate all departments and functions in a company into one operating system. This type of system is designed primarily for internal processes and may lead to increased efficiency in order processing and other paperwork by decreasing manual input between the different steps in the production process and among actors in the supply chain.

Communicating Market Demands to Forest Machine Operators

Market information and forest inventory data allow wood-processing industries to manage the purchasing of standing timber or logs, distribute the stands over time, and manage bucking. The operational planning at a wood-processing mill with a stock of standing timber involves the following steps: selection among available stands, distribution of the selected stands over time, allocation of stands to the harvesting teams, and determination of harvesting instructions, including bucking matrixes for each stand. Today, harvester operators use onboard computers to carry out the bucking, based on 1) input information from the log length and the diameter sensors in the harvesters and 2) a bucking matrix that consists of diameter classes of logs required per length. The bucking matrix optimizes in relation to demand or a price list. However, to date, the possibility of using real-time information about market demand has not been fully taken advantage of. A disadvantage with the cut-to-length (CTL) method is that the possible lengths and dimensions of deals and boards are practically fixed after cutting. Tree-length logging systems involve postponing the bucking until the sawing process at the mill. Thus, bucking of whole stems could be carried out on demand right before processing to optimize the use of raw material and to allocate wood correctly.

The sawmills aim to improve the relationships with harvesting contractors by joint planning and performance reviews, together with frequent communication within and among organizations. The introduction of ICT tools will facilitate the processing of available data, simplifying decision making and thus improving management of wood-procurement activities. Developing an extranet to communicate with contractors could be beneficial by providing accurate and up-to-date online information. In the sawmills it would be desirable to use online ordering and follow the wood through real-time tracking (of order status). Contractors could perhaps gain access to information such as harvesting instructions, maps, bucking matrix, production plans, and forecasts. Furthermore, the spatial information generated by harvesters with a global positioning system (GPS) could be utilized by forwarders in order to base routes on assortments, thus making it possible to prioritize some assortments to fulfill orders.

The sharing of information facilitates day-to-day working, which suits decentralized organizations, and the information is always available online at any time. The communication among the actors will be less dependent on telephone calls regarding routine work questions. Over the last years, some companies have implemented Internet solutions to facilitate information exchanges with the harvesting teams, but the ICT solutions in procurement are still generally immature. A dilemma when using mobile devices is that the coverage is poor in many areas, which makes mobile solutions less attractive.

Transport Management

Transport planning can still be carried out manually using maps, telephone, and fax, but the use of computer-based optimization is increasing. Tree stands are often geographically dispersed, and the decision-making process is therefore highly decentralized. Sawmills frequently keep inventories low, making transport planning crucial; thus, high-quality and rapid information exchange is essential. Managing the haulage allows precedence to be given to certain tree species, dimensions, or qualities, and also the reduction of inventories.

The problem of log-truck scheduling is complex and involves constraints regarding logs and loading sites, trucks, road networks, and unloading sites (cf., Karanta *et al.,* 2000). Scheduling is a routing problem that consists of finding a feasible route for each truck so that customer demands can be satisfied and total transport cost minimized.

Different ICT-based planning systems for timber transport and haulage coordination have been developed and implemented by forest companies (see, e.g., Linnainmaa *et al.*, 1995; Rönnqvist and Ryan, 1995; Weintraub *et al.*, 1996; Walter and Carlsson, 1998). Input data could be collected online directly from forest machines, and some of the systems are based on communication via the Internet. The Swedish systems KOLA (navigational aid) and SMART (navigational aid and transport optimization) use vehicle computers, GPS, geographic information systems (GIS) and real-time communication for immediate updating of databases (cf., Dahlin *et al.*, 2002). Today, these transport-management systems are primarily used by larger companies, while smaller companies rely on traditional methods. However, the wood-processing industry is consolidating, which may lead to new possibilities for transport management; for example, different mills within a company could focus on certain products or markets.

Tracking of Wood

As a result of the "normal" commodity product strategy, many sawmills try to imitate process industries. But the nature of production rests on the flow of individually treated logs through the sawmill, thus, in principle, resulting in a flow of individual output products. A large part of the production process is spent on homogenizing the production into batches based on tree species, dimensions, and quality parameters. A tracing system passes on information in the form of individual associated data (IAD) attached to each log from one process to another in the supply chain. This helps match sawlogs with market demands and orders, but this is also the first step in gaining control of the production process *as a whole*—from procurement to sales and marketing, including a feedback system so that further improvements can be achieved. In addition, IAD-based systems could be used for guaranteeing the origin of logs, which is of great interest as a result of the growing demand for certified products.

Conclusions

Today, the use of ICT differs considerably among wood-processing firms; larger firms have greater opportunities than smaller firms to invest in new technology. However, the development of different standards of, for example, Internet communication protocols, will make it easier for smaller companies to gain access to different applications. The control of raw-material procurement and ways of communicating short-term needs to suppliers are vital issues for the wood-processing industry. The development of information technology and its introduction in forestry enables the improved management of raw-material supply. Harvesters are equipped with computers and wireless data communication for receiving instructions concerning the required log lengths and dimensions and for reporting daily output by assortments. Trucks may be equipped with computer-based, satellite-assisted navigation systems with road maps and location data and specifications of roadside inventories. The introduction of the new information technology has, to some degree, resulted in a more efficient supply to the wood-processing industry. Nevertheless, the possibilities for further improvements are many.

The increased use of ICT applications in wood procurement and the development standards for information exchange between logging units and the wood industry strengthen business-to-business integration in wood-procurement activities. Improved market information and precision with respect to quality and time of delivery add value to the raw material and may lead to price increases and, hence, to profitability in the business and the wood industry. The introduction of new technologies can also lead to increased productivity in forest harvesting operations. The fact that there are no shortages of land for wood production will probably lead to increased supply. Better information about markets and demand will also lead to increased competition among raw-material suppliers, which will affect raw-material prices. Finally, the introduction of new technology can lead to higher production efficiency in the wood industry and better utilization of logs, resulting in reduced demand for raw material. Thus, ICT may affect the forest business positively in the sense that it adds value to forest products. But it may also affect forest industry negatively in the sense that the supply increases, the competition becomes fiercer, prices increase, and the demand for raw material decreases.

8.8 Do-It-Yourself, Repair–Maintenance–Improvement, and E-Commerce

A substantial share of the consumption of products from the wood industry is related to the repair–maintenance–improvement (RMI) and do-it-yourself (DIY) sectors, and the wood industries expect this sector to become increasingly important [cf., the "Roadmap 2010," CEI-Bois (2004)]. Most wooden RMI products are purchased by homeowners carrying out work on either residential buildings or leisure housing or by small contractors hired by house owners. The roadmap also notes that consumers in general are becoming more demanding, and that they require RMI products with a "consumer products approach" (i.e., DIY).

The DIY market includes a range of products, both materials and equipment, for carrying out renovation and small-scale construction; it does not necessarily only include wooden products. A major and growing tendency is for products to be sold through large retail store chains (the market share of the ten largest RMI consumers is approximately 50%), but they can also be sold directly to consumers by industry, from smaller retail stores, or from specialized builders' merchants.

RMI products can also be marketed and sold via electronic commerce. E-commerce business models range from simple e-retail to customized and functionally integrated market makers, for example e-businesses interacting with construction firms through interoperable systems like IFC and aecXML. Large commercial retail platforms and market markers are probably capable of using market power to enhance competitive bidding regimes between suppliers, thereby increasing rivalry within industries and increasing competition from substitutes. This will force producers to improve their cost-leadership/cost-cutting strategies. On the other hand, customized business solutions and functionally integrated market makers will probably lead to less-intense competition and diversification in production.

Web platforms focusing on the RMI construction market will also probably offer materials that can be substituted for wood and therefore increase competition. Furthermore, e-business is likely to enhance industry standards, thus increasing product homogeneity and resulting in cost-cutting strategies for producers of commodities such as wooden building materials. It is unlikely that the wood industry will be able to attain substantial competitive advantages in such markets, but gaining advantages through providing complementary services may be possible, for example, the provision of instructions for handling or use or adding value to products and thus exploring niche markets.

8.9 Conclusions

As is obvious from the discussion above, ICT is having a definite impact on the wood-industry sector. There are, however, no direct substitute threats to wood on account of ICT, as, for example, in the case of newsprint. Substitution by another material may occur, but whether wood and EWP would gain or lose market share to other materials because of the extensive use of ICT is unclear.

Why should the wood sector benefit more (or less) than the steel, concrete, or plastic sectors from the use of ICT? The answer is not obvious. The technology does not promote any of these sectors at the expense of the others. Wood may gain market share from other materials, but this is more for reasons of environmental friendliness or cost-efficiency than the use of ICT. ICT is just as important to the wood sector as to the steel, concrete, or plastic sectors; it is hard to find an argument that favors any one of them.

ICT may have had a role in the design of more aesthetically pleasing offices, in the development of multistory wooden houses, and in the introduction of "intelligent" houses. ICT itself, however, will not promote wood, but ICT in combination with other factors may do so. The efficient indoor production of parts for multistory housing in wood would require an industrial approach that is quite different from today's more manual approach. The combination of new and efficient production units with advanced and computerized manufacturing (including robots), together with the marketing of wood as a material from sustainable resources, could lead to new markets for wood.

One combination of ICT with other factors to promote wood could be in terms of environmental concern and traceability. Suppose that future logging systems could be installed such that fellings would always be attached to coding in terms of x/y/z coordinates. This would make it possible to apply coordinates at the moment of planting that would stay with the tree until it is felled, making it possible to trace the entire history of a piece of wood wherever it is used. This information could also be correlated with growth and yield conditions, which would not only mean promoting environmental concerns but also ensuring sustainability in terms of global resources.

The application of advanced measurement methods, coupled to ICT systems, will also improve product quality as a result of improved sorting methods. Advanced construction methods can also be developed in the context of ICT to produce elements, for example, for dwellings, offices, and commercial centers, that will turn the wood industry from a low-tech to high-tech industry. To sum up, as ICT may improve wood construction methods, it may also—indirectly—favor the use of wood in construction. While desirable from the point of view of the wood industry, competing industry sectors will undoubtedly come up with many counterarguments and many competitive products.

There have been various attempts to measure the effect of investments in ICT on industry performance. An early study of the effects of ICT was conducted by Hitt and Brynjolfsson (1996), who found that investments in ICT increased productivity in businesses and services. There are no such studies focusing only on the wood industry, but a comparison of several manufacturing industries (including the wood industry) is provided in Ark *et al.* (2003). European and North American industry was investigated for the period 1990–2000. Productivity growth in the wood industry was very low in the first half of the period: –1.2%, 2.5%, and –2.8% in Canada, the European Union (EU), and the United States, respectively, but increased somewhat in the second half to 2.3%, 2.7%, and 0.3%, respectively. Productivity growth in the wood industry was, however, well below the top performers, and the wood industry was also among the industries with the lowest share of ICT capital in production.

Even more remarkable is that increased productivity in many industries has not resulted in higher profits. Hitt and Brynjolfsson (1996) found that the benefits of increased productivity resulted in lower prices and a spillover distributional effect in favor of the consumer, while the producer surplus decreased. Porter (2001) suggests that the introduction of ICT is likely to increase industry rivalry and competition from substitutes. Along the same lines, Carr (2004) argues that the introduction of ICT results in hardly any sustainable competitive advantages for businesses. On the contrary, increased productivity results in commoditization of products, increased competition, and the erosion of profit margins. Because of increased competition, all companies within an industry must invest in ICT to remain competitive. ICT is a prerequisite for staying in business, but it does not provide competitive advantages.

In a base scenario where "business as usual" is the main argument, the total net effect of ICT on wood consumption in the world is expected to be marginal—far more important are economic factors, consumer preferences, and environmental factors. The long-term projections for the consumption of sawnwood in the world can be expected to follow those given by Food and Agriculture Organization (FAO) for the world, supplemented by the recent projections for Europe from the United Nations Economic Commission for Europe (UNECE) (Kangas and Baudin, 2003) (*Table 8.1*).

Table 8.1. World projections of sawnwood consumption by region and five-year interval in thousand cubic meters up to year 2020. FAO projection scenario 2 (FAO, 1997).

	1,980	1985	1990	2000	2010
Africa	9,917	11,254	10,601	10,183	12,297
N/C America	123,139	140,307	153,387	155,402	166,557
South America	20,895	23,606	23,506	26,322	28,819
Asia	98,201	102,941	112,324	114,374	118,801
Oceania	6,104	6,759	6,465	6,287	5,597
Europe	73,465	91,754	102,772	102,514	118,114
Former USSR	91,314	90,774	98,617	16,509	37,604
TOTAL	423,035	467,395	507,672	431,591	487,789

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Chapter 9. ICT in Forest Management and Conservation

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9.1 Introduction

Forest management is the art and science of managing forest resources. However, the term "managing" carries with it various connotations including, for example, directing and controlling. In the sense of directing, forest management is fundamentally concerned with deciding how to use forests to provide the values, goods, and services desired by society (Davis *et al.*, 2001). In the sense of controlling, forest management is concerned with the application of a diverse array of specific operations to satisfy the goals and objectives established by decision makers. As other chapters in this book address the impacts of ICT at the operational level of forest management, this chapter tends to focus on the impacts of advances in ICT on decision making as a forest management process. We draw liberally on conclusions from other chapters to address the impacts of ICT on forest management in the broader sense.

In the context of decision making, the impacts of ICT can be understood in terms of how they influence the effectiveness and efficiency of decision processes or in terms of how ICT inherently impacts the shaping of such processes. We consider the impacts of ICT on the effectiveness and efficiency of forest management in Section 9.2; but what exactly *are* the impacts of ICT? Technology is simply applied science; and as information and communication sciences underlie ICT, the potential sources of impacts on forest management decision processes include technological advances in the acquisition, representation, storage, processing, and sharing of information. ICT advances in the acquisition of information through remote sensing and in the representation and storage of information in enterprise-scale database management systems are well covered in Chapter 5. We thus cover these topics only slightly in Section 9.2, relying on that prior chapter to provide a more detailed background. Similarly, ICT advances in information sharing through the Internet and other more traditional media are well covered in chapters 2 and 6, and we depend on those chapters to provide a more detailed background for our observations here.

There are both direct and indirect effects of ICT on forest management. There are direct effects of ICT on decision-making processes, as discussed in the previous paragraph, and there are also direct effects at the operational level. Moreover, impacts on the effectiveness and efficiency of forest operations can indirectly influence decision processes by introducing, for example, new alternative operating procedures that need to be considered.

The dramatic changes observed in forest management, caused by advances in ICT over the past 20 years, also offer some useful insights into what we might expect to see in the next 20 years. In Section 9.3, we project into the near future the consequences of what seem to be the more important recent trends in the effects of ICT on forest management. For some of these trends, there are reasonably discernible policy implications, which we discuss in Section 9.4.

The title of this chapter addresses ICT in the context of both forest management and conservation. A few words of explanation are perhaps in order. Conservation can be thought of as a principle but, like forest management, it can also be understood as a process. These two processes are not independent; conservation is simply an instance of forest management in the sense that it can be seen as an application of forest management in which conservation values happen to be emphasized. Why, then, do we make a distinction in the chapter title? In part, we think conservation deserves separate consideration because of the international significance attached to forest ecosystem sustainability since the 1992 Earth Summit in Rio de Janeiro, Brazil (United Nations, 1992). Subsequent major international agreements, such as the Montreal Process and Helsinki Accords, and subsequent major international initiatives in forest and forest-products certification, all point to the growing attention being accorded to conservation as a primary consideration of forest management.

9.2 Current Status

Worldwide, forests are a key resource serving a multitude of functions, such as providing industries with timber and communities with plentiful and clean water, protecting infrastructure in mountain regions against natural hazards, creating and managing habitat for wildlife species, maintaining biodiversity and aesthetic values, sequestering carbon, and others. The growing need to consider so many different kinds of values has posed considerable challenges for modern forest management, which must now additionally consider multiple, and often conflicting, ecological and nontimber objectives over a range of spatial and temporal scales. ICT advances and innovations in the past 20 years have enabled significant changes in the practice of forest management. In the following sections, we first consider the drivers behind ICT adoption and recent ICT innovations, then how the practice of forest management has been impacted by ICT, and finally the consequences of these impacts in terms of issues such as the efficiency and effectiveness of forest management.

9.2.1 Drivers behind ICT adoption and innovation

The adoption of ICT and growth of ICT innovations in forest management have been driven by a combination of forces, including advances in the scientific understanding of forest systems, public pressure for involvement in resource management decisions, and organizational needs for enhanced competitiveness. Approaches to forest management have been undergoing dramatic changes since at least the mid-1970s, when forest ecologists began emphasizing the need to understand and manage forests as ecosystems (Duerr *et al.*, 1979). Related concepts of hierarchy theory (O'Neil *et al.*, 1986), adaptive management (Holling, 1978), and forest ecosystem sustainability (Anonymous, 1995; Maser, 1994) have been instrumental in shaping the evolving practice of forest management in the period since 1980. Managing ecosystems and better addressing organizational business needs in general prompted the deployment of remote-sensing systems and enterprise-scale database management systems (Chapter 5) to acquire and store the vast amounts of complex and diverse information. The need to comprehensively project and analyze the likely future development of ecosystems led to the proliferation of ecosystem modeling, which in turn benefited enormously from technological advances in ICT. The latter trend also drove the development and deployment of sophisticated analytical systems able to address the internal needs of organizations and provide the transparent solutions needed to support the continuing dialog on public policy for forest management.

9.2.2 How forest management is currently practiced

Stimulated by developments in business administration and industry, computer-based decision support systems (DSSs) have been improving the quality and transparency of decision making in natural resource management. DSSs provide support to solve ill-structured decision problems (Leung, 1997; Rauscher, 1999) by integrating database management systems with analytical and operational research models, graphic display, tabular reporting capabilities, and the expert knowledge of scientists, managers, and decision makers to assist in solving specific problems (Fischer *et al.*, 1996).

Because DSSs are based on formalized knowledge, their application in decision making has facilitated decisions that are reproducible and as rational as possible. Further, DSSs have proved most useful for complex, strategic problems, that is, for problems that cannot be completely supported by algorithms and analytical solutions (Turban and Aronson, 2004). Finally, through the use of DSSs, the way the decision maker arrives at a decision is automatically documented; thus, the process of decision making can be evaluated *post hoc*. Over the last two decades, research in decision support has evolved to include several additional concepts and views.

In the period since DSSs came to prominence, there has been a shift from automatic cartography to geographic information systems (GIS). The potential power of GIS goes beyond producing maps by providing mechanisms for the input, storage, analysis, and use of spatial information. GIS has increased the acceptance of DSSs and led to the development and application of spatial decision support systems (SDSSs) (David and Reisinger, 1985; Covington *et al.*, 1988; Fedra and Reitsma, 1990; Densham, 1991; Naesset, 1997; Varma *et al.*, 2000). Spatial data and the analytical capabilities of GIS within an SDSS have been necessary to address new demands in strategic and operational planning for natural resource management. SDSSs offer decision-making capabilities based on integration of alphanumeric information with geographic parameters and allow the modeling of spatial processes and spatial analysis to generate new information.

Multicriteria decision making (MCDM) techniques have been integrated with (S)DSSs to help decision makers model trade-offs between multiple and conflicting objectives in multipurpose management implicitly or explicitly (e.g., Lexer *et al.*, 2005). Spatial multicriteria decision problems may involve a set of geographically defined alternatives (events) from which a choice of one or more alternatives is made with respect to a given set of evaluation criteria. The integration of multiattribute methods in SDSSs offer unique capabilities for managing and analyzing single-user as well as collaborative spatial decision problems with large sets of feasible alternatives and multiple conflicting and incommensurate evaluation criteria (e.g., Vacik and Lexer, 2001; Ascough *et al.*, 2002). Recent ICT development has facilitated the integration of new data and new models to build effective multicriteria SDSSs (Engel *et al.*, 2003).

Artificial intelligence (AI) approaches such as artificial neural networks (ANNs) and expert systems (ESs) have been instrumental in supporting new forest management paradigms and in enhancing forest management processes, both at stand and landscape levels. The characteristics of ANNs (e.g., Zahedi, 1993; Turban and Aronson, 2004) make them particularly useful for addressing problems such as pattern recognition, forecasting, and classification, but ANN application in forest management and conservation has some limitations. The accuracy of an ANN solution is highly dependent on the availability of large data sets for network training and testing purposes. Further, determining an adequate system architecture, information processing, and learning methods is not trivial; thus, ANN design can be complex. Another important limitation is the lack of explanation capabilities, as the knowledge base is often a black box to the user.

The characteristics of ESs (Zahedi, 1993; Mallach, 1994; Turban and Aronson, 2004) make them particularly useful for addressing interpretation, prediction, diagnosis, planning, monitoring, and control problems. Both stand and landscape management and conservation have been supported by ESs. For example, the Ecosystem Management Decision Support (EMDS) system (Reynolds, 2001) has evolved an integrated ES approach to multifunctional forest management. EMDS is currently being used to address ecological as well as economic and social sustainability concerns, namely, as portrayed in the Montreal criteria and indicators (Reynolds, 2001; Reynolds and Hessburg, 2003; and Reynolds *et al.*, 2003). Many forestry problem areas are suited to an approach that models the process used by people to make decisions about a system rather than representing the system itself. Further, ES design is relatively easy, and several commercial development environments are available to support it. Knowledge representation in ESs is explicit, so it is simple to alter a rule or to identify an object and change its attributes (Zahedi, 1993). As ESs also open the process of reasoning through explanatory interfaces, the system is a white box to the user (Zahedi, 1993). The ability to explain its reasoning is inherent in the ES knowledge structure (Mallach, 1994). However, ES application to forest management also has some limitations. Knowledge acquisition and engineering are mostly external and people-driven processes, being dependent on extracting knowledge and expertise from people. Experts and knowledge engineers can be expensive and hard to find. Moreover, as pure ESs are primarily applicable to recurring problems, and strategic problems are seldom recurrent, pure ESs are mostly applicable to operational problems and to fairly structured tasks (Mallach, 1994).

9.2.3 Impacts of ICT adoption and innovation

9.2.3.1 Efficiency and Effectiveness of Forest Management

ICT adoption in the forest sector has impacted both the cost of making decisions and the accuracy and quality of decisions. With respect to forest management in the broad sense, ICT impacts on forest operations have generally been positive, creating increases in efficiency and effectiveness at operational levels. For instance, both logging and logistic processes have been generally benefited by

ICT (Chapter 5). Similarly, advances in remote sensing and enterprise-scale database systems (Chapter 8) have contributed to increasing the efficiency and effectiveness of forest management. Here, we consider the contribution of ICT advances related to decision-making processes and some interactions related to acquisition, management, and communication of information.

Impacts of ICT advances on decision processes have not succeeded in appreciably reducing controversies over issues or objectives in modern public policy debates. Moreover, current planning processes for forest management may well be less efficient with respect to the time and other resources that are now being committed to public participation processes compared to 20 years ago. Nevertheless, important progress has been made in the past 20 years with respect to improving the transparency of decision processes, improving access to information on likely impacts of decision alternatives, and improving the effectiveness of public participation. It is hard to imagine how the current forest ecosystem management paradigm might translate into actual planning without the support of ICT.

Both strategic and operational management planning require information about the state of the forests. A field inventory is expensive, and because of the need for cost-effectiveness, stands not under active management may be omitted, which tends to create information gaps. Some basic inventory information such as species composition and standing stock can potentially be obtained by remote sensing. ANN may be used to interpret remotely sensed data, thus contributing to the efficiency of inventory processes, namely, by the automation of photointerpretation and land classification processes (e.g., Blackard and Dean, 1999; Liu *et al.*, 2003). Improved efficiency of inventory processes is the key to addressing ecosystem management problems with large data requirements and is thus a condition for the effectiveness of forest management. Effectiveness is further improved by more transparent and readily available information about forest resources and its socioeconomic context provided by management information systems.

Spatial information is the key to addressing both operational and environmental concerns in forest management. As the diversity of ecosystem management objectives increases, demand grows for spatial resolution. The use of GIS is thus critical for both the efficiency and effectiveness of decision making. Moreover, increased public involvement in the definition and analysis of questions tied to location and geography is becoming more important. Recent developments in the field of GIS (Web services, interactive dynamic maps) allow the limitations of present GIS technologies in public participation processes to be overcome. Web GIS applications allow an expanded framework of communication and discourse, opening opportunities for public participation across the processes of problem definition and problem resolution.

Addressing extended planning horizons requires projection capabilities that are made possible by automated simulators and prescription writers in a model management system. For example, automated landscape-level disturbance simulators may generate information to address the impacts of fires in forest management. The early warning system regarding forest pests of the U.S. Forest Service (www.fs.fed.us/foresthealth/) help integrate health considerations into forest management. According to Davis *et al.* (2001) developing, evaluating, and applying prescriptions is the central activity of professional forestry. Ecosystem management objectives determine the number and the complexity of prescriptions. Automated simulation of prescriptions is thus the key for forest management effectiveness (Rose *et al.*, 1992; Borges *et al.*, 2003).

A DSS may fully implement the basic decision-making process, which includes problem identification and analysis, identification of alternatives, evaluation, implementation, and monitoring (Mintzberg *et al.*, 1994). For instance, the DSS introduced by Lexer *et al.* (2005) can improve the consultation process between small-woodland owners and local forest authorities. The DSS presented by Borges *et al.* (2003) integrated heuristic methods (e.g., Borges *et al.*, 2002) to address both public and private forest management. A good decision, in the sense of decision science (e.g., Keeney and Raiffa, 1993) builds on objective information as well as the preferences and expertise of stakeholders and decision makers. Without such tools, forest owners usually do not otherwise have access to quantitative information about future stand development and the consequences in terms of resource conditions and economic outcomes. Thus, the DSS approach has the potential to facilitate good decisions. It contributes to the efficiency of forest management by automating data management processes. Yet it puts emphasis on the improvement of the effectiveness of forest management by better representation of decision-making problems. Decision making may take longer, but decisions are better (Turban and Aronson, 2004).

Hybrid systems that combine functionalities of ES, ANN, and DSS may further improve both the efficiency and effectiveness of forest management. For example, symbolic processing by ES may help in the interpretation and assessment of scenario-analysis information provided by DSS. Overall, the impacts of advances in ICT have provided forest managers with better tools to reason more effectively and come to conclusions more quickly and easily, despite the increased complexity of issues and the greatly expanded volume of information being dealt with in contemporary forest management. Forest management may be more effective now, compared to, say, 20 years ago, in the sense that it attempts a much more comprehensive understanding of interdependencies among resource conditions as a basis for more-informed management decisions.

9.2.3.2 Management for Conservation

Modern analytical tools supporting decisions in forest management are better able to accommodate much more complex management questions, including management consequences, to a broad array of resources, as described in Section 9.2.2. So, at least in principle, there is the potential to treat conservation issues more effectively in the broader context of forest management. However, a variety of systems have been developed in recent years to specifically support effective and efficient solutions for conservation. Some attempts have been made to maximize conservation values while minimizing impacts on, for example, timber harvest reduction (Andelman *et al.*, 1999; Anonymous, 2001; Fisher and Church, 2003). Conversely, another class of solutions attempt to maximize economic uses while minimizing impacts on resource values such as reductions or threats to biodiversity. Conservation management has been greatly enhanced by capabilities for improved spatial analysis and simulation brought about by advances in ICT. For instance Netherer and Nopp-Mayr (2005) presented a GIS-based approach to virtual monitoring of the risk of bark beetle infestations in national parks in the Czech Republic.

9.2.3.3 Global Variation in ICT Impacts

A digital divide underlies the global variations in ICT impacts on forest management and conservation. A huge gap in telecommunications infrastructure drives the differential use of ICT across the world. In developed countries, better infrastructures generally support the use of ICT in public and private forest management and conservation. Yet the effectiveness of participation in public forest management in these countries is constrained by the dimensions of the digital divide (e.g., income, education, and ethnicity). In developing or underdeveloped countries, ICT mostly impacts both public and vertically integrated forest management. Castells (2001) points out how dedicated systems, often via satellite transmission connected to sophisticated local networks, support the needs of preferential clients (e.g., financial and high-level governmental institutions) in these countries. The forest sector is no exception. The technological sophistication of the vertically integrated forest industry contrasts with the lack of ICT support for communal and private forest management. Both the telecommunications infrastructure and informational literacy have constrained the use of decision systems in the public domain.

9.3 Future Impacts of ICT

Prognosticating about the future is an uncertain business at best, and past predictions about technological advances and their impacts have at times turned out to be amusingly wrong. For example, the editor in charge of business books for Prentice Hall in 1957 asserted in an interview, "I have traveled the length and breadth of this country and talked with the best people, and I can assure you that data processing is a fad that won't last out the year" (from www.famous-quotations.com). Suitably chastened by such examples, we nevertheless believe that recent trends lead to some reasonable expectations about advances in ICT and their impacts on forest management in the next 20 years. In particular, the driving forces behind ICT adoption and innovation in forest management for the past 20 years, discussed in Section 9.2.1, remain substantially unchanged and no less compelling today; and they are likely to remain so for at least the next decade.

To help set the stage for this section, we start with two short vignettes.

9.3.1 Private forest management in 2025: A vignette

In 2004, A.M., a 25-year-old, nonindustrial private forest (NIPF) landowner, attended a meeting in northern Portugal organized in the framework of a project to develop decision support tools for private forest management (Instituto Nacional de Investigação Agrária de Portugal, 2002). Twenty-one years later, M. still had vivid memories of that day in Penafiel, where forestry institutions from most regions on the Iberian Peninsula had discussed issues related to NIPF forest management, and where a Web-based innovative NIPF decision support system—MetaForest (Ribeiro *et al.*, 2004b) was presented. For A.M., that meeting was a landmark for NIPF forest management. Actually, it was a milestone for forest management and conservation on the Iberian Peninsula, because 93% and 68% of forestland in Portugal and Spain, respectively, was privately owned. Over the next two decades, research and outreach aiming at the maintenance and the evolution of systems such as MetaForest had a substantial impact on forest policy processes, on the involvement of civil society and nongovernmental organizations (namely NIPF associations) in national forest programs and regional forest plans and, ultimately, on how A.M managed his own forest land.

These memories come to life as A.M. develops a forest management plan for his holding in 2025. He does not need to invest much in technology or software to use the best available tools to develop his plan. He just uses his Web browser to access the computational capacity of the server that stores and manages all relevant ecosystem data from his holding and from other NIPF holdings in the region. A.M only has permission to access data from his holding, but his NIPF association has conducted integrated inventories for all associates and has permission to access all data.

A.M. recalls the progress made in data acquisition, management modeling, and development of information systems. Rather than focusing solely on intrinsic data quality, accessibility, contextual and representational data quality were also considered (Ribeiro *et al.*, 2004a). Further, better representation of decision processes and problems with new models and more effective decision support by hybrid technologies had allowed MetaForest to address ever-changing challenges in forest management over the last two decades. Explicit recognition of the human component of information systems (e.g., NIPF)—people who anticipated and conceived the management problems—had been critical for this development. The forest resource base is a social construct, and it had evolved over time. It was people who translated information into knowledge. It was people who made the decisions. It was people who coped with the consequences of decisions. Forest organizations are mostly people (Oliveira, 1998). As Davenport (1994) puts it, people are the soul of ICT. And yet for a long time, the ICT design for forest management and conservation had overlooked and underestimated the human dimension of information systems. A.M. recalls the high percentage of former ICT investment failures in the forest sector that had ignored this component.

Today, A.M navigates through the remote-information-system interfaces to check the current situation in his holding and to develop alternative management scenarios. Interfaces hide the complexity of models and technology, are user-friendly, and are continuously updated according to NIPF feedback and needs. In particular, they enable trade-off analysis between forest, livestock, agriculture, and environmental objectives. Over 85% of NIPF in the region develop activities other than forestry in their holdings, and the system integrates forestry objectives within overarching holding-level objectives. Furthermore, the system's interface enables interactive planning by A.M. to generate management scenarios. About 30 minutes after he accesses the system, A.M. has the information needed to develop a management plan.

However, A. M. has also agreed to negotiate regional management objectives with other NIPFs. Forest fires are a major concern as a consequence of global warming, and effective forest fire management requires concerted actions by the NIPF. Thus, A.M. accesses the system to send the NIPF association information about his new management options and to request a negotiating round between all involved NIPFs. Upon receiving the request, the planner at the association immediately accesses the system to generate management scenarios for the whole region, based on the current individual management plans of the NIPF and on the options of A. M. made accessible to him by the system. A few hours later the planner realizes that some landscape-level objectives cannot be met with current individual plans and options.

The planner at the association uses standard system features to communicate to the 1,500 associates the trade-offs between individual holding and landscape-wide objectives in the regional management scenarios. She further calls for electronic meetings to negotiate compromises so that landscape-wide objectives may be met. The system has group decision-support features, and its interfaces facilitate the negotiation. Four weeks after A.M first accessed the system, a compromise has been reached that complies with the objectives of regional forest plans. Both the individual management plans (all 1,500 of them, in fact) and a regional forest plan have been revised and updated in this period.

As A.M. uses the system to implement his new plan, he recalls how the idea of developing human-centered ICT in the last two decades has contributed to strengthening NIPF associations and changing political processes. By providing better services, associations have attracted more associates and revolutionized forest management and conservation processes that had been fragmented or nonexistent in 2004. Further, the strength acquired by the NIPF associations has enabled them to participate more actively and effectively in regional forest planning and in national forest programs in countries with a tradition of centralization and state authoritarianism.

9.3.2 Public forest management in 2025: A vignette

J.B. is a regional forest planner for a country in interior Africa, which is richly endowed with forest resources. On arriving at work six weeks ago, she found an e-mail message from the national forest planning staff, advising that it was time for her region to update its forest plan.

J.B. started by consulting the region's Web site. Village elders, via satellite Internet access, regularly visit the regional site to review and comment on regional plans and express their villages' concerns and interests with the forest environment. J.B. queried the site's content bots who gave her an updated analysis of recent key issues raised by the elders. Concerns for forest sustainability remained the top issue, but concerns about timber poaching had lessened, and there was now increased interest among the villages in promoting forest sector jobs.

Issues had changed enough since the last round of planning for J.B. to decide to visit the online planning resources site of the International Union of Forest Research Organizations (IUFRO). Querying the site's model database, she found a model from five years ago, developed for central Europe, that was actually a pretty close fit to the current issues in her region. The selected model needed some minor modifications, but J.B. had not yet had in-depth training in designing these particular kinds of planning models so she visited the online training area of the site. The self-paced training took her four hours. At the end, the training program administered a short test to check that key concepts of model design had not been missed. The program also checked its own database of knowledge resources and recommended a colleague in Hungary that J.B. might want to consult if she needed advice on model design and application.

Model revisions required two days, and, on review, J.B.'s Hungarian colleague concurred that her modifications seemed appropriate. The regional Web site notified the village elders by e-mail that a new planning model had been proposed. Although these models are technologically very advanced, they also are very intuitive and easy to understand. They were quickly reviewed and validated by the elders.

The planning model defined the data requirements for an initial assessment of current condition. J.B. visited the GlobalForestCommunicator site, and quickly assembled the appropriate GIS layers for her region, all suitably transformed to the projection her government routinely uses. The initial assessment was presented to the national forest planning staff, who suggested three strategic alternatives for further consideration. The regional planning site advised the village elders about this new information. After their review, a fourth strategic alternative was added.

Evaluating the alternatives required running a number of programs, including, for example, a harvest scheduling optimizer, a stand growth simulator, and various expert systems, to project the consequences of the four alternatives into the future. The planning model actually documented this sort of information for its users but only in a general way. J.B. also needed more specific guidance on how to tune parameters for the recommended models, so she visited IUFRO's ForestModelArchive Web site.

Once the projections had been run, initial results were again reported to the national planning staff, who recommended choosing their original alternative C. All of the map products, analyses, and recommendations from the planning process were organized with the region's e-plan application and posted to the regional Web site, where they were now reviewed by the villagers. The village elders encouraged everyone to review and comment, so there were actually several thousand comments received. However, the e-plan application's automated processing of comment content made it easy to track public response and document the adequacy of comment handling by the agency.

J.B. reviewed the content analysis and presented her findings to the national planning staff. While the national planning staff had originally recommended alternative C, the villagers were almost overwhelmingly in favor of alternative D, and using map products and documents from the e-plan Web site, they made a rather compelling case. On further review and discussion with the village elders, a compromise alternative, capturing important elements of both C and D, was mutually agreed to by the national and regional planning staffs and the village elders.

With a strategic alternative now agreed to by all parties, J.B. ran additional components of the planning application to develop specific, tactical plans for what sorts of management activities to perform in what areas of the planning region. These plans launched the initial phase of plan implementation. Interestingly, the basic evaluation system used to perform the initial assessment of current condition and the assessment of alternatives would now be used in the plan implementation to track and report progress.

J.B. leaned back in her chair, and paused to reflect at the end of the process. She recalled those horror stories from graduate school of how forest planning processes in North America and Europe could take eight to ten years back in the 1980s and 1990s. Why, even in the 2010s, it was not unusual for a planning process to run 30 to 36 months. She had to smile, realizing that six weeks really wasn't long at all.

9.3.3 How forest management might be practiced

Current technologies supporting strategic and operational forest management (Section 9.2.2) are foundational in the sense that they provide core competencies for forest management; forest research can continue to build on these so that it can respond more adequately to the drivers of Section 9.2.1 (scientific understanding of forest systems, public pressure for involvement in resource management decisions, and organizational needs for enhanced competitiveness). In each of the following subsections, we begin by summarizing the current state of a contemporary forest management topic; we then consider the likelihood of advances in ICT and obstacles to advancement.

9.3.3.1 Supporting Public Participation

The number of stakeholders and interest groups involved in the management of natural resources has substantially increased over the past few decades. Meanwhile, widely disparate laws, information resources, and the environmental concerns of affected communities have continued to accumulate, further complicating planning processes. While there has been great progress in the ability to develop and apply ecosystem models in policymaking and planning for the management of forest resources, social interdependencies in natural resource management have received much less attention

(Kakoyannis *et al.*, 2001). Decision making in contemporary natural resource management is usually about making a compromise between conflicting objectives. To reach solutions acceptable to affected stakeholder groups requires acknowledging the need to include stakeholders in the decision-making process, not just as sources of information but as active participants in the decision process (Mendoza and Prabhu, 2003). The forestry community as a whole has yet to take full advantage of developments in the area of collaboration technologies. The increasing number of stakeholders involved in the management of natural resources and the concomitant need to consider multiple interests and preferences in the decision-making process further suggest the usefulness of those technologies.

ICT has the potential to play an important role in facilitating participatory planning processes. New capabilities, provided by ICT, help to bridge the gap between the general public, whose input must now be more effectively accommodated in the decision-making processes, and scientists, researchers, and politicians, who make decisions on behalf of the general public every day. However, the design of participatory planning processes also poses a major dilemma. On the one hand, there is increasing demand for more rigorous and formalized decision-making approaches to reduce the perception of subjectivity and increase effective communication among participating stakeholders. On the other hand, the use of methods and tools that are too sophisticated often poses the risk that people will be more likely to acquiesce to an unsolved problem than accept a solution that they do not understand. Thus, it needs to be acknowledged that, for land-use planning and resource-sharing projects involving cooperative development, the ICT support potentially available can sometimes be technological overkill. In such an environment, the search for optimum solutions in natural resource management should not be driven by technology but rather by social acceptance of tools and methods by the involved stakeholders (Kakoyannis *et al.*, 2001). There is reason to believe that this argument holds good for many participatory planning situations in industrialized regions of the world.

There will continue to be strong demand for research into the development of ICT solutions that, on the one hand, allow participatory planning processes to be transparent and, on the other, utilize available technology. Types of engagement include either individual discussion (in the form of an online interview) or group-based discussion (participative forums such as citizens' juries, round tables, study circles, and collaborative management groups). ICT is already capable of providing interactive maps based on GIS-server technology or discussion forums handling bulletin boards, polls, FAQs, and notes (Tress and Tress, 2003). In fact, significant progress has recently been made in this area. For example, the GeoCommunicator Internet portal (www.geocommunicator.gov) of the Bureau of Land Management (U.S. Department of Interior) and the Forest Service (U.S. Department of Agriculture) is already offering unprecedented public access to spatially referenced government data on a wide range of natural resources. The e-planning initiative of these two U.S. federal agencies goes further and is beginning to deliver sophisticated, highly interactive, Internet-based planning documents with equally sophisticated backend capabilities for processing public comments (see, for example, www.eplanning.blm.gov/).

Globalization, as well as increasing public awareness of natural resource management issues, will lead to increasingly tough planning problems for many organizations. This suggests the need for further development of group-decision support systems (GDSSs) that are explicitly designed to provide brainstorming, idea evaluation, and communication facilities to support team problem solving (Courtney, 2001). Further development of collaborative technologies such as GDSSs will help avoid the consequences of knowledge fragmentation and will extend support to decision-making processes involving several individuals (Jessup and Valacich, 1993; Palma dos Reis, 1999; Turban and Aronson, 2004).

Implementation of teledemocracy is another feasible way of improving citizen access to participatory decision-making processes. Developments in this area could reduce problems resulting from geographical insularity and long distances, for instance, in participatory planning and decision making, and facilitate rapid registering of large numbers of opinions directly to computer memory

(Kangas and Store, 2003). However, considering contemporary experiences with ICT, teledemocracy is not likely to entirely replace other channels of public participation for the foreseeable future.

9.3.3.2 Managing Across Spatial Scales

Ever since the introduction of ecosystem hierarchy theory (O´Neill *et al.*, 1986) and associated principles of ecosystem management (Holling, 1978), it has been widely accepted within the forest management community that comprehensive planning requires the consideration of a range of spatial scales and that the basic levels of strategic and operational planning need to be at least closely coordinated, if not actually integrated, in order to support a coherent and efficient process over a range of scales. The distinction between coordinated and integrated planning involves both a matter of degree and qualitative differences. In an integrated approach, the outcome of a strategic plan tightly constrains the formulation and selection of options within the tactical planning level, whereas, in a coordinated approach, tactical planning is more loosely constrained by the strategic outcome. The qualitative distinction relates to the ontology of information that is used at different planning scales. In an integrated approach, data used at the strategic scale is derived, when possible, from the synthesis of fine-scale information from operational levels. In a coordinated approach, on the other hand, there may be no such constraint on the derivation of information. Given these distinctions between coordinated and integrated approaches to multiscale planning, the latter is preferable insofar as it assures a higher degree of consistency across scales of planning.

A few DSSs for forest management have an intrinsic capability of explicitly implementing a hierarchical approach to planning (e.g., Martell *et al.*, 1998), but there are only a few definitive examples of integrated, multiscale forest-resource planning that have been described (for example, Rose *et al.*, 1992; Reynolds and Peets, 2001). More importantly, we are not aware of any currently available ICT system that provides both full and explicit support for such an approach to planning. Rapid technological advancement in this area is highly likely in the next few years. Indeed, principles for implementation are well understood, and there are no obvious technological obstacles. The previous paragraph offers some hints as to the nature of an appropriate information theory needed to support the design of such an ICT system, but more research is needed to formulate a useful theory that could guide design of such a system *de novo* or suggest how existing ICT systems might be adapted. The formal articulation of such a theory also has important implications for how information is organized within information management (IM) systems that provide the raw material for planning.

9.3.3.3 Managing Across Ownerships

Lack of standards for data acquisition and representation across ownerships has been a barrier to the development of DSSs that can effectively address problems in forest management involving multiple ownership. A number of complicating factors pertaining to the design of appropriate systems for collections of individual landowners are readily apparent, including 1) diverse sets of values and objectives, 2) issues around property rights, 3) disclosure of private data and business plans, and 4) incentives for voluntary participation. We could probably enumerate many more such issues, and we have not even considered the more technical questions of how such a system might actually operate to support a collective planning process.

Integration across ownerships has been at least partially addressed by some systems. For example, in the framework of the Minnesota Generic Environmental Impact Statement of statewide forestry programs (Rose *et al.*, 1992) the DTRAN SDSS addressed both statewide and national forest management objectives. The Monsu MC-SDSS system (e.g., Pukkala, 1998) has been used to test and demonstrate alternative approaches (e.g., up-down, bottom-up, and integrated) to develop landscape-level forest plans for areas involving multiple ownership (e.g., Pykalainen *et al.*, 2001). The project of the Instituto Nacional de Investigação Agrária de Portugal (INIAP) (INIAP, 2002), which started in 2002, has been evolving a Web-based MC-SDSS for addressing the management objectives of both regional planning and individual holdings.

However, most current IM or ICT systems that provide explicit support for forest resource management in the context of multiple ownerships typically do so only in the most trivial sense that a natural resource agency may be tracking resource status across multiple ownerships and offering forestry consulting services to small landowners. The present lack of IM and ICT systems for integrated management across ownerships is not surprising. Most research and development has been funded by government agencies and large corporate landowners whose primary concern has usually been management of their own resources. A few systems, such as NED (Twery *et al.*, 2000) and DSD (Lexer *et al.*, 2005), have been developed specifically for small landowners, but these systems focus on the individual owner and provide only very limited or no support for active collective management.

The potential benefits to be derived from focusing research and development on this topic are compelling, considering that, in many countries, a sizable proportion of the forest land base is privately held and that, in a significant proportion, private holdings represent the majority of the forest land base. Unfortunately, rapid ICT advances in this area in the next 10 years or so do not seem likely. Apart from the conceptual problems, already noted, when dealing with multiple ownerships, significant progress in this area will also depend on the integration of other emerging technologies such as GDSSs and planning systems (Section 9.3.3.1) and perhaps support for multiple spatial scales (Section 9.3.3.2). Furthermore, availability of data on small woodlands tends to be very limited, even in most developed countries; thus, feasible solutions may also depend on advanced technologies such as remote sensing.

9.3.3.4 Managing for Sustainability

The concept of sustainability, in particular, sustainability of timber production, has a long tradition in forestry. Since the 1990s sustainable forest management (SFM) has become a highly relevant topic both in forest and environmental policy. In the wake of the United Nations Conference on Environment and Development in 1992 (United Nations, 1992), the concept of sustainability has become of significant public interest. In Europe, this trend culminated in the Second Ministerial Conference on the Protection of Forests in Europe (MCPFE) in Helsinki in 1993, when SFM was defined and adopted at a politically binding level (Resolutions H1 and H2). A very similar effort, specific to boreal and temperate forests, is represented by the Montreal Process (WGCICSMTBF, 1995). By the early 1990s the traditional perception of sustainability, primarily focusing on sustained yield, was radically expanded. It is now more broadly defined as “stewardship and use of forests and forest land in a way, and at a rate, that maintains their biodiversity, productivity, generation capacity, vitality and their potential to fulfill, now and in the future, relevant ecological, economic and social functions, at local, national and global levels” (MCPFE, 1998). Within SFM, the use of criteria and indicators is a widely accepted approach because these appear highly capable of measuring aspects of SFM at national, regional, and forest-management-unit level. In the subsequent process of the MCPFE, pan-European, national-level criteria and indicators were adopted as a policy instrument for evaluating and reporting progress toward sustainable forest management in individual European countries and in Europe as a whole. From the criteria and indicators of the MCPFE and the Montreal Process, it is evident that SFM is not just an ecological issue but a network of ecological, economic, and socioeconomic issues that increase problem complexity and force decision makers to balance multiple, and often conflicting, objectives in natural resource management.

Significant practical advances in SFM are highly likely in the next few years. Analytical systems for SFM are already available, at least in prototype form (Reynolds *et al.*, 2003b) and could be brought to full implementation fairly easily. Lack of suitable data to support such systems is a far more significant problem, but this has more to do with logistical issues than ICT.

Various organizations, most notably the Center for International Forestry Research (CIFOR), have been working on design of SFM assessments for more local scales (Colfer *et al.*, 1996; CIFOR, 1999). Development of integrated, multiscale implementations, linking national, regional, and operational scales, are highly feasible but will not happen without concerted effort (Section 9.3.3.2). Developments thus far have been progressing more or less independently of other scales, although there are obvious parallels across the scales for which SFM assessment is currently being implemented. Development efforts at the various scales are likely to continue along independent lines for the next few years simply because all these initiatives are still relatively new and basic approaches to practical implementation are still being worked out. As assessment programs mature, however, a second round of iterative adjustments, probably requiring several more years, will be needed to reconcile how information is represented at the different scales and to devise effective information structures for efficient communication between scales.

Different approaches used for the assessment of forest conditions or certification issues are described in the scientific literature (e.g., Brang *et al.*, 2002; Mendoza and Prabhu, 2000; Duinker, 2001; Wolfslehner *et al.*, 2004). Many see great promise in forest certification because it strikes a balance between economic needs and conservation objectives, offering a market-based rather than regulatory solution for improving forest practices. Voluntary environmental management systems such as ISO 14001/EMAS (Eco-Management and Audit Scheme) and forest certification (e.g., PEFC, FSC) are already a standard in the forest industry. In addition, forest organizations, industrial plants, and traders must have chain of custody certifications to prove the origin of products. These instruments pose new demands for management information systems in the organizations of the forest sector to provide verifiable evidence of compliance with the certification criteria. This will emphasize the link between quality and environmental management systems and foster the integrated use of information for purposes such as forest certification. GIS systems and forest management plans will have to meet defined requirements to comply with sustainability criteria (Lounasvuori *et al.*, 2002).

New technologies are needed to monitor and control supply chains to meet the requirements of chain of custody verification (e.g., log tracking in the tropics of high-value species based on bar coders). In general, to further support certification programs, forest owners need assistance with implementing sustainable forest management through Web-based systems, for example, for evaluating current management practices and recommending best management practices. Virtually all the underlying technologies needed to support these processes already exist in well-developed forms and require only relatively modest research investment to support adaptation to these new areas of application.

Illegal logging is causing enormous damage to forests, to forest peoples, and to the economies of producer countries. Some estimates suggest that the illegal timber trade may comprise over one-tenth of the total global timber trade, worth more than US$15 billion a year (World Bank, 2004). It seems likely that at least half of all logging activities in particularly vulnerable regions—the Amazon Basin, Central Africa, Southeast Asia, and the Russian Federation—is illegal. The European Commission's Action Plan on Forest Law Enforcement Governance and Trade (FLEGT) recognizes the potential role of trade instruments in preventing cross-border trade in timber products originating from illegal harvests.

Among possible solutions to illegal logging, the use of Voluntary Partnership Agreements (VPAs) has been promoted between the European Union (EU) and those producer countries that see value in a trade instrument as a tool to help control illegal logging in their territory. An important element of VPAs is the introduction of instruments (e.g., a licensing scheme) that would allow EU customs agencies to distinguish between legal and illegal imports from partner countries and allow entry only to legal imports. In addition to activities in building country capacity to establish and strengthen legal regimes, it will be necessary to develop integrated monitoring systems to monitor forest activity, changes in forest conditions, and compliance with laws, including remote-sensing and ground-based technologies (Boehm and Siegert, 2001; Bhandari and Hussin, 2003). Similar to the situation regarding support for certification systems, virtually all the underlying technologies needed to support VPAs already exist in well-developed forms and similarly require only relatively modest research investment to support adaptation to this new area of application.

9.3.3.5 Managing Knowledge

Information management in support of forest management and conservation and the technologies that support such applications of IM have been the central focus of this chapter. However, with the emphasis in Section 9.3 being future research priorities in ICT, it seems appropriate to go a step further and consider research possibilities in the relatively new field of knowledge management (KM).

As a discipline, KM is concerned with the efficient organization and sharing of knowledge, and especially with the efficient generation of new knowledge. IM and ICT are essential foundations of KM, but because the generation of knowledge is a uniquely human enterprise, KM systems can be seen as an evolutionary step beyond IM systems, in which the human actor is an essential component of the system.

KM systems have been rapidly adopted in the commercial world over the past several years. Some indications of the measure of their success can be gleaned from the profusion of KM companies and Web sites that have appeared on the Internet in the past five years and from the number of Fortune 500 companies on the client lists of companies offering KM products and services. Rapid diffusion of KM technology within the commercial sector can be understood in terms of the old adage, “knowledge is power.” In a commercial context, this translates to “knowledge is competitive advantage.”

Agencies and organizations within the forest sector, and especially those whose primary mission is the management of natural resources, have been relatively slow to adopt KM technologies, but this is quite understandable. Knowledge about commercial business practices tends to be organized within relatively narrow and well-defined domains. In contrast, knowledge about management practices relevant to forest ecosystems represents a vastly larger domain, and even if that knowledge can be efficiently parsed among the myriad disciplines that participate in a large organization, there is still the very formidable problem of organizing the components of a KM system to optimize the exchange and creation of knowledge within the larger domain of resource management. This would therefore seem to be an area of research closely related to ICT and ripe for attention.

In the process of decision making, decision makers combine different types of data (e.g., documents, figures, models) and knowledge (both tacit and explicit), available in various forms. The decision-making process itself results in improved understanding of the problem and the process and generates new knowledge. When solutions are evaluated and found effective, the acquired knowledge can be externalized, for example, in the form of best practices. Although decision making and processes for knowledge creation are interdependent, research has not adequately considered the integration of decision-support and knowledge-management systems (Bolloju *et al.*, 2002). Knowledge management practices might be categorized according to their contribution to problem solving and problem recognition in the decision-making process. The fact that many problems require both the generation of some new knowledge and the application of some preexisting knowledge leads to the classification of practices that support the identification and resolution of new or unique problems and those that deal with previously solved problems (*Figure 9.1*) (Gray, 2001).

The knowledge management framework allows the identification of practices and tools that support decision making and knowledge management with practices and tools that:

(1) Encourage decision makers to discover new problems and opportunities by exposing themselves to new information, situations, issues, and ideas. It might happen to make valuable unexpected discoveries (e.g., discussion forums, virtual communities, workshops, and conferences).

(2) Allow decision makers to actively create new knowledge if they are aware of a new problem and they are developing novel solutions (e.g., developing and applying expert systems, models, etc.).

(3) Capture and retain knowledge, making it available to decision makers who are seeking solutions to previously solved problems (e.g., using expert systems, search engines, hypertext systems).

(4) Could help decision makers recognize upcoming problems for which solutions have been developed previously.

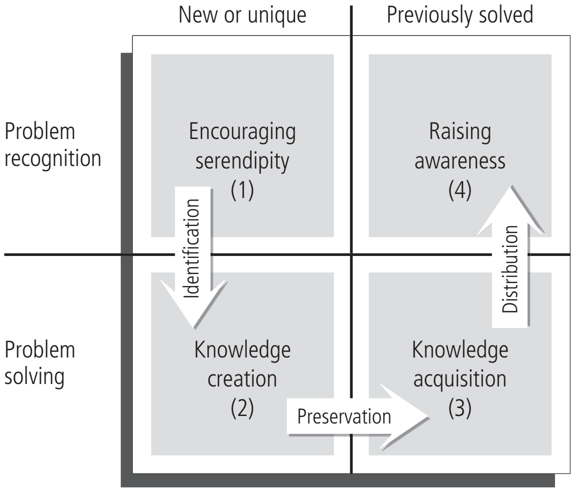

Figure 9.1. Framework for knowledge management practices (Gray, 2001).

Knowledge gains economic value when it is used to solve problems, explore opportunities, and make decisions that improve performance. As the problem-solving process is the vehicle for connecting knowledge and performance, future developments of DSSs will have to address practices for enhancing and promoting knowledge management in organizations (Girad and Hubert, 1999). Historically, the focus of research in the field of DSS has been on model specification and model solution. In the future, the analysis of solutions will be the more important aspect of modeling, along with providing the decision maker with an understanding of the analysis results. This expanded purpose of DSS as knowledge enhancement also suggests that the effectiveness of each DSS will, in the future, be measured based on how well it promotes and enhances knowledge, how well it improves the mental model(s) and understanding of the decision makers, and thus how well it improves decision making (Nemati *et al.*, 2002).

9.3.4 Effectiveness and efficiency of forest management

Likely advances in ICT, discussed in the previous section, bring with them significant potential for improving on the effectiveness and efficiency of contemporary forest management.

Improved support for public participation in forest management decision processes could yield substantial dividends. In this context, effectiveness and efficiency may be very closely linked. As decisions systems become more effective at representing the complexity of management issues and clearly explaining the bases for reasoning about options and solutions, both public understanding of, and confidence in, decision processes are likely to increase. Systems that also effectively engage the public in terms of access to, and input into, processes about which they may have strong concerns, can promote a higher sense of satisfaction with participation in the processes. A significant body of social science research suggests that public satisfaction with decision processes is a much more significant factor than agreement with outcomes (Kakoyannis *et al.*, 2001). To the extent that future forest management can succeed in ameliorating some of the current sources of conflict surrounding forest management issues, dividends are likely to come in terms of issues being settled around the table, as it were, as opposed to by litigation, which is both time-consuming and costly.

Databases are an essential part of the infrastructure of contemporary forest management. However, optimization of their organizational structure to support integrated, multiscale evaluation has not received adequate attention. Research attention in this area could quickly achieve significant efficiencies by minimizing or even eliminating redundant data collection over multiple spatial scales. Effectiveness of decision-making processes in the multiscale context is also likely to be enhanced because synthesizing information from finer scales, when possible, increases the likelihood of this synthesized information, helping direct decisions at coarser scales in ways that assure consistency with decision processes operating at finer scales. It would be a mistake, however, to construe the primary research effort as an exercise in database design. Instead, the initial phase of research needs to be concerned with questions such as: what are the problems that need to be evaluated at each scale, what are the data requirements for the problems at each scale, and how do problems at different scales relate to one another? In other words, at least the initial phase of research in this area is more of an exercise in knowledge engineering.

Evaluating the cumulative impacts of perhaps numerous independent management actions on a forest landscape is not difficult after the fact; at any particular point in time, there is, in principle, a historical record available for interpretation. Projecting cumulative impacts for the purposes of directing forest management in the same context, however, is far more problematic. Decision systems capable of handling diverse ownerships could greatly increase the effectiveness of management activities with respect to adequately accounting for their cumulative effects. Some efficiencies are also possible in terms of targeting intensive research and development on a well-defined but diverse client base. On the other hand, it is not at clear what, if any, efficiencies might accrue to forest management (Lundquist, 2003).

Managing forests to assure SFM on a global scale is perhaps one of the most pressing issues for forest management in the next few decades. Major international initiatives have established broad agreement on the criteria and indicators of SFM that require monitoring (WGCICSMTBF, 1995; MCPFE, 1998), but interpretation of such complex information as a basis for guiding national and international policies remains one of the most important outstanding issues requiring attention before successful implementation of SFM can be fully realized (Raison *et al.*, 2001). Furthermore, initial assessments (e.g., Anonymous, 2004) clearly demonstrate that most data needed for indicator measurement are currently not available, suggesting the need for dramatically expanded monitoring programs in most participating countries. Initial attempts at developing formal frameworks for interpretation of the criteria and indicators of SFM (for example, Reynolds, 2001; Reynolds *et al.*, 2003b) are encouraging, insofar as they suggest the feasibility of implementing effective programs for SFM in the next 20 years. Satisfying the increased monitoring requirements for effective implementation of SFM will impose a heavy burden on virtually all countries. Fortunately, formal frameworks such as those suggested by Reynolds (2001) can also help assure that data gaps are filled as efficiently as possible.

Knowledge is increasingly recognized by organizations as a critical corporate asset that, when properly managed, enhances organizational competitiveness by delivering better solutions faster to management problems. The paradigm emphasizes both conservation and creation of knowledge and is designed to specifically promote efficiency and effectiveness. Compelling success stories from private industry over the past 10 years suggest that application in the forest sector could be very successful.

Given the discussion in this section up to this point, what, if anything, can be concluded about the impact of all these expected impacts of ICT on the future price of wood? There is no way of answering this question with quantitative rigor, but we will attempt a qualitative answer. First, however, other effects on future wood prices due to forest management are covered in chapters 5 to 7 (forest inventory and monitoring and remote sensing, and forest operations such as logging, hauling, wood processing, and distribution). Thus, we need to emphasize that our conclusions are limited to the incremental contributions of expected ICT impacts on decision processes in forest management in particular. As discussed above, most such impacts of ICT are expected to produce efficiencies in management, creating opportunities for cost savings that could be passed along to consumers in the form of lower prices. Perhaps the most significant factor among those discussed is the potential for cost savings as a result of reduced litigation. On the other hand, increased effectiveness often comes at a price. That is, new, more-effective solutions may be less efficient than those they replace. However, in the specific context of ICT impacts on decision processes in forest management, we have generally argued that increasing effectiveness also promotes efficiencies, although in some cases actual increases in efficiency may be questionable. Relative to all other influences from ICT impacts on forest management, those impacts on decision processes probably account for a modest to moderate influence in terms of helping keep wood prices down.

9.3.5 Management for conservation

In Section 9.2.3.2 we discussed a few specific ways in which ICT has contributed to enhanced capabilities for managing forest land from a conservation perspective. More generally, however, it seems likely that conservation considerations will increasingly be seen as integral components of mainstream forest management. For example, indicators to assess the chemical and physical properties of water bodies and soils feature prominently in the major international initiatives on SFM. Whereas conservation measures have historically tended to be implemented at local or, at most, at regional scales, the incorporation of conservation-related indicators in national-scale SFM programs effectively elevates management for conservation to the national and international levels.

The impacts of ICT have a potentially important role to play in enhancing conservation, given the above scenario. First, there are currently major data gaps for many of the indicators related to conservation. Continued advances in forest monitoring and remote sensing will be necessary to make the collection of such data practical. Second, advances in the implementation of conservation programs also are dependent on the technological advances already discussed. For example, the SFM initiatives open up the possibility of strategic, national-scale planning for conservation, but the efficiency and effectiveness of such planning depend heavily on suitable information infrastructures, as discussed in Section 9.3.3.1. If such infrastructures are lacking, it will be difficult, if not nearly impossible, to effectively translate strategic direction downward for coordinated implementation at regional and local scales.

9.3.6 Global variation in impacts of ICT

As discussed in Section 9.2.3.3, a substantial technology gap currently exists between developed countries and developing or underdeveloped ones with respect to the impacts of ICT on forest management. The situation with respect to major "hard" technologies such as those supporting forest operations, wood processing, and distribution is not likely to change appreciably in the next 10 to 20 years because of financial constraints in developing and underdeveloped countries that lack outside investment. However, the situation with respect to soft technologies, such as decision systems for forest management, could be quite different. Historically, most development of such systems has occurred in the developed countries, again primarily because development costs for such systems can be high. On the other hand, many of these systems have been developed by government agencies and are thus in the public domain and freely available. At the same time, availability of computing infrastructure needed to use such systems is now not nearly the barrier to technology adoption in developing countries that it once was. Computing power and computer storage have increased dramatically over the past 20 years, while equipment costs have steadily declined. Consequently, we expect to see a steadily increasing diffusion of advanced software system technologies for forest management from the developed to the developing and undeveloped countries over the next 10 to 20 years. The technology gap in this particular area is therefore likely to be much smaller 20 years from now.

9.4 Policy Considerations

Based on the main points from the previous section, we conclude with some considerations that we hope will inform decisions about policy formulation in relation to opportunities for continued systems development to support forest management:

- Decision support systems and expert systems, as well as the more traditional analytical tools for simulation and optimization, continue to provide the core competencies underlying support for decision making in forest management. Each of these technologies is likely to continue to evolve, spurred by continuing advances in the enabling technologies, but the greatest potential for these technologies to contribute to improved effectiveness and efficiency of forest management will probably come from research focusing on systems integration.
- Technologies for group decision support, and in particular those for remote collaboration, have advanced rapidly in the past 10 years, and are likely to continue to do so. Possibilities for realizing significant efficiencies in, and improved effectiveness of, complex planning programs are therefore substantial, but contemporary forest management has not fully capitalized on this potential. In large measure, failure to fully capitalize on these technologies can be attributed to a lack of familiarity with them within the forest management community. Research reporting, demonstrating the efficiency and effectiveness of such technologies, would aid the diffusion process.
- Systems development aimed at improving the effectiveness of public participation in planning processes for forest management (for example, Web-based services such as e-planning) could be instrumental in reducing, at least to some extent, the contentiousness in society that now surrounds forest management issues. However, developments in this area are quite recent, so there is little practical experience with the benefits or pitfalls associated with these kinds of technologies. The social sciences could therefore play an important role, documenting the extent to which current solutions are effective and how they might be improved.
- Forest ecologists have long emphasized the need to understand and manage forest ecosystems at multiple spatial scales. Unfortunately, there has been far more arm-waving about the subject than practical demonstrations of how multiscale management can be effectively implemented. A limited number of examples do exist, however, and these may provide a useful starting point for designing a formal theory with practical implications for implementation.
- Progress in the immediate future toward effective, integrated support for multiple ownerships is perhaps the most uncertain of the issues we have been considering. In large part, as discussed earlier, this uncertainty is a consequence of the perceived need for the confluence of perhaps multiple technologies. We think it would be a mistake, however, to relegate this area of research to a low priority. More critical, in-depth analyses of the topic could well lead to unanticipated breakthroughs in developments along these lines.
- Major international initiatives have been very successful at reaching agreement on the information that member countries need to collect in order to assess forest ecosystem sustainability at national and regional scales. In contrast, there has been far less progress on questions concerning the meaning of that information and how it could be applied to arriving at interpretations of sustainability. Lack of progress in this area is understandable. After all, interpretation is at least as much a matter of policy as it is of science. Research could help to formalize the respective roles of science and policy in interpretations of forest ecosystem sustainability, and this would be especially helpful if international agreements are ultimately intended as instruments for international policy.

- Availability of enabling technologies to support the implementation of verification in certification programs is not a limitation. It will primarily be an issue of following through with investments for implementation. On the other hand, much like the situation with international initiatives for assessing forest ecosystem sustainability, approaches to certification could likewise benefit from the application of formal specifications that would help ensure consistent application of standards.
- Increasingly, both public and private organizations have come to recognize knowledge as a valuable corporate asset. Consequently, the concept of managing knowledge to ensure its conservation and optimize its creation within an organization has received considerable attention in business management sciences in the past several years as a way of improving the effectiveness and efficiency of an organization. Experience with application of knowledge management in the context of natural-resource organizations is still very limited; thus, as we have already suggested, relative to studies on effectiveness of public participation processes, research into its application to forest management may be fruitful.
- Management for conservation is increasingly seen as an integral component of contemporary forest management. Inclusion of conservation indicators in SFM initiatives tends to strongly accentuate this trend. On the other hand, we have argued that conservation is simply forest management with particular emphases on certain values. Therefore, future advances in conservation management are very likely to be closely associated with ICT advances in forest management more generally.
- Finally, we have argued that the prospects for closing the technology gap between developed countries and those that are developing or even undeveloped are good with respect to forest management systems. In particular, it is likely that only modest subsidies from the developed countries would be required to assist with creating the required infrastructures. However, some further commitment from developed countries in the form of training programs would almost certainly be needed as well.

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Chapter 10. ICT and Social Issues

Alan Thomson and Carol Colfer

10.1 Introduction

The top three major social issues of global concern identified in the United Nations (UN) Millennium Declaration[1] are peace, security, and disarmament; development and poverty eradication; and protecting our common environment. The road map developed to achieve the aims of the Declaration is laid out in the Millennium Development Goals (MDGs), discussed in Chapter 11. ICT will play a significant role in meeting these goals (UN, 2001a).

In addressing these societal issues, ICT is recognized as having a momentous impact, not only on institutions and systems but also in the way people live together and cooperate, with access to increased knowledge being reflected in improvements in many aspects of daily life. However, access is not equal, and knowledge and technology gaps exist within and among societies; such gaps are termed the "digital divide." A recent UN Task Force on Information and Communication Technologies indicated that while the gap between developed and emerging economies is narrowing slowly, the gap between emerging and least-developed countries is widening (UN, 2003a).

There are different forms of ICT-related divides. Equally important to the gap between developed and developing countries is the divide within societies: this may lead to a more intractable issue, a "democratic divide," in which power and influence in political systems are related to access to the Internet (Norris, 2000). Gender-based divides are highlighted by initiatives such as the "Communication for Women" Strategic Plan[2] of the ENDA (Environmental Development Action in the third world) organization. In the United States the racial gap is not decreasing (Wilson *et al.*, 2003). Even when the hardware and infrastructure gaps are closed, there remain gaps not only in content but also in software tools to locate appropriate material. Of particular significance is the "knowledge divide" (Sciadas, 2002), which arises from the fact that most of the vast amounts of data and information on the Web are codified and are useless without the knowledge to understand and make use of the content. In evaluating the importance of these divides, it should be noted that newspapers are a form of communication affected significantly by advances in ICT. However, Internet-based newspapers in many places, such as parts of Africa, face political obstacles even more challenging than the technical limitations of remote areas with poor connectivity (Amin, 2001).

In sections 3, 4, and 5 of this chapter, therefore, we will explore the three key social issues of peace, security, and disarmament; development and poverty eradication; and protecting our common environment. We will examine not only changes resulting from ICTs but also situations where the expected future may not materialize, and we will contrast the future effects of ICT on society across the extremes of the divides indicated above. The approach taken will be to review the principal drivers of ICT-related change in society and illustrate the future in key areas of the lives and activities of individuals and institutions using vignettes, as in Worzel's (1997) approach. Sections 10.3, 10.4, and 10.5 have an emphasis on the developing world; in Section 10.6 we change focus to examine the future effects of ICTs on individuals and institutions in developed countries.

Aspects of the future beyond the scope of the present chapter are covered elsewhere in the literature: Ferrigno-Stack *et al.* (2003) provide a perspective on society and the Internet in particular, while Coates *et al.* (1997), Worzel (1997), and Kurzweil (1999) discuss other aspects of daily life such as intelligent homes, clothing and jewelry, cybernetic artists and musicians, neural implants,

[1] www.un.org/millennium/declaration/ares552e.htm (last accessed 21 October 2004)

[2] www.enda.sn/synfev/plact01-03en.htm (last accessed 22 October 2003)

changes in leisure activities, medical breakthroughs, and automated personalities, and by 2099, the blurring of the distinction between human and computer.

10.2 Drivers of the Future

Society and culture drive the adoption and use of ICTs and, in turn, are changed by their use. We therefore begin with an evaluation of the principal social, cultural, and technological forces that will drive future interactions between ICT and society. Technological innovation can open possibilities, but social and economic factors control the development and use of a technology as well as the distribution of its benefits. It is the use of ICTs rather than the quantities of ICTs that may be most important for the future (see 10.2.2); the real issue is how to take account of the human dimension of the digital and other divides among and within countries. To illustrate this issue, the vignettes in this chapter will generally look at the complex ramifications of the ways in which people (or their organizations and institutions) interact with ICT.

10.2.1 Social and cultural drivers

The interactions of social and economic forces, often related to population increase, play a major role in ICT adoption. Perhaps the greatest social driver of ICT use is the wish of individuals to enhance life and security for themselves and their families, and it is this drive that will result in reallocation of personal time and resources to allow for participation in the Information Society in spite of problems of illiteracy, innumeracy, indebtedness, and the basic requirements of day-to-day survival.

Communication is the basis of societal development and is the “C” of ICT. People make decisions to interact with face-to-face communication or electronic media in a variety of ways. In the developing world, one of the most omnipresent forms of ICT is phone messaging or the short messaging service (SMS). Meetings in Indonesia are routinely interrupted by the musical themes that indicate someone is calling; and such phones have even affected courtship behavior in the Philippines (Ellwood-Clayton, 2003). Expense and difficulty in getting conventional phone lines has meant a ready market for comparatively inexpensive and readily available cell phones. Cell phones represent one instance in which the developing world has indeed been able to leapfrog technologically (see 10.2.2).

Innovation diffusion, introduced in Chapter 3, is a kind of social change in which alteration occurs in the structure and function of a social system, and ICTs will be a major source of such change. Many aspects of diffusion cannot be explained just by individual behavior: norms and social system level qualities have an influence and can be barriers or stimuli to change. Social networks play an important role in the diffusion process (Haggith *et al.*, 2003; Thomson *et al.*, 2004).

There are cultural differences in people’s receptiveness to ICT that will affect its future adoption and use. For example, for some farmers, economic aspects of relative advantage may be the most important factor, whereas for peasant farmers in third-world nations, greater importance may be attached to social approval (Rogers, 1995). Colfer’s experience has been that villagers in Indonesia, though retaining some skepticism initially, have been interested in and quickly become enthusiastic about the use of various kinds of new technology (Colfer, forthcoming). In southern Cameroon, on the other hand, an attempt to tape-record interviews failed as the people were too frightened of the technology. How much of this is cultural and how much relates to political realities is difficult to say, however. Another example is the significant cultural differences in e-commerce adoption (Aoki, 2000).

While ICT is viewed as an enabler of development (UNDP 2001a), the failure rate of software development projects has been estimated to run as high as 70% (Slofstra, 1999), and most information system projects in developing countries fail either totally or partially (Heeks, 2002). Failure often results from an inability or unwillingness to understand the social, cultural, or ethical context of ICT use (Wood-Harper *et al.*, 1996; Thomson and Schmoldt, 2001). Total or partial failure of ICT projects attributed to lack of consideration of differences in culture may have a number of causes. Heeks (2002) identifies the following: 1) formal, quantitative information stored outside the human mind is valued less in developing countries; 2) work processes are more contingent in developing countries because of the more politicized and inconstant environment; 3) developing countries are more likely to have cultures that value kin loyalty, authority, holism, secrecy, and risk aversion; 4) developing countries have a more limited local skills base, especially in IS/IT; and 5) management and structures of developing country organizations are more hierarchical and more centralized. Awareness of cultural differences in use of ICTs in a work setting is key to successful management of globalized enterprises (Bures and Alyshbaeva, 2001).

Such differences are reflected in approaches to ICT developments, which can actually embed particular political and cultural values that get transferred along with the technology: "What is transferred … is not simply machines, hardware, or knowledge but a collection of attitudes, values, and social, political, and cultural structures" (Shields and Servaes, 1989, cited in Heeks, 2002). In contrast to this accidental embedding of cultural values, future systems will increasingly include explicit cultural considerations, such as different codes of environmental ethics, to ensure a better fit of system performance to local conditions (Colfer *et al.*, 1989; Thomson, 1993; Thomson, 1997) (*Box 10.1*).

Box 10.1. Cultural computing: Example of a rule from Colfer *et al.* (1989)

RULE NUMBER: 11

IF: Ethnicity is Javanese transmigrant
THEN: Landowner is normally considered to be a male household head and
Land is viewed as very limited and
Rights to land are traditionally certified and private and
Women's agricultural labor is recognized as necessary but not preferred and
Ethnicity is symbolized by farming and small-scale female trade and
World view is hierarchical and authoritarian and
Domestic animals may include <2 cows and goats and chickens and 2 or more cattle and
Most crops planted probably require intensive management and
People value fertilizer and hoeing and cattle

10.2.2 Technological drivers

The current level and rate of change of the digital divide can be explored through comparison of ICT-related indicators using a country-by-country approach, with ICT investment and GDP being closely interconnected (Sciadas, 2002) (Vignette 1; Vignette 2). However, although time series data are available for many of the technology-oriented indicators, such as main telephone lines or cell phones per 100 inhabitants and Internet hosts per 1,000 inhabitants, simple extrapolation is not appropriate as "ICTs offer the developing world the opportunity to "leapfrog" several stages of development… [rather] than undergoing the traditional stages and cycles of progress to the Information Society. Cellular service, for example, has become the first and only telephone service for people in many developing countries where it is available much sooner—and much cheaper—than fixed line service" (UN, 2003b). Other rapidly developing technologies such as worldwide interoperability for microwave access (WIMAX), wireless local area network (WLAN), wireless metropolitan area network (WMAN), wireless personal area network (WPAN), and wireless wide area network (WWAN) will similarly facilitate leapfrogging.

Much more extensive lists of ICT indicators than that used by Sciadas (2002) were developed in relation to the World Summit on the Information Society (Koanantakool, 2003) and also by the Organisation for Economic Co-operation and Development (OECD) (Schaaper, 2003). However, interpreting such indicators depends on how they are measured. Even when countries have similar indices, their future course may diverge considerably, as national policies and initiatives set the parameters within which ICT evolves in a country and are influenced by an ICT “strategy divide” between developing and developed countries (Koanantakool, 2003).

Vignette 1—Africa 2017: With poverty, famine, and disease rampant over the last 10 years, the proportion of its GDP spent on ICT-related projects by a small African country was much less than in more-developed countries. The little it did spend was a poor investment for various reasons, and it was widely felt that the money could have been better spent on other purposes. As a result of the interaction between ICT investment and GDP growth, the economic situation was becoming even worse. A neighbor of the country, which had been equally poor a decade ago, had used a different ICT policy under similar circumstances and was now doing considerably better. It had even taken over some key markets of the first small country as a result of better use of ICT, exacerbating the local poverty situation in the first country.

Vignette 2—Europe 2017: Over the last 10 years, the small European country had seen its neighbors’ prosperity increase dramatically as a result of their ICT policies, and many of their own ICT personnel had emigrated to these neighbors, worsening the situation. National ICT policy was expected to be a major issue in the upcoming elections and result in a change of government.

Indicators of availability of ICTs and access to networks can be misleading indicators of future potential, if people’s skills and what individuals and businesses actually do are not taken into account too (Sciadas, 2002). To use new technologies, recipients must have confidence and feel motivated to take a certain amount of risk. Because of their social circumstances and experience, the poor may lack confidence and be risk-averse. Heeks (1999) discusses several social issues relating to the use of information from ICT sources. Unless people are from the same context as the sources creating the information (“source proximity”), problems of miscommunication and misunderstanding can arise. Before accepting information, recipients must trust both its source and its communication channel. This is knowledge that helps people to apply information by adapting it to their particular needs and circumstances, and such knowledge is frequently limited to a local context or social setting.

The ICT priorities of a country are reflected in its policies and laws, and these influence rates of growth (Dutta and Jain, 2003); but even where infrastructure is created, its use may be questionable if its content is government-controlled. International agreements based on existing technologies are also major drivers of change and are covered in Chapter 11 along with legislation and policy issues.

New technologies will also be drivers of the future. Predicting the appearance of future new technologies is difficult, and forecasting their effects on society is even more so; this is because new technologies usually have unanticipated consequences and technologies are themselves shaped by social interests and forces (CRA, 1996). For example, expected breakthroughs in nanotechnology include orders-of-magnitude increases in computer efficiency, leading to a “nanodivide” in wealth distribution (Roco and Bainbridge, 2001). ICT-related effects on society are therefore an example of an upheaval in the making. The interaction of nanoscience, biology, and information will lead to increasing rates of change in society, creating “disruptive technologies” that will cause failure of existing major corporations (Christensen, 2000). The resulting changes will be very unsettling and disruptive to many if not most people, and it will be extremely difficult for social and political systems to evolve quickly enough to keep up with technology (Williams and Kuekes, 2001).

The case of nanotechnology indicates the importance of being prepared by having management plans and policies in place that can respond flexibly to new issues. Roadmapping is a forecasting approach that is especially useful for projecting the course of potentially disruptive technologies such as nanotechnology (Walsh, 2004; Phaal *et al.*, 2004). According to Crow and Sarewitz (2001): “At issue here is not the value of change, but the path that change follows. What may look in retrospect like the march of progress may be experienced in real time as wrenching dislocation. The Dickensian squalor of nineteenth century London remains a symbol of the human impacts of technological change." As Tenner (2001) indicates: "We can expect five things: (1) The experts will be seriously wrong about at least some important things; (2) Long-term, cumulative problems will be a greater problem than the perils of catastrophe; (3) Organizing and supervising nanotechnology will create dilemmas; 4) Successes may be as costly as failures; (5) We have probably not imagined the greatest benefits of nanotechnology, either because these seem too technologically modest or because they may result from improbable chains of events."

10.3 Peace and Security

Conflicts are not restricted to military interventions and can occur along a continuum of severity and scale, from individuals to nations. Conflicts can also occur between the interests of society and those of large and powerful organizations (Bella, 1992). Without peace and security, initiatives to reduce poverty and hunger, including forestry and other development programs, are doomed to failure. Today's wars are primarily fought within states, although some spread to neighboring areas, and there is a need to provide the UN with tools for conflict prevention, peaceful dispute resolution, and postconflict peace building and reconstruction (UN, 2001a). Tools will also be needed to assist local agencies. ICTs will play an ever-expanding role in both these arenas.

10.3.1 Predicting the onset and course of future resource-based conflicts

Natural resources are at the center of many conflicts (Buckles, 1999; Ohlson, 1999). Conflicts among different groups on the land base, and between these groups and the state, are often rooted in different systems of knowledge. Future knowledge-based systems will have the ability to predict the cause, location, and course of such conflicts, advise on methods of amelioration, and even advise the optimal response. The cause or course may involve formation of a new social grouping or religious development: "natural resource issues can lead to social and cultural disruption, resulting ultimately in environmental and Malthusian refugees, eco-theologians, ecoterrorism and environmental warfare," and it may also be possible to predict their appearance and characteristics (Thomson, 1996).

Vignette 3—Central America 2022: The police inspector was happy that the street fighting[3] over the available water had been suppressed without major casualties, as his force had been on hand from the onset and able to prevent its spread. His early arrival was the result of an e-mail received that morning—he was always amazed at the accuracy and precision of the predictions and analyses in the automated e-mails produced by the United States-based system. As he understood the process: daily remote-sensing images were automatically analyzed and water limitations evaluated around the globe. Areas with water stress were cross-indexed with local census data to determine the cultural makeup of the population on a street-by-street basis. The system then used an automated "polemic analysis" process to analyze all digital discourse pertaining to the area to evaluate the threat of violence. When high threats were determined, a synopsis of the threat and its location and timing was automatically sent to the local authorities. Resources available to meet the threat were also analyzed and an optimal response generated. In this case, the analysis indicated that the timing and severity of the water shortage was related to forestry activities in the region, and that the frequency and severity would increase under the present rate of harvest.

10.3.2 Security

Early warning of environmental disasters such as drought, famine, and desertification will enhance environmental security in the future, and "disaster-reduction" programs will increasingly replace

[3] Fass (1984) describes street fighting over water.

current “disaster-response” programs. ICT approaches similar to that in Vignette 3 but with a focus on famine, drought, or desertification prediction and amelioration, may play a significant role here, especially in reducing uncertainty about the future. A ubiquitous Internet-based safety net for dealing with disaster has already been proposed (CRA, 2003).

Disaster-reduction programs illustrate a key feature that will be exhibited by many future successful ICT initiatives in developing countries: the inclusion of more traditional technologies such as telephone and radio, especially at the local level, as described in UNDP (2001b). Actions suggested by these systems will be as compatible as possible with the normal operating procedures of the people and institutions involved (*Box 10.2*).

Box 10.2. Critiquing systems

In cases such as Vignette 3, or the “disaster-response” systems, where an optimal response can be estimated and supplied by a system, there is often uncertainty about some aspects of a prediction, and many people are reluctant to use a system that is perceived as a “black box,” especially where there are human-safety or liability issues. The future will see an increased use of “critiquing systems.” These will allow people to enter elements of their own plan that may be acceptable within the bounds set for the system but will flag any elements, especially combinations of elements, that might have unanticipated consequences or give cause for concern. Other approaches such as expert systems or optimization can play a role in setting the bounds. These place more emphasis on support for human decisions than decision-making systems per se. For example, the Alternatives to Slash and Burn Programme (2001) indicates that “a remarkably wide range of smallholder land use options are agronomically sustainable, depending upon the larger environmental and economic context.” A system that did not recognize the acceptability of this wide range of alternatives would be unlikely to succeed.

Vignette 4—Penyanding (born in the village of Long Segar, East Kalimantan, Indonesia in 1975, translation from the Kenyah language)—2030—How times have changed. When I was young, we didn’t even have electricity. Now I can contact my American friend, Peligit, almost any time I want—taking into account the time difference, of course! I can communicate routinely with my husband, who’s working in Malaysia. And keeping up with my children who’re in school in Jakarta—that’s easy. I got an e-mail the other day from my three-year-old grandson, probably his very first attempt! When Tinen Uyang and I want to figure out who’s making a rice field where, I can send her an e-mail or call on the cell phone rather than having to walk all the way up the hill, like we did in our youth. Of course, we still have to work in the hot sun to grow our rice, but that gives me such a feeling of accomplishment that I don’t want to give it up. Some of my new friends in other countries find this a little hard to understand. I try to explain that rice cultivation is part of the woman’s role here in Kalimantan, but…some of them just don’t get it! Those instant translation machines are fabulous, but there are still a lot of cultural differences that are pretty hard to get across (and of course I think some of the things they think and do are nutty too!). Working in the forest is also so much safer now. If there’s an accident—someone falls down the ladder to the field hut or gets slashed with a bush knife—we can call for help immediately with the cell phone. Not to mention the ready access to information about prices and improved transport, both of which make our agricultural production so much more profitable for us! Life upriver has become much easier.

At the personal level, in many developing countries, access to a phone for communication with police or emergency services is still one of the most pressing priorities for security, as illustrated in Vignette 4, which also indicates another key feature of introducing ICTs: they must fit into people’s regular daily life and routines, much of which will remain unchanged.

10.4 Development and Poverty Eradication

Poverty, hunger, and deforestation are intricately linked (Marcoux, 2000; FAO, 2001), and the role of forests in alleviation of hunger and poverty clearly identified. Here we are concerned with more general issues of ICTs in relation to poverty and hunger. Many development programs aim to reduce poverty and hunger, although the development paradigm (Jazairy *et al.,* 1992; McNamara, 2003) will influence both the manner in which this is attempted and the ultimate success; ICTs and development are also explored in Section 10.5 below.

It is important to define "poverty": many low-income societies are rich in social capital. As a number of the vignettes in this study illustrate, it is critical that this capital is not depleted by careless introduction of ICT innovations (cf., Dudley, 2004). Preservation and use of traditional knowledge, part of that social capital, is now recognized as an important aspect of many ICT initiatives: "Information and Communication Technology (ICT) will be increasingly used to support and encourage cultural diversity and to preserve and promote (indigenous) languages, distinct identities and traditional knowledge of indigenous peoples, nations and tribes in a manner which they determine best advances these goals. The evolution of information and communication societies must be founded on the respect and promotion of the rights of indigenous peoples, nations and tribes and our distinctive and diverse cultures, as outlined in international conventions. We have fundamental and collective rights to protect, preserve and strengthen our own languages, cultures and identities" (UNECE, 2003).

Hunger and malnutrition, as well as income, are all indicators of poverty, and in the absence of significant interventions will increase unless global population growth can be stabilized. Eradication of extreme poverty and hunger is foremost among the UN Millennium Development Goals, but success will be influenced by the outcome of the debate over whether there should be a "right to food" (UNCHR, 2002).

10.4.1 Poverty: "The fortune at the bottom of the pyramid"

Individually, the poor have little buying power, but collectively, low-income markets represent a major opportunity for the world's wealthiest companies (Prahalad and Hart, 2002; Prahalad and Hammond, 2003) (Vignette 5; Vignette 6). The future will see many ICT products specifically designed for the poor. However, for such products to be successful, they must ensure that the information delivered is appropriate for the audience and that related requirements such as microfinance are met. For example:

> Information supplied via ICTs (or via any other means) has no value unless it informs decision making and action. Yet action implies resource endowments that have nothing to do with ICTs. Information received about a new supplier is of no value if the entrepreneur does not trust the supplier. Information about a new market is of no value if the entrepreneur cannot increase production to supply that market, through lack of capacity or aversion to risk. Information about new government tax rules is of no value if the entrepreneur cannot afford to pay taxes. Inequality in endowment of both overt and social resources for action therefore keeps poor entrepreneurs poor regardless of whether information is supplied to them via ICTs" (Heeks, 1999).

Vignette 5—South East Asia 2015: The CEO of the new technology venture capital company found the new software from the Development Bank extremely useful. The software automated the production of business plans for "bottom of the pyramid" investments, which, although potentially very profitable, carried a high risk and without a sound business plan were unlikely to succeed. The new software not only drafted a business plan that accounted for all the information available in the target area, it also launched software agents (see *Box 10.3*) to locate other interested parties with whom to form a consortium and spread the risk.

Vignette 6—South East Asia 2015: Nguyen is illiterate and lives in a slum in a large city where he hand crafts articles for sale in Western markets. This activity is much more profitable now because of a new business in his community that provides a link between local producers and a larger export firm. The export firm runs an online ordering facility for North American retailers, guaranteeing the quality of the workmanship of the products it ships. Nguyen receives feedback from his contact about which kinds of articles he should produce for his next delivery date. Through use of her computer, Nguyen's contact was able to find a microfinance opportunity for him and his neighbors to buy more materials and new tools to expand their production even more. He has a little card that he knows is a record of his reliability in meeting delivery schedules and paying his portion of the small loan he and his neighbors received.

Box 10.3. Software agents

Software agents are referred to in many of the vignettes and will play a major role in future systems. A software agent is a computer program that carries out tasks on behalf of another entity, either a human or another computer program. Agents can be used to search the Internet for specific information meeting a set of requirements and can exist as part of an agent community, agent ensemble, or agent armada, cooperating (and/or competing) in pursuit of common goals (http://agtivity.com/agdef.htm). Agents can interact in cyberspace, requiring a set of ethical rules to develop patterns of trust, loyalty, etc., similar to the activities of human agents. Artificial Intelligence can provide mechanisms to include codes of ethics in software systems (Thomson, 1997; Lamuth, 1999), and autonomous agents (Thomson, 1996).

It is well recognized that women predominate among the poorest members of many societies and have fewer opportunities for education; women often comprise a low percentage of Internet users, especially in Africa and the Middle East. There are often social and cultural barriers to women's participation in the use of ICTs, and approaches linking the Internet and radio may be especially useful in addressing gender issues (UNDP, 2001b; Daly, 2003b). Additionally, there are often distinct gender differences in information requirements and in the requirements for an appropriate setting for ICT infrastructures such as telecenters (*Box 10.4*). A major role for ICTs for the poor in general, and women in particular, will be in strengthening their "voice." The fact that ICT use does not require the physical strength of men is a built-in advantage for potentially improving women's status and life opportunities.

Box 10.4. Telecenters

Many development ICT initiatives are based on telecenters. Roman and Colle (2002) describe a telecenter as "a public place where people can get a variety of communication services, and where a major part of the operators' purpose is to benefit the community" and list 10 themes for telecenter sustainability. The themes emphasize partnerships, champions, volunteers, clusters, awareness, participation, business plans, and a focus on service rather than on the technology. Care must be taken not to select champions who themselves are intimidated by the technology, and local and/or national politics can also be a problem (UNDP, 2001b). Rogers (1995) points out that many technologists believe advantageous innovations will sell themselves, but most innovations diffuse at a disappointingly slow rate in the absence of a change agent or champion.

(See also Section 10.6.3)

10.4.2 Food acquisition, production, and distribution

Making low-cost food more plentiful in a region can alleviate hunger, and ICTs can play a major role in improving the efficiency and reducing the costs of many aspects of food production, postproduction storage, transportation, and distribution (Daly, 2003a). Vignette 7 contrasts a situation in the United States with Africa, where variations on the approach have similar outcomes. A variation on Vignette 7b would have Margaret's interaction with the system carried out by a third party, who also produced the customized narration. While customized narratives are currently possible in certain well-defined settings (Thomson, 2004a and 2004b), automated production in a general setting probably lies some time beyond the 2020 date used in the vignette.

The two versions of Vignette 7 imply equal acceptance of the outputs of the technology by the farmers in both cultures, but in practice, acceptance of information from a stranger in developing countries is much less likely—strangers are more likely not to be trusted. There may be social limits to the use of such knowledge, such as where community elders discourage its use if they were not involved in an appropriate manner during the development of the process.

Vignette 7a—United States 2020: Robert Jones has a small farm in the southern United States. His connection to the Internet lets him activate a set of software agents that automate the process of obtaining a detailed remote-sensing image of his farm, predict fertilization regimes for his different crops, and produce a precision-agriculture approach to his fertilization that minimizes his costs.

Vignette 7b—West Africa 2020: Margaret Ndereba has a small farm. She does not have much education, but her local telecenter allows her, for a small fee, to print a map of her farm with symbols marking the places where she should conduct different activities. She also receives a small device that she takes home and plugs into an attachment on her radio. She can then hear a narration of what the symbols mean and can replay it whenever she wants. It did not cost much at all and she finds it very helpful. The telecenter manager once told her how it all worked, mentioning something about "agents," but she did not really follow his explanation—she just knows she can produce a lot more food more cheaply.

10.4.3 Sustainable livelihoods: Developing countries

The UNDP Sustainable Livelihoods Unit[4] has defined livelihoods as the assets, activities, and entitlements that people use to make a living. The sustainability of livelihoods then becomes a function of how men and women utilize asset portfolios on both a short- and long-term basis. Care must be taken when introducing new technologies not to disrupt existing sustainable patterns of use. The adverse effects of introducing a new technology in a traditional culture are based on abundant evidence [see, for instance cases, reported by Rogers (1995, pp. 415–423)].

In Vignette 8, Andrew found it easy to transfer hunting-related knowledge, and the results described for Robert's community are very similar to those in Rogers' (1995) examples. A different type of knowledge could have been much more difficult to introduce. In the experience of the Center for International Forestry Research (CIFOR), within an ethnic group there are huge differences in openness, depending on the topic: for example, Colfer (forthcoming) found transmigrant Javanese farmers in West Sumatra willing to try anything within reason in their agricultural fields but very resistant to any external views on health matters. With a careful approach to ICT transfer, some potential problems may be avoidable; Thomson (2005) advocates an "adaptive knowledge management" process to fit knowledge management in general, and reporting in particular, to

[4] http://www.undp.org/sl/

particular cultures, weighing both the human and financial costs and benefits involved; Colfer (forthcoming) recommends the use of participatory action research to develop strategies together with community members that will address such potential problems.

Vignette 8—The e-Hunter (Zimbabwe 2015): Andrew Smith is an agricultural extension officer working in a remote area of Zimbabwe. Three years ago, Andrew brought a solar-powered, voice-activated computer to one of the larger villages in the area. The computer was linked to the Internet by satellite, and Andrew used the computer to develop risk-reduction strategies for the village. He has also been using computer technology to assist a 25-year-old hunter, Robert Msika, for the last three years. In that time, Robert has gained a reputation in his village as one of the best hunters, but Andrew is concerned about changes he has seen in the social hierarchy of the village.

Andrew worked with Robert so that when Robert spoke his name to the computer, the computer would tell him, in his native tongue, where and what to hunt; but Andrew had come to realize that Robert regarded the whole process as a form of highly successful magic. Andrew, however, knew that in reality, when Robert spoke his name, the voice-recognition software activated a custom-designed suite of software agents that went out over the Internet to find sites that would provide information such as the weather, the predicted biological status of the major animal species (from a number of simulation models) in relation to the state of the vegetation (by custom analysis of remote sensing images), as well as the current locations of the major predators in the area (by monitoring the transmissions from the radio tags used in wildlife research). A master agent pieced the information together to predict the best hunting pattern, converting the map coordinates to directions related to landscape features that Robert would recognize. The final result was then passed to the translation software to provide the final message that Robert would hear. Although not a computer expert, Andrew had found that the new software tools available had made it easy for him to design the system.

Although Robert was now the most successful hunter in the village, Andrew knew that his family was not prospering as well as might be expected. Traditionally, hunting prowess conferred status in the village society, but Robert's success was not based on the traditional expertise-based approach and the other villagers were increasingly shunning his family. Robert was unwilling to give up the key to his newfound success, as he had formerly been one of the least successful hunters in the village and his family often went hungry. Robert's success had resulted in a loss of status for the village elders, as their own hunts were often unsuccessful. Their traditional knowledge could not keep abreast of changing migration patterns related to climate change and the inroads of civilization. This reduction in the status of the elders, and the uncertainty generated by the change in social stability, had led to an increase in domestic violence and abuse of alcohol in the village, and Robert's encroachment on the traditional hunting areas of a neighboring village resulted in conflict.

10.4.4 "The threat of small households"

A decline in poverty will allow many people who currently share accommodation, to move to their own homes, resulting in a potentially unexpected outcome of poverty alleviation. "The threat of small households" is the title of an article by Keilman (2003), in which he describes how smaller households result in higher energy use and greater impacts on biodiversity. Exploring the future of this concept is facilitated by consideration of another example from Zimbabwe that delineates the problems resulting from a switch from fire-based cooking to solar power (Rodgers, 1994). Use of solar ovens has entailed a sufficiently large change in routine and custom as to be termed a "radical innovation," and solar power is central to many ICT initiatives in developing countries. The key issue here is that introduction of one technology may lead to a requirement for major changes in unanticipated areas, with results obvious only after a number of years. Considerable foresight, possibly with the aid of system dynamics models, is required to minimize such unanticipated consequences. ICT changes faster than our ability to understand the social forces producing it and the far-reaching implications for society. Information infrastructures coevolve with a variety of social formations (CRA, 1996, p. 3). Many of the effects of ICT will be seen at the family and household level: of particular relevance to forestry will be changes in fuelwood demand caused by housing proliferation resulting from increased ICT-based prosperity (Vignette 9).

Vignette 9—The threat of small households (India 2021): Baleshwar Singh has seen enormous changes in his village in the last 18 years as a result of a significant reduction in poverty attributable directly or indirectly to advances in ICT. Many more people can now afford a house of their own and his village is now encroaching on the surrounding agricultural land. Some of the plants and animals familiar in his youth are now rare. Firewood is now hard to obtain as the proliferation of housing has significantly depleted the available fuelwood. Although solar power can now be used for cooking and lighting, the food does not taste as good, and his mother misses the traditions and customs related to the older ways of preparing and cooking food.

10.5 Protecting Our Common Environment

Protection of the environment is a cornerstone of sustainable development, discussed in Chapter 3. ICTs are at the heart of many development initiatives, but it is important to regard ICT use as a means of achieving goals, not as an end in itself. A multitude of agencies that may be conducting programs in the same region, as well as overlaps and lack of coordination, can be a problem for the target groups, resulting in development opportunity costs such as ignoring the fact that radio covers approximately 75% of Africa's population and television 40% (Heeks, 1999). Local knowledge is often overridden, and people's time and resources get overstretched, allowing those with political, economic, and social power to reinforce their position at the expense of those without such power. The most difficult questions of sustainability are not about technology: they are about values. Answers to such questions cannot be found by asking the "experts" but are often best resolved in the political arena.

Participation plays a key role in sustainable development. Rights to participation are enshrined in many international conventions and agreements, and ICTs offer not only new forms of participation such as virtual workshops (Thomson, 2000) but also new tools to use in more traditional settings. Related issues of participation, information, communication, and decision making are key components of Chapters 8, 26, 31, and 40 of Agenda 21 of the Rio Earth Summit. The UN Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (http://www.unece.org/env/pp/) specifically addresses the topic in an environmental setting. "Eliciting people's own views of their information priorities, opportunities and needs is key. This demands a differentiated and participatory approach to information needs assessment" (FAO, 2001), although participation is often beset by problems (Cooke and Kothari, 2002). For example, if "a picture is worth a thousand words," then improved ability to communicate graphically with technology is significant, especially when the software can interpret a sense of motion by the elements (Easen, 2003).

The new technologies will offer new capabilities and opportunities for participation. However, in participatory processes like that in Vignette 10, ownership of the process and products is a key element of acceptance of the process outcome.

Ownership may be higher when the hand-drawn sketches are used, and it will be important to evaluate the acceptability of the new tools, compared to the older, "messier" methods. Another aspect of the new technologies and human-computer interfaces is that the speed of communication and update of knowledge make reflection and verification difficult. This can make it difficult to properly integrate the technology with the decision processes with which people are comfortable.

Vignette 10—Robert Jameson (2012): Robert Jameson is a field officer for an international development agency in Chile. He has just completed a participatory mapping exercise with the elders of a small mountain village. He is pleased at the performance of his new technology, which consists of a 1m x 1m flexible display linked to a satellite phone. He had mounted the display on a board in the local meeting hall, displaying a downloaded remote sensing image of the surrounding region as a backdrop. As the elders sketched their homes, fields, and sites of interest, the software converted the sketches to a neat representation of the feature. To Robert the result looked much nicer than the hand-drawn sketches that he had worked with in the past, and he looked forward to trying the newer version of the system, which came with a book of "stickers" representing fields, huts, and animals. These stickers, which could be peeled out of the book and stuck on the display, were actually intelligent objects that communicated the object's location and properties to the central software through sensitive elements in the flexible display.

As described in 10.2.1 above, many projects fail in whole or in part. This is often because many donor agencies do not fund business-type ventures with social agendas; future successful projects may include socially oriented indicators of success, such as learning or awareness raising, rather than focusing purely on issues such as the project becoming economically self-sustaining (cf., Colfer, forthcoming).

Governance, participation, and development are intricately connected. While governance and ICT are addressed in Chapter 11, some social aspects are worth highlighting here. ICTs have a role in the democratization process (Celdran, 2002; Qiang, 2003), where their ability to mobilize personal networks is a powerful force for reducing hierarchy and increasing interaction in ways that contribute positively to democratic trends. ICTs also carry with them potential equity implications relating to governance. Virtual communication can carry with it a considerable amount of anonymity (including relating to gender or ethnicity). ICTs allow communication without regard for, or knowledge of, the characteristics of those communicating—which could work to women's (and others') advantage. Another potential benefit derives from the fact that one can participate effectively from any locale. This means that women, often housebound because of childcare responsibilities, could potentially have much greater opportunities to participate in various kinds of governance-related decision making than they have in the past.

10.6 The New Information Society

The Information Society (*Box 10.5*) is "characterized by a high level of information intensity in the everyday life of most citizens, in most organizations and workplaces; by the use of common or compatible technology for a wide range of personal, social, educational and business activities, and by the ability to transmit, receive and exchange digital data rapidly between places irrespective of distance."[5] The current trend is to emphasize that intensity by the use of the "e-" prefix for everything from shopping to governance, but that distinction will disappear in future as the use of ICT in business, government, and daily lives ceases to be unusual.

10.6.1 Communication

As described in 10.2.1, communication is the "C" of ICT, and cell phones, fax machines, pagers, and e-mail are a way of life in modern society. An "ecology of media" describes how people use the increasingly different media that are becoming available (CRA, 1996), with content, technologies, and social conditions together forming an interactive whole system. A modern component of media ecology is telepresence, "the experience of being fully present at a live real world location remote

[5] http://whatis.techtarget.com/definition/0,,sid9_gci213588,00.html (Last accessed 4 June 2004).

from one's own physical location."[6] Similarly, text in an ecology of media may be constructed by a program. As customized text generation by artificial intelligence (AI) systems is already in use (Thomson and Taylor, 1990), in future will it be possible to tell if an article was written by software or by a human? (Vignette 11).

Box 10.5. The future of the Information Society

Major questions must be answered so that the future of the "New Information Society" can be properly understood (CRA, 1996):

"• How credible is the information, and how is knowledge verified? Are there many alternative 'truths'? How do individuals determine what is rumor and what is fact in online arenas?

• When anyone can publish, what new forms of news are created? Does the speed at which news travels have an impact on public discourse?

• How will the information-processing limitations of people, organizations, and institutions affect public discourse? What are the alternative navigation strategies that mitigate the tendencies of individuals to select only those truths that are palatable to them and to exclude all others?

• What are the effects of different levels of technology—individually, locally, nationally, and globally—for accessing information and managing its flow? Will the capacity to manage information flow be different for various people, organizations, and institutions?

• What are the impacts of freedom of speech issues and censorship on information available to individuals and on the capacity of individuals, organizations, and so forth, to participate in public discourse?"

Vignette 11—News Flash (Los Angeles 2025): The first use of avatars in television occurred today, when popular TV anchor Trevor Michkin participated simultaneously in three different discussions. He was "live" in only one of the settings; in the others, a digital avatar, an Artificial Intelligence entity created from a database of his past shows, represented him.

Note: "Among people working on virtual reality and cyberspace interfaces, an avatar is an icon or representation of a user in a shared virtual reality."[7]

10.6.2 Sustainable livelihoods: Developed countries

Sustainable livelihoods in the developing world were discussed in 10.4.3. It is interesting therefore to construct a vignette of daily life in the New Information Society: the contrast with Vignette 8 from the developing world is marked—where is the sustainability? Vignette 12 is based on descriptions in many technology-oriented futurist publications, including those listed in the Introduction, of how even clothing and common appliances will have "intelligence" and intercommunication ability built in.

A similar supply chain scenario may occur in forestry (see Chapter 5), with paper demand automatically triggering a chain of software agents that finally recommend harvesting of a particular stand of trees at a particular time. Supply chains were part of a seminar on new e-business models in the forest products industry at the 2003 World Forestry Congress.[8] Supply chains based wholly or in

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[6] http://telepresence.dmem.strath.ac.uk/telepresence.htm (Last accessed 17 October 2003).

[7] http://www.learnthat.com/define/view.asp?id=368 (Last accessed 17 October 2003)

[8] http://www.wfc2003.org/en/inscription/seminaires_formation.php#1 (Last accessed 21 October 2003).

part on software agents will become increasingly common in future: development of “trust” among software agents has already been discussed and will be a key feature of supply chain success.

Vignette 12—New York (2014): Wendy is a busy 23-year-old office worker who finds it hard to fit the daily chores into her busy schedule. However, modern technology has made things easier for her: as she removes items from her fridge, the fridge records the depletion, and once a week sends an order to the local supermarket, which delivers the order to her door. Wendy’s bank account is debited automatically, and the account software, which has been monitoring the wear-and-tear information sent to it by Wendy’s clothing, sends her an e-mail warning her that budgeting will be required if she wants to replace items. Meanwhile, at the supermarket, as items were removed from the shelves to fill Wendy’s order, the intelligent shelving sent a message to the inventory program, which determined that stocks were running low and sent a new order to the supplier.

10.6.3 Lifelong learning and information literacy

Information literacy (*Box 10.6*) is about “learning how to learn” and is often an intensely social process (CRA, 1996). Focus on the social nature of learning will contribute significantly to future ICT development projects as indicated by current experiences with community telecenters (*see Box 10.4*) (Delgadillo *et al.*, 2002). These aim at improving the economic, social, political, and personal lives of many people, especially the poorest and most marginalized sectors of society: “What makes a community telecentre different from a cyber café is its social vision, its explicit support for human development, and the contribution it can make to transforming and improving living conditions. To achieve this, it is not enough to offer connectivity, even at low prices. If they are to be successful, community telecenters must have a social vision, they must be firmly rooted in the dynamics of local organizations and community action, and from that basis they must become tools for supporting social change” (Delgadillo *et al.*, 2002). Technology must be integrated into general concepts of stimulating learning in communities through expanded access to information, such as those discussed for resource-related cases by Wollenberg *et al.* (2001) and Leeuwis and Pyburn (2002).

Box 10.6. Information literacy

Literacy is already an issue for ICT use in developing countries. “Information literacy” adds additional constraints on people’s ability to join the Information Society. An information-literate person is one who (Doyle 2004):

- Recognizes that accurate and complete information is the basis for intelligent decision making;
- Recognizes the need for information;
- Formulates questions based on information needs;
- Identifies potential sources of information;
- Develops successful search strategies;
- Accesses sources of information including computer-based and other technologies;
- Evaluates information;
- Organizes information for practical application;
- Integrates new information into an existing body of knowledge; and
- Uses information in critical thinking and problem solving.

Information literacy is now an important aspect of educational literacy in developed countries; its absence from curricula in developing countries contributes to a growing “knowledge divide.”

There are already online tutorial programs through which educated Africans provide help for children in the United States, suggesting the possibility of a virtual brain drain, in which people with the most-needed skills and knowledge in poor countries dedicate those skills and transfer that knowledge to people in rich countries via the Internet, all without leaving home (Daly, 2003c) (Vignette 13).

Vignette 13—Stephen Stone Steinert (born in Seattle in 1999)—2020—What a great day it's going to be today! After several years of hard work, through classroom and Internet courses on my favorite hobby, primate behavior—something that's become increasingly possible due to the flexibility I now have because I can telecommute part of the time—I'm going to hook up with my new telementor. I can't believe my luck to be paired with the most famous expert in the world. In the old days, the fact that she lives in Africa and I live in Seattle would have made collaboration difficult, but not now. She'll be able to lead me to all the best sources, introduce me to other well-known behaviorists, and critique my efforts. It'll be fantastic to actually see the great woman, virtually, in my living room. And if we really hit it off, she might even agree to do a study together.

10.6.4 Aging society and the digital workplace

The age structure of society is a striking difference between the developing and developed worlds (Karoly and Panis, 2004; UN, 2001b). People in developed countries have a much longer life span and improved health to enjoy that longevity. How the age structure of society interacts with the digital workplace has many facets: Vignette 14 will illustrate only a small sample of them.

Vignette 14—Joanna Brown 2045—I feel multiply blessed on my 100th birthday. My productive life span has been extended well beyond anything I ever dreamed possible. Physically, through advances in medical technology and genetic manipulation, my body remains at least reasonably functional. The Internet explosion has aided immeasurably by allowing me to maintain my research career from home—preventing my fading body from seriously inconveniencing my still-active brain. The structures in which research is conducted have changed radically as well—and for the better! When I was young, research was typically planned by scientists in single-discipline offices and labs, with little attention to real-world needs. Attempts to respond to the world outside were slow and ungainly. Now, the ubiquity of the Internet has allowed us to change our system from one marked by rather rigid organizational structures and predefined, single-discipline plans to a much more process-oriented, responsive, and interdisciplinary approach, with software agents and robots[9] being integral parts of the research team. Of course, preplanned, researcher-driven work continues, but it is balanced by systems that allow those of us who want to respond to village needs to do so quickly and in an integrated, interdisciplinary manner. The whole scientific culture has become much more integrated into day-to-day life—not taking it over, but supplementing, as needed and desired.

The Pentagon's Lifelog project aims at monitoring the behavior of military commanders with a view to enhancing their performance (Shachtman, 2003). "Cameras and microphones would capture what the user sees or hears; sensors would record what he or she feels. Global positioning satellite sensors would log every movement. Biomedical sensors would monitor vital signs. E-mails, instant messages, Web-based transactions, telephone calls and voicemails would be stored. Mail and faxes would be scanned. Links to every radio and television broadcast heard and every newspaper, magazine, book, Web site or database seen would be recorded."[10] Records of this type could be the basis of the type of software described in Vignette 15, and in a more general setting are discussed by

[9] Future research teams can include software agents and robots (CRA, 2003), and robots have already been used in research on climate (National Aeronautics & Space Administration, 1999).

[10] http://www.siliconvalley.com/mld/siliconvalley/news/editorial/6001716.htm (16 October 2003)

Hogan (2003). There are fears, internationally, that foreign visitors to the United States may be subject to comparable scrutiny, even now.

Vignette 15—News Flash (London 2031): A national strike has been called by the few remaining labor unions in Britain for next Monday as a result of a leaked cabinet document that proposes a change in policy permitting software agents to be placed in management positions to oversee the performance of human workers. The leaked document also describes the existence of a long-term project monitoring the work habits of employees with a view to automating their job functions.

10.6.5 Institutions in the New Information Society

The earlier sections focused on individuals; however, individuals in society belong to institutions such as businesses or organizations, for which ICT has different drivers and consequences than for individuals. Many of the new aspects of business are discussed in chapters 4 and 5; here we address the phenomenon of globalization, the term used to summarize the increasingly complex interdependence among nations and societies in terms of the financial flows, trade, industry and communication, people and knowledge that dictate that both developing and developed countries be considered together. "The movement of people and knowledge/technology may be seen as the real driver and cause of globalization, generating institutional and social changes that are taking place within and beyond the geographic borders of nation States. Such movements are much more difficult to quantify than the impact of trade and finance flows" (UNESCAP, 2002) (Vignette 16).

Vignette 16—California 2008. Amy Judge had moved to her large new home on the outskirts of the small township in the Sierra Nevada mountains in 2005 after advances in ICT had changed her work to the extent that she had to visit the head office only infrequently. She had soon become involved in several resource-oriented conflicts with the local residents who had different amenity values, most recently in relation to the community fire-prevention policy. She and other recent arrivals were demanding a program to reduce the fuel load in the forests around their properties to minimize fire risk, while the longer-term residents wanted to put the limited funds available into projects that would benefit the whole community.

ICTs are not only the basis of the current globalization but also affect the movement of people within countries. The pattern of movement differs in developing and developed nations: in developed countries ICT workers move from cities to rural areas, whereas in developed countries ICT workers move to the large cities in which an adequate ICT infrastructure exists.

10.6.6 ICT-related divides and globalization

In earlier sections there was mention of different forms of ICT-related divides: digital, democratic, gender, racial, knowledge, strategy, and nano—here we explore this topic and the related issue of globalization in more detail. The original concept of the digital divide had its foundation in differences in ICT between developing and developed countries. Many developing countries now have significant ICT capability; for example, in Asia, agreements between countries such as the 2003 Memorandum of Understanding between the Association of Southeast Asian Nations and the People's Republic of China on Cooperation in Information and Communications Technology"[11] will have far-reaching effects on the societies of that large area. The agreement covers topics such as training and mutual recognition for ICT skills certification; development of information infrastructure such as fixed and mobile communications networks; strengthening centers of

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[11] http://www.aseansec.org/15148.htm (accessed October 21, 2003).

excellence, encouraging private-sector enterprises to actively participate in the development of ICT application systems for governments and businesses; enhancing the compatibility, integrity, and security of ICT systems and harmonization and compatibility of data-exchange standards, cyber crime prevention, and data protection.

The rise of ICT capacity in the developing world has led to the phenomenon of outsourcing of ICT-related business activities to suppliers in other countries where costs are lower. While outsourcing is commonly regarded in the North as a phenomenon of jobs being lost in Western countries and new jobs being created in Asia, outsourcing can also occur among Asian countries (Ernst, 2001). However, the significance of outsourcing for job loss should decrease in future, as new businesses will be developed under a model in which services are performed externally from the onset.

Outsourcing of services is one facet of the dematerialization of some sectors: the shift away from producing and consuming products to producing and consuming services. Dematerialization is closely linked to sustainability and to the reduction of "ecological footprints" (Lenzen and Murray, 2003). However, the future will see a shift to services in developed countries as an economic survival mechanism rather than a proactive approach to sustainability, as globalization moves production increasingly to the developing countries. It should be noted that some recent studies, using full life-cycle studies and other environmental or "green" accounting concepts and methods of industrial ecology (*Box 10.7*), suggest that ICT-based services may have less effect on sustainability than anticipated (or even have a negative effect) (Kuhndt *et al.,* 2003).

Box 10.7. Environmental or "green" accounting concepts and methods of industrial ecology:

Adjusted net savings analysis
Environmental space and ecological footprint analysis
Indicator development
Life-cycle assessment
Material flow accounting and substance flow analysis
Material intensity analysis
Physical input–output tables
Sustainable process index
Supply chain analysis
Total cost accounting
Total material requirement and output

It is important to recognize that economic growth in developing countries due to globalization will not necessarily reduce poverty (UNESCAP, 2002). "The greatest irony of the digital divide debate is that when divides between countries shrink, domestic divisions often increase" (Bridges.org, 2001): There are two views about the role of globalization in bridging internal divides within countries. The first view is that the economic boom will facilitate the slow diffusion of ICT throughout the population. The alternative view is that ICT-enabled companies will further beat out their less internationally based competitors. Whether internal divides will diminish within a country will depend on local legislation, policies, and practices and is often influenced by the concept of "escalation of commitment," which suggests that once a direction is set and investment placed, it is difficult to abandon that path. There are national differences in willingness to change directions, related to different approaches to risk (Salter and Sharp, 2001).

10.7 Research Directions

Many of the research questions regarding the impact of ICT on society are sociological in nature. The American Anthropological Association (AAA) and the Computing Research Association (CRA) combined to evaluate immediate and potential social impacts of ICT (CRA, 1996) and raised many research questions (see *Box 10.8*) that are still as urgent today. Roco and Bainbridge (2001) raise similar research questions in the field of nanotechnology regarding how to measure societal impacts and what will count as benign or adverse.

Box 10.8. Research questions regarding the impact of ICT on society (from CRA, 1996):

- What are the standards for effective use of social science knowledge in systems development?
- Does the character of relationships change?
- Does the availability of the information infrastructure lead to a broader or a more constricted network of social relationships?
- What are the different roles within a community with respect to new technology?
- What are the mechanisms that create community? Are online arenas building new communities as they undercut the old?
- Do online arenas displace ongoing communal activities or fill social voids?
- How are conflicts over the proper bounds of public discourse played out in the multiple contexts of information technologies?
- How is "access to public discourse" to be defined? What publics?
- How credible is information, and how is knowledge verified? Are there many alternative "truths"? How do individuals determine what is rumor and what is fact in online arenas?
- What are the alternative navigation strategies that mitigate the tendencies of individuals to select only those truths palatable to them and exclude all others?
- What are the impacts of freedom-of-speech issues and censorship on information available to individuals and on the capacity of individuals, organizations, and so forth, to participate in public discourse?
- In what ways can a global information infrastructure help address the borderless problems of environmental degradation, overpopulation, and refugee movements?
- What are the effects of new information technologies—whether cellular telephones, satellite direct-broadcast television, or computer-mediated communication—on indigenous populations?
- How are the new telecommunications and computing technologies changing the nature of authority in public and private institutions?
- Are the face-to-face relationships of loyalty and authority breaking down? What is replacing them?
- What are the critical characteristics that determine whether, with the advent of this new technology, a group adapts and adopts or is overwhelmed by the technology? Can critical indicators be identified?

The complexity and dynamism of human and natural systems has become increasingly obvious to researchers in recent years. One of the implications of these features is the fair amount of futility involved in trying to describe systems in the static ways we have used in the past, on the assumption that we would then be able to make firm and accurate predictions. One direction, suggested by some researchers, is that future research should focus more on links or connections among systems than on the systems themselves (Uphoff, 1996). If this is in fact the direction taken, the role of ICTs, which have already shown their fantastic ability to link people, is likely to expand still further.

The use of system dynamics and other modeling techniques is also likely to grow—not in the sense that we can accurately model and therefore precisely predict but rather as a means for improved communication among participating modelers and for the development of potential future scenarios that participants can then consider when making tentative alternative plans for the future [Haggith, 2001; or the collection by Gunderson and Holling (2002)]. Two other key areas of research are in the field of institutions and organizations: how best to deploy agent-based technologies; and how best to participate in supply chains, both of products and knowledge.

Finally, ICTs and their conceptual and practical links to people's participation in a variety of new spheres seem to hold considerable promise for further research on practical issues like participatory action research, social learning and adaptive management, social capital, and communication networks. Such approaches have been used with communities and in formal organizations; but they also seem likely to be important in policymaking contexts.

10.8 Key Findings

The UN Millennium Declaration and MDGs provide a framework within which to evaluate the future effects of ICTs on society. Conflicts and security issues will hinder the meeting of these goals. Conflict related to population increase and pressure on natural resources will become an ever-increasing topic for ICT applications; alleviation of poverty and hunger will be major factors in the mitigation of these situations. Achieving the MDGs is hindered by many different forms of ICT-related divides: digital, democratic, gender, racial, knowledge, strategy, and nano. As the divides narrow in terms of available technologies, it is the required competencies and skills that may be more limiting in future (Ponz and Werquin, 2003). "Information literacy" is actively being pursued in educational curricula in developed countries. Failure to address this issue in developing countries will impede or negate potential benefits from introduction of ICTs. In the absence of information literacy, appropriate human intermediaries are essential interfaces between people, the technology, and information content.

Society and culture drive the adoption and use of ICTs and, in turn, are changed by their use. Ignoring social, cultural, and ethical considerations can result in a high probability of failure of development projects in general and ICT projects in particular. In developing countries, the communication component of ICTs may be the most significant aspect in the short run. New technologies require new social norms, new legislation and policy, and new institutions, but the new social forces take time to develop. Coevolution occurs: technologies shape society; society shapes, moderates, and redirects technology. ICT has different drivers and consequences for institutions such as businesses or organizations than for individuals. Globalization, outsourcing, and dematerialization are current features of the new information economy. Outsourcing should decrease in importance in the future. Many of the impacts of ICT on forestry are extensions of the case of society in general: those with access to such resources can increase their knowledge, both in terms of quantity and timeliness, although quality may be uncertain.

Development programs increasingly have a large ICT component: selection of an appropriate development paradigm is essential to guide the deployment of ICTs. Resolving the factors that currently contribute to the high failure rate of ICT projects and development programs will be essential in bridging the divides. That resolution will require an increased focus on ethical issues of ICT development, transfer, and use. Future successful ICT development projects will be well integrated into communities, have optimal use of existing infrastructure, and have adequate human intermediaries (support personnel) available. "Champions," a form of change agent from innovation diffusion theory, will be a key component of success. With regard to innovations, a key consideration running through many examples is that innovations often have functional interdependence and adoption is actually based on an innovation cluster (Wolcott *et al.*, 2001). Most innovations first appear in developed countries, which are also the first to integrate these innovations into ICT clusters. Developed countries are therefore the first to explore legislative and policy responses to the new technologies and are also the home base for many of the international organizations and development agencies whose initiatives have consequences for developing countries. It is worth noting that many of those working on ICT in the developed world are actually from developing countries: a "brain drain" that exacerbates the divides between these areas.

Identities are constructed through such interaction with others: people build their lives in small groups, with built-in personal histories, stories, and narratives (CRA, 1996). As stories, narratives, and histories start to include more and more ICT-related elements, these innovations should be increasingly compatible with people's lives and acceptance should increase, but the increased use may come at significant personal, social, or cultural costs, as explored in the vignettes.

Research questions regarding the impact of ICT on society are often sociological in nature. In all areas of research, development of appropriate indicators will be critical.

It is important to differentiate between planned outcomes, surprises, emergent effects, and unintended impacts of ICTs on society. Predicting not only the direction of ICT but also the future effects of ICT on society is a chimera. Failure to see the future and predicting a future that does not occur are both possible. This is not surprising in the light of some of the findings from complexity and chaos theory (cf., Gunderson and Holling, 2002), which suggest that accurate prediction in complex, dynamic systems—such as the human and natural-resource systems with which we are concerned—is in fact impossible. In spite of these difficulties, forecasting is still a valuable exercise, as it helps to build a shared understanding of our current knowledge and highlights those areas where our understanding fails to match observations.

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Chapter 11. ICT and International Governance

Ewald Rametsteiner, Tiina Vähänen, and Susan Braatz

11.1 Introduction and Objective

There is general agreement that ICT affects all sectors of society and the economy. Governments have played and continue to play a crucial role in this sphere through their investments in ICT research and development. They will also be influential in shaping the future of ICT—either in fostering or impeding its increasing application—through their national and international policies. Policies aimed at creating an enabling environment for the development and deployment of ICT at the domestic level need to address issues of trade, investment, industry development, and e-business. Many of these policies are necessarily connected to and have to be compatible with ICT arrangements in other countries, and many are negotiated among key international institutions through international agreements.

Governments are not only major players in shaping the future of ICT, they are also strongly affected by it in their efforts to coordinate the development, implementation, and review of agreed policies nationally and internationally. In fact, ICT has been one of the main drivers for major changes in the conduct of governments and in our understanding of the traditional nation state. Over the last decade, the development of a range of principles and mechanisms for "new modes of governance" in policymaking (for example, involving more stakeholders and increasing transparency) has benefited significantly from ICT. On the other hand, ICT tends to undermine the traditional sovereignty and security of the nation state, as ICT communication and transactions frequently transcend national borders. International agreements and international governance arrangements reflect both positive and negative influences in terms of the influence of governments on ICT development and the influence of ICT on the development of international governance.

The governance of the forest sector, through policies, initiatives, and other efforts to promote the sustainable management and use of all types of forests, is both affected by and will profit from ICT. ICT has considerably changed the number of organizations nowadays involved in international deliberations on forest matters [many nongovernmental organizations (NGOs) are now involved] and the way they interact. For example, ICT speeds up the exchange of documents and opinions prior to meetings. It has also made monitoring of forest resources and the flow of goods from forests, as well as the distribution of that information, much more widespread and accurate. ICT will further change international forest governance, a topic that will be taken up in the latter part of this chapter.

The label "governance" at the international level was developed quite recently as a response to the fact that, in an increasingly interdependent world, there are administrative and organizational problems that transcend the boundaries of national sovereignty (Rhodes, 1996). Governance in this context refers to the rules and procedures that states and other involved parties agree to use to order and regularize their treatment of a common issue. It does not mean the same thing as "government"; in fact, the term was chosen specifically to differentiate less binding forms of rule-setting processes and rule implementation from more binding ones. The Commission on Global Governance, composed of a number of influential individuals and funded through the United Nations and other sources, defines governance as "the sum of the many ways individuals and institutions, public and private, manage their common affairs. It is a continuing process through which conflicting or diverse interests may be accommodated and cooperative action may be taken. It includes formal institutions and regimes empowered to enforce compliance, as well as informal arrangements that people and institutions either have agreed to or perceive to be in their interest" (Commission on Global Governance, 1995).

Telecommunication probably started with the first public message sent by Samuel Morse in 1844. Twenty years later there were several regional conventions in place to facilitate interconnection of national networks; by 1865 the first International Telegraph Convention was signed in Paris by 20 founding members and the International Telegraph Union (ITU) was established. More than one hundred years and a multitude of further international agreements later, innovations in several key areas in ICT development, namely, the Internet, mobile telephony, geographic information systems (GIS), and multimedia, have sparked a new "digital revolution." These developments have reinvigorated debates on ICT-related international agreements. The digital revolution changes the ways businesses are conducted and how goods and services are produced. The rapid development of the Internet has led to the emergence and quick deployment of new services that have contributed de facto to the creation of a global economy in which networks of all kinds and networking have become the salient features. This requires new agreements regulating property rights, safety, coordination of standards, trade in goods and services, and other issues that are geared toward utilizing the full potential of these technologies.

However, the full promise of the new ICT and the Internet has not been realized. ICT poses a "digital challenge" to governments in terms of its proper use in policy and administrative practice and the proper regulation and governance of ICT at the national and international level. Contentious issues range from intellectual property rights to security and taxation. Another challenge is the mastery of opportunities that ICT provides in the field of e-governance on the international level.

A third area is the concern about the widening digital divide between developed and developing countries and regions. The term "digital divide" has been coined specifically to refer to the widening gulf between the haves and the have-nots in the world of information technology. The literature classifies different countries as innovators or leaders, adopters, and excluded or latecomers. However, there is an equally and possibly even more important dimension to the digital divide that essentially runs between rural and urban areas within countries. Although some observers are now suggesting that the ICT gap between countries is closing, the same cannot be said about access to ICT within countries, particularly developing countries (Sadowsky *et al.*, 2004).

The objective of this chapter is to review the effects on international governance of the digital revolution: the status quo, recent developments, and possible future outlooks, both in general and in particular for the forest sector. The chapter will focus on both Internet and ICT governance; it does not, however, aim to provide a comprehensive view of the latter. The focus will rather be on highlighting the key issues and priorities in these areas and their effects on some key aspects of governance.

11.2 International Governance of the Digital Revolution

There is general recognition that the growth and development of new communications technologies have created new policy challenges at both national and international levels and across sectors. Cybercrime, consumer protection, illegal and harmful content, privacy, copyright, trademark, and domain-name disputes are but a few examples. In each case, it is understood that concerted action at a level beyond the nation state is required if the desired ends are to be achieved. Broadly, three key policy layers can be identified at local and global levels: policymaking with regard to a) technology, b) infrastructure, and c) content/service (see *Figure 11.1*).

Technology policy includes the determining of technical standards and protocols. The coordination of technical standards globally is paramount within ICT policymaking to ensure compatibility and access worldwide. Standards are instruments for control, and standardization is a form of regulation as crucial as hierarchies and markets. The aim of infrastructure policy is to achieve interconnection and interoperability, ensuring open and universal access. Competition policy and essential facility rules are often the main policy tools used to ensure access and connectivity. The aims of policy in the areas of "content" and "services" are the broad issues of protection of minors, cybercrime, e-commerce and trust, security and privacy, copyright, trade, and local content creation.

The emergence of new ICT, especially the Internet and wireless networking technologies, has brought forward new issues with global scope. Internet governance, as part of the global ICT governance issue, has perhaps been the most heavily discussed in the last few years.

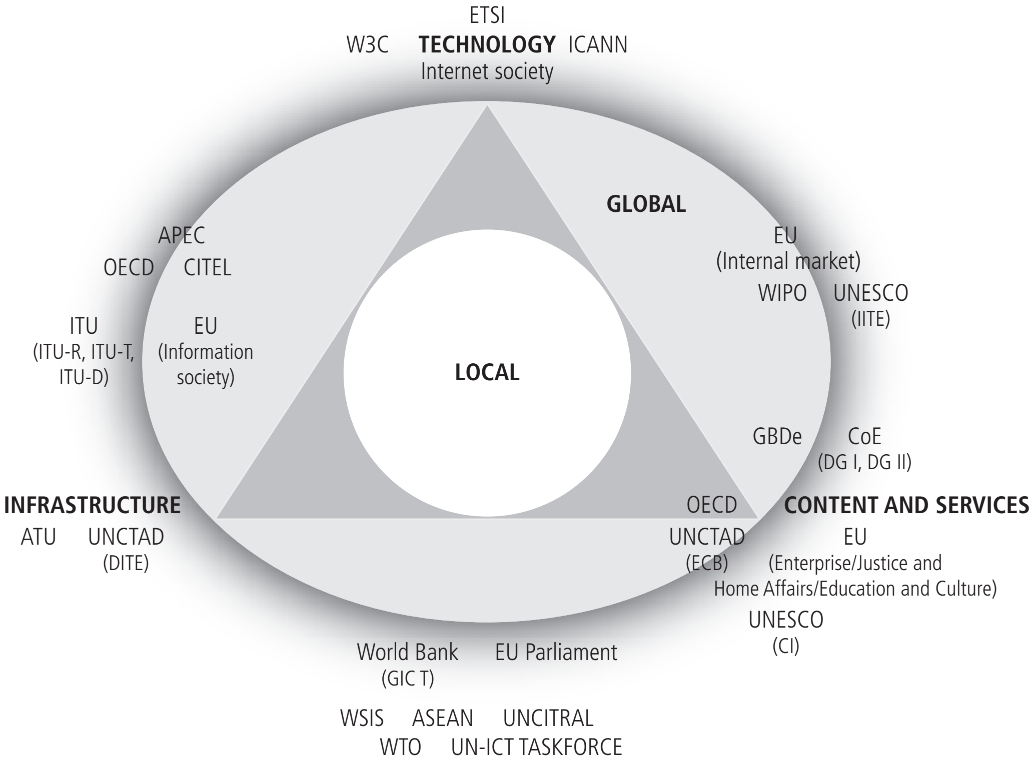

Figure 11.1. Key policy areas and main international players.
Source: Markle Foundation (2003).
Note: See Appendix for key to acronyms used in this table.

11.2.1 International ICT technology/infrastructure governance issues

ICT has long been quite firmly in the hands of state-backed organizations, such as the International Standards Organization (ISO) or the International Telecommunication Union (ITU). The ITU provided early international governance relating to infrastructure networks in the telecommunications sector. A Joint Technical Committee of the ISO and the International Electrotechnical Commission (IEC) is responsible for developing international standards for Information Technology. It is, in fact, the largest body within ISO. However, some ICTs, especially the Internet, have developed at a pace that has outstripped this type of government-backed standards negotiation. Internet specifications were not developed by government-backed standards bodies, leading governments to believe they could not control them very easily. Moreover, legislation in this sphere frequently becomes quickly outdated and incapable of dealing with Internet- or other ICT-regulation issues. The ITU, for instance, refused to recognize the Internet Protocol (IP) until the mid-1990s; the ISO formally backed the “Open Systems Interconnection” Protocol and refused to recognize the Transmission Control Protocol/Internet Protocol (TCP/IP).

Realizing the shortcomings of government-led interoperability standardization, many governments have increasingly supported the concept of self-regulatory approaches by the private sector and the industry, especially among governments of the Organization for Economic Co-operation and Development (OECD) (OECD, 1998). Many governments seem willing to let the Internet community manage its own technical affairs.

One key example highlighting the issues arising in international private self-governance is the Internet Corporation for Assigned Names and Numbers (ICANN), a private body created for the management and coordination of Internet names and numbers (see *Box 11.1*).

Box 11.1. ICANN

At the time of the creation of ICANN, there was a clear global need to establish some sort of entity that could support, manage, and coordinate the domain name system—or otherwise face chaos or the collapse of the network. ICANN was created and is supported by a national government, the United States (U.S.) Department of Commerce. The first ICANN board was chosen by its founder, then appointed by the U.S. government. However, the governance structure of ICANN quickly became one of the main issues, given both its nature and origin. To balance this, it was decided that approximately one-half of the board would be appointed via Internet voting. This procedure is a rare example of a global-level, bottom-up exercise in private-sector governance that made use, perhaps for the first time, of new ICT to involve a variety of stakeholders from many countries through e-voting.

ICANN has a Government Advisory Committee to represent the voice of nations, but this has no decision-making powers. Nonetheless, it is still under U.S. government control and has been facing a range of criticisms vis-à-vis the global governance principles of modern democracies (Sadowsky *et al.*, 2004).

In the eyes of many, the "experiment" of Internet governance carried out under ICANN has had mixed results. ICANN established rules, procedures, and related polices that successfully enabled the smooth operation of Internet space. But ICANN has met quite substantial criticism on some key global ICT-governance issues that are regarded as unresolved and open such as, among others, its legitimacy and accountability to the global community, the imbalance in the participation of developing countries, the true internationalization and legal independence of ICANN from any national government, its openness and transparency, and the vested business interests of powerful players.

While some think that ICANN should be replaced by another organization, preferably under the auspices of the United Nations, others feel that the whole system should stay "as is," as any change will disrupt the operation of the Internet and lead to instability ("It ain't broken, so why fix it?") (ESCWA, 2004). The bottom line of this discussion is whether higher efficiency should be more important than higher legitimacy or if a correction toward more legitimate arrangements is needed.

11.2.2 International content and service management issues

The list of issues related to content and service management issues in international ICT-related matters is long. The recent advance of the Internet and broadband technologies has again accentuated some of these issues.

Content issues may be among the most difficult. Among others, these include spam, illegal, hateful, politically objectionable, libelous, or culturally objectionable content. While it is recognized that different cultures and countries have different standards, there has been a worldwide commitment to freedom of expression. Article 19 of the Universal Declaration of Human Rights provides: "Everyone has the right to freedom of opinion and expression; this right includes freedom to hold opinions without interference and to seek, receive and impart information and ideas through any media and regardless of frontiers." In the past, content has been regulated physically. While Internet traffic is capable of being filtered, the process of filtering is increasingly much more complex because of the millions of sites and the ability of a site to add or change the address of potentially objectionable material.

Security is another major issue for governments in relation to ICT. The prospect that Internet users, including private individuals and governmental agencies, may hide their identities, coupled with the lack of central control of the Internet, its unaccountability, its ubiquity, and its rapidity in accessing and disseminating information represents a serious challenge to policymakers. Information systems critical to governments are presently susceptible to data interception, data interference (e.g., through viruses), system interference, illegal access, financial fraud, and spyware, among others. The traditional approaches of nation states to protecting and policing territory are simply becoming insufficient. Control is a fundamental trait of national sovereignty. Its erosion or loss, through ICT, seriously undermines the capacity of nations to manage their domestic affairs and changes the nature of international relations. International efforts by both private and public actors have dramatically intensified in such diverse fields as intrusion detection, protection through firewalls, encryption, antivirus measures, and biometrics.

Protection of intellectual property is crucial to many aspects of the Information Society, ranging from online e-commerce through IT-enabled outsourcing to software development. The Internet poses special challenges to the protection of intellectual property, especially as broadband services make transfer of large music and video files feasible. The three main branches of intellectual property law are copyright, trademark, and patents. There are more than two dozen international agreements concerning intellectual property. The World Intellectual Property Organization (WIPO) is an international organization under the umbrella of the United Nations (UN), tasked with administering international treaties and assisting governments, organizations, and the private sector with intellectual-property-related issues. Two of the crucial international treaties administered by this organization are the Copyright Treaty and the Performances and Phonograms Treaty, which came into force in 2002. Equally important is the Agreement on Trade-Related Aspects of Intellectual Property Rights, which nations must adopt in order to be part of the World Trade Organization (WTO). These set a minimum standard for intellectual property protection that all signatories must meet and are based on existing property rights conventions (Sadowsky *et al.*, 2004).

Privacy issues are a further concern to governments. Privacy is also widely recognized as a human right. Yet this right is increasingly difficult to enforce, as communication through ICT and data stored on ICT devices can be scanned and read by third persons much more easily and quickly than data stored in paper files. For instance, it is reported that the U.S. National Security Agency, through its Echelon network of stations, can read virtually any global communication transmitted via ICT. In the commercial world, the increasingly widespread use of Radio Frequency Identification Devices (RFIDs) in retailing makes it easier and easier for virtually anyone to identify exactly which products were bought by which consumers—and where such products are located. Some international organizations have developed guidelines or rules that set forth a consistent set of basic consumer privacy protections. The OECD elaborated Guidelines on the Protection of Privacy and Transborder Flows of Personal Data in 1980 and has continued to provide guidance on the issue. The European Union (EU) issued a Data Protection Directive in 1995. Both have had an impact far beyond Europe (Sadowsky *et al.*, 2004).

As commerce moved to the Internet, legal questions arose as to the validity and enforceability of contracts entered into by electronic means. Over time, many legal systems have given special significance to signatures as an expression of intent to be bound by a contract. The United Nations Commission on International Trade Law has addressed these issues, developing model laws on Electronic Commerce and Electronic Signatures and a model law on International Credit Transfers (Sadowsky *et al.*, 2004). The Bank for International Settlements has promulgated a set of Core Principles for Systematically Important Payment Systems. The EU has an extensive body of rules and procedures on electronic funds transfers, including a directive on electronic money institutions. As security and trust issues are the most important obstacle to the development of the Internet as a major trading and property-rights exchange platform for business, this area will be of key interest in developing internationally robust technical and legal governance solutions.

E-commerce will flourish only if legal systems enforce both commercial and consumer contracts. Special protections are warranted in the case of consumers. For example, the protection of consumers includes laws prohibiting misleading advertisements, regulating consumer financial services and consumer credit, and liability for defective products across national jurisdictions. International bodies that have developed models on the protection of consumers with respect to distance contracts and e-commerce include the European Union and the OECD. A related issue of interest to governments is the taxation of electronic commerce that crosses national borders. Key principles on taxation of e-commerce were agreed at the OECD Ministerial Conference in Ottawa in 1998.

While the spread of ICT across the globe has been one of the most prominent features of globalization, discussions in the WTO have been limited to electronic commerce and whether to impose customs duties on electronic transmissions over the Internet. At the same time, the use of ICT and the Internet by enterprises has impacted the way global business is carried out; it has created new dynamics in international trade and export competitiveness and in business process outsourcing based on the use of Internet and ICT. ICT is growing rapidly in many countries, creating new export and employment opportunities. To fully grasp the potential of ICT for trade and export competitiveness, governments are asked to put in place an environment favorable to the development of IT-enabled services. A number of multilateral trade agreements are of relevance to the deployment and growth of ICT. They include the WTO Agreement on Basic Telecommunications Services, the moratorium on electronic commerce, the Information Technology Agreement for ICT goods, the General Agreement on Trade of Services for ICT services and the electronic delivery of services, as well as the General Agreement on Tariffs and Trade (GATT) for digitized products. While ICT goods are subject to import liberalization according to WTO rules, ICT services so far are not. For developing countries to increase their export of services by taking advantage of the new technologies and e-commerce, open markets are required in the developed countries that are potential importers of these services. WTO negotiations on trade in services will be one area of key future negotiations spurred by developments in ICT.

11.2.3 A UN-based world platform for coordination and development: WSIS

Much of the past and future work on legislative and regulatory initiatives on the global and regional levels related to ICT were highlighted and discussed in the context of the World Summit on the Information Society (WSIS), held in Geneva in 2003. At the WSIS, representatives of 175 states adopted the Declaration of Principles on Building the Information Society: a global challenge in the new Millennium, as well as a Plan of Action. In addition, WSIS decided to establish a Working Group on Internet Governance. The Declaration of Principles adopted at WSIS, Geneva, in 2003 recognizes that governments, as well as the private sector, civil society, and the United Nations and other international organizations have an important role and responsibility in the development of the Information Society and, as appropriate, in decision-making processes.

The Plan of Action reiterates that international and regional institutions, including international financial institutions, have a role in integrating the use of ICT into the development process and making available necessary resources for building the Information Society and evaluating the progress made. It states as a goal that, by 2005, relevant international organizations and financial institutions should develop their own strategies for the use of ICT for sustainable development. The Plan of Action outlines a range of “action lines” that draw attention to areas of importance or concern in the international context and thus to international agreements with regard to ICT (see *Table 11.1*).

Under action line 11 on international and regional cooperation, the Plan of Action calls for international cooperation in the implementation of the action plan, inter alia, by providing means of implementation and by raising the relative priority of ICT projects in requests for international cooperation and assistance on infrastructure development projects from developed countries and international financial organizations. The plan also calls for public–private partnerships focusing on the use of ICT in development to be built on and accelerated within the context of the UN’s Global Compact and in pursuance of the United Nations Millennium Declaration. It also invites international and regional organizations to mainstream ICT in their work programs and to provide assistance to developing countries so that they too can be involved in the preparation and implementation of their own national action plans.

The issue of governance mechanisms for the ICT sector was one of the more contentious before and at the World Summit, partly because of the widely differing viewpoints of specific sectors, individual countries, and groups of countries. Some recommend a new governance structure with heavy involvement both from government and an intergovernmental body such as the ITU to coordinate governance of the Internet internationally. Others insist that little or nothing is “broken” about the present structure, which is extensively private-industry-centered under ICANN. Others want to escalate Internet matters to a government and intergovernmental level in the hope of tackling “digital divide questions,” thus ensuring more influence for less-advanced nations at any international Internet governance table (Kummer, 2004). The uniqueness of Internet development, characterized not only by the extraordinary rapidity and success of its diffusion but also by its governance arrangements, is a unique new challenge for UN-based governing processes. The existing governance structures of the Internet were both questioned and defended at the Summit, and consensus was reached only on the fact of the issue being relevant. The Summit decided to set up a Working Group on Internet Governance tasked “to investigate and make proposals for action, as appropriate, on the governance of the Internet.”

Table 11.1: WSIS 2003 Plan of Action: Topics of action lines.

1) The promotion of ICT for development
2) The development of ICT infrastructure
3) ICT and access to information and knowledge
4) The need for capacity building with regard to ICT
5) The building of confidence and security in the use of ICT
6) The creation of an enabling (trustworthy, transparent, nondiscriminatory, legal, regulatory, and policy) environment
7) ICT benefits in all aspects of life (e-government, e-business, e-learning, e-health, e-employment, e-environment, e-agriculture, e-science)
8) Cultural diversity and identity, linguistic diversity, and local content
9) Media (as an important player and contributor to freedom of expression and plurality of information)
10) Ethical dimension of the Information Society
11) International and regional cooperation

11.2.4 The future of international ICT governance

The 2003 World Summit on the Information Society opened a new era of international ICT governance, especially of the Internet, by establishing a UN-based platform for negotiation and exchange on international governance. Two main schools of thought manifested themselves in the WSIS negotiations: that calling for multilateral cooperation within the UN framework, possibly with a UN body or intergovernmental/international organization assuming a key role on Internet governance issues; and that happy with the status quo.

WSIS can be seen as a success by those governments and organizations that see the existing private-based governance structures as inadequate in terms of their legitimacy, transparency, equal access of different groups and countries to them, impartiality (not vested private-business interest), and accountability. In fact, these areas are key components of standards for modern democracies and are promoted as key pillars of good governance. By recognizing some important principles, the Geneva Declaration laid the conceptual groundwork for any future form of Internet governance and set some valid benchmarks for the work ahead. These are based on some of the traditional principles of international cooperation, such as transparency and democracy. They also introduce some Internet-specific aspects, such as the recognition that the Internet is, by now, a global facility. Furthermore, they recognize the multistakeholder character of the Internet.

One important function of the state and of international arrangements is the support of wide public access to technology and the promotion of its wide adoption. What needs to be underlined as a lesson for future governance is that technical and technological change does not necessarily change civil society and policy institutions nearly as much or as quickly—on either an international or national level. Forecasts of a global, open, and transparent world, enabled by ICT and governed by private institutions, are therefore unrealistic. The true surprise is not likely to be the change that the use of ICT brings but the robustness of social and institutional structures when challenged by such new opportunities.

Social or organizational change is much slower than ICT change, but the long-term social and political implications of technical changes are profound. Those governments now questioning some of the current private-sector-led arrangements of the Internet are addressing core issues of legitimacy and democratic accountability. Nonetheless, it seems that many countries have yet to fully learn the lesson of how profoundly governance philosophies are changing and that network arrangements between public and private institutions will possibly be the standard model in the near future. In other countries that are more concerned with—or, in fact, benefiting from—the efficiency and workability of current arrangements, sensitivity about the importance of legitimacy and the overall democratic responsibility of international arrangements may have been sharpened as a result of the events of recent years.

Currently, the concept of national sovereignty is changing to allow for more complex arrangements. Public–private partnership concepts imply the transfer of public powers into the hands of private actors. However, something that has so far not always worked out well is the simultaneous imposition of the obligations of due process, oversight, and accountability that are the hallmarks of modern governments. What seems to be emerging is a confluence of two different standard models of governance arrangements—one that is purely governmental and the other that is composed of largely or purely private institutions—into a functionally differentiated model of governance. Governments, as repositories of legitimacy and as democratically accountable entities, are ultimately responsible, while private institutions are often supposed to work and manage more efficiently. However, to make this model of legitimate AND efficient international governance operable, all parties involved have considerable work ahead. In a recent analysis Dingwerth (2003) attests that to date global governance has lacked a clear and coherent concept of democratic governance beyond the nation state.

Overall, the emergence of ICT and the globalization that it drives have had quite a profound effect on a number of international governance networks and on the arrangements needed to coordinate the increasing complexity of the management and coordination of ICT-related issues. The rise of ICT has brought with it a rise in institutions for coordination, rule setting, and enforcement in relation to ICT. They thus make none of the existing international architectures obsolete. On the contrary, they add another dimension in international governance in a wide range of forums. While a new balance between public and private institutions is emerging in relation to technology and infrastructure, content and service issues are likely to be governed through new or better international agreements on some key issues—above all, on security issues.

11.3 ICT Effects on International Governance

11.3.1 ICT changes, structures, and modalities of international governance

The last decades have seen a rise in global governance institutions, for example, UN bodies, international nongovernmental organizations, and technical standardization bodies. The most important change resulted from the emergence of private transnational governance institutions as new key players in global environmental politics. This phenomenon, known as the "institutionalization of private governance," "governance without government," or private governance "in the shadow of the hierarchy," is also becoming more and more institutionalized at the international level. The emergence of private authority has increasingly become a feature of international governance over a wide range of issues. One of the enablers in some issues and the driving force in others has been ICT, either through improved methods, reduced costs, or the pressing need for international coordination. As outlined in the previous chapter, ICT developments have created an existing governance gap on the international level, resulting from transboundary problems and the diminished capacity on the part of the state to cope with these challenges. This creates a demand for private institutions to fill this functional gap. In many cases, their role is to reduce transaction costs and provide information; in others, they enhance the capacity of some institutions to exercise authority over others.

Research, however, has thus far hardly addressed the effects of ICT on international governance. It is largely unclear how ICT has affected and will change structures and characteristics of international governance, including the density of networks. Because of its nonterritorial logic, ICT impacts on the traditional concept of governmental territorial sovereignty, but it is unclear how. Nor are the effects clear as to how ICT impacts on the number and role of different actors in international governance—governments, interest groups, international organizations—or how power relations change. Woodley (2001), studying the impact of a range of transformative technologies on governance over the last centuries, observes that long-term shifts of power do occur but that existing power structures seem to cope fairly well.

ICT seems to have been highly influential in creating the technical means to reorganize or reengineer national and international governance toward a more network-based development in international policy. Different bodies, including the OECD and the EU, have developed principles of good governance with which changing governments arrangements can be compared. In the following, a range of key aspects of governance are listed, and the role of ICT is indicated.

ICTs are indispensable for conducting a more transparent and open policy, in facilitating the participation of a larger group of stakeholders in international policy deliberations, in higher accountability, and in turn, possibly, for more-effective international policymaking. In some of these areas, the full potential of ICT has not to date been mobilized, especially for enhancing the effectiveness and coherence of different policies. If a government is not open, the Internet will challenge the regime's commitment to restricting information flows because it offers a cheap and easy way for organizations and individuals to circulate information that governors have previously kept within narrow circles. It allows the formation of international advocacy networks and communities that rally behind common causes and that can be very effective in building up political pressure directly and through other governments. Illegal logging is one case in point.

At the UN Millennium Summit in 2000, countries adopted a set of eight independent goals to be achieved globally by 2015. These Millennium Development Goals (MDGs) serve as useful benchmarks and provide a meaningful framework for assessing progress toward human development in the areas of the most urgent priority for developing nations. ICT plays a role in helping progression toward practically all those goals. As regards the goal of eradicating poverty, ICT has given rise to both optimism and pessimism. The use of ICT can give a boost to income and productivity as well as to consumer comforts and the promise of further economic expansion. On the other hand, access to this asset is distributed even more unequally than others because of the unevenness in the availability and quality of infrastructure, language barriers, obstacles to training and capacity building, relevance, and ways of profiting from ICT.

The links between ICT and education have been the source of a growing body of literature. As a social interaction that requires the communication of information and knowledge, education has obvious natural synergies with ICT. ICT increases the effectiveness of education process through cheaper and better multimedia and interactive tools. The potential for gender empowerment through ICT is also important. The argument for leveraging ICT to pursue environmental sustainability is the same as for other MDGs. ICT accords information and knowledge, speed, critical paths, and flexibility that other media do not. One MDG seeks to foster international systems that are generally more sensitized to and supportive of the needs of developing countries. It calls for developing "a global partnership for development." The indicators used are purely ICT-related—telephone lines and cellular subscribers, personal computers in use, and Internet users.

11.3.2 The emergence of e-governance on the international level

E-governance is a relatively new term. Basically, it is the extension of e-government to the world of governance. E-government can be defined as the application of ICT to transform the efficiency, effectiveness, transparency, and accountability of informational and transactional exchanges within governments, between governments and government agencies at federal, municipal, and local levels, between citizens and businesses, and to empower citizens through access and use of information (World Bank definition). E-government has emerged as one of the principal tools by which international bodies and national administrations can improve their administrative arrangements both internally, for improved efficiency and effectiveness, and externally, for improved relations with stakeholders. A range of international organizations, including the OECD, have started initiatives to promote e-government at the national and international level.

How ICT is used in governance can be detected by the degree of interaction between two parties—from one-way provision of information to full transactions—and by the complexity of ICT applications—from e-assistance to e-democracy. E-assistance should support general aspects of daily life, such as general information on opening hours. E-administration should support internal and external administrative interaction. E-democracy should support democratic communication, participation, and interaction, as well as legal procedures in democratic elections (e-voting) (see *Figure 11.2*).

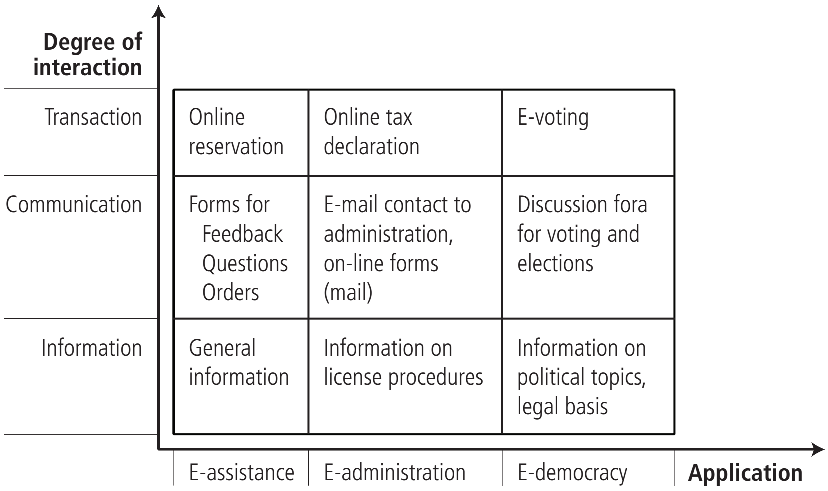

Figure 11.2. Components of e-governance.
Source: Brücher and Gisler (2002).

E-governance and e-government bring with them a wide range of changes with the potential to improve the efficiency and equity of governance. Making such information as that connected with government contracts or grant programs more easily available could foster greater equity and efficiency in government purchasing and in the distribution of public resources. E-mails and other Internet facilities can greatly speed the flow of information within and among governments, once all parties are equally able to work with these systems. Likewise, the introduction of the Internet is increasing the quantity and velocity of political information in circulation. However, greater information flows do not increase the time available for processing information. As democratic dialog is all about expressing conflicting opinions regarding what governments ought to do, increasing information flows provide inputs into the political debate by increasingly differentiated interested parties and will increase the range of conflicting views. Political decision makers need to reconcile competing demands on government, and they may find it more difficult to do so because of the greater number of conflicting views. Participation in e-democracy is likely to be received and used differently by different user groups, creating a playing field that is biased in favor of those who are adept enough and sufficiently equipped to take advantage of the opportunities created through e-governance initiatives.

What is technically possible may not be organizationally feasible or socially or politically desirable. These three domains are shaped by considerably different realities. While technological possibilities progress with increasing speed, their uptake by organizations is often very slow, even in technologically and economically advanced societies. Despite the increasing speed of adoption of new technologies and the increasingly steep learning curves in the last decades, a host of barriers impede the widespread and equal adoption of these technologies worldwide. Nontechnical barriers include difficulties in organizational cooperation, legal issues, lack of funding or of political support, skill and knowledge deficits, risk aversion, suspicion, privacy concerns, social exclusion, and structural and cultural barriers. Matching technological possibilities with political, organizational, and human realities is thus an important future step. Some of the key areas where future development is needed are listed in *Table 11.2.*

Table 11.2. Contribution of ICT to promoting good governance principles.

1)	Openness and transparency	ICT is key to making information on decision-making processes and procedural rules more freely and widely available
2)	Participation	ICT contributes to wider and more intensive participation and decentralized decision making
3)	Accountability	ICT facilitates data collection and report compilation and dissemination to concerned stakeholders and the wider public. ICT allows improved dissemination of information on violations of commitments and thus provides one of the checks and balances in terms of policy conduct
4)	Effectiveness and efficiency	ICT enables better and faster compilation of data on the efficiency of policy conduct and effectiveness of policy measures; this can be fed back into policy processes and thus enhance the responsiveness of policies
5)	Coherence	ICT provides the technical means for interaction between policymaking communities and the dissemination of information on policies and decisions

Most of the research currently conducted to support governments' application of ICT is focused on technology. However, given the complexity of the environment, the need for government applications to work well in a variety of settings, and the interdependence of many players, technology research alone is insufficient. Other powerful factors shape the ability of a government to adopt and use IT effectively, including the degree to which individuals accept new technologies and the manner in which they learn them and adapt to them. Recent studies about the success of information systems in organizations suggest that more than 80% fail to achieve their objectives or to be implemented at all. The main reason for failure is the lack of involvement by system users in the design and deployment of the systems. Lack of attention to user needs and preferences is a common weakness in the design and deployment of advanced technology (Dawes *et al.*, 1999). Just as human factors circumscribe the use of new technology, organizational design and behavior also figure prominently in the adoption and use of new technology. This process of organizational change is especially difficult in the public sector, as it is bound by civil-service systems, one-year budgetary cycles, and fixed rules and procedures.

Nonetheless, governance systems will gradually adapt to the technical realities that already exist, including networked forms of organizations, the sheer limitlessness of available information, rapid and pervasive broadcasting, and decentralized decision making.

11.4 ICT and Future International Forest Governance

11.4.1 ICT influence on international forest-governance arrangements

ICT has influenced and will profoundly influence international forest-governance arrangements. Many more actors and organizations are involved in global and international forest governance today than in the past. These actors interact on the basis of a vastly increased number of formal and informal arrangements and agreements on forest-related issues. ICT has been influential in this development in a multitude of ways, usually rather invisibly and indirectly.

It is mainly through the use of ICT that the many actors form policy networks of different kinds on a multitude of specific forest-related topics. Nowadays, parties and advocacy coalitions exchange information, opinions, and background material through ICT with increasing speed and mobilize influential groups by ever-more-sophisticated means. The enhanced means of communication and information exchange makes it increasingly easy for a growing group of stakeholders to create international governance or advocacy networks and structures. One example of a private international governance infrastructure that was created by environmental NGOs is forest certification, the first system for which was devised by the Forest Stewardship Council (see *Box 11.2*).

Box 11.2. The Forest Stewardship Council (FSC)

The FSC is an independent, not-for-profit, nongovernmental organization created by a group of private organizations, partly out of frustration over the inability of governments to effectively counter tropical deforestation. The aim of the founders of FSC was to establish a credible system for identifying well-managed forests as acceptable sources of forest products. Founded in 1993, it sparked the development of an influential new international governance infrastructure: forest certification. The speed at which the topic of forest certification became a global issue and globally active private institutions were established—less than five years—is a result *inter alia* of the ability to network and communicate more freely, quickly, and effectively. Moreover, the cost of establishing and maintaining communication among the different bodies involved and with the public has been reduced by ICT to an affordable level. FSC is a prime example of a nongovernmental forest-governance infrastructure on national and international levels that would have been far more difficult to establish without ICT.

It can be expected that the number of internationally active multiactor networks and governance arrangements will further increase and, with it, the need for coordination and communication among those networks. The technical possibilities that ICTs provide and the degree of standardization for exchange between different technical systems will be an important determining factor in the number of actors and the complexity of their interaction.

International forest governance is dominated by governmental bodies and formal agreements among them. Forest-related international (multilateral) agreements among governments fall into two broad categories: multilateral environmental agreements (the majority) and multilateral trade and development agreements (the minority). The first multilateral treaty on an environmental issue was agreed in 1868 (Convention on the Rhine). The United Nations Environment Programme (UNEP) has estimated that since then the number has risen to at least 502 international treaties and other agreements relating to the environment, of which 323 are regional (UNEP, 2001). Over 60% of these 502 agreements have been adopted since the early 1970s (see *Figure 11.3*).

There are a number of legally binding international instruments at the global level that include articles and decisions addressing various aspects of forests or forest resources. These include the Convention on Biological Diversity, the UN Framework Convention on Climate Change and its Kyoto Protocol, the UN Convention to Combat Desertification, and the International Tropical Timber Agreement, to name a few. As international deliberations to establish a forest convention failed in the early 1990s, international deliberation and exchange on the sustainable development and management of forests was carried forward by the Intergovernmental Panel on Forests and the Intergovernmental Forum on Forests, and since 2000 by the United Nations Forum on Forests (UNFF). International governance in forest matters is conducted by the member states that are party to the international agreements; international organizations, such as the Food and Agriculture Organization (FAO), as well as private bodies and NGOs, including lobbying groups and international associations representing forest research, business interests, environmental concerns, or social issues.

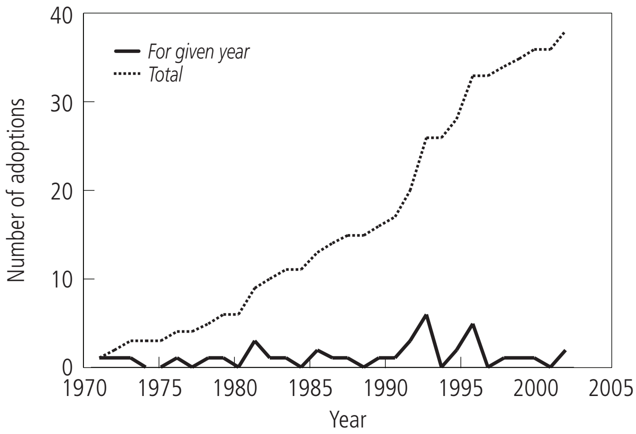

Figure 11.3. Core environmental conventions and related agreements of global significance—Number of adoptions 1971–2001.
Source: UNEP (2001).

In the future, the number of actors and agreements is quite likely to expand further, adding to the sense of congestion felt at times in international policy dialog on forest issues. At the same time, however, this "thickening" of the international governance infrastructure also enhances the influence of international arrangements on the national and subnational levels—and always very efficiently.

11.4.2 ICT changing markets, trade, and consumption: Implications for forest governance

The impact of ICT on consumption patterns for forest products has been an issue of great interest for a long time, especially on the future use and consumption of paper products. The possible impacts of ICT have been most clearly identified and are perhaps most significant for these products. The future prospect of a "paperless office" has already been foreseen for decades (see Chapter 2), even though paper consumption has been constantly on the rise. While the evidence points to ICT developments not having had the effects commonly foreseen by analysts, namely a reduction in paper consumption, the dramatic influence of ICT developments on how information is accessed remains. For instance, access to news, magazines, and books via the Web is still increasing. In December 2004, for example, Google Inc. announced a joint project with a range of important university libraries to digitize around 15 million books and make them available via the Web.

The increasingly easy access to information via the Web tends to increase the number of people downloading and printing information out on to paper. Technology aimed at helping consumers handle this information more conveniently than through the medium of paper could have a dramatic effect on paper consumption. For instance, the ICT industry is continuing to develop electronic paper (e-paper). Electronic paper aims to display electronic text on thin, flexible sheets that look and feel like paper and could be bound together into book or newspaper form. Using wireless technology, content could be downloaded instantly on to the electronic pages. The e-book market, although still very tiny, has changed course and is the strongest-growing segment in the rather static publishing world (Glazer, 2004).

If ICT devices that provide a viable and practical alternative to handling and storing information become more widely available and accepted, governments may play a crucial role in dramatically increasing their use, as long as these technologies are considered more environmentally friendly in terms of resource and energy use. Governments have considerable purchasing power as consumers and users of such devices in administration and have committed themselves to taking a leading role in development toward a sustainable society. Such a development would have quite an impact on the quantity of paper consumption and would support the further improvement of these new technologies for broader use.

While incentive-driven policies are more likely to be used by governments to achieve sustainable development goals, the case for better legal protection of forests and the environment will also be raised by NGOs and governments, as environmentally superior technology increasingly becomes available. This is particularly likely if the drive for fast-growing plantations, commonly used for pulp and paper production, leads to widely visible environmental and social damage.

Depending on the future availability of forest resources for production purposes, the shift of production capacity and consumption, and related trade patterns, governments will be under further pressure to govern the sustainable development of forest resources and their use in an acceptable way.

11.4.3 ICT in support of good governance principles in forest governance

ICT facilitates more transparent and open policymaking related to forests by encouraging the participation of a larger group of stakeholders in international policy deliberations, thereby increasing accountability and, in turn, possibly increasing the relevance and effectiveness of international policies. Although the full potential of ICT has yet to be realized, ICT has contributed significantly to international forest governance in the ways outlined below.

a) Openness and Transparency

The use of ICT has contributed to a substantial improvement in the transparency of international policymaking compared with only a decade ago. Online bulletins and Web logs allow an almost-immediate stream of information from international meetings, including pictures, videos, and sound files. Web logs allow all interested parties to create or participate in Internet-based discussion forums on current events.

There are two types of information that participants need: 1) about the process, and 2) about the issue being discussed. It is fundamental that the rules of the game (i.e., the rules and procedures) of the international policy process are open and transparent. Information about the issue keeps the public or stakeholder group up-to-date on what the deliberations are about and what the possible outcomes might be. It is vital that the information is of good quality: complete, accurate, up-to-date, easy to understand, and accessible. ICT has been instrumental in the compiling and disseminating of such information. One important example is the Earth Negotiations Bulletin (see *Box 11.3*).

Box 11.3. Earth Negotiations Bulletin (see http://www. iisd.ca/ enbvol/enb-background.htm)

The Earth Negotiations Bulletin (ENB) began as a joint initiative of individuals from the NGO community who were participating in the preparations for the United Nations Conference on Environment and Development (UNCED). Following the conclusion of UNCED the International Institute for Sustainable Development (IISD) approached the founders with an offer to continue publishing the Bulletin.

The Bulletin is distributed each day to report on the progress of UN negotiations related to environment and development. In the ten years that IISD has published the ENB, electronic mail and the World Wide Web have changed the way that information is gathered and exchanged. Computer-mediated communications and derivative products have expanded the readership of the Earth Negotiations Bulletin to an estimated 35,000 people worldwide.

Transparency is also a key ingredient of responsible government behavior. For example, speaking of Latin America, Kaufmann and Kraay (2002) note that evidence casts doubt on the traditional public-sector-management approach to actions against corruption, which tend to focus uniformly on issues of pay and internal monitoring and supervision. The evidence points rather to the importance of open access to information and effective third-party monitoring in reducing corruption, improving governance, and mitigating state capture (inter alia, through providing public-service users with a voice). ICT is and will continue to be a key tool in ensuring and increasing open access to information. This information-based approach is taken and used effectively by Transparency International (TI), an international nongovernmental organization devoted to combating corruption. TI analyzes, diagnoses, and fights corruption, for example, by measuring its occurrence through surveys and indices and by other research. In its Global Corruption Barometer 2004, Transparency International (2004) reports that the public from 64 countries considers political parties and parliament/legislature to be the most corrupt institutions, well ahead of business and the private sector.

b) Participation in International Policy Deliberation and ICT

ICT has proved to be an extremely effective way of connecting like-minded persons within a region or around the world to rally for a cause. These networked subgroups consist of societies that share a number of common characteristics and where social cooperation bears significantly lower transaction costs within the groups than among them. Lobby groups, such as environmental NGOs, have used ICT very effectively to get their specific issues put on the global agenda, build up political pressure for their causes, and monitor compliance with commitments made.

Over the last two decades, governments have increasingly allowed NGOs to participate in international negotiations. For example, in 1946, there were only four NGOs accredited to the UN Economic and Social Council. By 1992 this had grown to 928, and by the end of 2000 to over 1900 (Dodds, 2001) (see *Figure 11.4* for the period 1946–1998). Public participation, as a principle of good governance, was formally introduced in international agreements in 1992. Principle 10 of the Rio Declaration 1992 states that public access to information, participation in decision making, and access to justice are key principles of environmental governance. Principle 10 stresses the need for citizen participation in environmental issues and for access to environmental information held by public authorities. Increasingly, while maintaining their advocacy role, NGOs espouse UN themes, assisting in implementing plans of action and monitoring programs and declarations adopted by UN member states.

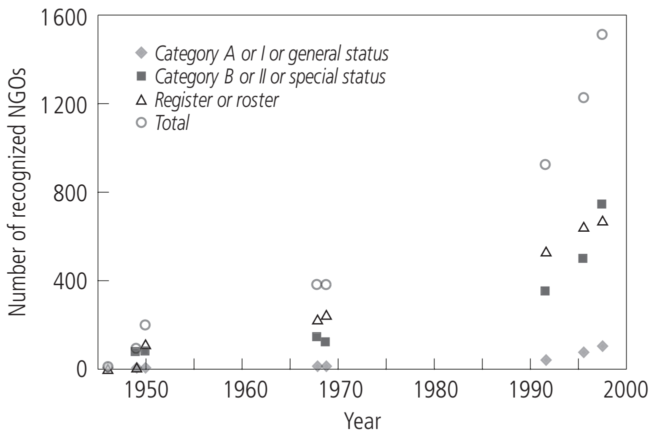

Figure 11.4. Number of NGOs recognized by the United Nations Economic and Social Council, 1946–1998.
Source: Dodds (2001).

While this development resulted from changing policymaking principles at the international and national level, it was also facilitated by the rise of ICT and its broad application. Thanks to ICT, an abundance of information on the procedures to be followed in deliberations, the status of discussions, and the technical means to participate in them is now available, and it is increasingly possible to make one's voice heard. Further development of procedural standardizations would help solicit a wide range of submissions electronically; these could be analyzed electronically and the results channeled to negotiators for their consideration. Similarly, e-voting or online opinion polling could become a more widespread means of taking the wider public's views into account. While the technical means for this already exist, grave concerns still prevail as to the security and trustworthiness of such procedures and their results.

Easier access for a diverse range of stakeholder groups to international policy deliberations has broadened, and this has been beneficial in many respects. This is true also of non-UN institutions concerned with policy, such as the Ministerial Conference on the Protection of Forests in Europe (MCPFE). Many governments have gone through or are undergoing a change from old-style governance (i.e., regulatory, top-down, uniform) to newer modes of governance and policymaking (i.e., more open, consultative, and flexible). While this could have been possible, although more difficult, without ICT, the availability of relevant and up-to-date information has greatly facilitated the involvement of those who want to participate.

The possession and use of information technology to one's advantage is a key competitive asset in international forest governance. For example, ICT is a very effective means of lobbying and putting political pressure on decision makers. A case in point is the issue of "illegal logging." Illegal logging was hardly ever mentioned in international governmental negotiations until the late 1990s. Two years later it was one of the hottest political issues. Several factors were behind its rapid rise on the international governance agenda, but one was undoubtedly interest groups' sophisticated use of ICT and effective information provision to both the broader public and decision makers.

Predictions that ICT technology, such as videoconferencing and virtual meeting rooms, would replace physical meetings have not materialized to the extent foreseen. Electronic communications alone, without face-to-face meetings, are poor vehicles for debate and discussion. Without adequate face-to-face contact, participants do not grow in mutual respect. Moreover, the nature of electronic communication amplifies small differences and makes compromise difficult. Face-to-face interaction is time-consuming and expensive but must occur from time to time, especially in international governance arenas, where the perceptions and objectives of the various stakeholders may be widely divergent. ICT will therefore not be able to replace international meetings completely. The role of ICT lies in complementing, rather than replacing, direct, face-to-face interactions in policymaking processes. Interaction in-between meetings through the use of ICT is also useful for laying the groundwork for more efficient and effective meetings.

Relevant and up-to-date information is vital for effective participation, which in turn is vital for democracy. Well-designed ICT-based support services for effective information transfer are crucial for the effective participation of both governments and nongovernmental stakeholders in international policy deliberations and the subsequent implementation of international agreements. The technical challenge in terms of ICT and data management for assisting in participatory processes is the development of expert systems and decision support systems in close cooperation with well-defined user groups so that specific and concrete issues can be discussed in ongoing international policy deliberations. What is important here, however, is not so much the development of the technical components but a better understanding of the actual needs of key information users.

c) Accountability

Accountability in international governance means that individual institutions that are part of the governance arrangements take the responsibility for an activity—or some inactivity—despite commitments made previously. Accountability is judged *ex post* (in contrast with transparency, which allows judgments before or during action). This judgment crucially depends on the availability and quality of data and other forms of information. The forest-related information reported by countries to international instruments and organizations falls into two broad categories: 1) actions taken to implement international commitments and situation, and 2) trends in ecological, social, and economic aspects of forests.

ICT plays an important role in monitoring, assessing, and reporting on the implementation of international commitments and thus in the accountability of governments regarding their international commitments. The most relevant international conventions and agreements related to forests request follow-up reporting on the implementation of commitments taken by signatory countries. The periodicity and content of national reports to be submitted to the various processes vary considerably (see Braatz, 2001 and 2002). Currently, reporting on measures taken to implement commitments under the instrument consists mainly of qualitative or descriptive information on activities and means of implementation, such as policy, legislative, or institutional measures. In a few cases, however, biophysical and socioeconomic data on forest resources or resource use is required, usually in quantitative form. Most instruments also have provisions for information collection, analysis, and exchange, and for monitoring and assessment of information. In recognition of the need for quantitative data to assess the impact of the measures taken, many of the instruments are working to develop impact indicators. So far, it is primarily governments and international governmental organizations that are held accountable by the public. Given the increasing role and participation of nongovernmental organizations in more complex international forest-governance arrangements today and in the future, more calls for these organizations to be more open and accountable to the public are likely.

It is important to recognize that monitoring, assessment, and reporting is not an end in itself but intended to improve planning and decision making. However, concern has been widely expressed about the proliferation of requests for national reports on forests and whether the information is fully used. Each of the forest-related conventions and processes has, in the recent past, highlighted the need to streamline requirements in order to make data and information more easily and widely available. Questions have also been raised as to whether the information provided is indeed used effectively. The secretariats of the conventions and other processes need to compile and use country information as an integral part of the progress reports they prepare for their governing bodies (e.g., UNFF). However, the flow of information between countries and secretariats seems to be more active than among the countries themselves. Different UN bodies have taken initiatives to address the situation, especially in streamlining reporting and disseminating information electronically and via the Web. However, the long-term decisions on reporting procedures in certain processes, the range of topics covered by the commitments made by countries in relation to forests, as well as the range of other forest information needs, has made progress on joint reporting formats or data collection mechanisms difficult.

In June 2002 the Collaborative Partnership on Forests (CPF)[1] established a Task Force on Streamlining Forest-Related Reporting. The CPF Task Force was created to propose ways of reducing the forest-related reporting burden, for example, through reducing and streamlining reporting requests, synchronizing reporting cycles, harmonizing data collection methods and increasing data comparability and compatibility, and facilitating the accessibility and flows of existing information. It also seeks to guide ongoing international processes by sharing experiences and lessons learned on different reporting frameworks and by seeking possibilities for common approaches to data and information collection, storage, and reporting by international organizations. In the longer term, CPF believes that the work could contribute to better information management system(s), whereby data and information will be more easily accessible and widely available, and in which the information could eventually be inserted and updated by countries themselves.

CPF's work on developing a joint information framework for country reporting and for improving the information management of international organizations and secretariats has considerable potential in the future for providing better and more coordinated information on forests and reducing countries' reporting burdens. This, however, is a long-term task that involves confidence building among the partners, use of modern technologies and existing information systems, and the acquisition of adequate resources to carry out the project (see *Box 11.4*).

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[1] CPF is composed of 14 international organizations and institutions (with a secretariat) that deal with forests. One of its main objectives is to enhance collaboration and coordination on forest issues among its members at all levels.

Box 11.4. A global market place for forest information: GFIS

Many international organizations and initiatives attempt to compile and provide better access to existing information. One such initiative is the Global Forest Information Service (GFIS), led by the International Union of Forest Research Organizations (IUFRO) as a CPF joint initiative. GFIS is being developed to provide an Internet gateway to forest information resources from around the world. Users can locate maps, data sets, Web resources, journal articles, books, and other resources relevant to their forest information needs. Such metadata and access-facilitation systems are highly useful once established and widely used. However, they are difficult to develop, and it is equally challenging to maintain them properly.

d) Enhancing the Effectiveness of International Agreements

Ultimately, what counts is whether international forest governance efforts have an effect on conditions on the ground, for example, through improved forest management, forest conservation, use of forest goods and services, and the distribution of related costs and benefits. To assess the impact of international agreements and related efforts to implement agreed actions, ground data on forests are needed. One of the major difficulties of international deliberations and agreements on forests is the diffuse nature of the underlying concept of "sustainable development" or "sustainable forest management." This means very different things to different interest groups, including "the North," more interested in biodiversity protection, and "the South," which insists on a fair opportunity for sustainable economic development.

It took more than a decade for a set of seven "thematic elements" of sustainable forest management (SFM) to be politically acknowledged by UNFF in 2004; these were based on related indicators developed through regional and international criteria and indicator processes. They should facilitate the sharing of information and demonstrate progress toward sustainable forest management. These common thematic elements, as they are called at the international policy level, represent a very concrete pivot point around which policy-level efforts for harmonization of information and data needs regarding forests can be focused. The CPF members are developing a joint information framework for forest reporting to further improve access to and coordination of information, ultimately with a view to reducing the burdens on countries with regard to future reporting. In this pool, information will be available in line with the seven thematic elements of sustainable forest management. Some forest monitoring systems are gradually being reoriented so that they can deliver data related to this increasingly widely shared framework. The global Forest Resources Assessment undertaken by the FAO, which is structuring its reporting according to the six (of seven) thematic elements of SFM, is one example.

ICT can play a key role in the collection, storage, analysis, and exchange of information on implementation efforts and on the status of and trends in forest resources. A tremendous amount of information on forests is collected by local, national, regional, and international organizations. International organizations, such as the FAO, organizations associated with the United Nations Environmental Programme, the UN Economic Commission for Europe (UNECE), and others currently host the main repositories of global data sets on forests. The international policy process will need to consider their real information needs carefully. In most cases, information requested from countries and other entities already exists. Furthermore, better coordination and sharing of information is needed, to make better use of existing data banks, reports, and analyses. ICT provides all or most of the tools to organize data pools and expert networks, for example by FAO FORIS, and open-access meta information services, such as intended by GFIS (see *Box 11.5*).

It seems essential to further develop information-management systems, such as GFIS or FORIS, that are able to supply customer-specific information. Further initiatives in this direction are the European Forest Information and Communication System (EFICS) and related projects, as well as efforts to further develop the compatibility of forest-information systems in North America.

Box 11.5. FAO FORIS

FORIS is the FAO knowledge-management system on forests and the largest repository of forest-related information in the UN system. It integrates several general modules for entering, storing, and dissemination of forest-related information. It covers themes, statistics, contact references, meetings, and free text. The database side of the system is seamlessly integrated with a content-management system that caters for the publication of stored information on the Web.

Many existing multilateral environmental agreements involve factors that could be assessed remotely, such as wetlands preservation, deforestation, and marine and atmospheric pollution emissions. GIS-referenced data and RS (remote sensing) are able to provide countries with additional data not only about the effects of implementation efforts but also about existing environmental or social factors that interact with implementation efforts, such as land-use changes or demographic patterns. By increasing the ability to monitor the impacts of treaty-relevant behavior, ICT can encourage improved compliance. Just as important, however, are the potential cooperative uses of monitoring data. ICT-derived data, such as from GIS and RS, may help developing-country contracting parties with limited capacity to address treaty-related concerns to better target their resources.

ICT techniques such as GIS and remote sensing have potential, but their actual application is restricted. For instance, highly sensitive satellite observation instruments, such as ENVISAT ASAR that can detect movements of the Earth's surface of as little as 1mm per year are not able to produce truly accurate data on forests, as it is difficult to spot "newborn" forests or forest degradation (ENVISAT, 2004). National onground forest inventories tend to provide more accurate estimates that can and should be complemented by remote sensing. To make better use of RS in the context of international environmental agreements, changes need to occur in at least three areas (SEDAC, 2000):

1. The perception of environmental issues—sovereignty has made most contracting parties unwilling to accept third-party monitoring of compliance with international agreements. Until global or regional threats from environmental change are perceived to significantly affect national interests, states are unlikely to accept strict enforcement of treaties by third parties.
2. The technology—many treaty-specific, remote-sensing applications are still rather experimental; these applications need to be further refined before they have the credibility necessary to be used in compliance verification. In quite a few applications it is likely that they will not be able to replace but only complement other forms of data collection.
3. Data access—issues such as guaranteed access to data by all parties, documentation of methodologies, and long-term data archiving need to be addressed.

11.4.4 Bridging the digital divide: ICT in forest-related technology transfer agreements

Over 80 international instruments and numerous subregional and bilateral agreements contain measures related to transfer of technology and capacity building. About 30 multilateral agreements that cover issues of technology transfer are listed in the Compendium of International Instruments on Technology Transfer (UNCTAD, 2001). Around one-third of these instruments are related to forest matters. These agreements note that effective technology transfer will be essential to meet global challenges and to enable collaboration between developing and developed countries.

Regarding an enabling environment for technology transfer, the independent consulting company Indufor (2003) observes that most existing barriers are not specific to technologies for the forest sector. Instead, they result from international agreements (e.g., WTO agreements) or from national policy or macroeconomic frameworks (e.g., import tariffs for technology) that are designed outside the forest sector. There can also be fundamental bottlenecks impeding technology adoption, the most important of which are insufficient knowledge and capacity within the recipient country.

International reviews on technology transfer in the forest sector undertaken in recent years, such as those cited above, have not highlighted the role of ICT in any particular way. In fact, much of the debate on technology transfer centers on financing knowledge transfer, capacity building on the receiver's end, and the issue of intellectual property rights and related trade. One major issue of discussion in international forest-related policy circles is lack of access to information and lack of capacity to adapt and apply the related knowledge to a local situation. Indufor (2003) is more explicit than most when it writes: "The key problem does not appear to be the distribution of information at the international level, but having the capacity at the country level to use the available technology-related information in a systematic manner and being able reach out to those who are unable to access it. Training of local intermediaries is a key activity." Not a single line of policy recommendations is directed at ICT hardware or software. While it is a widely shared view in the IT community that hardware does not matter, software does matter, especially software that is adapted to the specific low-tech context within which most work is undertaken.

11.4.5 International forest-related e-governance: Opportunities and challenges

It is clear that international forest governance will continue to evolve, but it could move in various directions. One possible scenario is that a formal and rather powerful forest-governance structure is established that consists of one or very few well-coordinated bodies and related implementing agencies, private or public. Such an arrangement is likely to develop only if the changing climate requires more drastic globally coordinated action. Another situation is a looser but well-coordinated network of public and private institutions. Such an arrangement is not necessarily the most efficient, but it is likely to be more resilient and flexible. A third possibility would be the strengthening of regional policy processes and institutions that would, in effect, replace global governance arrangements. Yet another is the breakdown of all efforts to create meaningful international governance arrangements and a resulting strong reliance on local governance arrangements.

ICT is one key asset for setting up and managing any type of structure; it is especially useful for international forest governance of a network type. This, however, requires the adaptation and changing of network concepts, the support of multimodal interactions on the basis of standardized data-exchange protocols—the technical and informational infrastructure that enables participation and interaction of relevant existing and emerging actors with as few transaction costs as possible. Many of the e-administration activities and concepts now being explored and tested at the national level will increasingly be applied at the international level.

One of the key needs for enhanced use of ICT in international forest governance is the improvement of ICT quality, user-friendliness, and cost-effectiveness, as well as the coordination of international information needs. Efficient use of ICT to facilitate monitoring, assessment, and reporting (MAR) will require the various processes to 1) harmonize formats, 2) harmonize concepts, terms and definitions, and 3) standardize or harmonize technical infrastructures and/or languages so that interoperable systems and user-friendly interfaces, such as customer-convenient "one-stop shops" can be built up. The challenge ahead is how to overcome the multiple difficulties faced in the international harmonization or standardization of well-established national rules.

A further major challenge for international forest-related governance is how to take the local-level and rural settings appropriately into account. International forest arrangements that are not focused on or driven by a common global threat, such as climate change, tend to be quite ineffective, as they are disconnected from the issues on the ground. These often need to be resolved on a local basis rather than at the international level. The principle of subsidiarity has yet to be firmly established and implemented in international forest governance. ICT can nonetheless support good governance principles just as well on the local as on the international level.

11.5 Concluding Remarks

In the past few years, ICT has profoundly altered our ability to obtain and utilize information, data, and knowledge. The speed of change in information technologies is far outpacing our understanding of their impacts on relationships among individuals, societies, and states. In particular, attempts to understand the impacts these technologies have on political interaction and international policymaking processes have not yet been analyzed in detail.

The use of ICT has helped drive the shift from top-down government concepts to more open-network “governance,” which in turn has enabled ICT to influence international governance. An increasingly complex and networked world requires an equally dense institutional infrastructure to facilitate international coordination. ICT provides many of the essential tools; however, it does not reduce the multiplicity of values and conflicts of interests that international governance arrangements have to accommodate and manage. Technologies, moreover, evolve only when embedded in a social context and not independently. As organizational arrangements evolve considerably more slowly than technologies, it will take quite some time for the technical possibilities of today to become fully integrated into international or national governance arrangements. Nonetheless, future international governance arrangements are likely to evolve along the paths that have emerged over the last decade: governmental and private institutions acting complementarily but with different roles and responsibilities.

To build an international governance arrangement that makes best use of ICT, a range of talents and resources must be assembled to tackle the many open questions that this technology brings with it in relation not only to technical but especially to political, institutional, and organizational response and adaptation.

Appendix

List of Acronyms	
APEC	Asia Pacific Economic Conference
ASEAN	Association of Southeast Asian Nations
ATU	African Telecommunications Union
CITEL	Comisión Interamericana de Telecomunicaciones (Inter-American Telecommunications Commission)
CoE	Council of Europe
DG1	Directorate General I (Legal Affairs)
DGII	Directorate General II (Human Rights)
ECB	European Central Bank
ETSI	European Telecommunications Standards Institute
EU	European Union
GBDe	Global Business Dialog on Electronic Commerce
GIC T	Global Information and Communication Technologies (Division of the World Bank)
ICANN	Internet Corporation for Assigned Names and Numbers
IITE	Institute for Information Technologies in Education
ITU	International Telecommunication Union
ITU-D	ITU Telecommunication Development Sector
ITU-R	ITU Radiocommunication Sector
ITU-T	ITU Telecommunication Sector
OECD	Organization for Economic Co-operation and Development
UN	United Nations
UNCITRAL	United Nations Commission on International Trade Law
UNCTAD (DITE)	United Nations Conference on Trade & Development (Division on Investment, Technology and Enterprise Development)
UNCTAD (ECB)	United Nations Conference on Trade & Development (Electronic Commerce Branch)
UNESCO (CI)	United Nations Educational, Scientific and Cultural Organization (Communication and Information)
UN-ICT Taskforce	United Nations Information and Communication Technologies Task Force
W3C	World Wide Web Consortium
WIPO	World Intellectual Property Organization
WSIS	World Summit on the Information Society
WTO	World Trade Organization

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Chapter 12. Conclusions and Implications

Lauri Hetemäki and Sten Nilsson

This publication has assessed the impacts of information and communication technology (ICT) on the whole forest sector—from the forest itself to the end products at the market. The starting point was to identify how ICT has affected the forest sector to date, after which the possible future impacts were considered. The emphasis has been on a qualitative rather than quantitative analysis.

The study can be seen as a road map indicating the potential impacts of ICT on the forest sector. There are a number of different routes that the future could follow, and we have tried to provide visions or scenarios of these possibilities. In spite of this, ICT is quite likely to impact the forest sector in unexpected ways. This does not make the analysis a futile one. When the unpredictable happens, we can grasp its implications more quickly if we have engaged in prior thinking and visioning. Moreover, the success of this publication will not be assessed on the percentage of our predictions or visions that come to pass but (1) on how successful we have been in interesting the reader in the topic and (2) on how useful and stimulating readers find the concepts and visions we have presented.

In this chapter, we summarize some of the major findings and implications of the different chapters, providing linkage and feedback between them. We also present some general strategic and policy implications, based—but not strictly so—on these findings. We do this to raise awareness of the need for a thorough review of the implications of ICT for the forest sector as well as to draw attention to new questions and issues needing further analysis.

12.1 Dimensions of the Impacts

When technological revolutions take place, they also tend to fundamentally change societal structures. As shown, for example, by Perez (2002), revolutionary technological changes seem to have similar characteristics and patterns. A knowledge of history is thus likely to be useful when one is considering possible future technological revolutions. This type of reasoning leads Innes *et al.* (Chapter 3) to ask how the past can help us understand what to expect from future innovations in the field of ICT developments.

Case studies of past innovations show a mixed picture. Some of the societal implications of such innovations have clearly been misunderstood or could not be foreseen. Others have been anticipated with remarkable insight. Innes *et al.* provide examples of both, concluding that predictions are possible when there are trends in underlying technologies. They also point out that the forest sector has been heavily dependent upon technological changes that *originate outside the sector*. It is thus important for the forest sector and for forest researchers to closely monitor these technological developments.

The title of the chapter by Innes *et al.* is Surprising Futures. The title carries a message in it—be prepared for the unexpected: for that which we cannot foresee. That aside, the present study does not aim to identify all possible future developments but focuses on some important trends that are already visible. A number of future ICT impacts identified in this publication are what most of us would probably have expected, for example, that ICT applications have assisted, and will continue to insist in increasing efficiency and productivity in the forest sector. But in analyzing such impacts, we hope to provide *insights, conclusions, and implications* that are perhaps not so familiar to the reader.

One such insight is to consider how electricity and other general purpose technologies (GPT) have affected societies and the forest sector and apply this to ICT development. This idea has come out in a number of other studies (e.g., Perez, 2002; Carr, 2004) but has yet to be considered within the context of ICT and the forest sector. A basic feature of GPTs is that their impacts tend to follow somewhat similar patterns. According to Perez (2002), these can largely be categorized into (1) installation, (2) deployment, and (3) maturity. (Perez further divides these into subsectors.) The Perez (2002) analysis is similar to theories developed by Kondratiev (1935), Schumpeter (1961), and Mensch (1979) that were used to analyze the forest sector in Lönnstedt *et al.* (1983).

In the *installation period*, which typically lasts two to three decades, the infrastructure for the new technology is established and a critical mass of industries applying the technology forms (e.g., the introduction of computing infrastructure and hardware and software industries from the 1970s to the 1990s). In the *deployment* stage, which also typically lasts two to three decades, the transformation potential of the technological revolution spreads across the economy, yielding its full development benefits. This is a period in which institutions start to form around the new technology. When electricity went through this phase, companies and sectors that were early adopters gained important competitive advantages. Apparently, ICT deployment in the forest sector is currently at the deployment stage. *Maturity* is the end of the deployment period and is a phase that combines signs of exhaustion in many of the original core industries of the new technology with low growth rates in the last few new industries within the same technology paradigm. For example, when electricity matured and was adopted by all, the competitive advantages disappeared—electricity became just another necessary input. This type of framework is, either explicitly or implicitly, behind many of the analyses in the current study.

The study has also tried to provide insights by considering the *important interlinks* between subsectors of the forest sector—that is, how ICT development and its impacts in one subsector may turn out to be an important driving force and determinant of the development in another—for example, how the changes in communication paper demand caused by ICT development may affect the demand for pulpwood, which, in turn, has important implications for how we use our forests.

12.1.1 Implications to date

Hetemäki *et al.* (Chapter 2) analyze how the forest sector has handled the implementation of ICT to date. The authors conclude that ICT implementation has strongly contributed to improving the productivity and efficiency of the different forest subsectors, thus contributing to the forest sector's overall continuing competitiveness. Consequently, ICT has had a similar role to that of GPTs in the history of the forest sector—the analogy with electricity being a good example. The other GPT-type impact of ICT relates to globalization. As in other sectors, ICT has enhanced the globalization of the forest sector. Indeed, without an efficient use of ICT, this development would probably not have been possible, at least not to the extent that has occurred.

In the early 1980s, many people were convinced that we would soon move toward a *paperless office*. The visionaries got the dates wrong; the paperless office has not arrived, nor will it, probably, in the near future. Indeed, perhaps the paperless office concept should not be taken too literally but rather understood as indicating that ICT could lead to a significant reduction in paper consumption. If we accept this view, the problem with the paperless office concept was not with the concept itself but with its premature arrival on the scene. It anticipated some of the developments visible today and that will probably be increasingly relevant tomorrow. These early visions of modern technology rapidly reducing paper consumption should not make us forget that, at the beginning of 1980s, a number of serious studies were already doubting the possibility of such a scenario taking place. Indeed, as discussed in Hetemäki *et al.* (Chapter 2), several important studies clearly point out that the issue was not a technological one but also involved economic, social, and human dimensions. Those studies also conclude that in the coming decades electronic media would probably cause an increase in paper consumption rather than a decline.

Hetemäki *et al.* (Chapter 2) also show that ICT impacts in the forest sector have not just been restricted to the forest industry and wood production. ICT has also played an obvious and essential role in raising consciousness about forest-related *environmental issues* among the public, politicians, and decision makers. This awareness has changed the way forest resources are managed and has increased protected areas. These developments were mainly driven by the “green movement,” which utilized new ICT efficiently to get its mission and message across.

Another sector, outside forest-industry activities, in which ICT development has had a significant impact is *forest recreation and tourism*. The Internet and global positioning system (GPS) technology have changed how national parks can be managed and advertised, monitor their visitors, and collect information about a large number of different topics related to forest recreation. An interesting but again under-researched topic is how ICT has influenced people’s views on forests. To take one example, ICT may have led people to undervalue “everyday” or unspectacular forests because television nature programs and Internet pages have concentrated on the beauty of monumental and spectacular forests (e.g., the giant redwoods).

Summarizing ICT impacts on the forest sector to date, the following observations can be made. First, ICT implementation in the forest industry and wood production sector has been along “installation period” lines rather than making the kind of ground-breaking advances expected in the “deployment period.” Perhaps the important exception is the globalization of the forest industry, which has been greatly enhanced by ICT development, with fundamental changes being made as a result to the industry’s operating environment. Second, many ICT impacts on the forest sector are indirect. That is, ICT changes society in general which, in turn, changes the forest sector. There are also indirect ICT impacts within the forest sector itself, with many of the fundamental impacts relating to forest industries and their markets rather than to forests themselves. However, the changes in forest industries and markets have, in turn, important implications for how we use forests. The present study reflects that situation. It emphasizes the importance of having a good grasp of how ICT impacts on the forest industry and markets, before drawing conclusions about its impacts on forests.

12.2 Future Scenarios and Implications

Next, we turn to the possible future impacts of ICT on the forest sector by chapter. Although based on the earlier presentations, the discussion here also extends and adds to what has been stated in previous chapters and therefore draws on some publications not covered in the earlier chapters. Responsibility for the policy and strategic implications here rests with the authors of this chapter.

12.2.1 Forest businesses and e-commerce

The term *e-business* covers all business applications using ICT to improve a firm’s efficiency. According to Porter (2001), e-business includes a firm’s infrastructure development, human resources management, technology development, procurement, logistics, operations, marketing and sales, and after-sales service. *E-commerce* is one component of e-business and includes buying and selling over the Internet. Nyrud and Devine (Chapter 4) deal specifically with the e-commerce component, and Boston (Chapter 5) analyzes the development of the e-business concept.

There are two different views with respect to the impact of e-commerce. One emphasizes that e-commerce will lead to increased competition and decreased prices. The other stresses that e-commerce will generate new business models and opportunities that are completely different from those we are accustomed to in the industrial society. However, both agree that e-commerce will be a natural and substantial component of future business.

Despite many firms having high Internet access and a large proportion of employees using computers, the extent of firms using e-commerce is still very low, although increasing substantially (Leck *et al*., 2003). The proportion is smaller in the manufacturing sector (e.g., in the forest industry) than in the service sectors. E-commerce use is currently most significant in tourism, media and printing, banking, insurance, and ICT services and retail (e-Business W@tch, 2003). Some of these sectors are important for the forest sector, which may therefore need to move faster in the direction of e-commerce.

E-commerce in general has been dominated by business-to-business (B2B) trade and local and national operations (OECD, 2003). But it is becoming more and more international, and e-commerce is increasingly applied for business-to-customer (B2C) solutions as well. It is assumed that e-commerce will spread increasingly in the emerging economies of the developing world (OECD, 2004). Low-cost producing countries entering e-commerce are also likely to affect the competitive environment, prices, and the structure of the global forest sector. Many developing countries are already reaching out to global markets through e-commerce.

There are good reasons to believe that e-commerce will lower information barriers in the forest sector markets, for example, as a result of greater price competition, more flexible trade arrangements, elimination of excess capacities, and gains in access to new markets and distribution networks (Obersteiner and Nilsson, 2000a). The forest sector has already seen the introduction of Internet marketplaces such as papiNet and Forest Express [see Nyrud and Devine (Chapter 4)]. In the future, forest products will increasingly be offered through large Internet retail platforms that will help to substantially reduce transaction costs. This, together with other emerging aspects of digital technology, is also likely to reduce, if not make obsolete, traditional market forecasting based on extrapolating from past trends (Obersteiner and Nilsson, 2000b).

Boston (Chapter 5) states that e-business in the forest sector can be grouped into three categories, namely, business/market intelligence, customer management, and operations management. He concludes that the forest sector has deployed ICT with respect to operations but has been less successful with other categories. There is thus a strong need for the forest sector to adopt a more holistic approach to e-business applications. Moreover, there is an important difference between small and large companies regarding implementation of efficient e-business concepts. Because of this, some observers anticipate that an e-business gap might emerge (CBI, 2002). If this happened, it could contribute to company consolidation in the forest sector too.

During the last two decades, the productivity, profitability, and competitiveness of the forest sector have largely been associated with the increase in production volume and the cutting of costs. However, investments to expand capacity to improve competitiveness will be more limited in the future. *Innovations* will thus be crucial for the forest sector's future competitiveness—and these innovations will be driven by technological developments and consumer preferences. They will not be caused by ICT in isolation but rather by the integration, for example, of ICT, biotechnology, and nanotechnology.

New technologies and their integration will create new business opportunities and product innovations (Tapscott, 2001). But the new technologies and evolutions in society are also likely to lead to a new generation of customers whose habits and preferences are different from those of current customers. Forest sector businesses in the future must focus more strongly on the customers. E-business can play a important role in the move from production orientation to market orientation (Ince *et al.*, Chapter 7).

12.2.2 Communication papers

Hetemäki (Chapter 6) analyzes the current and possible future impacts of ICT on communication paper markets. In terms of the quantity produced and the market value, communication papers make up the largest paper products group. Hetemäki shows that there has been a structural change in communication paper markets in a number of the countries of the Organisation for Economic Co-operation and Development (OECD) and that ICT has probably played a central role in these. The traditional market analysis and long-term consumption projections are also less useful here—and may even provide qualitatively false projections.

In the OECD, the future trend is likely to favor electronic media at the expense of printed newspapers. *Newsprint consumption* in a number of OECD countries has already declined and is likely to do so even more in the future. Developments with respect to *office and magazine paper* consumption and ICT have been less clear than with newsprint. The major exception is office paper consumption in the United States, where consumption has already stagnated or declined since the mid-1990s, mainly because online services have been substituted for the paper used for forms and stationery. There has also been a slowdown in the growth rate of the office paper sector in a number of other OECD countries during the last five years. Whether this is a cyclical phenomenon or a structural break is too early to say definitively. In general, however, the underlying economic, consumer, technological, and environmental forces are tending to favor digital media over print media, and it appears that office and magazine paper consumption will follow the trend of newspapers and newsprint with a time lag. The length of this will vary across countries, and its exact timing is difficult to project.

In the medium term, ICT development also generates demand for new office paper grades. Printing and publishing industry projections show increasing demand for high-quality, digital color printing, both in offices and homes (CAP, 2003). The new paper grades require, for example, new surface properties that are typically achieved by increasing the amount of fillers (pigments) at the cost of wood fiber in the paper. This trend thus also has an important implication for the paper industry's raw material utilization.

While ICT development is generating demand for new office paper grades, environmental considerations are simultaneously tending to work toward reducing the use of office paper. Companies, government offices, and universities, for example, are introducing paper procurement and consumption polices that aim for a substantial reduction in paper consumption to achieve sustainability objectives.[1] The increasing use of ICT is seen as one possibility for reducing office paper consumption and hence the environmental side-effects of paper products. The net effect of these two offsetting trends for future office paper consumption depends, of course, on the relative magnitude of these impacts.

The incentives to move from print to digital media are generic or universal by nature. Thus, they are also likely to be relevant for *non-OECD countries*. However, at least in the next decade or so, the other driving forces determining communication paper consumption in those countries will be much stronger. For example, in most of the non-OECD countries, per capita consumption of communication papers is still at a very low level compared to OECD countries. Consequently, communication paper consumption is likely to increase rapidly in these countries in the near future.

ICT developments are also likely to indirectly influence communication paper *prices*, but with a price decrease as a result. These impacts are more immediate than the consumption impacts mentioned above. For paper industry profits, the price impacts of ICT can be more significant in the short and medium term than the consumption impacts.

In summary, the structural changes in communication paper markets due to ICT will probably be substantial both in terms of volumes and prices. These changes will, in turn, have a number of strategic long-term consequences for the forest sector:

- ICT will strengthen the ongoing geographical restructuring of the communication paper industry from OECD countries (North) to non-OECD countries (South);
- There will be decreased demand and prices for pulp wood, recycled paper, and other raw materials used for communication papers;
- The need for cost cutting will be strengthened, for example, by increased utilization of plantations for pulp raw material and decrease use of natural and seminatural forests;
- Employment will decrease in the communication paper and allied sectors in OECD countries; and

[1]Bank of America announced on 1 April 2005 that: "The bank will minimize the volume, by weight, of paper products it purchases, where cost, quality, and general business needs allow. This will be achieved via procurement best practices, such as light weighting; internal operations initiatives, such as business process digitization; and customer product offerings, such as providing online banking customers with the option of receiving electronic statements in place of paper statements." (Bank of America, 2005).

- New challenges for forest management and forest sector development will be created, especially in traditional major forest countries (e.g., Canada, Finland, Sweden, and forest-industry-dependent states in the United States); on the other side of the coin, there will be new opportunities in a number of non-OECD countries (e.g., Brazil, Chile, China, India, and Russia).

We are at the beginning of the process of paper substitution due to ICT developments. Substantial additional research and analysis are required for a better understanding of this process and its consequences for the forest sector. As illustrated in Hetemäki (Chapter 6), this research cannot be based on traditional analysis but requires new approaches that can capture the essential features of ICT impacts on the paper sector. The need to update current approaches is the most immediate so that more credible long-term projections of communication paper consumption and prices in OECD countries can be made.

12.2.3 Paperboard and packaging

In terms of consumption, the *paperboard and packaging* grades form the other large paper products group. Ince *et al*. (Chapter 7) analyze the possible impacts of ICT developments on this group of products. The authors conclude, in the same way as for communication papers, that ICT implementations in the paperboard and packaging sector to date have been driven by cutting costs (the cost-leader strategy) to maximize output and utilization of capacities (production-push strategy). Because of the very different nature of the end uses of the two paper grade sectors, however, there are also important differences in the ICT impacts on these grades.

In responding to customers' new demands, Ince *et al*. see *intelligent packaging* as a challenge and an opportunity for the packaging sector. Intelligent packaging uses electronic sensors and/or chemicals to sense or transmit information about the environment, transport conditions, product information, and management instructions, and can be seen as a further development of bar codes. Bar codes on packages and boxes have revolutionized the way stores manage inventory and the speed at which checkout lines move in supermarkets. But while bar codes have to be seen in order to be scanned, radio frequency identification (RFID) tags can be read at a distance and from any angle. RFID technology has recently arrived and is being used to tag everything from pets to shipping containers.

To date, the main obstacle to RFID adaptation to the packaging sector has been the cost. Most RFID designs are too expensive for mass markets, but technologies have been or are being developed that will allow costs to be reduced. For example, Plastic Logic of Cambridge, England, has developed ways of using inkjets to print semiconductors using polymer materials, resulting in performance equivalent to the silicon components used to create the active-matrix substrate for LCD panels. According to Plastic Logic CEO, Stuart Evans, "Low-cost RFID for intelligent packaging is coming, but it's going to have to rely on print technology" (see Poor, 2003).

Ince *et al.* (Chapter 7) discuss the future impacts of ICT on the paperboard and packaging sector in terms of "three speculative scenarios." The first scenario builds on the hypothesis that intelligent packaging coupled with e-business concepts can offer an expansion of packaging materials in the paperboard and packaging industry. It also implies that the industry will move into value-added markets by developing new packaging services. This development would have the potential to increase the volumes consumed (compared to business-as-usual) and the prices of the products, with producers possibly able to keep the value-added generated by the new products. But to see this happen, the industry must be able to implement a strategy *to move from a commodity-oriented industry to a packaging system industry*. To do that, the industry must form alliances, networks, and joint ventures with sectors outside the traditional paperboard and packaging sector.

The strong development toward a packaging system industry with higher value-added and higher prices could also spill over into better economic conditions for forest management. Another interesting side-effect of intelligent packaging could be more efficient recycling, with better sorting of the recovered paper, more efficient reuse of recovered papers, less waste, and fewer environmental problems.

The second scenario builds on the assumption that the industry will stay commodity-oriented and that ICT implementations will aim for cost reduction and productivity increases and, in so doing, increase profitability. The theoretical analysis shows that this strategy will probably result in a future decrease in the price of and demand for paperboard and packaging grades. This, in turn, implies lower producer surplus and less profitability for the sector.

The third scenario assumes that a broad implementation of ICT will reduce not only production but also transaction costs and that, as a result, new and more efficient market segments (niche markets) could emerge. The analysis indicates, however, that even in this case producer surplus will be reduced, as will profitability for the sector as a whole.

The analysis also evokes the important question as to whether the paperboard and packaging industry is capable of moving sufficiently fast toward new interactive packaging systems. If this move is not implemented quickly enough, there is a danger that the paperboard and packaging sector will face increased substitution by other packaging materials. In general, the authors call for the paperboard industry to move away from production orientation toward market orientation when dealing with customer and market needs. They see that ICT and the e-business concept have the potential to support this move and, in so doing, could increase the value-added in the sector. Finally, one conclusion from Ince *et al*. (Chapter 7) is that important knowledge gaps exist about the market effects of ICT developments in the paperboard and packaging sector. This is an urgent challenge for the research community.

12.2.4 Wood products industry

Baudin *et al*. (Chapter 8) analyze ICT developments in the *wood products industry*, which comprises sawmilling, engineered wood production, furniture, joinery, and wood packaging production. The essential characteristics of the wood industries are that they produce standard products and have few barriers to entry. The current implementation of ICT in the industry has concentrated on the improvement of the supply chain management (the cost-leader strategy). However, the degree of ICT implementation in the wood products industries is substantially less advanced than in the pulp and paper industry. One reason for this is that the majority of industrial units are rather small and cannot afford large investments in advanced ICT implementation. However, new trends and requirements seem to be changing this situation.

The wood products industry is currently moving increasingly toward niche markets and value-oriented growth instead of relying on the volume-oriented growth and low-cost strategies of the past. The repair–maintenance–improvement (RMI) and do-it-yourself (DIY) markets are also huge and increasing. These markets require consumer-friendly or consumer-efficient products. Baudin *et al.* (Chapter 8) assume that e-business will be implemented in these markets on a large scale, resulting in substantial cost cutting. That does not necessarily mean, however, that the producer surplus will increase. The gains will mainly spill over to the consumers.

To sum up, ICT implementations in the wood industry are mainly expected to deal with efficiency and cost-cutting implementations in commodity and semicommodity strategies, resulting in increased productivity but lower producer surplus and profits (Hitt and Brynjolfsson, 1996). ICT will also possibly prove especially beneficial in the marketing process for small and medium-scale wood companies. These companies often have limited resources for marketing their products, especially abroad. Internet marketing, company Web sites, and e-commerce are likely to be of significant help in promoting products and handling customer transactions.

12.2.5 Forest resources and management

Above, it was concluded that ICT development is likely to strengthen trends in the forest sector that are already partly taking place for other reasons, for example, by increasing downward pressure on the real prices of wood raw material and by encouraging the geographic relocation of the forest industry (especially pulp and paper) from the North to the South.[2] Both these trends have important implications for forest resources. When discussing these implications, however, it is essential to draw a distinction between the North and the South, as the implications are likely to be different for each region. We first summarize the implications for *the North*:

- Forest industry companies have growing incentives to relocate their production to rapidly growing markets (e.g., Asia, Latin America, Russia) and to areas where raw material and labor costs are relatively low (e.g., plantation forests in South America). As a result, the demand for wood in the North declines, as do the real prices for wood. These trends weaken the potential for profitable wood production and forest management in the North, which, in turn, reduces the supply of wood and employment in the forest sector in these countries. Moreover, there will be increased incentives for larger forest holdings in which economies of scale could help to maintain financially viable wood production despite lower real prices. These trends would, however, make the forest more likely to be used for other purposes, for example, energy, recreation, or biodiversity.
- For countries and regions heavily dependent on forest resources, it is important to find new forest-based businesses, whether in manufacturing or services. This would help them maintain a viable forest sector despite the structural changes brought about by ICT development and other driving forces.
- National forest policy, if it exists, should take into account these developments and help in the adjustment to new regimes. Investing in long-term research and development, which could create new innovations for the sector, should be an essential part of policy.

The major implications for *the South* are:

- There will be increasing investments in the forest industry and the forest sector in general. Demand for fast-growing plantation forests and their wood supply will especially increase. These trends strengthen the possibilities for profitable wood production and forest management in the South, increasing both the supply of wood and employment prospects in the forest sector in these countries. Depending, for example, on where the new plantation forests are located, how they are managed, and how they change the management of natural forests, the possibility of using the forest for energy, recreation, or biodiversity will either increase or decrease.
- The pressures to apply biotechnology to further increase the returns from plantation forests will be strengthened by the developments mentioned in the previous point.
- Education and research related to forest management will probably need to be increased in the countries where new investments are located.

In general, for both the North and the South, the new conditions are bound to bring new challenges for forest sector research.

Reynolds *et al*. (Chapter 9) analyze the impacts of ICT on operational *forest management and conservation*. They define forest management as ways of using forests to provide the values, goods, and services required by society. For example, forest conservation is regarded as an instance of forest management—an application of forest management in an area where conservation values are emphasized.

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[2]*The North* refers here particularly to important traditional forest regions, such as North America, the Nordic countries, Japan, and some of the countries in central and western Europe. *The South* is a looser geographical category referring to countries, such as China, India, Indonesia, Brazil, and Chile, as well as Russia, Poland, and the Baltic countries. Moreover, a few countries with a strong forest sector fall between these two groups in terms of possible ICT impacts on the sector. For example, Australia and New Zealand have some of the disadvantages of the North (e.g., relatively high labor costs) and some of the advantages of the South (high yield and rapid-growth plantation forests).

Society is posing considerable challenges to forest management through economic, social, and ecological objectives that often conflict over a range of spatial and temporal scales. Reynolds *et al.* (Chapter 9) show how ICT developments have substantially contributed to changes in forest management during the last 20 years or so, for example, through more transparent decision-making processes, improved access to information, improved public participation, and spatial inventory databases. In general, although ICT implementation has improved the efficiency and decreased the costs of forest management, it has not managed to substantially reduce the existing controversies over forest management issues and policy.

Future ICT developments could contribute substantially to solving the controversial issues of forest management. ICT could play an important role by:

- Helping to treat conservation more efficiently in the context of forest management;
- Facilitating participatory (interactive) planning processes and bridging the gap between general public concerns and gaining social acceptance of the management measure applied;
- Management across spatial scales—a necessity for ecosystem management;
- Management across ownerships—collective management; and
- Management for sustainability—the most pressing issue with respect to future forest management.

As well as helping solve conflicts, future ICT development will contribute to greater *effectiveness and efficiency* on the part of forest management through improved decision making and better resource allocation. These, in turn, could result in increased income and decreased costs.

12.2.6 Changing institutions, values, and governance

Earlier, we noted that ICT can be regarded as a general purpose technology that typically changes institutions and the way things are done (or not done). GPT is also likely to change societal values, as was the case when conflicts arose during the industrial revolution in England between traditional and modern textile-production methods. An unforgettable illustration of what this type of "technology revolution" can mean for our everyday life can be seen in Chaplin's film *Modern Times* which captures the frustrating struggle of a proletarian man against the dehumanizing effects of the machine in the industrial age.

Thomson and Colfer (Chapter 10) state: "Society and culture drive the adoption and use of ICTs and, in turn, are changed by their use." The authors describe some of the social and cultural dimensions of ICT development. Many ICT impacts in society, and in the forest sector, are indirect or difficult to quantify. How, for example, do you quantify ICT impacts that may change the mindset of society, some of which may become evident and identifiable only after a long time period? Clearly, assessing these type of affects on society and on the forest sector is challenging. However, we venture to illustrate some of these impacts in the following paragraphs.

One issue that Thomson and Colfer particularly address is the *digital divide*. Concerns have recently been expressed that ICT development causes unequal opportunities in developed and developing countries, with ICT diffusion in the latter being slower than in developed countries or even nonexistent. The digital divide, however, would appear to be an integral part of a much broader and wider development divide (Hewitt de Alcantára, 2001; UNRISD, 2004; Paludan and Worzel, 2004). Without solutions to basic development problems, ICT risks widening the current divide among and within countries, which may also constrain the development of the global forest sector. Future divisions between people and societies are, however, unlikely to strictly follow the North–South transect. Indeed, ICT may to some extent decrease the traditional divide between developed and developing countries, for example, by shifting outsourcing services and manufacturing from the North to the South. However, digital divides within countries could increase because of ICT development; compare, for example, the city of Bangalore with the rural areas of India.

ICT development could also contribute to a changed education profile, having, for example, a liberating impact for women in the developing world and giving them access to information that was previously denied to them (Ess and Sudweeks, 2001). On the other hand, using computers instead of printed material for learning and education could over time change the way people see and value the forest sector. The necessity and relevance of printed material could become more blurred, which could affect attitudes toward wood production and the forest industry. On the other hand, papers such as tissue paper are hardly affected by ICT use.

Unsurprisingly, ICT development has changed and will continue to change people's habits. New generations have always adopted new habits because of technological developments. One has only to compare the habits of people who were adults after World War II (in the late 1940s and early 1950s) with those of adults today. Some habits are similar, but many are not, simply because different technological possibilities have prevailed at different times. Changing habits are thus an integral part of technological development. Future ICT development will likely lead to new types of preferences and consumption patterns, with concomitant implications for the forest sector.

One dimension of the changes caused by ICT development in our societies relates to *governance*. Rametsteiner *et al*. (Chapter 11) analyze the links between ICT developments and international governance, defining governance "as the rules and procedures that states and other involved parties agree to use to order and regularize their treatment of a common issue." The principles and mechanisms of governance, including governance of the forest sector, have gained significantly from ICT developments. For example, ICT has helped the governance of sustainable forest management, sustainable use of forest resources, interactions among forest ecosystems, and the climate system. Because of ICT development, an increasing number of interest groups and individuals have become involved in deliberations on forest matters. Moreover, processes have become more open and transparent, accountability has increased, the effectiveness and efficiency of policy measures have improved, and there is more coherence among the different policymaking bodies.

The implementation of ICT has influenced national sovereignty and reduced the capacity of nations to manage national issues and international relations. The development of ICT has helped to integrate more institutions in both national and international forest affairs, affecting the process of coordination, rule setting, and governance of forest issues, and thus improving administrative efficiency. However, it has also brought an increased number of conflicting views on the policy issues debated. Managing these conflicting views would result in better decisions and policies because conflicting views can also result in blocked positions that cause problems in reaching any decision or policy. Rametsteiner *et al*. (Chapter 11) set out four scenarios, according to which ICT developments can influence the development of international forest governance:

- A few well-coordinated international governance bodies with associated implementing agencies, that can be private or public;
- Loose but well-coordinated networks of public and private institutions;
- A strengthening of regional policy processes, with institutions replacing global governance arrangements; and
- Creation of meaningful international governance arrangements with reliance on local governance arrangements.

It is difficult to assess which route the international governance of forests will take. However, it appears that ICT development may make possible a shift from top-down governance concepts to more transparent network governance. Irrespective of which of the above scenarios materializes, if any, the forest sector has to develop a more sophisticated governance process. To improve international governance that makes best use of ICT, resources must be assembled to tackle the many open questions still remaining. ICT brings with it not only technical but especially political, institutional, and organizational challenges for governance.

12.2.7 Changing forest education and science

The evolution of ICT will transform and change how education and science in general are organized, financed, governed, and executed. Education and science will increasingly become a global knowledge and learning industry and form alliances with other sectors of society; but how science will be executed in practice in the future is impossible to predict today (National Research Council, 2002). Forest education and science will be no exception to this development path. ICT can contribute to forest science, for example, by improving the distribution and management of scientific information, by generating more data and allowing better data handling, by improving instruments/tools to analyze already-observed phenomena, by allowing the detection of never-before-observed phenomena, and by enabling effective and rapid communication among scientists.

The primary means by which scientists have communicated with each other remained frozen in time until the Internet was introduced. Scientists formerly produced only ink-on-paper articles that were published in specialized scientific journals, the subscription price of which was substantial—a good source of business for commercial publishers. The Internet and electronic distribution is changing all that. Distributing scientific information online is less expensive than in print, and access by scientists around the world is much greater and easier. Documents can also be made available in less time. Information content is boosted via the electronic medium, allowing for publication of audio, video, large data sets, and interactive tools. Peer review can be made more inclusive and rapid. These are just few examples of how ICT development has helped the distribution and management of scientific information. Many new ways will undoubtedly be introduced in the future.

The data available in the future will also be greatly driven by ICT development. It will be many orders of magnitude higher even than today, when the amount of information is already daunting. Efficient knowledge management will be required in the research organizations of the future to provide the right information to the right person at the right time (Wernick, 2002; Pinte, 2004). It is knowledge management that will drive the reorganization of research organizations in the future (National Research Council, 2004).

Currently, different national laws, security concerns, and financial interests are constraining access to scientific data. The data produced in developing countries are among the least open because of economic, organizational and political constraints, and scientific protectionism. A major data problem is the lack of digital archives of historical data. However, while access to data per se will not solve the problems, the integration of data can generate new knowledge and breakthroughs (Schwartz, 2004; CODATA, 2005). The Scientific Committee for Problems in the Environment (SCOPE) and the Committee On Data for Science and Technology (CODATA) of the International Council for Science (ICSU) request *free access* to scientific data, open-source software, data networks, models used, and digital publications; and they argue that the research task is not over until these items have been publicly posted (SCOPE, 2002; ICSU, 2004). There are strong research needs for the establishment of efficient open-access policies on scientific results and data (National Research Council, 2004).

The demographic, societal, and technological (including ICT) changes in society will cause substantial changes in the educational system, including universities. For years, it has been argued that *distance education* through ICT is a great opportunity for dramatically improved educational levels in the developing world—distance learning can train more people simultaneously at a lower cost. But as experience shows, there are hurdles to be overcome if distance education is to be optimized, such as drawbacks due to capital-intensiveness, isolation of students from instructors, high drop-out rates, and inappropriate packaging of courses. In the developing world, culturally appropriate material and approaches must be developed; it is not enough to import off-the-shelf products from the North.

Experiences of *e-learning* in the developed world to date are: less administration, better study support, Internet links to international courses, better individual supervision, easier access to educational material, and the possibility of individual study time plans, place and time of studies, and study strategies (University of Vienna, 2004). But successful e-learning platforms also require new study content structures, new content production, and new content management.

The world's students are increasingly conversant with hypertext, with multifunctional phones in their pockets, access to libraries through their laptops, and instant messaging. Many universities will become virtual because students do not want to be locked up in classrooms and limited in time, place, and media. The traditional curriculum and schedules will change and become continuous. Professors may have to change their mindsets—shifting from being content providers to designers of learning experiences. The university classes will be a *hybridized combination* of online and in-class instruction.

The demands on the workforce and workplace will change rapidly because of ICT development. The changes expected in society mean that bulk of the current global workforce will need retraining during their remaining working life just to keep up. The future will also bring a graying workforce that will need continuous reeducation to remain viable. Educational programs will need to be available at convenient times and places for working adults, which will mean a tendency toward *virtual educational institutions*. In the future, we can also expect many more global virtual laboratories and libraries, like the National Science Digital Library (www.nsdl.org) and the Global Library Initiative (www.globallibrary.org).

12.2.8 The challenge

The global forest sector appears still to be somewhat hazy and unprepared for the impacts of ICT. There are even some who seem to doubt the relevance of ICT to forests. This state of affairs is reminiscent of how biodiversity or forest carbon issues were viewed in the 1980s and even in 1990s in the forest sector. These issues were left in a drawer and taken out only when they had already grown into serious problems. As noted earlier (Chapter 1), it is such gradual and general trends that tend to be the most dangerous ones, as their relevance for current operations is often seen as minor.

Thus, the forest sector has not really made fundamental changes to current models, strategies, or policies as a result of ICT development. The business-as-usual approach still dominates. The paperless office debate may also have made many skeptical. When, despite rapid ICT development, the vision of the paperless office turned out to be inaccurate, this was taken as evidence that ICT development is not of great concern. For example, many industry analysts and forest economists still use the old models to project an ever-continuing growth in communication papers.

The analyses in this study show that the forest sector needs to pay more attention to ICT development. Long-term strategies to deal with the changes that will be caused by future ICT development are necessary. This study has identified a number of possible impacts of ICT developments, but their exact timing is difficult and, for some impacts, even impossible to identify. The analysis also stresses another overall conclusion, namely the *need to increase research* on ICT impacts on the forest sector. The forest sector and society need to thoroughly understand the ICT phenomenon and its links to the forest sector to prepare for the changes. This study has pointed to a number of issues that need further research.

An important overall conclusion from the study is that the forest sector needs to implement *new strategies* in the face of ICT development worldwide—but particularly in the traditional forest countries of North America, the Nordic countries, Japan, and central and western Europe. ICT development is likely to accelerate the trend of moving the forest sectors in traditional forest countries into the twilight zone of outsourcing, closing of mills, unemployment, and increasing difficulties in maintaining profitable and sustainable forest management. Without new strategies, restructuring, and prioritizing it is difficult to see how a viable forest sector could be maintained in these regions in the long run.

The mindset in the forest sector has to change from a cost-leader strategy to one of using technological innovations for the development of new transformational products. Combining forest resources with modern ICT and creating new innovative businesses, whether in manufacturing or services, could be one way of keeping forest sectors viable in regions that are currently heavily dependent on traditional forest industries. However, current forest companies do not necessarily have strategies to focus on these new directions but may prefer to produce an ever-larger magnitude of current forest products and to develop new markets, such as China and India. For example, Rooks (2005) and Kenny (2005) conclude that the paper industry has been unable to make real progress in producing high-tech products and that its challenge is brand-new, high-tech applications.

The first step toward these new opportunities is to acknowledge the importance of ICT in shaping the future of the forest sector. For those interested in pursuing new developments and innovations in the forest sector, there is also a strong need to look at developments outside the sector. For example, the use of new ICT technologies, nanotechnology, and biotechnology, and the ability to make returns from these technologies, are likely to require the establishment of strong networks outside the traditional forest sector. This probably means that we also need to look for products and industries that do not exist today, rather than viewing future opportunities through the lens of existing assets and capabilities. Instead, it may be appropriate to ask the question: “What if we start anew?” This question requires a *changed mindset*, a change that the traditional forest sector should make if it wants to utilize the new opportunities.

National forest sector policies could play an important role in creating an environment in which new innovative forest sector strategies and businesses could evolve. The natural role for government would be to enhance research and development in new technologies and their applications as well as support investments in more-risky, long-term projects related to new innovations. Simultaneously, governments should seek to avoid the policy of direct subsidies to wood production and the forest industry. That is, governmental policy should emphasize advancing new innovations rather than securing existing structures. For forest policy, a first step would be to acknowledge that ICT developments have already made a contribution to ongoing structural changes in the forest sector.

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