SUSTAINABLE INNOVATION

A New Age of Innovation and Finland's Innovation Policy

Antti Hautamäki

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PREFACE

Finland's competitiveness has been largely based on the export of industrial products (pulp and paper, electronics and engineering) and strong investments on research and development. However, the global economy is quickly changing and value is migrating from the west to the east, and from products to solutions and services. The incremental improvement of conventional products is no longer sufficient. A new age of innovation is emerging. The cornerstones of this new paradigm are user orientation, sustainability and innovation in global networks. As a result, there is increasing pressure to adjust Finland's innovation policy to meet the challenges of the human and solution-centric service economy.

In this book research Professor Antti Hautamäki, a former director of Sitra, presents a new conception of innovation, called sustainable innovation. The concept builds on many salient aspects of modern innovation: sustainable development, ecosystem thinking, participative and continuous innovation, as well as innovative leadership.

The author elaborates this new concept in a novel way, based on recent research literature and the experiences of Finland's innovation policy. Consequently, the book provides a stimulating outline for Finland's innovation policy to advance.

New concepts for innovation are particularly welcome as the world attempts to recover from the 2008 financial crisis. Sustainable success can only be built on reforming our behavior, values and institutional structures. Professor Hautamäki provides excellent introduction to this process.

Helsinki, July 2010

Mikko Kosonen
President
Sitra, the Finnish Innovation Fund

AUTHOR'S PREFACE

This is a book about sustainable innovation and the new landscape of the global economy. The focus is on presenting the emerging view of innovation, characterized by creativity, openness, networking, and responsibility. The aim is to introduce to a large audience and decision makers a new concept: that of a sustainable innovation policy.

This work draws on a variety research reports, lectures and seminars, and several interviews (the names of those interviewed are given at the end of book) conducted in Finland and the United States. While many of the examples I present are from the United States, the main emphasis is on Finland's innovation policy. My starting point is the conviction that countries' innovation policies are facing new types of challenges arising from globalization, many environmental complexities, and the changed character of innovation activity. The name of the book, *Sustainable Innovation,* refers to the requirement of promoting sustainable development within the means of the innovation process. For me, sustainable innovation also means participative, continuous, and global innovation, as well as innovative leadership. So the challenge of sustainable innovation concerns our whole environment of innovation, research and development activities, and the innovation strategies of businesses. This book should not be considered as a systematic presentation of a new innovation policy, but rather my personal perspective on the new challenges of innovation policy creation and implementation and about the considerations for them.

The Finnish innovation system has been deemed a success according to many international comparisons. But the global economy is rapidly changing and so the Finnish innovation system is in need of reform. Several changes in Finland's innovation system have taken place in the last two years. In 2008 a new national innovation strategy was presented, introducing a "broad-based innovation policy." The following year, Parliament passed a new Universities Act for a fundemental reform of the Finnish university system. Most specifically, Finnish universities have been given considerable autonomy, allowing them more space to operate and compete within Finland and beyond. Foreign audiences might be interested in becoming familiar with the new developments taking place in Finland. In this study I describe and evaluate these new phenomena in the context of the Finnish innovation environment.

This work is the result of the research project Global Knowledge Transfer, financed by the Finnish Innovation Fund, Sitra. During this project (2006–2007), I was a visiting scholar at the University of California (UC), Berkeley. In addition to my research, I participated in establishing FinNode, a new Finnish innovation center in

Silicon Valley, California. From those experiences a book in Finnish was first published in 2008 (Hautamäki 2008a). This English translation gives me a chance to update the text. The original book was written for a Finnish audience. The new English version was edited to be more interesting for international audience. In this effort, Barbara Crawford helped me to correct the language and to translate the text for an international audience. I'm grateful for her patience and ingenious recommendations. I am also grateful to Matti Kari for translating the original Finnish book. Finally I thank Sitra for publishing this work.

In March 2009 I accepted a position as research professor at the Agora Center of the University of Jyväskylä, an interdisciplinary research center focused on innovative research on human technology and the knowledge society. My research focuses on the innovation processes, particularly service innovation. From the beginning of this year, I was nominated to and accepted the post as the director of the Agora Center. I look forward to the new challenges and possibilities in bringing to life the concept of sustainable innovation presented here.

Jyväskylä, 19 May 2010

Antti Hautamäki
Ph.D., Research Professor
Director
Agora Center, University of Jyväskylä

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INTRODUCTION: SUSTAINABLE INNOVATION

Finland's recent economic success has been based primarily on our good innovation environment and well-functioning institutions. We have systematically developed the innovation system and emphasize research and development (R&D) activities. The work undertaken over recent decades has proved fruitful and we have become one of the top high technology countries. Our competitiveness, technological level, and ability to innovate are internationally top of the class. In Finland, a clear unanimity regarding the lines of the innovation policy and among the basic actors has focused the common goals and heightened cooperation.

The development of our innovation environment is continually at stake, and the present Finnish government has strongly committed support for the financing of R&D activities. The reports and strategies about the targets and challenges of development in recent years have been good, so is there a need for a new book on innovation policy?

I believe such a book is indeed needed, but with the focus not so much on the problems of the present system, but instead on future challenges. Global development has changed the framework and goals of innovation activity in many ways. Although globalization has been discussed for many years, only now are we starting to realize the changes it has on societies and economics, nationally and internationally. Such changes are occurring relatively quickly when we consider the surprising rate of growth in the economies of China and India.

Globalization increases competition, but, perhaps more importantly, it opens up totally new opportunities for a small country like Finland. And, with strategic agility, we would be able to seize these opportunities. In order to succeed in this world of unexpected possibilities, we have to find our strengths. Finnish companies may not be able to compete with other others in terms of price, but certainly they can when it comes to quality. In addition, we need to present totally new types of products and services, particularly those not readily found in other countries. To achieve this kind of qualitative advantage represents a significant challenge to the nation's innovation activity.

In the knowledge-based global economy that is taking shape innovations must be based on scientific knowledge. The best examples are new pharmaceuticals and methods of treatment based on biotechnology. This is why both developed industrial countries and developing countries invest in basic research. Companies today need highly educated workforces who can apply the newest results of scientific research within the innovation activity.

The global economy has not only opened new markets and broadened the scope of low-cost production in the developing countries, but has had a significant impact on innovation activity. There are experts all over the world and, of course, the majority of them are outside one's own country or company. The global world has been called "even" (i.e., flat), as well as "spiky."[1] It is even because the barriers are lower than before and interaction is easier. It is spiky because experts have made their way into innovation centers all over the world. In innovation activity, these phenomena must be utilized by opening the innovation processes to cooperation. Open and decentralized innovation is replacing the prevailing closed innovation.

Focusing on customers is the other order of the day. Successful innovation is based on the ability to respond to the needs of customers now and in the future. Rarely today is a simple technical invention sufficient. Often, ongoing refinement is required. Moreover, innovations in business activities are becoming more central: how can a company best serve the customer in a way the customer is willing to pay for? The focus is moving from technological innovations to customer and service innovations. This is a significant challenge to the traditional innovation policy, where the emphasis has been on the development of the technology.

Globalization has shown its strength but also its weakness. One of the most alarming phenomena of globalization is the environmental difficulty caused by rapid economic growth. Perhaps the warming of the atmosphere is the most serious challenge threatening humankind. The consumption of fossil fuels for energy has pushed the environment close to its limit. It is not unthinkable that the processes could get out of hand and we that find we cannot stop the global warming. We are also consuming our non-renewable natural resources at an alarming rate, jeopardizing the living conditions of future generations. Economic development is not occurring on a sustainable basis.

The call to sustainable development challenges us to consider the value of economic growth. Surely, economic growth has increased material well-being and improved the living standard in those countries pursuing this growth. However, the quality of life in these societies has not been improved in the same way, nor has it always been equally distributed. Worldwide, the threats to the environment have increased and the polarization of people into rich and poor—among and within countries—continues. Furthermore, the tempo of working life has become more demanding, and some companies have moved their activities into more profitable countries, and have then dismissed the employees they left behind. Much of our social development is not occurring on a sustainable basis.

In this book, therefore, I introduce a new term, *sustainable innovation*.[2] By sustainable innovation I mean innovation activities that are based on ethically, socially,

1 See T. Friedman, The World is Flat (2005) and Florida & Gulden, "The World is Spiky" (2005).

2 I presented the concept sustainable innovation in the Finnish edition of this book (Hautamäki, 2008a) and in an article (Hautamäki, 2008b). I founded also a Web site to disseminate the concept (www.sustainableinnovation.fi).

economically, and environmentally sustainable principles. With this concept I want to combine the opportunities associated with sustainable development practices with new perspectives on innovation activity and management. Thus, the concept of sustainable innovation consists of five principles: *sustainable development, participative innovation, continuous innovation, global innovation, and innovative management*.

The principles of sustainable innovation have been implemented in advanced organizations and companies all over the world. However, mainstream economic factions and public innovation policies have not yet adopted the idea. For these entities, sustainable development is perceived as a marginal condition only, and not as the central goal of a particular innovation. It seems material growth remains the primary purpose without much thought regarding its reasons or alternatives. I will return to this concept of sustainable innovation later.

Developing innovation activity requires the cooperation of many actors. Clearly, it concerns businesses and companies themselves, but also research institutions, financiers, company personnel, consumers and other interest groups. Innovation activity involves not only inventing (an internal company process), but also the introduction and commercializing of innovations (external processes). Many of the bottlenecks of innovation activity result from company management. While innovations are impossible to predict, one can create favorable conditions that allow them to emerge. This is a challenge for leaderships at national and regional levels and at the organizational level. Sustainable innovation requires a new type of management where the emphasis is on vision, enthusiasm, delegation, confidence, and purposefulness.

I do not directly address in this book separate technologies or branches of industry, with the exception of environmental technology. Preventing atmospheric warming requires the cooperation of many actors in research, industry, and society. All of the main branches of technology—knowledge and communication technology, biotechnology, nanotechnology, and energy technology—are relevant to sustainable development. "Cleantech" is not a separate technology, rather a cluster of various solutions and innovations that together produce the processes, products, and services that reduce the need for non-renewable energy and natural resources, thus stressing the environment less. This is why cleantech is the best possible example of an innovation activity based on the cooperation and uniting of different areas of knowledge. The future innovation environment must be the birthplace of innovations based on this kind of unification.

I also do not intend to present a systematic program for innovation policy. Instead, I start from the new challenges that developers of the innovation activity must face. How they should react to these challenges would require a separate study. I do make some proposals that I think should be considered. Additionally, in later chapters of the book, the presentation is more of a discussion of various perspectives than an empirical account. I believe that this approach is more likely to

encourage new ideas. I present new research, interview data, and examples. The References section provides a glimpse of the extensive literature in the field. I take several of my examples from the United States, which I think is justified because the United States is currently the world's leading country in the field of the scientific research and technology.

The contents of this book comprise the challenges we face. First, I begin with the challenge of sustainable development in search of economic growth (Chapter 1). Traditionally, the indicators of economic growth (consumption and GNP) have not accounted for the burden of the economy on the environment. However, the environment is very much an element of economic activity. We must proceed from the perspective of economic growth within a broader concept of human development: the ultimate goal of economic growth must be the promotion of human well-being. Therefore, all forms of capital must be taken into account in human development: industrial capital, human capital, natural capital, and social capital. At the same time, the conditions of economic activity can be estimated in a broader way. For example, the social and ethical bases of economic activity are incomplete if they do not promote global human rights. Keeping the company owner's interest as the sole or primary value of entrepreneurship gives a narrow view of the multitude of actors that the company depends on and affects. The interests of all groups (intended and unintended, directly or indirectly affected) must be taken into account broadly when developing entrepreneurship. Thus, global responsibility and the "worship of ownership" are examined as special issues in Chapter 1.

In the Chapter 2 an outline of the innovation system of Finland is presented. Its innovation policy has been a central part of the Finnish success story.

R&D financing in Finland has increased significantly in recent years. In the year 2009, the R&D financing of the state was already €1.9 billion. However, the universities lack resources, which impacts the basic research and quality of teaching. In the recent years, R&D funding has been directed significantly toward the financing of *technology* research in universities at the expense of *basic* research. What is essential now is for new R&D resources to be allocated to universities specifically for basic research.

However, times and circumstances are changing, and so the basic elements and the goals of the innovation policy must be re-examined. The new theory of growth, formed in the field of economics, provides the justification and economic rationale for innovation investment because of the ultimate benefit for economic growth. At the same time, the development of the global economy seems to be particularly influenced by the widespread integration of technologies in general use, the local adoption of knowledge and technology produced abroad, and, especially, the emphasis on the norms and regulations of social and public institutions. As a result, the development of institutions adds social innovations to the agenda of innovation policy. Moreover, the agenda of innovation policy is changing because success in contemporary markets depends significantly less on the nature of

the product and considerably more on companies' understanding of the needs of their customers, on their innovation ability, and on their management, networks, and support services. While good technology is a competitive advantage, it is no longer enough to guarantee—or even presume—success. Innovation policy must have demand and service-based innovation as its starting point. The end of Chapter 2 analyzes the major conclusions and suggestions presented in an international evaluation of the Finnish innovation system.

The role of the universities in innovation activities often is understood incorrectly. Universities, for their part, carry out basic research and produce new scientific knowledge, but the innovation in fact primarily arises from within companies. Meanwhile, universities have their primary influence in the development of society and the economy by placing the results of their research within the reach of everyone and by educating the future workforce. I call this division of tasks *the basic model of the transfer of knowledge* (Chapter 3). For transferring technology, Finland and other industrialized countries have built up various systems and organizations, from the licensing offices of universities to the financing of technology companies. The licensing activity of universities is not very profitable for most of them, which strengthens the credibility of the basic model.

Seeing that basic research is the foundation for all innovation activity, it should be readily available globally. I explore the functioning of some of the top universities in the United States, where most of the world's best universities are found. Although Finland most likely cannot reach the same level of financing and international recruitment of students and teachers to supplement its trained domestic researchers and educators as the universities of the United States have, Finnish universities could still learn something about their practices and academic atmosphere.

Innovations are born in creative environments. It is not enough that the innovation system feeds money through various pipelines into the innovation activity. According to the proposed basic model, innovations germinate within companies. We must therefore investigate the business environment of companies (Chapter 4). I use the concept of an *innovation ecosystem* to describe a dynamic and interactive environment where the companies can nurture innovations. The ecosystem of innovation incorporates not only established companies and entrepreneurs, but also universities and research institutions, capital investors and other financiers, a skilled work force, and the multitude of services supporting the ecosystem activities. But the real dynamics are formed by the mobility of ideas and people and the overall culture of innovation, which is unafraid to take risks. I believe these can form a good foundation upon which to develop innovation activity in Finland. In addition to the level of national governmental activity, a new type of regional-level development is needed. The two levels together help strengthen the local innovation environments. In order to create these local innovation environments, the various scientific fields, levels of the administration and local actors need to cooperate. A small country like Finland has to concentrate its resources on

specific attainable goals, and this is why I propose that five or six world-class innovation centers be established and supported around the country.

In the past, innovation activity was rather individualistic and isolated. Each company worked alone to create its innovations and to protect its ideas. Today's tougher competition compels companies toward still faster and continuous innovation. Companies' own resources are no longer enough to produce the innovations needed. This is why the different types of decentralized innovation need to become more routine (Chapter 5), in line with the much-talked-about paradigm of open innovation. However, I will show that there are several forms of decentralized innovation, most of them linked to open access, like the Linux system. In this type of decentralized model of innovation, the relevant organizations are able to draw on the know-how of the other companies, customers, users, and different "independent" experts. There is even the new concept of Wikinomia, which refers to an economy based on new mass collaboration.

The decentralized innovation process is becoming global. Knowledge is spreading throughout the world. Today, several developing economies contribute significantly to R & D activities, have built leading universities, and have created science parks and technology villages (or rather technology cities). This shows that experts are to be found everywhere. As a result, innovation activity should also be global, that there needs to be cooperation between the experts from any and all parts of the world (Chapter 6). A small country like Finland must be able to adopt the latest knowledge and technology from around the world. This is why the key question I raise is: How can knowledge be identified and adopted? In considering this question I have created a model that depicts the many channels of innovations. This model helps us to analyze the global networks involved in the movement and acquisition of knowledge.

At the end of this book I present a chapter of conclusions, which are aimed at decision makers. The theme of the chapter is the movement toward sustainable innovation. In principle, the idea of sustainable innovation must be understood within companies as well as among leaderships. The discussion on this is currently taking place in Finland and elsewhere. But structures change slowly. And so, in order to realize the changes, innovative leadership is required. At times I feel that we have lacked leadership in Finland and other industrial countries, lacked visionary and bold leaders. Companies today are able to adapt more flexibly and quickly. They are starting to display a strategic agility. Companies that move toward sustainable innovation will detect new business possibilities, and do so in an ethically sustainable way. However, for the public administration, the requirements of innovative management constitute a major policy challenge. Finally, I compare the traditional innovation policy with the new sustainable innovation policy that is currently being shaped.

Chapter 1:

SUSTAINABLE DEVELOPMENT REDEFINES ECONOMIC GROWTH

Innovations are usually observed within a framework of rapid change and increased international competition in the contemporary economic arena. In modern business, however, the word *innovation* can mean just about anything new, rather than things that are pioneering. This results in the creation of tools and processes without the focused investigation or the goal of whether or not the new tool or process has benefits beyond its immediate economic outcome. The picture would be totally different, however, if innovation were linked to sustainable development, the ongoing, long-term development of society and the realization of human values. In that scenario innovation is an output that promotes the common good while simultaneously supporting the success of the organization or the company., In *Innovation Nation* (2007), innovations expert John Kao defines innovation as the ability of individuals, companies, and nations to create continuously the future they desire. This concept of innovation reflects well the mission of this book.

Earlier, I characterized sustainable innovation as an innovation activity that is based on ethically, socially, economically, and environmentally sustainable principles.[3] From this perspective, the principles of the sustainable innovation embody

- Sustainable development: innovations that support sustainable development;
- Participative innovation: innovations that involve a variety of stakeholders, such as company personnel, customers, users, and citizens; the demand and user orientation in innovation; and the development and respect of the know-how of people;
- Continuous innovation: innovations with the ability to continually renew and break new ground
- Global innovation: innovation amidst global cooperation that utilizes the know-how generated anywhere and everywhere; and
- Innovative management: management within companies, organizations and society that enables and encourages innovations, as well as the innovation of management itself.

3 I introduced this concept of sustainable innovation in a Finnish version of this book (see Hautamäki, 2008a, 2008b).

Based on these components I propose that

> Sustainable innovation means innovation that balances the long-term influences of the innovation process and the actual innovative output with the needs of and impacts on people, societies, the economy and the environment.

The sphere of sustainable innovation encompasses the process, product, and service innovations of companies and organizations, but also the social innovations (Hämäläinen & Heiskala, 2007). Good legislation, the promotion of citizens' health and education, environmental protection, and the empowerment of the civil society are some of the goals and objectives of social innovations. Increasingly, social innovations are impacting the prosperity and success of countries, and, at times, social innovation is often more important than even the best technological innovations.

The emphasis must be on the long-term influences of innovations because the short-term influences of a product or service often do not reveal the product's real impact on people or society. For example, what are the long-term outcomes or implications of a new medicine for high blood pressure, genetically modified food, a new fuel, a new service, faster trains, mobile Internet, and so on? The perspective of sustainable innovation reaches beyond today and into future generations. The target of innovation activity must be to provide coming generations with a world that is at least as good as the one we inherited from our predecessors.

Often, "a better world" is understood in terms of increased prosperity, that an innovation activity must stimulate economic growth so that our material standard of living becomes better and we can consume more. The target here is to increase the number of goods. However, the idea behind sustainable development is to improve the quality of life. Thus, a clear conflict between the targets of the innovation activities surfaces: Should we emphasize everyone's material prosperity or improve the quality of life for all? Sustainable innovation is targeted to promote the latter goal. While sustainable innovation strives for economic growth, this outcome is not the foremost value.

The traditional way to address the challenges of economic competition is to improve productivity within innovation activity and, as a result, to further economic growth. Thus, we are bound by the formula

> **Innovation → Productivity → Growth (designated as IPG).**

From the point of view of sustainable development this formula is problematic. When all countries follow the IPG formula, we as a global community drift dangerously toward the extreme limits of tolerance in our natural environment. One of the largest threats to our planet and our species is the warming of the atmosphere. The recent report by the Intergovernmental Panel on Climate Change (2007) stated that

the warming of the atmosphere is unambiguous and can be seen in the increase in ocean temperatures, the large-scale melting of snow and ice, and in the rise of the sea level. According to the report, it is clear that the human activities have significantly influenced the warming of the atmosphere.

At the same time, we are using greater amounts of non-renewable natural resources, desertification is advancing, waterways are polluted, and fish stocks are declining. The human population continues to increase rapidly, especially in developing countries. It is estimated that the global population will be 7 billion in 2012, 8 billion in 2026 and 9 billion in 2043, meaning the population will increase by 50% in just 40 years. The related increase in the world economies and world populations is linked to increased energy consumption, primarily for vehicle traffic, industrial production and agriculture, as well as for indoor climate control (e.g., heating, cooling, etc.). Today, the United States consumes the most oil per person. However, if China and India start consuming similar per-capita quantities, worldwide daily oil consumption would increase from the recent 85 million oil barrels to 200 million barrels.[4]

Although there is a rather large global consensus regarding, for example, the negative influence of economic growth on atmospheric warming, the connection has yet to be seen clearly in the economic, social, and innovation policies of developed countries. The ongoing policy to promote material growth has not altered. However, such a change is on the cards because undoubtedly some type of future crises will require it.

Economic growth as the highest goal of development in the policies of the developed—and developing—countries is based principally on the dominant way of thinking in economics. In it, economic development is seen as the condition for social development. The aim of economic growth is to increase consumption and, ultimately, GNP: Both are quantitative targets. Meanwhile, social development refers to an improvement of opportunities for all members of society to satisfy their basic human needs, attain adequate living conditions, live meaningful lives, and have access to health services and education. Although economic growth often supports social development, there is no automatic connection between the two. It is sometimes said that economic growth automatically solves social and environmental problems, but there is no strong empirical support for the belief that "wealthier means cleaner" (Harris et al., 2001).

However, sustainable development refers to the continuity of development conditions. Development is sustainable if it meets the needs of people today without destroying the potential of future generations to meet their needs. From this viewpoint, many actions of today threaten the lives of future generations, especially the destruction of the environment. The long-term costs of economic policy have not been taken into account sufficiently—neither by companies nor national economies.

4 See NationMaster.com at www.nationmaster.com/graph/ene_oil_con-energy-oil-consumption

In sustainable economic thinking, the forms of capital must be realigned. Capital in this context means the "stock" or resources used to produce the flow of goods and services. Within economic activity, four types of capital are employed

1. *Industrial (or physical) capital*, encompassing all that is created by people, such as buildings, machines, tangible products, and so on, as well as the production processes;
2. *Human capital*, comprising the education, skills, knowledge, and culture of a specific society;
3. *Natural capital,* involving all resources of nature, which can be divided into renewable and non-renewable resources; and
4. *Social capital,* representing all that is formed regarding the knowledge, norms and practices existing within the cultures and the institutions of a society, as well as the totality of the networks and cooperation among people.

All of these forms of capital are needed within a nation's economic activity, although the emphasis currently in economic science is placed primarily on industrial and human capital. This perspective seems to propose that any loss in natural capital can be substituted by an increase in industrial capital, and so natural capital has not received any special consideration.

The tenets of the economy of sustainable development and strong stability, however, presume that the changeability or replacement of natural capital and the availability of industrial capital is limited (Harris et al., 2001). Both forms of capital supplement each other, and both are needed for industrial production. For example, fishing tackle is useless without a stock of fish. When there is a question of a critical natural capital, such as water, then in reality no form of industrial capital is able to replace it. This is why it is so important to develop economic activity in such a way that natural capital is preserved. One could even take the considerably stronger standpoint that the economy and nature are incommensurable.

Stanford University biology professor Gretchen Daily (see Daily ed., 1997) sees the services or the supply of the natural ecosystem in a broad way including:

- purification of air and water
- mitigation of floods and droughts
- detoxification and decomposition of wastes
- generation and renewal of soil and soil fertility
- pollination of crops and natural vegetation
- control of agricultural pests
- dispersal of seeds and nutrients
- maintenance of biodiversity
- protection from ultraviolet rays

- stabilization of climate
- moderation of temperature extremes and the force of winds and waves
- support of diverse human cultures
- beauty and spiritual sustenance

The treatment of the different forms of natural capital requires two fundamental rules. First, the use of renewable natural resources, such as forests and fish stocks, cannot endanger the natural ability of these resources to regenerate. Second, the use of non-renewable natural resources, such as petroleum, requires at least one of the processes in the production of this non-renewable source to be fulfilled by the use of a renewable, substitutive natural resource, such as using biofuel to power the petroleum refinement process. These types of rules must be obligatory, so as not to destroy the natural capital we currently have or to impoverish the life of future generations.

A good general way to examine economic activity and the form of capital needed is through the model of the three systems (Harris et al., 2001). These three systems are

1. *The economic system*, which includes the production, exchange, and consumption;
2. *The social system*, which includes the citizens, families, organizations, and the cultural and social institutions, and the values that are the basis for these elements; and
3. *The natural system*, which is the worldwide ecosystem on which the economic and social systems depend.

The worldwide natural system limits the expansion of the economic system: The natural system must be preserved physically, which means that its critical elements (i.e., pure water, clean air, minerals) cannot be replaced by the economic system. Professor Daily and colleagues (2000) emphasize that, therefore, unlike in times past, the implications on the natural environment involved in an economic endeavor must be included in the costs of the endeavor. Thus, the "bottom line" of future economic endeavors must include environmental impact accountability. When natural resources are plentiful and they are a part of the common good, taking them into account within economic calculations does not seem necessary. Indeed, though that may have worked in the past, we are now moving into an era of shortages of natural resources. Therefore, the value of natural capital must be considered a measured quantity and added to the bookkeeping of each nation's economy. In summary, each nation should measure its social and natural well-being in addition to its economic output. In this way, all three essential elements of national well-being are conscious elements in discussions and decisions regarding national policy and goals.

Sincein the 20th century the economic system has been self-monitoring, without constraints from government or society. From the point of view of sustainable development, the social system, which includes the democratic process, must implement constraints or boundaries on the overall economic development, based on human and cultural values. The natural system requires continuity and preservation; the social system requires human well-being and development. The Indian economist Amartya Sen, in particular, has addressed this (see Nussbaum & Sen, 1993). In his opinion, the emphasis in economic development must shift from incomes to outcomes, and from growth in the national product per person to the improvement of personal quality of life. From the point of view of individuals, economic development must open for people more and better opportunities to benefit from their talents, resources, wealth, and labor. Sen's basic philosophy is "development as freedom" (Sen, 1999), which means that development must expand the sphere of options within the reach of all. It is important to note, however, that this philosophy to broaden the sphere of options is not only the goal of development, but also one of its most important tools. People who are active, creative, and seize opportunities simultaneously advance their own development. Clearly, poverty, sickness, and insufficient education limit people's opportunities for choice.

Therefore, social capital is central to the successful functioning of society. To function, a society needs norms and the rules. Social capital is the binding element of the social system. Without mutual trust and the will to develop the common good, the costs of running society increase. Social capital is important also for the functioning of the economic system. It has been convincingly shown, for example in research by the World Bank (Grootaert & Bastelaer, 2002), that social capital is both the input and output of an economic system, that is it is both consumed and invested capital. As expressed by economics, social capital improves the function of the economic system by decreasing the costs of the exchange, which, in its part, promotes networking and cooperation.

So, these three systems are, in many ways, dependent on each other and influence the development of each other (see Figure 1). However, each of the systems also has independent areas, where a certain firm logic of specific development operates. In the social system, population growth and social participation follow certain rules related to, for instance, demographic factors and living standards. Certain laws of economics, business and market fluctuations influence the economic system. Regularities in the natural system are linked to changes in the atmosphere and the ecosystem (e.g., natural selection). Simultaneously, though, each of these systems is affected by the conditions of the others. Growth in the economic system increases material wealth, which adds to the development of the social system (e.g., through enhanced education and health services). The economic system may also create technologies that increase greenhouse gases, which can limit or influence the development of our species or the species upon which we live. These interdependencies form the basis of the development of the social and individual well-being.

As a whole, then, we can generate a general principle of the sustainable development in which *all forms of the capital must be developed in a balanced way and supplement each other*. Economic systems should no longer be viewed as independent processes when they can destroy the natural capital or weaken the social capital. Yet, this is what occurs regularly in developing countries, where traditional communal ways of life are being destroyed and the know-how of indigenous people is being devalued or lost. There is no legitimacy for an economic system that exhausts the useful non-regenerated natural resources in a couple of generations.

I started this chapter with the IPG formula: Innovation → Productivity → Growth. And the subsequent text has demonstrated that sustainable innovation requires that this formula be reconsidered. The starting point of the reformation is that the innovations must, above all, support human development and well-being throughout the world. To restate this in the language of economics, innovations must improve the use of the resources—all capitals—in a sustainable way in order to achieve the basic goals. Because quantitative growth is not a meaningful goal for natural or social capital, it is better to talk about the *sustainable reproduction of all resources*. This reproduction means using resources so that they are available also in the future.[5]

The formula of sustainable innovation now acquires the form

> Sustainable innovation → sustainable reproduction of the resources
> → increase of the well-being.

This can be condensed further into the formula

> **Innovation → Reproduction → Well-being (designated as IRW).**

Sustainable innovation is an interactive process in which the different forms of capital are used in a balanced way to produce innovations that promote long-term human development and the good of the people—in Finland and throughout the world. In this innovation process capital is both consumed and regenerated. The IPG formula stresses economic growth within the innovation activity, while the IRW formula stresses development in which the essential element is the reproduction of the different forms of capital.

The dominant economic thinking links rather straightforwardly national income and economic growth with social well-being. However, this linkage is not easy to prove since well-being cannot be defined with the same exactness as national income. The concept of well-being is derived from philosophy and social science rather than from economics. Some 2,300 years ago, Aristotle considered that the

5 According to an English-language dictionary, *reproduce* means to produce again by generation, to cause to exist again or anew. Karl Marx used the term *reproduction* in the case of human capital.

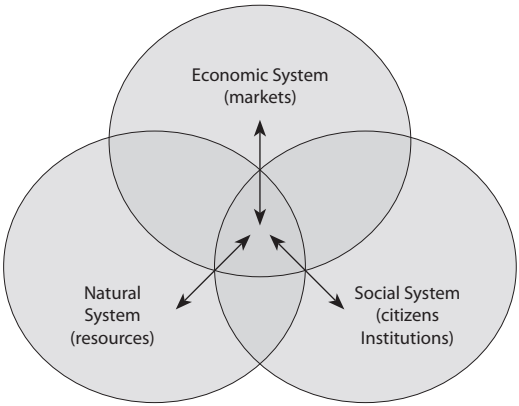

Figure 1.
The dependency and the interaction of systems.

most important task of the state is to promote the good life of the people. Many sociologists have taken well-being as an important category of their theories about society. The well-known Finnish sociologist Erik Allardt (1976) linked well-being with the satisfaction of need. In his opinion, the basic needs of people are linked with the living standard, friendships, and self-realization. Well-being, therefore, is a multi-faceted phenomenon, where the material living standard is only one dimension.

While my proposal puts human well-being and economic growth on an equal footing, I do not believe that growth in well-being automatically ties in with economic growth. They are different phenomena. Economic growth, in the long-run, increases conditions of well-being, but so does the functioning of the social system and democracy, as well as the condition of the natural system (pure water and air, the richness of the species, the refreshment value of nature). As a result, the formula that serves as a heuristic tool of the thinking on this is

> Well-being is the function of the nation's income,
> social capital, and natural capital.

The re-estimation of the theories of economic growth is a significant challenge to that scientific field. The productivity indicators of the national economy need to put more emphasis on the external influences of the environment, way of life, and social well-being. So instead of attending only to material growth, value must be given to the qualitative growth, which is linked to services, culture, knowledge and entertainment, to name a few. Information and communication technologies make possible the global flow of bytes, which decreases the "movement of the atoms"; in other words, when products and services are digital, the unnecessary movement of

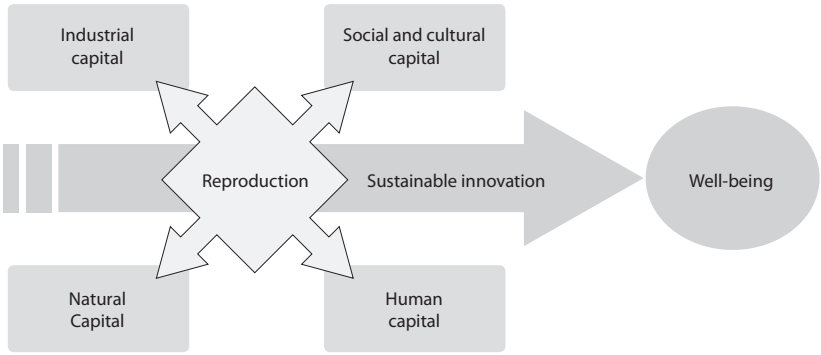

Figure 2.
The sustainable innovation in the reproduction of capital and in the improvement of well being (IRW-formula).

people and goods is diminished. The renowned nuclear physicist A.P.J. Abdul Kalam[6], the former President of State of India, has stressed that the definition of GDP should be changed to take into account the number of the poor people and the realization of the values of the nation. It has also been proposed that the gross national product (GNP) definition should involve "green accounting," meaning accounting for the condition of the environment.

Economic science has not reached consensus on the factors that influence a nation's growth. In fact, researchers at the Research Institute of the Finnish Economy (Etla) proposed that the time of quantitative, extensive growth is drawing to a close (see Hyytinen & Rouvinen, 2005). Even the quantitative increase in human capital (i.e., extensive growth) does not produce more value for society. Now, the new pursuit is "qualitative," high-level results (i.e., intensive growth). According to Etla, the new keyword in education, research, and development must be quality, rather than quantity, because the growth of productivity results in *intensive* growth.

Growth in productivity must be kept subordinate to human and sustainable development. Growth in productivity can be viewed from two perspectives. Either the same input is used to achieve a larger output, or the input is decreased but achieves the same output as before. The first course increases the products and services while the other spares the inputs; and the first course may increase the standard of living, but the second may increase the quality of life and well-being. An even more important goal of productivity is to produce the "right type" of products. However, I do not underestimate the need for growth in productivity. Growth in productivity could compensate for an aging population or the high cost of labor. Growth

6 This information was presented by Dr. Kalam at a presentation at a Sitra seminar 2006.

in productivity also provides an important means of competitiveness for industrial countries, where the cost of labor is much higher than in developing countries.

In a broader sense qualitative growth means a transition from the short-sighted thinking of economic growth to the promotion of long-term sustainable development. Using the catchwords fashionable in the US, there is the question of the *clean-* or *green-tech* revolution. The entire industrial structure and all transportation and daily living activities must be changed quickly into a model that either decreases dependence on non-renewable natural resources or decreases energy consumption. We must look for innovations in which energy production, industrial production, transportation, agriculture, daily life, and city operations are reformed from the starting point of sustainable development. This presents a significant challenge for innovation policies.

The realization of this kind of innovation policy—sustainable innovation—requires unusually unbiased and long-term points of view on the part of our decision makers and heads of industry. Resisting the pressure to compete globally in traditional ways (i.e., by increasing the productivity and the material growth) is extremely difficult. However, if politicians, leaders of industry, and even average citizens look to the future without prejudice, it is clear that the change of the direction is directly ahead.

Countries that adapt their economic functioning to the cleantech era will benefit enormously. An important aspect of this cleantech era is the increased role of services in society. Services do not necessarily consume large quantities of energy or non-renewable natural resources. For example, some services will be based on totally non-material events through data networks. Distance learning and computer games are useful and/or fun activities not dependent on a physical place! Of course, the challenge of cleantech is higher for the areas of energy production and consumption, transportation of persons and goods, the development of social structures, and the production of goods. Yet, we must proceed on all these fronts.

If Finland goes down this road, we can, for our part, help prevent the warming of the atmosphere and promote the sufficiency of natural resources. This would also reduce our energy bills. From the point of view of the economy, we could have an advantage because we would be able to offer the products, services, and know-how of the future. The demand for these will explode in the next 10–20 years. Today, t the environment business is already worth US$1.6 billion, and it will grow to US$7.4 billion by 2025 with the market growing at about 8% a year.[7] The market for clean technologies is growing even faster, averaging 30% a year.

It is important to note that companies that continue their old-fashioned production ways *are* meeting traditional market demands. However, these demands are changing. Increasingly, consumers are stressing natural production, energy savings, and sustainability as the values and decision-making criteria of the market-

7 http://www.hkc22.com/environmentalbusiness.html

place. Ultimately, this trend will grow and, with it, changes in industrial production will come. The entire industrial value chain, from subcontractors to customers, will receive direction from changing social and consumer values. The primary field of knowledge in future industrial applications will be *environmental knowledge*, that is, energy and material efficiency without undesirable environmental impacts—in other words, clean technologies.

The durability of products also will become an important matter. Today's homes and offices, and, more importantly, landfills, contain a variety of equipment and products that either no longer work or have been superseded by products that meets new requirements. For example, some consumers replace their mobile phone every year because the old one has problems or does not have some new desirable quality.[8] While this situation may be good business for the manufacturer, it is certainly bad for the consumer and the natural environment. Here, it is apt to remember Hannah Arendt's (1958) distinction between the using and consuming. *Using* means that an object, such as an apartment, is "adopted" as a part of one's way of living and, thus becomes a permanent aspect of one's own environment. *Consuming*, on the other hand, means the destruction of the object.

In the clean future, products will last years or decades, in some ways reminiscent of the rustic kitchen utensils, furniture, or tools of former centuries, which were handed down from generation to generation. When thinking about the short life cycle of products today, the move from disposability to durability would be a huge change in the course of industry's earnings. Although recycling has been embraced by many industries, the idea of producing something that would not need to be recycled is revolutionary. Of course, not all products need to be or can be long-lasting. For example, it is reasonable to replace cars spewing carbon dioxide with new electrically operated cars. Here, technology functions in two dimensions: products can be made more durable than before and problematic products can be replaced with better products than before. It is clear that technology will continue to develop even as better, more durable products are created. To stop technological innovation would be disastrous from the sustainable development perspective.

Sustainable innovation and increased well-being must be promulgated as the central tenet of development within the innovation activity. This requires new thinking in science, technology and innovation policies, in regional development, and within public organizations and private companies. It is no longer enough to do more and better within the same processes of the last century. Simply investing

8 Nowadays, e-waste is becoming a significant problem, especially for developing countries to which developed countries send their defunct computers and other ICT equipment. According to Ted Smith, the founder of the Silicon Valley Toxics Coalition, "Every new generation of technology … sends zillions more of our computers and TVs to global trash heaps". It has been estimated that Microsoft's new operating system, Windows Vista, makes many computers useless and creates a tsunami of e-waste. Another important environment concern is the energy consumption by computers and computer centers, most of which is linked to cooling the environment around the machines. The computer centers spend 50 times more energy than the corresponding normal offices (San Francisco Chronicle, 9.8.2007).

more money in traditional R&D activities or company financing will not address the challenges of the 21st century and beyond. Nor is it enough to simply reorganize the research network or the supporting organizations. More money or revised structures cannot completely satisfy the changes to come that are based on different values and management expectations.

All principles of sustainable innovation are closely linked to values. Sustainable development, international cooperation, realizing the know-how of personnel, customers, and citizens within the innovation activity, and building up an environment that supports innovations all reflect value choices. These values are based on respect for people and the natural environment, a defense of equal opportunities for all people, and confidence and solidarity within a world community. One of Finland's trump cards in global competition is its adherence to traditional Nordic values, which are favorable in terms of sustainable innovation and the responsible management that promotes it. This asset is not derived from money, although money can destroy it. To date, only Japan and Norway have prepared strategies of sustainable innovation activity.

Sustainable innovation is a worldwide responsibility

One inseparable dimension of sustainable innovation is to improve economies and, especially, the well-being of the populations of developing countries. At a conference in Finland in 2007, Japanese science and technology expert Ayao Tsuge demanded a globally sustainable ecosystem within innovations. In his opinion, worldwide problems can be solved if countries and businesses invest in sustainable development through technology. Surely there are more of these of problems, sadly more than we can imagine: poverty and sicknesses in developing countries, the worldwide use of energy, the burgeoning demand for pure water, the maintenance of the rain forests and other natural ecosystems, the support of democracy, and stopping circles of violence, to name just a few.

To be sure, the problems listed above are very complicated, and the solutions will require several approaches and deep cooperation from various quarters and interest groups around the world. John Kao (2007) calls these kinds of problems "wicked," and sees them as the keys to the most influential breakthroughs of the 21st century. Part of the solution to wicked problems requires new breakthroughs in business models and ways of thinking, so that the status quo is changed. They require integrated approaches that combine new perspectives with new ways to innovate. In Finland, we need a new attitude of readiness to grasp the most difficult problems and seek the solutions for them within global cooperation. This attitude is required from people who want to develop a genuine innovation nation.

Sustainable innovation requires a global perspective, where, in particular, developing countries are drawn into the spotlight. An interesting point of view on developing countries was given by C. K. Prahalad, the developer of company strategies, in *The Fortune at the Bottom of Pyramid* (2004).[9] Prahalad argues that a totally new type of entrepreneurship and innovation arises from the poverty of developing countries, based on the goal of producing good quality but inexpensive products from minimal resources. What is most important in this new entrepreneurship is not cheap labor, although this is an important factor, but smart cost cutting, extremely far outsourcing, and new forms of financing. As a result mobile phone calls can be offered for a couple of cents a minute and heart bypass surgeries for €1,500. Profits are earned from the mass market, not high prices.

The extreme conditions (mass markets, low solvency, etc.) in developing countries have created a totally new ecosystem of innovations, where various innovations are born, compared to "fat" markets. For example, the companies of Silicon Valley, California, often do not think first about the price of a product or service. Quality and newness are enough to generate sales at the product's introduction. While the iPod costs about $US200 and iPhone about $US400, computers in India are produced in the $US100 price range. Of course, this is not solely a pricing issue, but this shows that one could produce almost similar products for different markets in quite different price categories. Tata Motors in India brought to the market a new car called the People's Car Nano, which costs about US$3,000. Needless to say, a car for that price drew great interest in European markets as well. Another example is the Indian technology for video negotiation,[10] which functions by small data transfer rates and, thus, can be used in the remote villages and schools, where fast broadband connections are scarce.

In recent years, Western companies have invested heavily in developing countries like India, often for the rationales of cheap labor and increasing markets. According to Prahalad (2004), it has not been understood, however, that outsourcing is not the export of the labor, but the import of innovations! When a company or investor settles down in a new business environment it is possible for it to take part in the local ecosystem of innovations. Western companies need to discover in the developing countries' radical innovations applications that are also suitable for industrialized countries and which, in many fields, may revolutionize production and business logic. In addition, most products from developing countries would be more environmentally friendly because buyers need and expect durability and longevity from their products. Moreover, the limited natural and financial resources

9 The challenges of developing countries must be answered by a new type of innovations, the so-called BOP Bottom of the Pyramid, innovations, highlighted by the wise use of resources (human and material). Through a BOP innovation, a producer could reach the emerging market of the next 4 billion consumers (see Prahalad & Krishnan 2008, p. 5).

10 See the Object Oriented Programming Services (OOPS) Pvt. Ltd., at http://www.oops.co.in/about/theoopsstory.html

in these developing countries mean that buyers cannot continually replace products and therefore seek out long-lasting, simple, quality products at an affordable price.

An interesting phenomenon of the time is the Innovation Democracy, Inc., established in Silicon Valley. This non-profit organization aims at change by identifying and supporting small but important initiatives made by local innovators that benefit local communities[11]. The organization helps, in particular, local entrepreneurs to grow their business activities in the critical geographical areas of Central Asia, the Middle East, Eastern Europe, and Asia.

The organization emphasizes a reliance on small steps and innovation. The goal of the mission[12] is to

- "Make the ability to contribute—and innovate—everyone's right and privilege in a society.
- Invigorate people's belief in their own self worth; Boost and support their capacity to make a difference to their local community and beyond.
- Find innovative ideas and people already working on local initiatives to turn their novel ideas into business ventures. Act as an experienced mentor and early-stage investor to ingenuity and entrepreneurship."

In order to realize this mission, Innovation Democracy looks for innovative and business-minded people in developing countries, makes micro-investments in their companies, and organizes, in conjunction with local universities, learning opportunities on entrepreneurship and business. This basic philosophy is progressive. Instead of giving general development aid or delivering food, local people are assisted in developing their own know-how. They are educated in economic processes so that they can develop their own products for their own markets, thus becoming both producers and consumers, rather than just consumers. As the Chinese proverb goes, Give a man a fish and you feed him for a day; teach a man to fish and you feed him for a lifetime. Although Innovation Democracy is still a small and fledgling operation, it has already received a good reception in Silicon Valley, a sign that the values and thoughts of business people are changing.

11 See http://www.innodemo.com/
12 http://www.innodemo.com/page2.html

The "management worshipping ownership" crisis

Sustainable innovation is a topical and important principle for companies. Some of the world's best companies already are implementing sustainable innovation: Their personnel (at all levels) are their most important resource, the viewpoint of sustainable development is adopted in all activities, and their products and services are developed together with customers. Social responsibility has become a hot theme nowadays in companies, and the success of companies in the markets is more often affected by their good reputation and their role as an active member of the society.

Despite such promising corporate behavior, far too many companies still operate on the attitudes of the past, where the advantages of the owners (and investors) are worshipped and the only acceptable motif of the business management is to profit the owners. In his shocking article "Bad Management Theories are Destroying Good Management Practices," the recently deceased London School of Economics professor Sumantra Ghoshal (2005) argued that the "liberalism"[13] represented by Milton Friedman and his comrades has led business schools toward a wrong type of theory and to harmful teaching based on it. The economic models practiced since the 1960s that have grown out of Friedman's "liberalism" have transformed the daily practice of business management in the United States and other industrialized countries.

Without going into the methodology of this type of business management[14], the dogmas of Friedman's "liberalism" are, according to Ghoshal

- There is no place for moral or ethical observations in business management
- The task of the managers is to maximize the value of the share-holders' investment
- The human being is an opportunistic "homo economicus," who always tries to maximize his own advantage, which is why people must be controlled
- Options are an acceptable way to bind business management and add to the owners' value

13 I put "liberalism" in the quotation marks, because Milton Friedman's "liberalism," a so-called individualistic neo-conservatism, is just one kind of liberalism.

14 According to Ghoshal, there is bad theory behind the bad practices. The theoretical background is based on the British individualistic philosophy (Hume, Bentham, Locke), positivism (moving the model of the natural sciences into the social sciences), agent theory, the theory of exchange costs, the dominance of economics in the theories of business science, Friedman's liberalistic ideology, and an underestimation of practical experience. The dilemmas of the philosophical science behind are the causality vs. intentionality, quantitative models vs. qualitative materials, etc. The "principal in the first degree" is the so-called Chicago school, where Friedman represented economics.

- When producing value, invested money is more important than the contribution of labor
- Salaries and the position of the employees must be kept as low as possible.

The reasons for this negative development can be found, in addition to the "bad theory," in the waves of leadership. Miles et al. (2007) have plotted the development of management and social thinking from the 19th century until today. They note that the recession of the 1930s and the Second World War created a culture of solidarity within management, where the basic values were equality and the common responsibility to promote the well-being of all. However, the ideology started to shift in the 1970s, when the members of the baby boom generation, who had grown up amid good welfare conditions and without first-hand knowledge of the World War, began to influence various areas of the business world. Finally, the rise to power of the conservative US President Reagan and Britain's Prime Minister Thatcher brought about changes in social policy. Among the outcomes in business management were that the shareholder value model displaced the stakeholder value model, and that the advantage of the owner rose above the advantage of other interest groups (customers, subcontractors, NGOs).

The "liberalistic" ideology is based on a pessimistic view of human beings and on the attempt to loosen the company from the human and social framework. In this way of thinking, no place exists in business for the joint responsibility of companies or attentive listening to the stakeholders. This "liberalistic" thinking and acting has led to several corporate scandals in the United States (e.g., Enron, Tyco, the option backdating scandal in Silicon Valley in 2007) and other industrialized countries, to enormous compensations and severance payments to the company leaders, to employee layoffs in order to get higher profits, and the 24/7 work culture, to mention just some of the problems.

Both Ghoshal and Raymond Miles (Miles et al., 2005) consider that the old model of thinking has drifted into a crisis concerning both theory and practice. Ghoshal (2005) demands a "positive thinking" about the workers and organizations, to eliminate the theoretical dead end in contemporary management thinking[15]. New sustainable characteristics can then be emphasized, values such as excellence, dynamism, flourishing, superfluity, perseverance, virtuosity, and, above all, confidence. Additionally, the old monolithic basis of theory needs to give way to genuine pluralism.

Furthermore, an interesting argument against the "liberal" management practice emerges from innovation theory (see Miles et al., 2007). In the global economy of today, the competitive ability of developed countries is based on knowledge-inten-

15 Much of contemporary management theory views the human as being pessimistic or opportunistic in traditional management theory: Workers need to be controlled.

sive innovations, which involves the adaptation of the newest science and technology within product development. Innovation based on knowledge presupposes an organization where a confidential atmosphere supports the delivery of knowledge. Yet confidence rises only when all personnel of the company are treated equitably. In an equal and confidential atmosphere, knowledge and know-how are given freely, and cooperation on all levels functions without problems. A good "chain" of innovations is built in such a way that innovation depends on the delivery of knowledge, and the delivery of the knowledge, for its part, depends on the build-up of confidence and equal treatment of all.

Raymond Miles' broad perspective about the changes in business management in the United States brings up, in an interesting way, the connection between a company's social values and success. The last 20–30 years have been a period of hegemony in the emphasis on the owners' value and the "liberalistic" way of thinking. Yet some US scholars seem to think that the US is losing its leading positions in innovation (see , e.g., Kao, 2007; Estrin, 2009).

John Kao (2007) has argued that the basis of the innovation activity in the United States has diminished essentially. He refers to problems in the school systems, the decreased openness resulting from, for example, the tightening of the international work permit policy, and the reverse brain drain. Judy Estrin is also concerned about the innovation capabilities of the US in *Closing the Innovation Gap* (2009). According to Estrin, the US is rapidly losing its advantage. The main reason is the short-term orientation in business and in research and development. She points out the current problems in the educational system as well. In a *BusinessWeek cover story*, Michael Mandel (2009) writes about "innovation interrupted," in which, during the last decade, US innovation has failed to realize its promise. Interestingly, he sees this interruption as a partial explanation for America's current economic woes, such as its borrowing practices. One conclusion of this discussion is that the financial crisis is covering over an innovation gap that lies behind it. This means that the real solution to the current woes of the US is to enhance its innovation capabilities. This long-term economic recovery perspective is also an important reminder to Finland.

Miles et al. (2005, 2007) stress that an innovation economy based on knowledge cannot function well if the society is divided and the trust falters. Here, in comparing competitive ability, he presents as examples the small winner countries, such as Finland, Sweden, Denmark, and Switzerland. These countries' good social conditions, strong competitive ability, and innovation correlate with each other, a point also stressed by Manuel Castells and Pekka Himanen in *The Information Society and the Welfare State: The Finnish Model* (2002). The great interest around the world regarding the Finnish and the Nordic "model" is for us a sign that the welfare society must be purposefully developed—not weakened—by the innovation policy. Also Kao (2007) takes Finland, Denmark, and Singapore as examples of countries that purposefully developed into innovation nations.

From the policy of restrictions to the policy of possibilities

Global problems, including the warming of the atmosphere, poverty and underdevelopment are in many ways linked to business activity, although opinions vary considerably regarding the role of individual companies in this equation. On the one hand, companies are viewed as scapegoats while globalization, led by the multinational enterprises, is accused of being responsible for everything that is wrong with the world today. On the other hand, many companies have taken an active role in their societies and in protecting the environment, and in binding themselves to social responsibility and ethical principles. Furthermore, many companies have realized business opportunities based on clean technologies and new energy technologies, and have developed sustainable innovations. Next, I will analyze this dispute about the role of companies in climate change and other global problems like poverty.

Professor Robert B. Reich of the University of California, Berkeley, who served as the Secretary of Labor in President Clinton's administration, presented an interesting and challenging opinion about corporate responsibility. In *Supercapitalism* (2007), he describes the change of the capitalism of the 1970s to a new type of capitalism that he calls supercapitalism. Decades ago in the United States one could talk about democratic capitalism, where the values and goals of the society and the economy were seen be combined. New technology and globalization, however, have produced an extremely competitive economy. Amid this competition, some companies operate with only one target: to satisfy their customers in order to earn more profit for their owners. Supercapitalism means that profit for shareholders is the only target of business.

Thus, for many within this competitive business arena, human values and the environment do not contain any intrinsic value. Global competition and global value chains have increased productivity and created an extremely large supply of goods and services. However, this development has brought a growing group of problems, some of which were identified above. Between 1979 and 2005, the mean after-tax income for the top 1% increased by 176%, compared to an increase of 69% for the top quintile overall, 20% for the fourth quintile, 21% for the middle quintile, 17% for the second quintile and 6% for the bottom quintile (Income inequality in the United States, from Wikipedia). A similar development is taking place in Finland and all of the industrial countries.

The most interesting part of this analysis is the contradictory situation for citizens. Though they confront a host of problems brought about by their nation's companies operating in the competitive global economy, they also benefit from the productivity of the stock investments of those same companies. The security and growth of their insurances and pensions depends upon the growth of those shares.

Citizens also seem to benefit from cheaper consumer goods that result from the productivity and cheap labor of the developing countries supporting that productivity. In this way, the people benefit from supercapitalism as consumers and as investors, but lose out as the citizens of their national society and as members of humankind.

Reich disagreed with opinions that the nationality of a company and the declaration of its social responsibility could change its supercapitalism. Firms are always looking for the best locations for their operations, independent of the nationalities of the firms' origin or ownership. Generally, company owners do not willingly "waste" their company's money on social charity. If and when the companies reduce the use of energy, produce environmentally friendly products, pay good salaries, or invest in the training of the personnel, it is typically because the company benefits from it. Good reputation also has a monetary value, which also can be lost, as Nike discovered when its reputation was damaged from its use of child labor at its Indian factories. Therefore, the connection between the seeking out and supporting the common good and the perceived function of the company is broken.

A company's home country does not bring much benefit any more either. Owners of companies are the faceless pension funds in Europe, Japan, the United States, and so on. The owners are not interested in whether the employment positions are eliminated in the "home country," when new factories and research institutions can be established abroad—mostly in developing countries like China and India—for a lower financial outlay. What's good for the company is not necessarily good for the country.

Interestingly, both Milton Friedman and Reich conclude that the primary focus of business leaders is economic profit, but for different reasons. While Milton Friedman (2002, p. 133) advocates that companies function best when they do not distract themselves from goals other than producing profit, Reich (2007) criticizes the fact that they have no other possibility than to do so. In his critique of supercapitalism, Reich points that the current economic system (i.e., demands of owners or stock holders) leaves no options for conscientious managers to accept broader goals, such as social responsibility, even if they want to.

During this era of the supercapitalism, the fulfillment of capitalism is separated from the achievement of democratic values, and politics is a means by which companies pursue their own aims. At least in the United States, the influence of companies and special interests—through lobbying—within the political realm is more common than ever. Legislation is needed to safeguard the political process from the competitive advantages sought by the various alliances of companies, as Reich shows with several examples.

Robert Reich's vision is to restore the value of democracy in the corporate world, and to bring about legislation that promotes social and human values. However, this can happen only by engaging ordinary citizens within the political process. The most important goal is to prevent excessive influence by companies on the

political agenda and the legislative process. It is unrealistic to expect the majority of companies would voluntarily bind themselves to promoting the common good. Rather, Reich proposes, promoting the common good requires strong laws and strict enforcement.

The current international economic crisis, which started in US in 2008, is proof of Reich's perspective. Uncontrolled mortgage lending and subprime loans led to the expansion of risks and, finally, to a crisis of confidence in financial institution. This ultimately hurt the financial stability of some companies and industries beyond the financial industry. There is much distrust and uncertainty among financial market actors and federal regulators, and thus lending has become more tightly controlled and, in some cases, quite limited. The crisis underscores the viewpoint that trust and social capital are the foundation of economic systems. The proposed solutions to the financial crisis include the stronger regulation of, and more transparency in, the banking industry in order to rebuild confidence in that economic sector. Yet the problem might be strongly connected to the values system of US, as Raymond Miles (Miles et al., 2005) observed. Judy Estrin (2009, p. 5) says directly that, "America has lost the core values that were the catalysts of its success." So America has to close the innovation gap that is growing not only relative to Asia, and especially to China, but also relative to its own past.

Reich's (2007) analysis is very similar to that of the traditional environmental and anti-globalization movements. They see company profit seeking as leading to indifference toward atmospheric warming, poverty, and underdevelopment. In this profit-seeking position, economic development and democracy are considered mutually exclusive activities. Therefore, in their view, companies should be controlled more tightly, their economic activity should be limited, and they should follow very strict environmental norms.

This policy of limitations is addressed by environmental advocates Ted Nordhaus and Michael Shellenberger in *Break Through* (2007). They argue that a policy of limitations will be unsuccessful because it does not take into account changing values. In developed countries, consumers have moved from material values to post-material values, such as self-realization, status in the society, and membership of communities. For such people the opportunities to fulfill oneself freely through one's own choices are central. A policy of limitations stands at odds with this set of values. It creates a negative policy, which in turn arouses opposition. In addition, Nordhaus and Shellenberger note that atmospheric warming can no longer be prevented; the emphasis now should be on quickly learning to adapt to it.

Instead, a more workable solution to the challenges of the environment and society could be found in the "policy of possibilities" proposed by Nordhaus and Shellenberger (2007). Its main idea is the ability of human beings to overcome difficulties and to face challenges by using creativity and energy. Nordhaus and Shellenberger present a pro-growth agenda that leads to such a well-being, improves

the overall quality of life and overcomes the ecological crisis. In the policy of possibilities, concepts that typically had been considered polar opposites (i.e., human being–nature, society–individual, and public administration–markets), must be overcome.[16] Indeed, these concepts must now be considered related concepts that need to be balanced in some ways and in some circumstances. In the sustainable innovation model, I have overcome these traditional boundaries in the division of the four forms of capital by stressing the interaction among the economic, social, and natural systems.

From the point of view of the environment, the policy of possibilities stresses a combining of investments and innovations. The needed reduction in both naturally occurring and manmade greenhouse gases cannot be achieved without radical technological innovations and new organization of social functions. These demand creativity, innovations, and challenging goals, much like the process of the American Apollo space program.[17] A new Apollo-type program, required by the "planetary emergency" described by US vice-president-turned-environmentalist Al Gore in *An Inconvenient Truth* (2007), would radically change the energy use and greenhouse emissions by industries and communities. The growth promoted by the policy of possibilities does not necessarily mean the growth of a nation's economy, but rather the growth of a nation's general well-being. This growth opens possibilities for all people to develop as individuals, creates new markets for clean technologies and environmentally friendly products, and provides solutions for addressing the needs of developing countries regarding energy, waste management, and clean water. Developing countries are unable to adapt to climate change without getting new technologies from developed countries

It might be true that the policy of possibilities sounds like a dream, but Nordhaus and Shellenberger (2007) speak strongly about the need for and power of the dreams. Surely the challenges of humankind cannot be solved through limitations and abstinence, but rather by harnessing the creativity and innovation of individual dreamers and forward-thinking companies to produce a better world.

Nordhaus and Shellenberger (2007) demanded a break in the absolute barriers. Companies function within a society and are dependent upon the frameworks offered by that society, its legislation, trained labor, investments and, almost fundamentally, its values. In addition, social values and goals can create the demand for clean technologies and environmentally friendly products. I think that Reich does

16 The old environmentalism is based on these kinds of oppositions, which might inhibit finding workable solutions to environmental issues. For example, market mechanisms are useful for producing affordable clean technology.

17 The first Sputnik launch into orbit in 1957 was an enormous shock to the United States. The goal of the Apollo program in 1961, established by President John F. Kennedy, was to send a man to the moon before the end of the decade and to defeat the Soviet Union in the conquest of space. The Apollo program expressed the effort to reestablish national pride through science and technology. The program was a success and produced large quantities of diverse know-how and innovations. In 1969, Neil Armstrong became the first person to step onto the surface of the moon.

not give enough weight to the demand factors, although he stresses the companies' ability to respond to the needs of consumers. My own thinking is closer to Nordhaus and Shellenberger's policy of possibilities than Reich's policy of limitations. However, I admit that the development of technology, especially effective information and communication technologies, have created extremely stiff competition where the common good can be easily forgotten. An efficient way to restrain the negative influences of competition is to make the rules binding in the same way for all actors, regardless of their countries. Reich does not speak about global rules in his book, but I see a substantial need to make national, as well as international, rules for business competition. Within international and multinational corporations and organizations, a stronger voice of democracy needs to be heard. More specifically, few of the solutions to international problems or issues should be generated from the economic-needs perspective of companies. Instead, such decisions should take into account the multifaceted influence that these rules would have on populations, social development and the environment.

Perhaps, the most important basic question is how to find the balance between democratic values and the needs of companies. A country that adopts remarkably tight environmental norms, keeps wage levels high, protects employment opportunities, and so on, will lose global competitiveness. On the other hand, a country that allows its environment to be destroyed, the income disparity of its citizens to grow excessively, its to jobs disappear, and its social capital to deteriorate is not a society worthy of people. A good society must be maintained using all available means while the companies' areas of operation are developed. Finland has good possibilities to combine successful business activity with a high quality of life and well-being.

Chapter 2:

AN OUTLINE OF FINLAND'S NEW INNOVATION POLICY

In general, the Finnish innovation system has been quite successful.[18] The World Economic Forum (WEF) ranked Finland first in growth competitiveness in 2005, followed by the US. According to the WEF, Finland has one of the most innovative business environments in the world, which is particularly critical in driving productivity in the country. Finland is one of the EU's two star performers on the European Innovation Scoreboard (2009). Its innovation policy has been a key component in all government programs in Finland since the economic depression of the early 1990s. The country's investment in research and development grew from 2.5% of GDP in 1995 to 3.5% in 2000, something of a record globally.

In 2008, the GDP share of R&D expenditure in Finland rose to 3.72%, up from 3.5% where it had stood for some years, while for 2009 the share was estimated to be 3.92%. For many years Finland's GDP share of R&D expenditure has been the second highest among EU countries (behind Sweden), and when compared more broadly to other countries, Finland trails only Israel. About €6.9 billion was spent on research and development in Finland in 2008. Business enterprises accounted for €5.1 billion (74%), the higher education sector for just under €1.2 billion (17%), and the rest of the public sector for nearly €600 million (9%) (Statistics Finland, 2009).

The governmental structure of the Finnish innovation system generally comprises:

Research and Innovation Council, chaired by the prime minister, advises the Government (Council of State) and its ministries in important matters concerning research, technology, and innovation, as well as their utilization and evaluation. The Research and Innovation Council is responsible for the strategic development and coordination of the Finnish science and technology policy and of the national innovation system as a whole.

The *Ministry of Education and Culture*[19] is responsible for developing education, science, cultural, sport and youth policies, and international collaboration in these fields.

18 A general description of Finnish Innovation system (in Finnish) can be found in Dahlman et al. (2006) and TEM (2009a); see also www.research.fi. Miettinen (2002) gives a critical overview of national innovation system concept.

19 The name of Ministry of Education was changed to the Ministry of Education and Culture in the year 2010.

The *Academy of Finland* is the prime funding agency for basic research in Finland. The Academy operates within the administrative sector of the Ministry of Education and Culture, getting its resources from the budget of Government.

The *Ministry of Employment and the Economy* (MEE) is responsible for the operating environment underpinning entrepreneurship and innovation activities, securing the functioning of the labor market, and workers' employability, as well as for regional development within the global economy. The Ministry was established in 2008 through a reconfiguration of the former Ministry of Trade and Industry, the Ministry of Labour, and the unit responsible for regional development within the Ministry of the Interior.

Tekes, the Finnish Funding Agency for Technology and Innovation is a publicly funded expert organization for financing research, development, and innovation in Finland. Tekes operates within the administrative sector of the MEE.

Sitra, the Finnish Innovation Fund, is an independent public fund under the supervision of the Finnish Parliament and promotes the welfare of Finnish society.

In recent years, the main steps to enhance innovation in Finland include establishing Strategic Centres for Science, Technology and Innovations (SHOKs), university reform, and creating a new innovation strategy.[20] SHOKs will strengthen key areas of research and innovation in terms of strategic competencies required by the business sector, while significantly increasing the dialogue between cutting-edge research and the testing and piloting necessary for capitalizing on findings. Currently, six centers are in operation:

- Forest cluster: Forest Ltd.
- Information and communication industry and services: TIVIT Ltd.
- Metal products and mechanical engineering: FIMECC Ltd.
- Energy and the environment: CLEEN Ltd.
- Built environment innovations
- Health and well-being.

The first national innovation strategy, *Making Finland a Leading Country in Innovation*, prepared under the auspices of Sitra, proposed establishing 5–10 university

20 The content of this new chapter is based on the information provided in www.research.fi, as well as the websites of the Finnish Ministry of Education and Culture, Ministry of Employment and the Economy, and Tekes.

concentrations (Sitra, 2005). Finland is now proceeding towards this target through university reform. Parliament passed the Universities Act in June 2009, which gives universities larger economic and administrative autonomy, though their main mission—education, research, and regional interaction—remains unchanged. University administration and management will be reformed and strengthened to enable universities to respond more flexibly and independently to the challenges arising from their new financial status. The reform will also consolidate academic decision-making and the position of university rectors. The government guarantees index-bound core funding to the universities and will provide enough capital to assure their liquidity, solvency, and credit standing. University capital will accrue from the movable and immovable property of each university, as well as from direct transfers. In addition to the government funding, other organizations and businesses can contribute towards the university capital.

The new status of independent legal entities is intended to consolidate university autonomy. The Universities Act designates two kinds of universities: public and foundation. Finnish universities will become either independent corporations under public law or foundations under private law (Universities Act, 558/2009). All universities operate in their new form from 1 January 2010 onwards. Their operations are built upon the concepts of university autonomy and freedom of education and research.

In eastern Finland, the universities of Kuopio and Joensuu merged together in 2010 to form the University of Eastern Finland. A consortium between the University of Turku and the Turku School of Economics and Business Administration started in 2008. In the greater Helsinki area, a new university is being made by joining together the Helsinki University of Technology, Helsinki School of Economics, and the University of Art and Design to form the Aalto University, started as a foundation university in 2010. This reform reduced the number of universities from 20 to 16 by 2010.

The forming of Aalto University is the clearest change in the university system in the decades. The legal form of the new university is a foundation of private law. Its basic capital comes from a state investment of €500 million until 2012 and donations of at least €200 million from business and private donors. After 2012, the functions of the university are to be financed by a combination of state aid, tendered research financing, teaching services, and income from external donations to basic capital and to different types of dedicated foundations. The initial financial basis of Aalto University will be clearly strengthened by the doubling the combined state aid of the three former institutions until 2012.

Prime Minister Matti Vanhanen's Second Cabinet's Government Programme committed to prepare a new national innovation strategy.[21] The practical prepara-

21 Two national-level innovation strategies have been formulated in the last five years. The first was created by Sitra (the Finnish Innovation Fund) in 2005, titled Making Finland a Leading Country of Innovation. The second strategy, created in 2008, was created by the Vanhanen government (see Aho et al, 2008).

tion of the strategic work was carried out by the Ministry of Employment and the Economy (until 31 December 2007, Ministry of Trade and Industry). The strategy was prepared on a transparent basis, involving an extensive consultation by specialists, stakeholders and the public. Nearly 800 specialists gave their views in workshops and online. A steering group chaired by Esko Aho, President of Sitra, was appointed for the actual preparation of the innovation strategy (see Aho et al., 2008). The steering group submitted its proposal for a national innovation strategy to the Ministry of Employment and the Economy in June 2008. The strategy identified four key drivers of change: globalization, sustainable development, new technologies, and demographic changes. Each involves both threats and opportunities for society and the economy.

According to the Government Programme, improving the productivity and competitiveness of the national economy would only be possible if innovation policy was given a broader basis and made more efficient. The government paid particular attention to policies concerning education, research, and technology, emphasizing the significance of business, design and organizational innovations alongside technical ones. Four basic focuses were presented in the strategy: innovation activity in a world without frontiers, demand and user orientation, innovative individuals and communities, and a systemic approach.

The strategy was an agenda for change, and this culminated in a systemic approach to pursuing innovation. The systemic approach constituted a key concept in implementing a broad-based innovation policy. Such an approach would constitute a comprehensive outlook, which would be essential, for instance, in solving environmental problems, enhancing the efficiency of public services, and constructing regional innovation centers. The strategy acknowledged that benefiting from the results of innovation activities requires broad-based development activities that enhance structural renewal, as well as a determined management of change. The strategy established two important reforms in order to improve the systemic change in governance:

1. The work of the Cabinet Committee on Economic Policy was enhanced as the forum for the state consortium's strategic management. The minister of education was included as a member of the Committee.
2. In support of the targeting, monitoring, assessment, and reconciliation of science, technology, and innovation policy, the Research and Innovation Council was established on 1 January 2009 to replace the former Science and Technology Policy Council, the tasks and composition of which have had a narrower scope.

The strategy and the government's communication on it to the Finnish Parliament contain dozens of proposals in several areas of the innovation policy (Työ- ja

elinkeinoministeriö, TEM, 2008). Some of them are quite general and it is unclear at the moment how successful implementing any of them will be. To my mind the real significance of the strategy is the offer of an accurate view about innovation and innovation policy to decision makers and innovation actors. The strategy presents a challenge of change. It is also important that an international review of the innovation system was carried out in order to identify changes in structures and operating models and development measures, as prescribed in the innovation strategy.

Universities in the Finnish innovation system

In several evaluations and studies of the innovation system, the development of the universities is seen as one of the most important challenges. In its strategy report *Science, Technology, Innovation*, the Finnish Science and Technology Policy Council (2006) stated directly that the most critical issue from the viewpoint of the functionability of the whole public research system is the structural reform of the university system, so that all of its parts can function as a part of the national innovation system and international education and science community. The reform of the research system has resulted in two important structural changes: the establishment of Strategic Centers for Science, Technology and Innovation (SHOKs) and the university reform, which, as mentioned, includes the merging of the Helsinki University of Technology, Helsinki School of Economics, and the University of Art and Design into the Aalto University.[22]

The Finnish R&D institute system consists now of 16 universities, 25 polytechnics, sometimes called universities of applied science, and 19 state research institutes under eight ministries.[23] The Academy of Finland is the prime funding agency for basic research. Tekes, the Finnish Funding Agency for Technology and Innovation, is a major funding agency for innovative research and development projects in companies, universities, and research institutes. Funding by the Academy and Tekes is allocated through a competitive proposal process. The R&D funding in the national budget was €1.9 million in 2009 (see Table 1). Tekes' portion was 30.3%, the universities' was 25.8%, and Academy of Finland's was 15.7%.

It is interesting to note the difference between the financing of Tekes and the Academy of Finland in the R&D financing by the government. Tekes' research financing (about €580 million in 2009) is nearly twice that of the Academy (€309 million). Tekes awarded about €223 million as research financing to universities, polytech-

22 The concept of Aalto University is interesting worldwide because it provides a novel combination of technology, art and design, and business (management, marketing).

23 The most important state research institutions are VTT (Technical Research Centre of Finland), the Finnish Forest Research Institute, the National Institute for Health and Welfare, and Agrifood Research, Finland.

	€ millions	%
Academy of Finland	309.0	16.3
Universities	490.0	25.8
Tekes	574.9	30.3
University central hospitals	40.0	2.1
State research institutes	299.0	15.7
Other R&D funding	186.7	9.8
TOTAL	1899.6	100

Table 1:
Finnish R&D financing in 2009. Source: Statistics Finland

nics, and public research institutions in 2008, and about the same amount goes to the companies in R&D project financing.

The financing from Tekes and the Academy has increased continuously by several percentage points a year, while direct government financing to universities has remained at the same level for many years. The largest concern in this development involves funding basic research, which has been under-financed in favor of applied-oriented and rather short-term research projects. As the literature has indicated, financing basic research should be long term and start from the internal priorities of science (see Geiger, 2004; Vest, 2007; Estrin, 2009).

In past decade and a half, the overall number of students in Finnish universities has risen by 30%. The number of master's degrees awarded has increased by 41% and the number doctoral degrees awarded has almost doubled. At the same time, the number of the lecturers has remained at almost the same level, with just a 4% increase. The student-teacher ratio in universities is 22:1. However, the number of research personnel has increased by 70%, reflecting the more than doubling of the research financing, from €425 million to €876 million (see Table 2).

Finnish universities have been very successful both in the numbers of the degrees granted and in publication activity. Finland has just 0.09% of the world's population, but 0.65% of the scientific publications and 1.0% of the citations. Moreover, Finland ranks as one of the top countries in the world when the number of citations is compared to its GNP. The following quotation from a 2006 report on scientific publications demonstrates the success of Finnish research activity:

	1995	2007
New enrollment in degree programs	18,679	19,648
Degree students altogether	134,872	176,306
Teaching staff	7,550	7,831
Research personnel	3,629	6,155
Other personnel (staff etc.)	12,162	14,083
Master's degrees	9,819	13,883
Doctorates	765	1,523
Funding (in €million)	1,081	2,089
– budgetary funds	765	1347
– external funding	316	742
– research funding from external funding	47	471

Table 2.
Numbers of students and personnel, degrees, and funding of universities in 1995 and 2007.
Source: The Ministry of Education, KOTA database[24] (2009)

> Relative to population and GDP, Finland is one of the world's biggest publishers, ahead of such traditionally strong countries in scientific research as the UK and Germany. In 2005, Finnish researchers produced 8,300 publications, the highest figure on record. The number of publications by Finnish researchers in international esteemed scientific journals has increased 2.5-fold during the past 20 years. The growth has been fastest in the early 1990s, when the number of publications increased at around 8 per cent per annum. In the 2000s, the annual growth rate has slowed to a few per cent.
>
> Finnish publications account for just over 2 per cent of all EU 25 publications and for just over 1 per cent of all OECD publications. Relative to population, the number of publications produced in Finland in 2005 was 1,600 per one million population. In a comparison of 30 OECD countries Finland ranked fourth after Switzerland, Sweden and Denmark. In 1995, Finland ranked fifth. (Research.fi, 2007)

Although productivity indicators reflect well on Finland, the situation of its universities is not as good. According to the 2009 list of the world's top universities, as ranked

24 Kota database: https://kotaplus.csc.fi/online/Etusivu.do;jsessionid=HgJcLy2LLTKQFbjWvGRFQQCm9hctV5BJkKPNlvjbx8GpLfy7xp4W!-1980908456?lng=en

by the Shanghai Jiao Tong University,[25] only one Finnish university ranks within the top 100 universities: the University of Helsinki is placed at number 72. This position is quite good, but other Finnish universities are not so well ranked.

It is interesting to compare the best university in Finland, the University of Helsinki, with the best university of the University of California system, namely, UC Berkeley (as indicated by the Shanghai ranking; see Table 3). Both are public universities with about the same number of students. The information used in this comparison comes from the universities' own data. However, the basic definitions might be different, so the numbers here are only approximate. UC Berkeley is in third place on the Top 99 list for 2009 and the University of Helsinki ranks 72. Berkeley is among the best public universities of the world, and Nobel prizes have been awarded to 20 of its researchers, the latest being George E. Smoot for physics in 2006.

	Helsinki	UC Berkeley	
Students	38,806	33,558	
Post-graduates	5,628	10,070	
– Foreign post-graduates %	9%	17%	
Total personnel	7,707	13,551	
Teaching and research personnel	3,784	5,161	
Expenses	646	1,589	US$ million [26]
– Teaching	316	475	US$ million
– Research	233	391	US$ million
Private financing	11%	18%	
Endowments [27]	27	2,200	US$ million

Table 3.
The University of Helsinki and UC Berkeley compared in statistics from 2008.

This comparison indicates that the overall number of personnel at UC Berkeley is about double that of Helsinki. The number of teaching and research personnel is 75% higher and teaching expenses are 50% higher compared to the University of Helsinki. In proportion to the number of students, the teaching resources in UC

25 Shanghai Jiao Tong University has created a ranking system for universities. The universities selected for analysis in the Shanghai ranking list are compared and evaluated on the basis of several indicators of academic or research performance, including alumni and staff winning Nobel Prizes and Fields Medals, highly cited researchers, papers published in Nature and science, papers indexed in major citation indices, and per capita academic performance of an institution. For each indicator, the highest scoring institution is assigned a score of 100; the remaining institutions are calculated as a percentage of the top score. Scores for each indicator are weighted to arrive at a final overall score for the institution.
http://www.arwu.org/ARWUMethodology2009.jsp.

26 Endowment capital, here euros are converted to US dollars: €1 = US$1.25.

27 The market value of endowments changes constantly. The University of Helsinki has also property (e.g., the University Pharmacy) with a market price about €500 million and a net yearly income from the property and business of about €55–60 million. (My thanks to the Bursar Ilkka Hyvärinen for this information.)

Berkeley are considerably higher. While foreign students constitute 3–4% of the student bodies at both universities, UC Berkeley has three times the number of foreign postgraduate students than the University of Helsinki. UC Berkeley contributes significantly to postgraduate studies, and as a result it is able to recruit top talents both as students and personnel. The University of Helsinki designates about 36% of its resources to research and UC Berkeley about 25%, but in real terms, Berkeley designates almost 70% more money to research than the University of Helsinki. However, the most significant difference between these universities is the enormous gap in endowment. In the United States, contributions to university endowments are actively sought, and the interest earned on endowment principal is a very important source of income.

To see the relative strength of the new Aalto University, one can compare its joined resources to the University of Helsinki (according to statistics of 2007). The research expenditure in Aalto University is €146 million, while the University of Helsinki spends €240 million. The student body at the University of Helsinki is about twice as large as the Aalto University is. On the 2009 Shanghai list, the Helsinki University of Technology (the strongest of the trio of universities composing the new Aalto University) is in the group ranked between 400 and 500, whereas the University of Helsinki is position 72!

Proposed government financing to establish the new university is so high that other universities around Finland fear they will not receive the additional financing promised by government in introducing the Universities Act.[28] So there must be other, more pressing reasons for forming Aalto University. And indeed there is: its unique combination of technology, management, and design might be quite considerable in enhancing interdisciplinary basic research and, thus, the innovation in industry, at least in the Helsinki region.

Only a few of the top universities in the world have as high a student-teacher ratio as the universities in Finland.[29] Perhaps, one symptom of this is that Finnish students study longer that their counterparts in other countries (see TEM, 2009b). In particular, it seems that one of the central tasks of the university, that of providing higher education based on research, is not properly supported.

Finland's universities host very few foreign students.[30] In 2006, just 4,000 foreign students were enrolled in master's or lower studies (undergraduate) and 1,900 were graduate students. About 4,500 undergraduate students went on international exchanges lasting more than 3 months and Finland received about 4,800 foreign students through the same programs. The percentage of foreign students to domestic students was about 2.7%, and about 60% of these were from countries outside of

28 The issue here concerns the growth of budgetary funding.
29 Student-teacher-ratio was in Finnish universities 18,5 (2005), where as it was in OECD countries 15.5 (2003)
30 The information in this passage comes from Sitra's report *Study Concerning the Creation of a Scholarship System for Foreign Degree Students* (in Finnish, Sitra, 2006). According to an OECD report (2008), international students consist of 3.7% of all tertiary enrolments compared to the OECD average of 6.9 %.

the EEA (European Economic Area). These figures are low compared to other OECD countries. In 2003, foreign degree students comprised 31% of all university students in the United States, 14% in Great Britain, 13% in Germany, 12% in France, 10% in Australia, and about 5% in Japan. All of the Nordic countries enroll more foreign students than Finland, especially Sweden and Denmark. In 2007, Finnish teachers and researchers made a total of 614 visits of at least one month's duration to foreign universities. Correspondingly, 1,104 foreign researchers visited Finnish universities. This moderate international exchange will be a serious problem for Finnish universities because, in a small country, it is hard to find the large numbers of talented domestic students and researchers required for raising the standard of the universities to the top. Therefore, Finnish students and scholars must be encouraged to visit foreign universities. At the same time, the attractiveness of Finnish universities needs to be improved by special programs.

Challenges for the Finnish innovation system

One could compare the innovation strategy and policy to the recent analysis of the Finnish innovation environment and industrial performance presented by Professors Charles Sabel and AnnaLee Saxenian in *A Fugitive Success: Finland's Economic Future* (2008). First, they consider that Finland is at risk of becoming a victim of its economic success. Areas of Finnish industry, forestry and ICT, have succeeded in optimizing their performance, but have neglected the development of totally new products and services. According to Sabel and Saxenian, "It is necessary to reorient national support for research and development away from familiar interlocutors in large firms and research institutes and towards a more varied 'ecology' of potential users" (p. 15). They even raise the idea of eliminating the national innovation system. Instead, they advocate local activities, openness to entirely new sources of knowledge and expertise, and building flexible institutions. What is essential in a global economy is "disruptive innovation," which alters the markets. They are skeptical about creating disruptive innovation in SHOKs, an approach that has the potential to exacerbate the existing concentration of resources in a network of establishing companies, universities, and locations rather than enhancing cross-fertilization. On the other hand, Sabel and Saxenian see the Center of Expertise Programme as a more promising, decentralized regional approach. This national program involves 13 national competence clusters and 21 regional centers of expertise around the country.

This analysis of the Finnish innovation system should be taken seriously. The forest sector, in particular, is experiencing the very concerns they describe. Meanwhile, Nokia is struggling with its transformation into a provider of services and structural solutions, although Yves Doz and Mikko Kosonen (2008b) detailed the

flexibility of Nokia's management. On the other hand, entities at the leading edge of Finnish industry are already in the collaborative mode and networking locally and globally, although the mainstream entities of industry are still in the performance-optimizing mode. In a recent study of the transition of Finnish industry, Petri Vasara, Antti Hautamäki, and their colleagues (2009) provide several examples of ongoing collaboration in innovation by Finnish companies. Finally, the new innovation strategy states clearly that a national-level definition of needs (top down) and actor-level, customer-oriented preparation of implementation (bottom up) must be combined in an interactive way. One instance of this combination strategy is the proposal to build regional innovation centers, which I describe later.

In 2009, an international evaluation[31] of the Finnish national innovation system was published. According to the evaluation "the current state of the Finnish innovation system is good but it does not suffice. Major adjustments are needed in order for Finland to meet its further challenges" (TEM, 2009b, p. 298). The most important are summarized here, with the proposals to address them:

1. The Finnish system is less international than conventionally thought and there are signs that it is falling further behind. Tapping deeper into the global knowledge pool should become one of the main objectives of the innovation policy (TEM, 2009b, p. 297).
2. Several organizations are engaging the same societal problem (e.g., stagnant growth in entrepreneurship) with similar tools, which leads to wasteful replication and adds institutional clutter. The innovation system is too complex. The panel calls for pre-screening of new actions in order to prevent duplication and overlaps (TEM, 2009a, p. 10). Adjusting existing organizational boundaries is needed (TEM, 2009b, p. 297).
3. Finland does not produce enough growth firms and Finnish entrepreneurs are too modest in their ambition. Finland has a structural mismatch: despite being recognized as one of the most innovative countries in the world, inputs to the innovation system do not appear to have resulted in equivalent outputs of a greater global supply of world-class, advanced goods and services stemming from Finnish ideas or entrepreneurial firms. Tax policy should explicitly recognize the incentives needed for talented persons to consider an entrepreneurial career choice, in addition to encouraging potential high-growth entrepreneurial firms to pursue international expansion (TEM, 2009a, pp. 60, 69).

31 The international evaluation was conducted by an independent international panel and its analysis and results were published in two forms by the Finnish Ministry of Employment and the Economy (Työ- ja Elinkeinoministeriö; TEM): the *Evaluation of the Finnish National Innovation System, Policy Report* (TEM, 2009a) and in a larger *Evaluation of the Finnish National Innovation System - Full Report* (TEM, 2009b).

4. Current national innovation support has an "unspoken" regional bias, which may have a negative overall impact in the relatively disadvantaged regions. Finland as a whole would benefit from redesigning its policy combination in order to foster the reallocation of its resources to their most productive uses. Also, attention should be paid to the two drivers of aggregate productivity: creative accumulation (productivity growth within companies) and creative destruction (productivity growth at the industry level; TEM 2009a, pp. 76–77).

Some of these issues are considered in the following chapters. The evaluation report considers that the ongoing university reform is the innovation system's most important change in several decades. On the other hand, the establishment of SHOKs is the most significant new policy instrument of the 2000s.

The SHOKs are legally limited companies (Ltd.) owned by private corporations and some public institutions, like universities. Building these strategic centers poses multiple challenges. Currently, SHOKs are in the form of incorporated companies functioning as networks. On the other hand, international experiences show that behind the success of this kind of center works a tight community of top researchers. If this basis is taken, top research units should be built up by establishing a physical institute and declaring an international competition for the best research plans. The researchers themselves could determine which area they would like to investigate. In this way, the influence of financier guidance from above could be avoided. The researchers or the group of researchers awarded funding through the competition would work in the institution. Better still, the institute would be located on a university campus conducting similar research, just as, for example, the research institute for biofuels has been established at UC Berkeley. The winning groups should have close links with industry and with institutions and colleagues all over the world doing the similar research. At best, the industry financing the research would have researchers in the institute. In this way, the research knowledge would directly move into use by the companies.

The international evaluation panel noted that it is "cautiously optimistic about the national SHOKs but suggests limiting public resources devoted to them. In the panel's view, SHOKs are mostly about incrementally renewing larger incumbent companies in traditional industries" (TEM, 2009a, p. 10).

Furthermore, the evaluation panel voiced two major concerns with the Finnish system of higher education (TEM, 2009a, p. 80). Finland tends to rank low when it comes to research output volume and particularly research quality.[32] Additionally,

32 This statement is quite strong compared to the general performance of Finnish universities in last 10 years (see www.research.fi).

Finland's higher education and public research sector is highly fragmented across three dimensions:

1. Resources are scattered into three types of institutions—universities, polytechnics, and public (state) research organizations—with partly overlapping duties;
2. These institutions are scattered around the country;
3. Universities are internally fragmented around the country.

According to the evaluation panel, the most critical challenge is to increase the quality of research in Finland. For that to occur, funding rules must be changed to emphasize quality.

In line with the evaluation report, a recent report from the Academy of Finland, *The State and Quality of Scientific Research in Finland* (Löppönen et al., 2009), notes that international comparisons of research output and quality show that Finland has fallen behind all the other Nordic countries and that the visibility and impact of scientific publishing in Finland has in recent years been on the decline. Finland's ranking in OECD comparisons has been declining since the 1990s. The report by the Academy analyzed the situation as follows:

> One factor contributing to these trends could well be that research funding in Finland as well as the current science and technology policy debate tend to lean quite heavily in an applied direction. A disproportionate amount of research at universities today focuses on application and product development at the expense of basic research. Key policy documents over the past few years have placed scientific research primarily in a technological and economic context. Other relevant factors probably include the large proportion of doctoral students within the research community, the standard of the science infrastructure, the research system's low level of internationalisation as well as defects in the principles of research funding and scientific management. (Löppönen et al., 2009, p. 17).

The evaluation panel also observed that resources for basic research are meager:

> First, it seems that resources for high quality **long-term** basic research are too low. Achieving the international level in research requires systematic and long term development of potential research units. Although both the Academy of Finland and Tekes may serve their purposes well in project-based funding, neither is suitable for building long-term high-quality research agenda for potential research units. (TEM, 2009a, p. 81; emphasis in original text).

Simplifying the development of technology is important in an innovation policy. The successful development of technology is strongly linked with large-scaled basic research. I believe that Finland will receive the best result from its public R&D financing by investing in quality higher education and basic research. Financing for the Academy of Finland and universities must be significantly increased. By these recommendations I do not mean that programs funded by Tekes for technology product development in companies are useless. On the contrary, continued publicly financed technology projects are certainly needed and appreciated by companies. The question is more about the principle and focus: Many of the resources of the state that had been directed to applied research and product development should be redirected now to where there currently is a serious lack of resources and, more importantly, a growing need: the universities. As is shown by the extensive international literature on innovation, investment in universities' large-scale and multifaceted research results in outcomes that are directly applicable to the development of technology and its successful introduction by companies (Scotchmer, 2006).

The second conclusion of the evaluation panel is that it is necessary to streamline the higher education and research infrastructure. The panel proposes that,

> *Universities* should be given incentives to excel in academic research, while *polytechnics* should maintain the more applied and regionally oriented nature of their curriculum. Within universities the *specialization* should happen through universities reacting to incentives rather than by the Ministry of Education dictating structural changes. Also the role and tasks of public research organizations (PROs) should be critically assessed and the basic research activities of PROs should be shifted to universities. (TEM, 2009a, p. 86; emphasis in original text).

Following Sitra's innovation strategy (Sitra, 2005) and the recommendation of the evaluation report (TEM, 2009a), university reform should be more thoroughgoing. One proposal is to continue to reduce the number of universities to create just four or five research universities that would be high quality, internationally competitive universities. They would include the University of Helsinki and Aalto University. How the rest of universities would be organized as research and teaching universities would take place through the selection process that includes competitive research funding, guidance based on quality, and the concentration of the universities within their strongest research disciplines.

However, it is quite clear that the creation of top universities in Finland requires considerably more economic resources than the university system now has. The teaching activity of the universities is in an especially critical condition, because the number of the degrees granted increased significantly without a corresponding

increase in permanent teaching personnel.[33] Currently, the student-teacher ratio in Finnish universities is over 20-to-1. This should be halved, either by decreasing the intake of students or increasing the number of teachers. Most probably, both must be done simultaneously. While teaching is one essential aspect of the basic financing of universities, it cannot be financed by research money, except in postgraduate studies. This means strong pressure is mounting to increase the budget to support universities. The Finnish government has promised to increase the basic financial resources of universities, but the sums involved are modest. This cannot persist if the aim is to achieve the same quality of teaching as in the top universities abroad.[34]

However, there is an even greater need for research resources. The basic research financing of the Academy of Finland and universities should be significantly increased. The scope of this research financing should include realistic general costs and the strengthening of the research infrastructure. In this situation, financing through competition is an efficient way to increase quality. However, the financing awards should be based on long-term and significant basic research projects. To supplement these, universities need their own sufficient research financing to maintain a broad base of research know-how.

As noted above, research financing should be awarded on a long-term basis and enable researchers to achieve project goals, which must be significant in scope. In this way, the strongest research groups would receive sufficient, long-lasting supplementary financing. The current practice of short-term financing has led to a situation in which project leaders spend too much time writing applications and reports rather than in conducting actual research. At the same time, many young and talented researchers are placed under short-term contracts, which stresses them and imposes a strain on family life. A career in research is no longer particularly attractive, and universities have to work hard to interest young people in becoming researchers.

From the point of view of the structural development of universities, the basic question is: how can Finland attain enough high quality research groups and units? It is clear that in order for a university to get to the top level it needs to reach a critical mass in specific areas: enough talented researchers and students, a good research infrastructure (buildings, equipments, data, etc.), and close links with other research groups in Finland and abroad. Because most Finnish universities are rather small in size, most of the subject units and research groups are too small. To correct the situation, it is necessary to gather the scattered research from multiple universities into just a couple of universities. For example, molecular biology research could be conducted only in one or two universities and then as a general rule research on molecular biology would not be pursued in the other universities.

33 Much teaching is conducted by temporary part-time teachers.

34 In Finland universities are primarily economically dependent on government funding. In 2009 65.8% of university funding derived from the state budget, and 34.5 % comes from other sources, such as the Academy of Finland, Tekes, and businesses.

Creating such a system requires the important process of dividing the work and focuses among the research universities, informed by strategic discussions between the Ministry of Education and Culture and the universities. The universities should concentrate on and specialize in their strongest fields and relinquish the research fields that currently do not have sufficient resources. Note that focuses in research must include the humanities and social sciences as well as natural sciences and technology. The focused research in a particular discipline would recruit quality researchers from the other domestic universities and abroad. In the research fields considered nationally important, more funding would be directed toward competitive proposals that have specified criteria.

If a university's focus cannot be determined voluntarily, the Ministry of Education and Culture should use its steering mechanism to stress quality. The result of voluntarily concentrating on research strengths and relinquishing less quality research activities, the competitive research financing with high-quality criteria, and the Ministry of Education and Culture's guidance based on quality would be a new type of university structure in Finland. Each university would have at least some strong fields that would have well resourced basic research and the highest level of teaching based on it (up to the doctoral level). The largest universities would have several top research units.

Structural reforms do not have any inherent value but they are important here because they would be directed toward increasing the quality of teaching and research. The challenge is for Finnish universities to achieve international competitiveness and attractiveness. They operate in the global education markets. University reform in Finland must therefore go further than the ambit of the new Universities Act (2009) and be more in line with what has been proposed by the international evaluation panel (TEM, 2009a, p. 10).

Chapter 3:

UNIVERSITIES CREATING THE BASIS FOR INNOVATION ACTIVITY

An important element of a nation's economic growth is directly or indirectly based on its universities, that is, their teaching and research activities. The further a knowledge-based economy proceeds, the larger role the build-up of scientific knowledge plays in the nation's innovations. The influence of universities on society and the economy comes from two primary outputs: the education of new generations of society members/workers and the production of new, scientifically justifiable knowledge. Thus, teaching and research are the fundamental tasks of the universities. However, many contemporary universities have also a third task: interaction with society. This third task can be defined as increasing the influence of the universities in the development of society and the economy, which is achieved most fully through realizing the impact of the first two. In this chapter, I consider the development of the top universities more profoundly. I will start by looking at the interaction between universities and the business community.

Knowledge and know-how in various areas move from universities to the business world between the ears of the people who have earned a university degree and go to work for companies. Important new knowledge can be gained by investing in high-level basic research, which is conducted mainly in universities and public research institutions. The results of scientific research are published in books and articles and become components of the common good, to which all interested users have access.

Innovations arise primarily from within companies, the site for developing new products and services for the competitive global markets. The basis of the innovation activity in companies, then, benefits from their own research and development activity that is conducted by their own personnel, perhaps the professionals who have completed their scientific educations. The latest scientific knowledge moves to the companies with these experts. But other channels also are used in this company-innovations process. The companies use the published results of basic research, and companies often have direct channels to the universities through research collaboration or exchanges of personnel (i.e., company persons teach for a period, professors/researchers consult, or advanced students obtain internships, etc.).

From the point of view of the companies, the innovation activities of universities, like the commercialization of inventions, are not as important as the basic research (see Scotchmer, 2006; Powell et al., 2007). The capitalistic economic system does not stimulate companies to invest significantly in the production of knowledge. First, risks are linked with basic research in that the company cannot know in advance what the outcome of the research will be, and if there are significant results, they will be available only after several years of research. Second, scientific research spreads freely and, since everyone can use it, it is difficult to maintain a proprietary right to it. In short, a company would not receive a high enough return on its investments in basic research to justify the investment, and so the investments toward basic research would stay too small, when we think of the social use of such research. This is why society has to underwrite the basic research of universities and the higher education associated with it.

Universities form the core of the innovation system in a knowledge economy. This foundation supports the *basic model of knowledge transfer*, as I call it (see Figure 3). According to this model

- universities conduct the basic research and create new scientific knowledge;
- universities are responsible for providing higher education that is based on scientific knowledge;
- companies create innovations by linking their own experiences and other sources of information with the new scientific knowledge, using qualified personnel who have been educated at universities or who are otherwise familiar with new inventions of universities;
- various channels (e.g., joint research projects, research institutions of companies and universities, licensing processes for technology, and, most importantly, direct research collaboration between universities and companies) transfer the knowledge and technology among the players.

This basic model is presented in a very simple way so that the important matters stand out clearly. In order for the basic model to function well, the research and teaching activities of universities should be at a qualified international level.[35] The innovation policies of many countries in recent years have stressed the transfer and commercialization of technology and have neglected the importance of basic research. Now, however, there seems to be a recentering of the role of higher education in the innovation process. The development of universities has become a top priority in Europe and the United States, as well as in Asia. In Finland, for example, universities have returned to the center ground of innovation policy.

35 This level is measured by different indexes, such as a citation index.

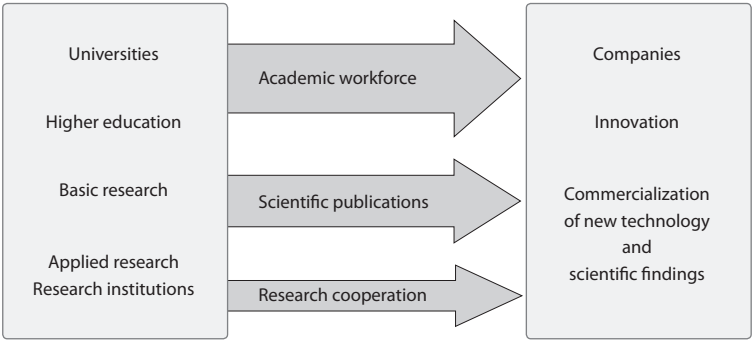

Figure 3.
The basic model of knowledge transfer: The channels for the transfer of knowledge from universities.

Recent research has confirmed the long-lasting influence of academic education on economic development (see, e.g., Douglass, 2006). Academic education is an "investment" in human capital, whose influence on economic growth is important. Claudia Goldin and Lawrence F. Katz (cited in Douglass, 2006) estimate that during the last 100 years, a quarter of the growth in salaries in the United States can be explained by increased student participation in education. Similar results about the influence of education on economic growth have been documented in Europe (Douglass, 2006). Tertiary education and research create the primary components of knowledge and know-how development, which are needed in order to advance innovations and produce the experts needed to move the innovative products and services to market. The accumulation of the know-how, stressed by the new growth theory (Helpman, 2004), is based significantly on the long-term research activity and the education linked with it.

Although inventions are regularly associated with universities, it seems clear that the substantive activity, as indicated by patents, licensing, or company-based spin-offs of inventions, is completed by companies. However, such evidence does not necessarily provide the best picture about the role of universities in the development of the economy. The flow of knowledge and the movement of personnel between the universities and companies are critical aspects of creating a dynamic innovation environment.

In revealing surveys about the importance of copyrights to universities, Professor Walter Powell from Stanford University, together with other researchers, has shown that university income from copyrights is rather low, with some exceptions. Those universities that do generate income are a small group with mostly bioscience

rights (see Powell et al., 2007; Rhoten & Powell, 2007). The important relationships between the universities and industry involve publications, the supply of an educated workforce, shared conferences, and informal interaction. From the viewpoint of adapting the results of science, research shows that informal and non-agreement-based relations between universities and industry are crucial. The development of the Boston, Massachusetts-area biotechnology cluster and Stanford University's experiences in Silicon Valley lend support to Powell's conclusions.

The bio-cluster near Boston has built-up around public research organizations such as universities and research hospitals. These research organizations have been central to the creation and growth of the cluster exactly because they have functioned like traditional universities, as open organizations from which knowledge flows to the surrounding society. The research collaboration between the universities and companies has been crucial in the transfer of new knowledge. In this type of research results transfer, the commercialization of the copyrights and the contractual relations are not as important as the strengthening of the interactive relations between the universities and companies.

In the light of the basic model of knowledge transfer, the concept of an "innovation university"[36] is confused terminology. As noted earlier, one of the key tasks of universities is to carry out basic research, while the innovation activity takes places principally within companies. There is no reason to make innovations the main characteristic of the universities.

In many innovation policies, much attention has been paid to the use of scientific knowledge in the marketplace. To promote this, massive machineries and systems have been built: an organization for the transfer of technology, incubators, sciences parks, product development financing, license and patent offices within universities, institutions of applied research, financing instruments for companies in different phases of development, the commercial companies of municipalities, information offices, and so on. These *financing and intermediary organizations* might be important, but, nevertheless, economic success results from the creation of know-how and the universities maintaining it.

The economist Suzanne Scotchmer identifies two models by which publicly financed scientific inventions and findings are put into the reach of users. The first model is the *commercialization model* and the second the *free-access model* (Scotchmer, 2006). The commercialization model includes matters of licensing, patents, and various types of joint ventures between universities and companies. It is used mainly by research institutions. The commercialization model has brought to universities surprisingly little income, as mentioned above. I will return to this later.

The free-access model fits well with the basic motifs of publicly financed research. The markets simply cannot produce all of the scientific knowledge that companies need. Because scientific knowledge is a public good, it is most influential

36 The new Aalto University in Finland is called an innovation university.

when it is freely usable by all. According to Scotchmer (2006, p. 242), the free-access model has brought enormous economic profit to society and has served superbly the goal of spreading knowledge.

Universities can influence the development and economic growth of their geographic area in many ways, but especially by formal and informal links between firms (Florida, 2003; Lee & Walshok, 2003; Geiger, 2004). This influence contains the following features:

- High-quality research activity safeguards high-level expertise and reliability, which attracts investors, entrepreneurs, and multinational companies to the area that are interested in innovations and in safeguarding high-risk investments.
- High-quality research activity makes it possible for universities to supply their region and its developing industrial clusters with new high-level knowledge and know-how and an educated labor force, which are needed by knowledge-based companies.
- The activities and programs of universities (e.g., license services, financing, mentoring, etc.) that support technology companies and entrepreneurs strengthen the region's companies and create the basis for the growth of new companies, which, in turn, brings to the area high-salary employment.
- Adult and lifelong education programs offered by universities safeguard workers' competencies, particularly those that are needed by the continuously changing needs of the region's economic life.
- Quality universities entice various talents, students, teachers, and researchers to the area, which establishes important creative potential.

These characteristics emphasize the basic research and education tasks of universities. However, because many countries in recent years have been investing in the transfer and commercialization of technology, the development of universities has been downgraded in favor of other aspects of the innovation system. Yet now is the time for universities. Economist Paul M. Romer (2001) stresses that governments (at least in the US) have concentrated too much on the development and commercialization of technological innovations and the demand for know-how, without recognizing the need for and process of the production of know-how, meaning the education of researchers and engineers.

Channels for transferring know-how and technology

Identifying the channels used in the transfer of knowledge into technology is essential in order to make innovation activity more effective. The transfer mechanisms of technology have been studied intensively in the United States. Some American researchers have created interesting models to describe the process. I will present some of them briefly here and, a bit later, I will discuss by way of example the transfer of technology from the universities in Finland.

In 1980, the US Congress passed the Bayh-Dole Act, which gave universities ownership rights to all the inventions made under Federal financing. The aim was to encourage universities and researchers to commercialize their scientific findings. The law has, without a doubt, increased the licensing activity of universities, and some universities have succeeded rather well in the commercialization of their research findings. In 2004, the combined license income of all US universities was about $1.4 billion. The Bayh-Doyle Act has been a model for several countries and has been imitated in the European Union. However, Powell cautions against blindly imitating this law, stating that its influences have been exaggerated and the functioning environment of universities in Europe, for instance, is quite different from that in the United States (Powell et al., 2007).

In *Knowledge and Money* (2004, p. 169), Geiger divides university personnel conducting research into three non-exclusive groups: the academic core, organized research units, and the medical centers. The academic core comprises the research personnel of the faculties who are responsible for the university's tasks of research and teaching. The separate research units, meanwhile, exist to fulfill different needs of independent funders (i.e., from basic research to consumer research). And the medical centers are driven by a single unique segment of the research economy as well as by the financial imperatives of health care delivery. The organized research units and medical centers have clearly increased their role in the overall research activity of universities, with the academic core growing little during the last 10–15 years. So the research activity in universities has shifted toward more organized research personnel and is positioned outside of the teaching tasks and normal responsibilities of the faculties. The same development can be seen in Finland. However, Geiger believes that increasing the academic core's role in the research activity is the best direction for research development, because it supports the overall development of the university, including its teaching activity.

Geiger presents a persuasive analysis about the influence of academic research on industrial production. In his model, academic basic research influences the innovation activity of industry through the generic academic research. And it goes to industry through three routes (see Figure 4).

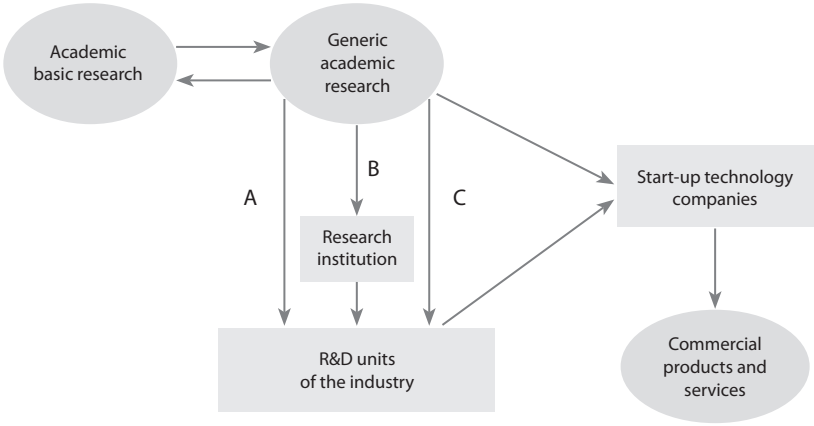

Figure 4.
The transfer of academic research to industrial products (Geiger, 2004, p. 203, Fig. 15.)

- Route A: Companies are in direct contact with universities via various arrangements (e.g., research agreements, participation in programs, etc.). Within this collaboration, companies' R&D activity is supplemented.
- Route B: Companies participate in the activities of separate research institutions, which simply provide services to companies. These research institutions are publicly supported, which means the companies receive the results of the newest applied research with quite favorable costs.
- Route C: Within the innovation ecosystem near a university, new technology companies are formed, which take basic research and develop it into new technologies or apply the research through new products or services. These young companies may grow up to be important actors within the innovation ecosystem or larger companies may buy them.

The interest of universities in developing these three routes has continually increased. In fact, some universities have established start-ups themselves, or have licensed their inventions to independent start-ups. One good example of this is the work of Stanford University's postgraduate students Sergey Brin and Larry Page, who created Google with the support of the university. Google still pays royalties to the university.

According to statistics for 1999, the 16 universities that earned the most licensing income collected 74% of the total income of all universities (see Geiger, 2004,

p. 219). Columbia University collected the most ($96 million), followed by the University of California (the entire system at $81 million), Florida State University ($57 million), Yale University ($41 million), and Stanford University ($40 million). Data for the same year shows that Stanford University has established the most start-ups (19), followed by the Massachusetts Institute of Technology (MIT, 17) and the University of California system (13). The remainder of the 16 top licensing universities has established fewer than 10 new companies apiece. Significantly, 85% of the licensing income comes from the biotechnology field, from patents in the life sciences area. The majority of the success stories are concern biotechnology, where the model of the transfer of the technology is different from the general technology transfer process shown in Figure 4.

In the area of biotechnology, the transfer of technology from universities goes through the intellectual property rights (licensing). In the traditional model of knowledge transfer (taking into account the newer route C), knowledge functions as an indirect common good, which is used by any company in independent innovation processes. In the model of "bio-capitalism," universities produce patents for the biotech industry. Another route is for universities to establish spin-off companies that develop the innovations produced within the universities into commercial products (see Figure 5). Many universities have established special offices to handle the patents and licenses issues; these offices also support the universities when establishing the companies based on the research.

The Milken Institute in Los Angeles has made an international comparison of the transfer and commercialization of universities' biotechnology (DeVol & Bedroussian, 2006). They found that the five best universities at commercializing their

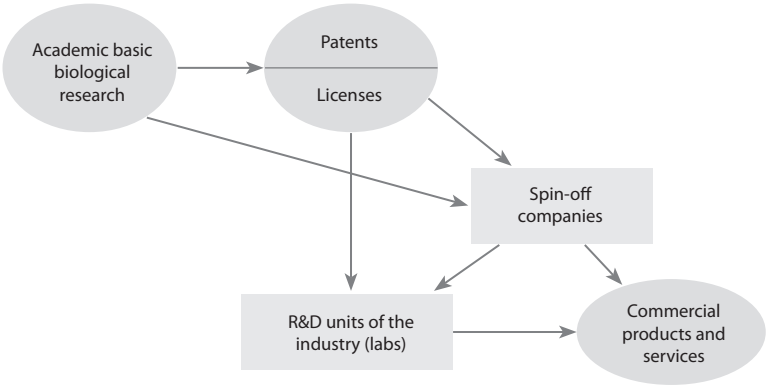

Figure 5.
The routes of knowledge transfer in biotechnology from universities to industrial products (Geiger, 2004, p. 226, Fig 16.)

research are MIT, the University of California, California Institute of Technology (Caltech), Stanford University, and the University of Florida. Nine of the ten biggest patent owners are in the United States. The University of London is the tenth. An investment of US$1 million averages a license income of $27,825 in the United States, compared to just $11,988 in Europe. Interestingly, the authors estimated that each dollar spent in the technology transfer offices of universities produces $6. It must be remembered when looking at these numbers that the income of the license offices are drawn from some of the most successful licensing universities, such as Stanford University and UC, Berkeley. The study points out that most university technology transfer offices are small, rather new, and rarely produce profit.

The Milken study did not articulate any one model for the successful transfer of the technology. Instead, the research offers some interesting general conclusions and recommendations (DeVol & Bedroussian, 2006):

- The cultural attitude of the country toward risk influences the growth possibilities of the biotechnological industry: Entrepreneurial capitalism should be encouraged.
- Universities and their technology transfer offices must be committed to the long-term development of biotechnology. In addition to money, commercial success requires personal commitment enthusiasm, and high-level know-how.
- Biotechnology clusters should be global rather than only regional or national.
- When developing the transfer mechanism, the key factors for success are clear incentives for all partners, sufficient financing, qualified personnel, skillful university management, ongoing support and engagement, and appropriate benchmarking and estimation.
- University technology transfer offices are often too small and inexperienced. Commercial success requires high-level expertise.

Although the Milken study concerns the commercialization of biotechnology, its conclusions and recommendations apply to all commercialization. At a general level, one can only agree with the report's statement that the better the understanding and governance of the technology transfer and know-how, the faster the fruits of scientific research integrate into the best of society. One central component in developing technology transfer is learning how to manage commercialization in the traditional university community. The customary tasks of universities have been to carry out objective academic basic research and provide the highest education based on it. One characteristic of basic research in the Western tradition is the long-term pursuit of truth, which includes openness to criticism and the publication of results. The new knowledge produced by research in universities is a public good, which can be used by all. As I argued above, quality basic research and the teaching

based on it are the chief ways through which universities can contribute best to the success of their society and economy. The commercialization activities of universities are not necessary in conflict with the ethos of basic scientific research. What is most important is to create clear rules for the common projects of the universities and the economic life, whether they come from the universities or the companies. For example, Finland passed a law regarding inventions in universities that came into force in 2007 that provides some clarity to these rules.

The aim of this Finnish law is to promote the identification, protection and utilization of the inventions made in Finnish universities in the appropriate way from the point of view of the inventor, university and society (Act on University Inventions, 269/2006). Research carried out in universities is classified as either open research or contract research. The type of the research determines how the rights are determined. Open research normally refers to the basic scientific task of the universities, which usually does not have private financing. Contract research, on the other hand, usually has a client or funding source that is outside the university. In open research, the rights belong to researchers, while the rights in contract research belong either to the university or the funding organization.

According to the Act on University Inventions, the inventor is always responsible for giving public notice about an invention falling under the scope of the law. This notice about the invention and its administration are the central parts of the new system. If the inventor has not announced an invention or indicated a willingness to utilize the invention within 6 months from the invention notice, the university can claim the rights to the invention created during open research at that university. The university can also take for itself the rights to inventions made during contract research within 6 months from the invention notice. The future will tell whether the law increases or decreases the commercialization of the inventions made in the universities. At least the law might lead to a bureaucratic system.

Sitra's Finnish-language report, Tutkimustulosten kaupallinen hyödyntäminen—kvantitatiivisia tuloksia (Commercial utilization of research results—Quantitative results; Kankaala et al., 2007), presents a study of the situation of technology commercialization in Finland. The findings are mainly consistent with the Milken study. I summarize the conclusions of the report as follows:

- The primary and most important route to utilizing research results is the collaboration between the companies and universities/research institutions;
- The economic results of the university licensing activity are modest (about €1.7 million in 2004);
- The experiences of universities regarding the economic conditions of held patents are modest.

- Research-based companies have been established in Finland as many as in other countries, but their economic development has been modest.

As these observations show, the commercialization of research results does not result in an economic bonanza for most universities. Commercialization functions more as one of the channels to utilize the research results, as a way to utilize the research broader in the society. In the United States and Europe, biotechnology is economically the most important field of commercialization. But not all countries are able to take advantage of the demand for biotechnology. For example, the problems Finland faces in the development of the field are the lack of risk financing and the existence of few relatively small companies in the medical field. Finland's largest group of research-based companies is in the field of information technology and digital media (Kankaala et al., 2007, p. 80).

Financing research and development activity should be reconsidered

Financing the research and development activity should be reconsidered carefully in light of the basic model of knowledge transfer and the literature based on the experiences of others conducting technology transfer. The basic model stresses the central position of basic research and teaching based on it in the innovation activity. The innovation activity is supposed to be financed and administered primarily by companies themselves. Technology transfer from universities has not been very profitable, although useful. The critical issue is the relationship between financing universities and public financing of technology.

Shifting the emphasis of the innovation policy away from the technology policy places huge demands on empowering science in multiple sectors (social sciences, economic sciences, and cultural sciences), in addition to the technical–natural sciences. From this viewpoint, technology-oriented research projects do not cover all the fields of science that are important to the innovation activity, especially if it is intended to be sustainable innovation.

We should also consider the relationship between basic and applied research. Basic research is characterized by the thorough analysis of phenomena, setting hypotheses, and carefully testing these hypotheses, which then produces systematic and theoretical knowledge (models, laws, theories, and concept systems). Basic research is motivated by "seeking the truth" for its own sake, without thinking beforehand about the usefulness of the research results. In short, basic research is curiosity research. The field of basic research is very large and growing to cover natural phenomena and the world created by people, cultures, and societies.

Applied science is often seen as the application of basic research to special cases. As such, it is in fact a part of basic research because the influence of natural laws always depends on the initial and boundary conditions that have to be be determined separately with tools of research. Such research is applied because it is directed to a particular phenomenon that has a practical meaning, such as a radio technique or curing a disease. The results of the applied research can often be presented as practice norms. For instance, if a low-disturbance radio net is developed, various support stations and receivers have to be built. Product development is a way to form the practice norms based on basic research and on the results of applied research and practical experiments, demonstrated through several tests and prototypes.

So the development of technology is a three-stage process:

1. Identification or quantification of the basic regularities of a phenomenon (basic research)
2. Manifestation or influence of the regularities in the specific circumstances (applied research)
3. Formation of practice norms in order to get the phenomenon to serve specific practical needs (technical research, product development).

In addition, applied research is often very large scaled. For example, consider the research of Web 2.0. The issue involves Internet-based social networking in which anyone can distribute files (pictures, videos, text) and communicate with others, familiar or otherwise. A satisfactory application of Web 2.0 technology requires research that is directed towards people's behavior, cognitive abilities, communication, values, and norms. This is not technological research, but human and social research. Without this kind of broad research, the technical norms could not be made. Thus, basic research in technology involves academic disciplines beyond the strictly technological fields, and these must be considered in the overall approach to basic research.

Quality universities are the core of an innovation economy

In order to guarantee sustainable innovation, universities must be developed long term and respect the logic of knowledge creation. Developing the innovation activity to confront the new challenges requires universities to be competitive at the international level in their research and education.

When looking for the model of a "top" university, the universities in the United States are in their own class. The Shanghai Top 100 list includes 55 US universities.

The United Kingdom is second in the top 100 list with 11 universities. Canada has four universities on the list and Australia has three, which means that 73 universities of the 100 top universities in the world come from English-speaking countries, partly reflecting the position of the English language as the scientific language of the world. I focus here on the United States, whose university system I know best.[37]

The 10 universities on the Top 100 list in 2009 were:

1. Harvard (US)
2. Stanford (US)
3. University of California, Berkeley (US)
4. Cambridge (UK)
5. Massachusetts Institute of Technology (US)
6. California Institute of Technology (US)
7. Columbia University (US)
8. Princeton (US)
9. University of Chicago (US)
10. Oxford (UK)

Although these types of lists are always imperfect, they have an impact on the general opinion of the quality of these universities and of the state of higher education in the respective countries. Additionally, these lists influence the willingness of the students and researchers to go to a specific country and the willingness of companies to establish research institutes in that country. This is why these lists are taken seriously.

Charles M. Vest, former president of MIT, highlights in *The American Research University* the development and success of US research universities. He presents several reasons why higher education in the United States is continuously excellent, efficient, and highly estimated all over the world (see Vest, 2007, pp. 7–9)

- A diverse array of institutions provides a wealth of environments and opportunities for students to select a school that matches their needs and capabilities. This diversity brings with it a wide range of funding sources.
- New assistant professors have the freedom to choose what they teach and the topics of research and scholarship they pursue.
- In research universities, the teaching and research are linked together. This brings freshness, intensity, and constant renewal.

37 I refer here mainly to Roger L. Geiger's book Knowledge & Money, Research Universities and the Paradox of the Marketplace (2004). Also Charles M. Vest's book The American Research University from World War II to World Wide Web, Governments, the Private Sector, and the Emerging Meta-University (2007) has been useful.

- Students, scholars and faculty from other countries are welcome. They bring a defining quality of intellectual and cultural richness to higher education institutions.
- An implicit national science and technology policy recognizes the support of frontier research in US universities as an important responsibility of the federal government. This policy is intended to provide financial support to researchers, based on their merit in a competitive marketplace of ideas. The funding of infrastructure is attached to grants and contracts.
- There is a tradition of individual philanthropy through which alumni and others support colleges and universities financially. Financial aid derived from donors' gifts enable talented students of modest means to attend even the most costly schools. Tax laws encourage such donations.
- There is an open competition for faculty and students. Such inter-institutional competition drives excellence.
- US universities have broad and deep commitment to public service, which permeates essentially all segments of the university community and has led to strong interactions with business, industry, and government. This public service concerns the nationally oriented private universities, and is especially the case in most public universities that are linked to state, regional, and local industrial needs.

Vest stresses that the success of US university system has greatly depended on the fact that the public financiers have funded, in particular, the research conducted in universities. By extension, this research financing also has benefited teaching. The result, then, is a strengthening of the basic tasks of universities: research and teaching. A part of this public financing has been the reasonable financing of indirect costs: buildings, equipment, travel, the social costs of personnel, and so on. As a result, the research universities, with their researchers, teachers, buildings, and equipment, have become the research infrastructure of the United States.

Economist Suzanne Scotchmer (2006) shows that the competition for merit-based scholarships is beneficial over the long run because the most talented and effective researchers are selected. Of course, the opportunity exists to terminate a scholarship if the researcher does not follow the agreement. But those who stay in the system demonstrate the real method of selection. If the researcher or group of researchers wants to receive future financing, competence and results must be demonstrated.[38]

Some of the characteristics mentioned by Vest (2007) can also be found in Finnish universities: freedom of education, competition for research financing, and

38 On the same note, while an incompetent group might get one grant, they most likely will not get a second.

linked teaching and research (i.e., professors teach). The third task of the universities, interaction with society, has even been given a legal basis in Finland. Universities in Europe are not, in general, far from the model of the United States. It is paradoxical then that, although the US model of the research university has been taken from Humboldt tradition, only six German universities are on the Shanghai Top 100 list, nine times fewer than those from the United States.

It must be noted that Vest does not refer to term fees (tuition) or the property of the universities on his list. But Roger Geiger (2004) has carefully analyzed the economy and competitive circumstances of research universities in US. The expenses of universities per student have increased continuously and, in parallel, so have the term fees. The average costs per student are nowadays about $26,000 a year in private research universities, and about $7,000 (18.500 for out-of the state students) a year at public universities[39] Tuition covers about 70% of the costs at private universities and 33% in the public, according to Geiger. The remainder of the costs is financed in private universities by income from endowment and in public institutions, mainly by the state appropriations. Universities do not become self-sufficient through tuition income, but they can decrease their dependence of other funding sources.

There is a strong selection process in the student markets. Universities want the best students. To generate interest, a university must present an image of high quality and prestige. High quality attracts many seekers, which provides the university with more choices in their student selection process. Through selection the university seeks to enroll high-quality students who are most likely to succeed. A high-quality university can increase tuition fees and so increase income to cover the rising expenses. A good reputation increases donor interest in the university, while successful professional alumni often feel gratitude towards their university and are willing to give financial support. This kind of selectivity functions primarily in the private universities, although public universities practice this in a more limited form. In order to guarantee access to financially challenged but talented students, universities, particularly the expensive ones, offer scholarships of various amounts. As a whole, the competition over the best students has divided the possibilities and status of the universities and students: some universities seem to have a privileged position.

Developing top quality universities is a continuous process. To maintain it requires considerable economic resources. However, the most important resources are the qualified and committed researchers and talented students. Doctoral students, who prepare their dissertations under the intensive guidance of professors, are in a very central position. A special atmosphere and supportive values exist in the top universities. The university and its researchers want to be at the peak of their research field. The researchers contribute significantly to their tasks and they work for years with the most difficult scientific problems. An atmosphere of openness to

39 See http://www.trends-collegeboard.com/college_pricing/pdf/2009_Trends_College_Pricing.pdf

ideas is characteristic of these universities, and an eagerness to succeed well envelopes the entire university community. Long-term research, in which the true state of phenomena is sought without prejudice –in other words, seeking an objective truth—is emphasized by the values of these universities. This counterbalances the concern that research based on industry sponsorship can lead easily to scientific compromises. I admit that this picture is idealized, but I have personally sensed this kind of spirit in several universities where I've visited in the United States. Therefore, I feel, that if this kind of value system and atmosphere is lacking, then a top university cannot not be established, even if its financing is increased.

An emphasis on quality should be central in creating a top university. Figure 6 presents a circle of success that describes this (see Geiger, 2004). Higher quality teaching (degree courses) and research leads to increased financing, which come both through quality related public support mechanisms and competed research financing. This in turn offers a good basis for recruiting qualified teachers and researchers. Top researchers can earn competitive salaries, which then attracts researchers from abroad. Good teaching and a good research infrastructure, as well as a good reputation, attract the most talented domestic students and high quality students from abroad. Highly qualified personnel and talented students open new possibilities to develop research and teaching.

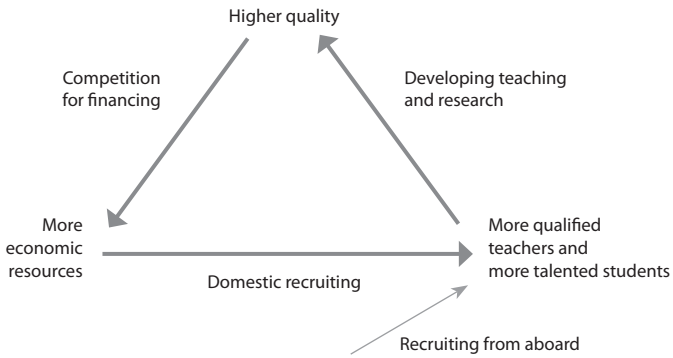

Figure 6.
Forming a top university by increasing quality.

The success of the United States' top universities cannot be explained without recognizing their rather strong financing position. The endowment capital of the most appreciated private universities is enormous. In 2008, the following universities had the highest endowment capital (National Association of College and University Business Officers, 2008):

	US$ Billion
Harvard	36.6
Yale	22.9
Stanford	17.2
Princeton	16.3
University of Texas System	16.1
MIT	10.0
University of Michigan	7.6
Northwestern University	7.2
Columbia University	7.1
The Texas A&M University System and Foundations	6.7

Note that this list includes public universities and university systems (i.e., Michigan and Texas). The endowment capital of the University of California system is US$6.2 billion. The endowment capital of UC Berkeley, which is included in the figures for the University of California system, is about $2 billion. The interest income from these institutions' endowment capital averages about 5% a year and it is used to finance special research, teaching programs, student scholarships and grants, and university personnel. Some endowments earn more than 5% in interest income, but the economic plans of the universities are based on 5% productivity. The endowment capital figures have increased considerably within the last 10 years, although in 2009, as can happen during economic downturns, many university endowments decreased in value. While the endowment capital totals of public universities have increased more quickly than for private universities, they are proportionately much lower and probably will remain so.

In the field of the higher education, the United States faces new challenges, despite the success of its universities. John Kao lists several challenges facing the US education system in global world (see Chapter 2 of Kao, 2007). For example, the number of research papers worldwide increased 59% between 1988 and 2001, but by 354% in China and just 13% in the US. The US ranks 16th out of 17 nations in the proportion of 24-year-olds who earn degrees in natural sciences or engineering as opposed to other majors. In the Program for International Student Assessment (PISA, 2006), the measurements show the average combined science literacy scale score for US students to be lower than the OECD average. US students scored lower in science literacy than their peers in 16 of the other 29 OECD jurisdictions and 6 of the 27 non-OECD jurisdictions. Finland came first in science literacy. Kao asks what US can learn from Finland, and answers his own question: "Human capital is the primary key to a national success strategy" (Kao, 2007, p. 85).

Chapter 4:

INNOVATIONS ARE GENERATED IN CREATIVE ENVIRONMENTS

The concept of an innovation environment is rather new in the innovation debate, compared to that of a national innovation system. The hypothesis behind the innovation environment concept is that people innovate best in environments rich in creativity, inspiration, and stimulation. Innovations also require a knowledge basis and an institutional framework, but these alone are not enough to produce innovations. Moreover, structures may sometimes become obstacles to innovation. Some believe there is a contradiction between a hierarchical organization and creativity. The central dilemma in developing innovation activity is exactly in this tension between culture and structures. This dilemma provides a good starting point to investigate the creation of innovation environments.

The dynamics of the innovation environment can be described with the help of the concept of the ecosystem of innovations. I have dealt with this before in other contexts (see Hautamäki, 2006) and outline here only the basic ideas.

Innovation ecosystems as creative environments

My core thesis is that innovations require a special ecosystem, one in which there are enough elements and processes to feed germinating innovations (Hautamäki, 2006, 2008b). The concept of an ecosystem, drawn from evolutionary biology, refers to self-steering and interaction. The basic characteristics of any ecosystem are

1. Adaptation to changes in the environment;
2. Self-steering, or the ability to maintain itself amid changes;
3. The relative autonomy yet mutual dependence of elements;
4. Continuous evolution, where elements emerge, change, and disappear as part of an overall growth cycle.

The first characteristic refers to the ability of the ecosystem to change its functions when the environment changes. Self-steering means the system can change or maintain how it functions through its own processes, without any outside or centralized steering. The third characteristic links the mutual competition among the ecosystem's elements (in the innovation case, this means companies, institutions, etc.) and, at the same time, some level of cooperation. The final characteristic raises the concept of "natural selection," which favors adaptable entities, and hastens the demise of those who cannot or do not adapt.

The ecosystem of innovations is, above all, a local system of actors where new ideas are generated and organizations make them a reality. Here, I take Silicon Valley in California as a model, which is probably the best example of a dynamic innovation environment. Bahrami and Evans (2000) see Silicon Valley as characteristic of the ecosystem concept: an "incessant formation of a multitude of specialized, diverse entities that feed off, support, and interact with one another" (p. 166).

The creativity and dynamics of world-class innovations are strengthened and maintained by the following factors:

- Top-level universities and research institutions
- Sufficient financing for new companies and research plans
- Availability of a skilled labor force
- Symbiotic combination of large established companies and new companies
- Specialization of and cooperation among companies
- Service companies specialized toward the needs of local companies
- Sufficient local market for new innovative products
- Global networking with other innovation centers
- A "community of fate," meaning the actors of the region see that their success is linked to the success of the whole region.

An analysis of Silicon Valley underscores the necessity of these factors, but they alone are not enough to explain the surprising success and adaptability of the area. Other important environmental elements must be in play as well. First, the ecosystem of innovations becomes alive and adaptable because of a strong entrepreneurial culture that stimulates creativeness and willingness to take risks. Another special characteristic is the continuous movement of ideas and people, or "recycling." People move easily from one company to another, and from research institutes to companies and vice versa. Informal networks function efficiently as transmitters of information and ideas (Figure 7).

A related definition of an innovation ecosystem is given by Judy Estrin (2009). In her view the innovation ecosystem is made up of communities of people with various types of expertise and skill sets. Each community must receive the "nutrients" it requires. Estrin describes an ecosystem as comprising three communities: research,

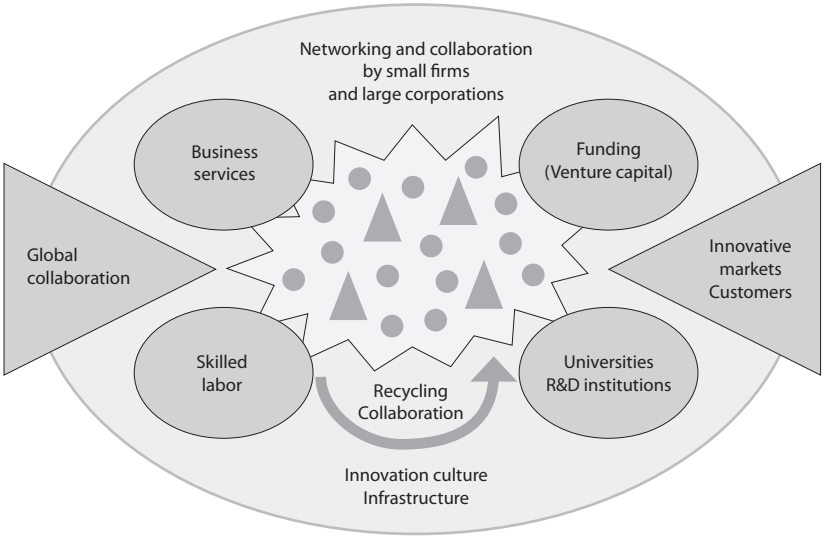

Figure 7.
Elements and dynamics of the ecosystem of innovations

development, and application. The role of each community is different. The research community produces new knowledge about basic phenomena, while the application community is oriented towards solving problems with practical implications. The development community then brings ideas to market. Estrin stresses that the sustainability of a national innovation ecosystem will depend upon maintaining a healthy balance between all three communities. She expresses concern that the role of research in innovation is being neglected. Research organizations have begun to look for the quick benefit of their research, at least in projects funded by corporations, a tendency becoming more common as well by government funders, such as the National Science Foundation and others.[40] However, basic research is a long-term process and so basic research funded by the government, at the very least, must allow for the natural (often long-term) progression of research. Estrin emphasizes that basic research must be broad-based and involve the social sciences, arts, and humanities as well as science, engineering, and medicine.

AnnaLee Saxenian (2006) has drawn attention to the networking of the Silicon Valley actors. The companies' flexible ways of networking in planning and production, and the exchange of knowledge and know-how between companies have

40 Although Estrin refers mainly to the US, her analysis is relevant for all industrial nations: long-term basic research is a firm basis for continuous innovation.

created an action model characteristic of Silicon Valley. According to Saxenian, the companies in Silicon Valley are able to build up teams quickly and spawn new companies by grounding their work in the area's strong scientific and technological know-how, deep professional and management experience, and the networks of the technology community.

The success of Silicon Valley is explained not so much by technological innovations as by organizational innovations (Saxenian, 2006). The innovative action model of Silicon Valley supports and encourages open networks and decentralized experimentation. In this context, experimentation means for example that a new company is quickly established around a new idea, and time will tell if it becomes a commercial success. Failure is accepted as an important part of the learning process. The networking process makes co-learning possible—in spite of natural competition. Thus, says Saxenian (2006), experimentation serves the entire local community, even if it bankrupts a particular company.

The ecosystem of innovations, through its local network of companies, research institutions and experts, continuously produces new ideas and tests their commercial potential. As a result, the ecosystem presents a proving ground where new companies are founded or die out, but the best companies grow or are absorbed into bigger companies. This business life cycle is fed by a network of business service companies. Martin Kenney and Urs von Burg (2000) call this service framework the "second economy," which supports the establishment, growth, and merger of new, primarily technology, companies. These services encompass risk investors, law and tax offices, management consultants, technology support companies (e.g., semiconductor design, Web hosting and design, etc.), and contract manufacturers. The services companies support the establishment and growth of companies within the related industries, and thus serve as essential components of Silicon Valley's growth.

Saxenian (2006) has also shown how international Silicon Valley is. In 2000, 53% of the researchers and engineers working in Silicon Valley were first-generation migrants from China, India, Taiwan, Iran, and other developing countries. In fact, 48% of the area's residents live in families in which the language spoken at home is not English. Of the technology companies (start-ups) established between 1995 and 2005, half had at least one migrant as its founder. The success of the region has been decisively dependent on the fact that it is a global talent magnet, drawing students, researchers, and engineers from all parts of the world. Interestingly, this movement has recently become a two-way traffic: migrants from China, India, Taiwan or other places often return to their home countries to establish companies. In this way, what was once a brain drain from the developing countries has changed into a global brain circulation, thus binding the know-how centers of the world with each other. I deal with global networking more in Chapter 6.

The ecosystem of innovations concept advances the argumentation on innovations on two fronts. On the one hand, it offers an alternative to the concept of a

"cascade model of innovations," the formerly central position that viewed the innovation process as a straight-line continuation from basic research, through applied research, to product development, and from there to commercialization (see Schienstock & Hämäläinen 2001). An ecosystem, for its part, is a dynamic network in which research institutions, financing organizations, entrepreneurs, and experts function in interaction and side by side. This collaboration of different elements opens possibilities for new ideas and innovations.

The second front in which the ecosystem of innovation advances theory is in its challenge to Porter's (1990) cluster model. Porter's concepts regarding nations' competitive advantage became a key element in the innovation policies of various countries, including Finland. However Kao (2007) raises three concerns with the cluster model. First, the cluster model states that the central actors in a nation's competitive advantage are the established companies with large markets. However, Kao points out, this kind of thinking simply stresses the existing industry while not actively encouraging radically new business activity. Kao takes the example of of Bilbao in Northern Spain (the Basque region), where the traditional industries were steel and ship building. When these industries fell into financial difficulty, Bilbao took a totally new direction and built, together with the Guggenheim Foundation, a new museum designed by the architect Frank Gehry. The museum started attracting tourists, as well as the interest of entrepreneurs in the service fields, design, and new media. The "Bilbao effect" was born.

The second weakness of the cluster model is linked with the view that the strengths of a region and country are separate from the rest of the world. A cluster is a system of national actors but, in the global economy, a company's or nation's most significant strengths might be its global networking. While it was advantageous for a traditional industry to have local supply chains local, contemporary companies, particularly the new service-based companies, have established supply and value chains around the world. This can be seen for example, in the Web-based services that have opened up in developing countries, especially in India.

The third and the most interesting matter taken up by Kao is the initiation of the new type of "weightless ventures." This concept describes new companies who use global information networks to decrease start-up costs. Such practices have been demonstrated by several companies of the new information economy that have been founded by students (e.g., Google, Skype, MySpace, Facebook). Weightless ventures do not need the similar cluster structure to achieve success. But they do need an innovative environment, talents, venture capital, business services, and so on. Kao emphasizes that success results more often nowadays from a critical mass of talent rather than a critical mass of goods.

So the ecosystem of innovations provides an excellent conceptual framework to analyze the conditions of innovation activity. In summary, the ecosystem of innovations comprises

- *entrepreneurs* and the companies they have founded
- *structural factors*, such the institutions of research, financing, and taxation, which create conditions for innovative activity in companies, and
- *dynamic factors* that stimulate interaction, such as cooperation, mobility, recycling, social networks, and an entrepreneur culture that supports the desire to experiment.

Although it is difficult on many fronts to compare the Finnish innovation environment with the Silicon Valley environment (e.g., the size of the regions, amount of venture capital, university resources, historical development, business environment, culture, etc.), the general characteristics listed above are relevant in all innovation environments, although with variations. Perhaps the most essential characteristic is the spontaneity particular to each ecosystem. The ecosystem of innovations is a self-regulating and self-feeding system, where the source of growth comes from the top experts and companies with it. Favorable conditions and stimulants for action and networking must be established and nurtured. From these the resources needed should be collected quickly around a new idea. The local character of these resources facilitates and stimulates development.

Finnish innovation policy has been characterized as guidance from above (i.e., government directives) and a large system of public aids organizations. Where Silicon Valley operates within a "second economy," that is, service companies (financing, jurisdiction, consulting) supporting new companies and their growth, in Finland public organizations finance and support the founding of companies and product development. Although the reason for government to intervene in the market economy is to repair market failures, there is the danger that the public actors might take over the consultancy roles that independent companies can—and should—provide. In the extreme, the public actors are overly careful, avoid risks, place multiple, inflexible conditions regarding financing and perhaps operations, and compete with each other for money and companies. Many public actors are serving the same companies with similar products.

Radical innovations revolutionize industry

Innovation means inventing and successfully introducing a new thing. Newness, of course, is a relative notion. An invention (for example, a Web service) might be new to the inventor, organization, local community, or the whole world. Rarely is an

innovation absolutely new. Yet, globalization increases the pressure on companies or individuals to invent something that is new to the entire world. Therefore, usually newness is viewed in relation to its origin. An innovation can be a small step ahead from the known (incremental innovation) or it may be radical step (revolutionary or emergent innovation).

Radical innovations are the enemies of existing systems. They create new and at the same time destroy old ways of acting. When a revolutionizing technology radically adapts or replaces an existing technology, the companies linked with the old technology lose out, and old processes become outmoded. This kind of creative destruction is always a part of progress. It creates new winners and losers, and thus changes the status quo. But these dramatic paradigm shifts rarely take place in the normal scheme of innovation. Indeed, it has been argued that during the 50 years of the computer industry there have been just three radical innovations (see Ettlie, 2006, p. 80). The far more typical innovations are small improvements to existing products or processes. The quality and efficiency of products and processes are developed, enhanced, or reapplied.

While a new revolutionary technology could make an existing technology unmarketable overnight, it must be remembered that most new technologies undergo years of development. For instance, the Boeing 707 airplane took 12 years to reach the marketplace and the transistor radio took 10 years. Also the development of the new technology takes time, but the cycles of utilizing it have become shorter (cf. the Internet and services based on it, like Twitter).

Clayton Christensen (1997) has developed the theory of disruptive innovations. According to the theory, sustaining innovations[41] produce improved products for existing markets. The examples are longer flight airplanes, faster or more powerful computers, longer lasting batteries for mobile phones, and higher definition televisions.

Disruptive innovations, however, introduce a new value proposition. They open a new dimension compared to existing innovations. Christensen divides the disruptive innovations into market-creating innovations (new-market) and low-price innovations (low-end). Both types of innovations contradict the existing market. A new market-creating innovation offers totally new possibilities for which there is no current demand because no corresponding product exists at that time. Examples of such products or services in their time are Kodak's camera, Bell's telephone, Sony's transistor radio, Xerox's photocopy device, Apple's Mac computer, and eBay's Internet auction. According to Christensen, innovations such as these offer ordinary

41 Christensen's concept sustaining innovation is not directly linked with the concept of the sustainable innovation that I am presenting in this book. Christensen uses the term sustaining innovation to mean the further development, in small steps, of an existing process or product. However, my concept of sustainable innovation refers to innovation that produces ethically, socially, economically, and ecologically friendly sustainable results.

people the possibility to create things that, prior to the innovation, had required deep expertise or significant wealth.

The low-end innovations come into situations where the existing products and services are "too good," and thus over-priced and unattainable to the average consumer. Examples of price-lowering innovations include the retailer Walmart and Dell computers, in which the customer is offered either products similar to more expensive versions, or lower prices based on the economies of scale or simplified services. The mobile phone market is another example of the diversity of products. Customers can purchase special phones with Internet access, MP3 capability, and camera and video functions (e.g., Nokia's Communicator, Apple's iPhone, Blackberry) or, at the other extreme, very basic models that offer simply the mobile phone (e.g., Samsung).

One puzzling perspective in the disruptive innovations theory is that, according to Christensen (1997), existing companies are unable to create revolutionary innovations (thus, the "innovator's dilemma"). Christensen states that these large companies are too linked with their existing customers and technologies to dramatically change the market. Revolutionary innovations, at their inception, are often ineffective and attract only a few customers. Within the structure of a big company, then, revolutionary innovations are often marginal activities. Such innovations also require an experimental spirit and willingness to fail—repeatedly—an attitude unusual in companies that are under considerable pressure to produced successful results. However, most of these constraints and expectations are not prominent in small companies, which allow them the room and freedom to pursue a revolutionary innovation. Radical innovation, then, provides the path toward growth and success.

The disruptive innovation theory is a strong challenger to innovation policy. On the one hand, we could conclude that if we want to support innovations and, especially, develop revolutionary innovation, supporting small start-up companies would seems an effective strategy. On the other hand, large and established companies have proved to be surprisingly adaptive. Although a challenge might come from an innovation developed by a small company, a big company may be far more capable of efficient commercialization and it might have experts with complementary capabilities, allowing it to integrate new know-how into existing know-how. Familiar and successful companies such as Apple, IBM, Kodak, and Nokia have shown their ability to adapt, having strategic agility (Doz & Kosonen, 2008a).

Large and established companies might be strong in process innovations, through which they can demonstrate productive and organizational flexibility (e.g., Nokia). However, history has pretty well confirmed that their ability to create radical product or service innovations is limited. This is true especially if their supplementary investments in R&D activity are not profitable. When markets mature and become central to a company's business plan, the company's investments in technological development often slows. These large companies are focused on maintaining their market positions. Their challengers, however, are new, market-creating innovation companies or skilled and aggressive imitators.

Continuous innovation as a permanent practice

The growth of innovations can be viewed from a national or regional level. In the global economy, the innovation of the nation is an important sign to international companies regarding the suitability of that country as a location for investment. Innovation can be estimated in many known ways, of course, but here I want to continue the examination based on Christensen's theory. Christensen et al. (2004) compared innovation activity in Japan and the United States and identified important differences. Japan developed quickly in the 1960s through the 1980s, and the country exhibited a high savings grade, lifelong employment for most workers, and influential company groups, called *keiretsu*. The Japanese Ministry of Trade and Industry led the technology policy of the country purposefully. However, these same factors became brakes in the 1990s, when reforms were needed amid a changing global business environment. Japan's big companies, like Sony, Sharp, and Matsushita, which had led the economic growth, suddenly faced the innovator's dilemma. Most of the openings in new markets looked too small and indefinite to be interesting to the old innovation leaders. The nation's technology policy did not encourage movement toward the narrow niche markets. As a result, Japan was driven into recession and deflation in the 1990s, from which it emerged only in the 2000s.

In the United States, the successful big technology companies that had been around since the late 19th century also faced the innovator's dilemma in the late 20th century. But, unlike in Japan, says Christensen, technological development continues in the United States either because individual developers of technology leave their jobs in established companies and start up a new company based on the new technology or other entrepreneurs outside of big business seize opportunities to develop technologies. In both cases, financing instruments and ready cooperation networks exist to facilitate technological development.

In this way, the wheel of disruption loops ceaselessly (Figure 8). This wheel is the micro-economic core of the macro-economy. In the United States, several structural practices have created and/or support this cycle, including lower marginal tax rates, decreased government regulation and increased government investment in science and technology. Christensen's model is linked primarily with the lifespan of innovation rising within big companies. In a well functioning ecosystem, ideas flow naturally from other sources too, including from universities and research institutions, migrant workers, the inspiration and sweat equity of serial entrepreneurs,[42] and the workings of various networks. Established companies benefit from the ecosystem by purchasing small innovative companies and, in this way, safeguard and

42 Serial entrepreneurs establish several innovative businesses one after another, or, at times, simultaneously. The fate of these businesses may be survival, buy-out, or failure.

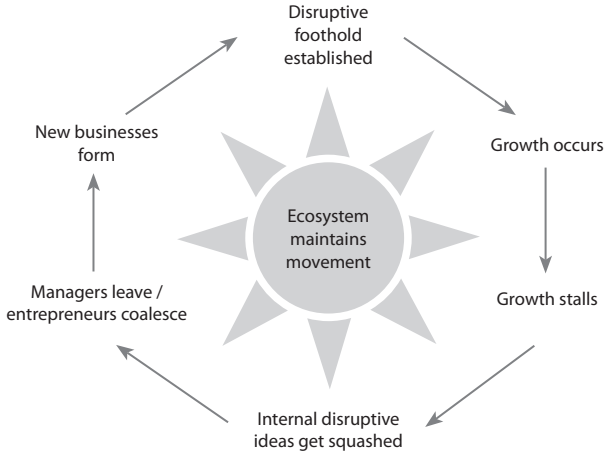

Figure 8.
Wheel of Disruption. Adopted from Christensen et al., 2004, p. 211, Figure 9–1.

enhance their vitality. I believe, therefore, that the wheel of disruption should include the channel for innovations that are opened by company purchases.

Christensen et al. (2004, p. 211–212) suggest six factors that keep the revolutionary cycle moving:

1. **A market for talent** that is flexible, encourages entrepreneurship and risk taking, and supports mobility between companies;
2. **Capital markets** that help new firms start and grow while targeting disruptive opportunities. Capital market policies that encourage debt financing inhibit the wheel of disruption;
3. **Unconstrained product markets** that provide ample motivation and ability, and open the access to new customers (e.g., new distribution channels);
4. **A supporting infrastructure** that has appropriate tax policies, encourages company formation, and has intermediaries that provide "lubrication" to the process of distribution, such as training and education, market research, and verification and accreditation services;
5. **Vibrant industry dynamics** with market-based interaction and competition to spur new business models;
6. **A research and development environment** that protects intellectual property while directing research toward breaking tradeoffs and applying technology into new markets.

These same factors characterize the ecosystems of innovations, as I discussed earlier in this chapter. Here, my focus is the national level. At this level the theory of revolutionary innovations predicts that the best long-range growth potential will be reached by creating an environment that supports nationwide revolutionary growth (e.g., creates a national wheel of disruption). Because revolutionary growth is based on the creation of revolutionary technologies and innovations and on new markets, Christensen et al. (2004) stress that company clusters should be grouped around new-markets, not based on industries.

Christensen's wheel of disruption offers a new way to look at the innovation activity. In most innovation policies, the attention normally focuses on starting new science-based companies. However, such companies are not so common and their path toward growth is often difficult. Meanwhile, the location of the majority of R&D activities takes place in larger, established companies, even if their ability to benefit from their inventions is limited. In many cases, inventions that surface within large companies will not be used because they do not support the basic business focus. Radical innovations, in particular, are problematic because they might even endanger the primary technology or marketability of the company. The point behind the wheel of disruption is that internal innovations should find expression and development either within the company of origin or, if necessary, outside that company. This is linked with the concepts of internal entrepreneurship and the externalization of inventions. National innovation policy, traditionally, has offered rather little for these processes. Fortunately, a variety of decentralized innovation models are gaining foothold in various countries, and through them new possibilities to implement the wheel of disruption are opening. This is the focus of the next chapter.

Small ecosystems can manage

The know-how hubs in a small but geographically scattered country like Finland are, as could be expected, relatively few. The Helsinki region is the only Finnish area of the metropolis class, with just about a million people within its labor and innovation pool. The other regions of Finland have, at best, just a few hundred thousand residents. So, when looking at the Finnish innovation policy, smaller regions and their environment for innovations have also to be considered. Globally, know-how and value creation seem to concentrate in larger city regions (London, New York, Paris, Tokyo, Boston, Cambridge, Silicon Valley, etc.). Yet, Finland, with its population of 5 million people—fewer than in many of the larger innovation *cities*—ranks as one of the most competitive countries in the world. This underscores the point that size is not as important as the world-class know-how, cooperation, and networking characteristics of the Finnish innovation environment. It is in this light that I want to look at the vitality of small ecosystems.

Increasingly, the process of knowledge creation is the path by which resources find their way to the centers of innovation. In the knowledge-based economy, the creation and distribution of knowledge are the central processes. Many innovations arise expressly from the combining of a variety of information and viewpoints. Therefore, in order to be innovative, a company or organization must have access to the sources of new knowledge. This new knowledge is derived from business partners, customers, competitors, experts, research institutions, universities, or authorities, to name a few. Proximity, then, to facilitate easy and regular face-to-face meetings, is essential to allow for the spreading of multiple bits of information and aid the speed of knowledge transmission.

An ecosystem of innovations functions precisely because it is based on this proximity. However, an ecosystem has an optimal size. In order to function efficiently, the ecosystem must contain a certain number of people, companies, institutions, and diversity. The "best" size probably depends on the fields of know-how, technologies, line of business, the history of the field, and so on, that provides the scaffolding for innovative activities; each system is unique and specific numbers cannot be concretized. In any case, however, the elements of the ecosystem are so diverse that only some of Finland's city-regions are able to offer a world-class ecosystem.

The argument of proximity explains the concentration of innovative activity, but does not dictate success in the global economy. Certainly, a number of regions have succeeded even though they do not represent a prototypical ecosystem. Thus, in order to understand this reality, the concept of technology must be broadened to that of a technological system (or field).[43]

A technological system is formed by

1. a group of technologies that rely on and support each other
2. a technological core that functions as the market standard (a basic architecture or dominating design)
3. a group of actors, who alone or in cooperation create, develop, and apply technologies
4. a group of knowledge, know-how, and established norms that define the contents, use, and development of technology.

A technological system is a developing totality, where change is influenced by all the factors within the system. This concept is useful because it envisions technology more as an institutional phenomenon than a technical apparatus (mobile phone) or a process (creating a signal). Another important feature is that the technological system may be local, regional, national or international. Increasingly, technological

43 In the innovation literature, the technological system has received scant attention, despite its usefulness (see Gustafsson, 2010, who studied technological fields and reviewed the relevant literature).

systems are global in scope and cannot be localized to one place. So the technological system is globally spread or a distributed system.

As a result, the development of a geographical region or locality can now be estimated from the viewpoint of its role in a globally spread technological system. Päivi Oinas and Edward J. Malecki (2002) have created a typology of local innovation systems that starts exactly from these different roles. A region might be in the forefront of the development (*genuine innovator*), may adapt the innovations at the forefront of implementation, concentrating more on furthering the development (*adapter*), or can imitate technology developed elsewhere and concentrate on production and implementation (*adopter*).

From a technological point of view, a region might be versatile or specialized. In most cases, innovations surface within regions where there is enough diversity in knowledge, technology, production or business, as stated above. Any regional deficits can be compensated for through specializing or by building up networks to look for and create knowledge in the regions or localities at the forefront. By combining the three roles with the regional multi-faceted capacities, Oinas and Malecki presented a classification of six types of regional innovation systems (Table 4). They used figurative names, but examples tell about the contents of the types.

Characterization of region	Sectoral diversity	Sectoral specialization
Genuine innovators (best practice places)	"Stars" (Silicon Valley, US; Cambridge, UK)	"Shooting stars" (Detroit, US; old Glasgow UK)
Adapters (relatively high levels of diverse competences)	"Living room lamps" (Hsinchu, Taiwan)	"Spotlights" (Bangalore, India)
Adopters (production-oriented competences)	"Chandeliers" (Bangkok, Thailand)	"Candle" (Dongguan, China)

Table 4.
Typology of regional innovation systems (Oinas & Malecki, 2002, p. 116)

Oinas and Malecki characterized these classes as follows:

- "**Stars**": Many local fields of activities and rich relations between the actor, top class know-how, and tight contacts with other centers;
- "**Shooting stars**": Well developed strong fields of activity, but dependant solely on the innovation capability of the region or field;
- "**Living room lamps**": Strong, many-faceted regional know-how and tight contacts with the centers of the forefront in the world;

- "**Spotlights**": Are able to develop products because of strong external relations, supplementing own know-how with the know-how of other centers and partners;
- "**Chandeliers**": Several sectors of productive industry in a region that do not cooperate. The companies keep up strong ties with their customers and collaboration partners beyond the region.
- "**Candles**": A rather simple production-directed talent in the region that is exploited by customers elsewhere.

This typology shows that a region and its functioning companies can succeed using varying strategies. Although globalization raises the value and meaning of stars and falling stars, the lamps and candles are able to succeed because of their specialization, networking, and tight cooperation with peer companies outside the region. However, the success of the companies functioning in the locality or in a larger region is predicated on their finding their most appropriate position within the technological system in which they participate. Each role has its own criteria and measure of success. The activity environment—the diverse ecosystem—supports innovation. Networking inside and outside of the region is important for all regions and companies, but it is vital to the adapters who function in a specialized and focused ecosystems. We can see these relations in Figure 9.

In today's knowledge-based economy, therefore, concentration is the primary direction of development. Activities linked to knowledge seem to accumulate in the central municipalities and larger cities. Around the former, satellite areas form that maintain close contact with the central municipality, as the related activities and companies benefit the central municipality. Often, the satellite areas also offer suburban residences for the workers, some of whom commute to the municipality each day. At times the satellite may equal or better the success of the central municipality,

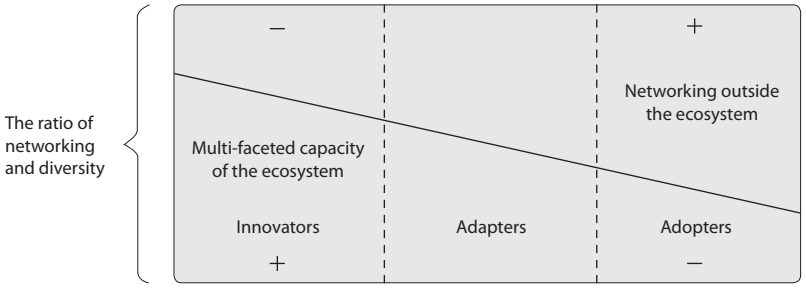

Figure 9.
The meaning of the diversity and networking of an innovation ecosystem.

perhaps becoming a center itself. In Finland, the city of Espoo serves as a satellite of Helsinki while being a center in its own right.

Meanwhile, the locations farther away from the central municipality are less likely to possess the multiple elements of the knowledge economy. Invariably, these peripheries are poorer economically than the central municipalities and satellites. Moreover, these peripheries often lose their best young laborers to the centers.

The report *Town Network and Town Areas 2006,* published by the Finnish Ministry of Interior (Sisäasianministeriö [SM] 2006) in Finnish, classifies the city areas as follows:

- **Metropolis area** (the greater Helsinki area[44])
- **Multi-faceted university areas** (Tampere, Turku, Oulu, Jyväskylä, Kuopio, Joensuu, and Vaasa)
- **Province locomotive** (Lahti, Pori, Kouvola, Kotka, Lappeenranta, Mikkeli, Rovaniemi, Seinäjoki, Maarianhamina, Hämeenlinna, Rauma, Kajaani, and Kokkola).
- **Specialized industrial areas** (Salo, Imatra, Kemi-Tornio, Uusikaupunki, Valkeakoski, Varkaus, Jämsä, Äänekoski, Pietarsaari, and Raahe).
- **Small area centers** (Iisalmi, Savonlinna, Forssa, Kuusamo, Ylivieska, and Kauhajoki).

The Helsinki metro area is superior in its strength and development preconditions and it can be viewed as the only European city area in Finland. What is the position of the Helsinki area in global innovation competition? How does its innovation ecology function and what are its strengths and weaknesses? The population of the immediate Helsinki city area is about 1 million, and that of the greater Helsinki region about 1.3 million. In 2030 about 1.5 million people will be living in the metropolitan area, enough to maintain the dynamics and diversity of the region. The employment rate is good and the growth of the economy has been faster there than in the country as a whole. The income level of the highly educated labor force is relatively competitive with other western metropolises from the viewpoint of companies (i.e., salaries are low). The region hosts six universities (e.g. the University of Helsinki, the Aalto University) and several polytechnics. More than 40% of Finland's R&D investments are in the Helsinki area. The country's largest companies—Nokia, Metso, VTT[45], and others—are located there, raising the region's profile regarding high-level applied research. Moreover, 15% of Finland's entrepreneurs operate within the Helsinki area,

44 In the report Town Network and Town Areas 2006, a metropolis area is defined rather broadly. Often the metropolis area of Helsinki is defined as consisting of 14 municipalities including Helsinki, Espoo and Vantaa, an area of some 1.3 million inhabitants.

45 Metso is a global supplier of technology and services for the mining, construction, power generation, oil and gas, recycling, and pulp and paper industries. In 2009 Metso Corporation's net sales were about €5 million. VTT—the Technical Research Centre of Finland—is the biggest multi-technological applied research organization in Northern Europe. VTT provides high-end technology solutions and innovation services.

and the percentage continues to grow. The most important business clusters in the area are knowledge-intensive business services, the knowledge and communication sector, wholesale business, and logistics. The ICT cluster environment, the largest sector, employs about 45,000 people.

When looking at the competitive ability index of the world's knowledge economy, the Helsinki area is among the 20 best metropolitan areas (Helsingin Kaupungin Tietokeskus, 2006). This important index is based on the impact of knowledge capital on economic growth, well-being and wealth. According to Richard Florida (Florida 2005), the Helsinki area is one of the most creative areas in the world. At least in the statistics, the Helsinki area is doing well by international comparison.

However, like most metro areas, Helsinki faces challenges, although opinions vary on what the most important challenges are. Certainly the geographical remoteness of Finland, the aging and homogeneous population, the smallness of the country, and even the cold climate have been raised as considerations. But I will begin addressing this issue from the other end, by considering the kinds of problems that world-class innovation centers have, using Silicon Valley as an example.[46]

The cost of living in Silicon Valley is high, particularly housing costs, which continually rise, although the salaries for engineers and other experts are higher than other employment fields in the area. However, within the US capitalist economic system, households often pay some or all of their own health care and pensions, and certainly most of their children's higher education. Some families also opt for private elementary and secondary education for their children. The urban sprawl associated with the immense population growth of the area has led to traffic jams and long commuting times. Working hours in some fields are frequently 50–60 hours per week, and most Americans are given just two or three weeks vacation annually, although some professionals do not even use their full allotment of free time. The costs and scheduling of high-quality child daycare and/or children's after-school activities can complicate women's full-time work opportunities and advancement in their careers. Migration to the United States has become very difficult in the post-9/11 era, which limits the flow of foreign experts into the country, and specifically into Silicon Valley. Furthermore, Silicon Valley faces new and steeper competition from other know-how concentrations, particularly in China and India. Today Silicon Valley is simply one of many world-class centers of innovation.

Nevertheless, Silicon Valley is not alone in many of its challenges. Almost every know-how concentration faces similar problems. It is a challenge everywhere to safeguard the quality of life. From this point of view, however, Finland and the Helsinki area have clear advantages. Because Finland is a social democracy, the basic needs of life—such as health care, pensions, and education—are part of every citizen's rights, and are, for the most part, working well. Moreover, Finnish society places

46 The case of Silicon Valley is described here only in a very general way based on discussion with inhabitants, blogs, and newspapers. But of course, everybody has his/her own perspective on Silicon Valley, and the diversity of opinion can rise from the disparity in wealth, education, access, and employment.

emphasis on maintaining a clean and beautiful environment. Its good public transportation system and tradition of bicycling make traffic congestion less of a problem. Thus the efficient welfare society and well functioning public sector are beneficial factors in global competition.[47]

Although the Helsinki area is rather small for a world-class metropolis, its importance is central to the competitive ability of the entire country. Keeping the Helsinki area the locomotive of the Finnish economy and the cradle of the nation's business activity requires nation-level investments and the development of a special metropolis policy. But at the same time the country must create a means for the outcomes of the Helsinki area to benefit all of Finland, in ways beyond simply producing tax income. In this regard, I refer particularly to the networking process of creating knowledge and innovation activity within a scattered model of activity, which I deal with in the next subchapter. Although I do not deal here with the other Finnish know-how regions and their ecosystems as I have with Helsinki, the ecosystem approach brings to the innovation policy a strong regional dimension as well.

Building up innovation centers in Finland

Looking at the innovation activity through the ecosystem of innovations concept presents different challenges than those of the traditional innovation system. Innovation activity is always linked to a certain environment and its networks. When I stress the importance of an ecosystem of innovations to innovation activity, I mean local conditions and local processes. With public R&D investments, for example, research activity and adaptation of its results, product development, incubating companies, and networking can be increased locally. But, in order to support innovations as efficiently as possible, focused attention on the living aspects and dynamics of the ecosystem needs to be emphasized at the same time.

In my report *Innovaatioiden ekosysteemi ja Helsingin seutu* (Hautamäki, 2007a; *The Ecosystem of Innovations and the Helsinki Area*), commissioned by the city of Helsinki, I stated that an innovation center must guarantee

1. *A High quality of life*, which is influenced in particular by the culture, living conditions, public sphere, and availability of quality services; and
2. *Good preconditions for business*, which is influenced by, among others things, the nature and tenor of the innovation environment, availability of public services, and traffic patterns and transportation.

47 See Dahlman et al. (2006). On the other hand, taxes are considered high in Finland and that is weakening the incentives for a highly talented individual to choose a risky entrepreneurial career, as was observed in the report, *Evaluation of the Finnish National Innovation System, Policy Report* (TEM, 2008a, p. 61.).

To achieve these goals nationally, the fine-tuning of the collective activities of the regions and their municipalities must be approached in a new way. Services, culture, traffic, community structure, and business activity are all essential factors in building up a well functioning and attractive environment for people and companies. A regional build up of the principles of sustainable development would be especially interesting. When global innovation centers—the Silicon Valleys—make their mark in locations around the world, Finnish experts and companies have many alternatives in their home environment to consider. Finland can become and remain attractive relative to its competitors only by building up its world-class innovation centers, where high standards of living and world-class business possibilities are combined.

According to John Kao (2007), the most important characteristics of innovation hubs are the quality of life, the possibility to specialize, and a reputation as being a tolerant place. Richard Florida (2002) proved convincingly that location is a central element underlying the economy and society. The quality of place—its potential for stimulation, tolerance, and creativity—impacts on whether creative individuals try to find their way there. Place has its physical and spiritual dimensions. Kao (2007) speaks about a physical place as the architecture of knowledge. Referring to Delphi, Stonehenge, and even to the Pyramids, he argues that special places open us to the possibility of taking in what we do not know yet. Therefore, each innovation concentration must contain something special, interesting, and exciting. The spiritual dimension of place is linked with the ecosystem it offers, which stimulates the creativity and gives a basis for transforming it into an economic success.

What would an innovation policy empowering the ecosystem look like? First, it would be more regional in scope, rather than national. As such it would reinforce the existing strengths in the area and use the local resources according to the local demand. It would improve the attraction of the area by investing in the vitality of the area's municipalities and build up a creative milieu. And cooperation among all the innovation actors in the region would be promoted and sustained.

Such an innovation policy would be more bottom-up than is usual today, as the crucial investments would be based on the local needs and the local proposals. The objective, guided, nationally centralized innovation policy, which includes national programs and competition for R&D financing based on them, would be supplemented by a demand-based development policy. More specifically, the innovation policy would be an entrepreneur policy, in that all the unnecessary obstacles for entrepreneurial activity would be cleared away and strong incentives would be made for companies to create new knowledge, innovation, and global business.

The core of the new innovation policy should be a smooth "horizontal" cooperation between the fields and levels of administrations creating the preconditions for innovation activity. The strengthening of ecosystems of innovations can only happen amid cooperation among the national, regional, and local actors. The forces and resources must be gathered around local innovation strengths.

When building up the local ecosystems of innovations, the Triple Helix model (Etzkowitz, 2003) offers guidance. This model emphasizes cooperation among the producers of knowledge, that is, the universities, industry (markets), and public administration. In short, a knowledge-based economy involves a subsystem that creates or produces knowledge (the universities and research institutions) and a subsystem that benefits from knowledge, where the basic actors are companies, schools, hospitals, and so on. The interaction between the knowledge-producing and knowledge-benefiting systems takes place at the local level, through various mechanisms of knowledge and technology transfer. In particular, the interaction of the ecosystem of innovations, which draws on the uniqueness of a specific community and culture, ultimately builds up the connection between these systems, and thus the universities, firms and public administration work together.

The approach of an ecosystem emphasizes the position and roles of local actors, especially municipalities, in developing the innovation activity. Although municipalities are not responsible for the system of knowledge production, in many ways they can influence the subsystem of knowledge benefiting. Of special importance are *intermediary organizations*, which are often local organizations such as technology centers, enterprise incubators, and development companies (Koskenlinna et al., 2005), whose primary tasks are to facilitate the transfer and commercialization of technology, and develop innovation networks. *Technology centers* promote the foundation, growth, and internationalization of technology-based companies. *Enterprise incubators* provide assistance to new companies during their crucial start-up and establishing phases. Local *development companies* help new local companies find funding and offer company guidance. Universities and vocational institutes have their own service units (*license offices*) specialized in technology transfer that oversee tasks concerning licenses and protecting copyrights and patents. Often these intermediary organizations are founded by local actors, such as the municipalities.

The intermediary organizations function between companies and between companies and research organizations (see Figure 10). While companies and research organizations are often directly connected, for example through research cooperation, the primary task of the intermediary organizations is to further—extensively or intensively—the cooperation between the knowledge producers and knowledge benefiters.

Because research on intermediary organizations is only just beginning, there are no reliable data on their influence. Nevertheless, the vision of sustainable innovation presented in this book points to the importance of intermediary organizations in their ability to support the functioning and dynamics of the local ecosystem. In their role, the intermediary organizations create official and unofficial networks between the actors, increase the movement of ideas, people, knowledge, and best practices, and strengthen the social capital in the innovation ecosystem.

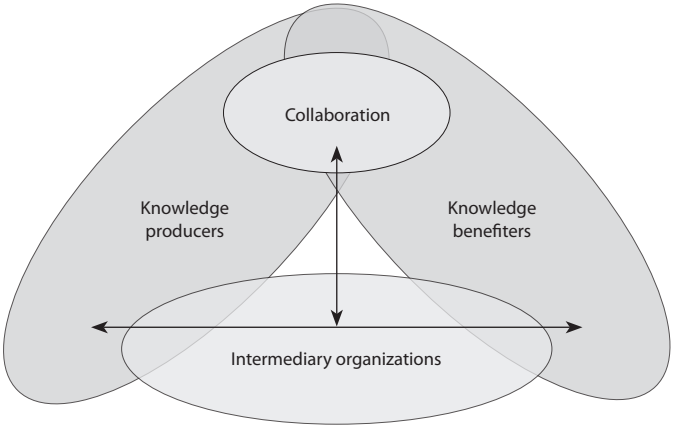

Figure 10.
Intermediary organizations as connectors of knowledge producers and knowledge benefiters

From the viewpoint of the ecosystem-based innovation policy, a central question is how intermediary organizations should be developed. In Finland, for example, the landscape is not clearly conceived. Throughout the country, hundreds of intermediary organizations—primarily regional development companies and enterprise incubators, although also tens of technology centers—have been started. In these areas, there are the Centers for Economic Development, Transport and the Environment (ELY Centers, 15 together), the Center of Expertise Programme, and the Regional Cohesion and Competitivenes Programme, which all aim at promoting business activity and increasing the efficiency of the transfer of know-how. Because of overlapping missions, the interplay of these organizations creates redundancies, while other important elements of technology transfer (e.g., linking know-how with the global economy or international markets) remain unaddressed.

One concern in Finland is that intermediary organizations are run by the public sector. While the economic perspective indicates that the actions of the public sector should be based on market failures, it is widely perceived and debated that the public service intermediary organizations are too extensive and overlapping. It is important to note that the role of public intermediary organizations in the Finnish market economy is relatively new, emerging perhaps within just the last three decades. Prior to that, there was no organization—public or private—to fill this role, and so the government stepped in. But in the 21st century, private firms are being created to serve their peers as intermediary organizations, and so the role of the public organizations in the market needs to be reconsidered so as not to hinder the natural progression of second-economy enterprises.

In rich corporate environments, like Silicon Valley, companies specialize in serving other companies, creating what Martin Kenney and von Burg (2000) call an "economy two." In this business-to-business environment, individual companies provide focused assistance to other companies, in areas ranging from legal issues to marketing expertise, and from technology transfer to international cooperation. These business support companies make their living by producing high quality and competitive services. As a result, demand guides the development of these service companies.

In developing intermediary organizations based on demand, a sensibility is required regarding the actual needs of companies. One way to support them is to give them vouchers to buy services. Another is to support the founding of second-economy companies. Nowadays, particularly in Finland, it is difficult to get financing for establishing consulting or support service companies. This is in line with the technology base of the innovation policy: A company will find it difficult to finance a service idea—no matter how promising the business innovation—if simultaneously it does not develop a new technology.

All in all, the ecosystem approach emphasizes the importance of the regional and local level in the innovation policy. Innovative companies need a rich ecosystem around them. As we might expect, the ecosystem comprises a diversity of companies and their clusters, research institutions, universities and vocational institutes, funding sources, and many types of services. But there is also a separate, parallel, human component to the ecosystem: the nature of the living environment. The quality of life is a central factor when a company, its specialists and managers decide on the company's location. In this way, the perspective of innovation policy broadens horizontal cooperation and develops the local conditions. To get the full benefit from local and national funding, you have to have local support—good conditions, such as local research, partners, subcontractors, and so on—if the company and region are to benefit. Therefore, without regional development and strengthened local ecosystems, high investments for R&D activity are simply not efficient.

In my view Finland needs a national initiative to build up the country purposefully through five or six world-class *innovation centers*.[48] This recommendation takes into account both the issue of local strengths as well as the available components of an ecosystem, outlined above. According to this concept, each of these ecosystems would concentrate on some specific area of know-how through which it can become one of the top innovative producers in the world. While these local ecosystems can be built through the cooperation of the relevant actors, there is also a role for state investment, particularly the R&D funding sources, universities nationwide

48 Naturally, it is difficult to choose the innovation concentrations. Selection could be done by combining different approaches, for example, by clarifying local strengths, considering the balanced development of the country, the benefits of competition (R&D programs, SHOKs research), and using the seed money of social innovation. One basis for choosing is provided in the town networks report from the Ministry of Interior (SM, 2006).

and experts from all regions. Reaching the pinnacle of innovation in a chosen area also requires the efforts of local administration (vocational institutes, intermediary organizations, cooperation of municipalities, investments of the regional councils) and the investment and commitment of companies to work in the area.

We should distinguish here between the Strategic Centers for Science, Technology and Innovation (SHOKs) and the local innovation centers referred to above. SHOKs are organizations that fund special research related to the interests of owners and research is conducted by networks of research institutions. The innovation centers are the local ecosystems of innovations. SHOKs are not necessarily linked with the local universities, companies, experts, risk capital, and so on. It would be ideal if SHOKs would be located near these innovation centers, which I propose, so that they form the core of centers' know-how.

Most of the financing needed to build up these five or six innovation centers can come from redirecting the existing funding resources according to a common strategy (Hautamäki, 2008a, 2008b). However, some new seed money is needed for social innovation because experience has shown the frequent difficulty in securing financing to coordinate the growth process and for the common projects within these large innovative plans.[49] The cooperation among the multiple actors develops more easily if there is an economic stimulation. Directing the seed money from the nation's annual budget would be the best means for bolstering regional development. I have proposed that the government should build "innovation packages" to support the creation of innovation centers. These packages would draw together money from several funding sources (Tekes, Academy of Finland, SHOKs, etc.), which would be dispersed through an application process to cities and regional communities for innovative development programs.

The process of building innovation centers would develop the competitive ability of the country overall, following the new development and logic of an innovation economy. The successful regions will encompass and advance the areas that surround them. When chosen well, these top innovation centers, together with their influence areas, could stimulate almost the entire country. Building world-class innovation centers is a modern regional policy based on the current view of innovation and the conditions that enable innovations to emerge.

49 John Kao (2007) proposes that the United States build up 20 innovation centers, called innovation hubs, each needing financing of US$50 million. In Finland and other smaller economies, the seed money needed would be notably lower. I have proposed that in Finland it would be possible to build four to five innovation centers besides the Helsinki region, in Jyväskylä, Kuopio/Joensuu, Tampere, Turku, and Oulu.

Chapter 5:

DECENTRALIZED INNOVATION GAINS A FOOTHOLD

As we have seen, sustainable innovation means promoting sustainable development through innovation. Through sustainable innovation, a company draws resources into its innovation process that are more extensive than the company itself. The principles of sustainable innovation stress that the expertise required for innovation lie outside the organization, and are more likely to do so in the future. More often nowadays, innovations take place within informal networks, where company personnel, users, subcontractors, customers, and voluntary experts collaborate with one another.

In this chapter I will define various concepts of innovation. The main line of division is between *closed innovation* taking place inside firms and *open innovation* created in (often external) networks. Furthermore, I will define *public and half-public innovations*, which contain a strong element of voluntary commitment. For example, open source programs are produced by communities of peers. Often, users of certain products improve these products to better meet their own needs, which leads to the concept of *user innovations*.

Traditionally, innovation activity has been contained within an individual company, which invested in research and product development and, independently, created and commercialized its own innovations. Henry Chesbrough (2003), who launched the open innovation paradigm, calls this basic model of innovation the closed innovation paradigm. The advantage of the closed innovation paradigm is that a company can control the complete innovation process (the use of resources, the quality and the timing of the process, and the introduction of the innovation to the markets, etc.) by keeping it entirely within the company. Moreover, the guarantee of copyrights and patent ownership hold a key position in safeguarding R&D investments in the closed paradigm. Copyright ownership also safeguards economic returns: none of the profits belonging to the company and are divided among others, for example, in the form of license payouts.

Although the closed paradigm is no longer the exclusive innovation model, it still dominates principal industries. However, new models of innovation activity are beginning to demonstrate that they can be serious alternatives. Several big companies, such as IBM, Nokia, Procter & Gamble (consumer products), and Qualcomm

(mobile phones), are examples of the open innovation paradigm. Another means of innovation is seen in the Linux operating system, in which voluntary experts create together a source code that is available for all. In this chapter several models of decentralized innovation are reviewed and their important differences and similarities discussed.

Open innovation in markets of innovations

According to Chesbrough (2003), the open innovation paradigm presumes that companies can and must utilize ideas from both within and beyond the company, and use avenues and processes to markets that originate both within and beyond the company. In the closed basic model the innovation process is like a funnel, which is bound by the limits of the company and where the best ideas produced by the R&D activity of the company are picked up and pursued into products and taken to markets. In the open paradigm, however, the funnel is porous, with new ideas and technologies from outside the company sought and taken into use at all phases of product development. At the same time, any ideas that the company cannot use itself are transferred to other companies, who then make products for new markets (Figure 11).

The open innovation paradigm allows companies lower innovation costs, quicker access to markets, and the possibility to share risks. In order to be able to benefit the open innovation, a company must renew its business model and its

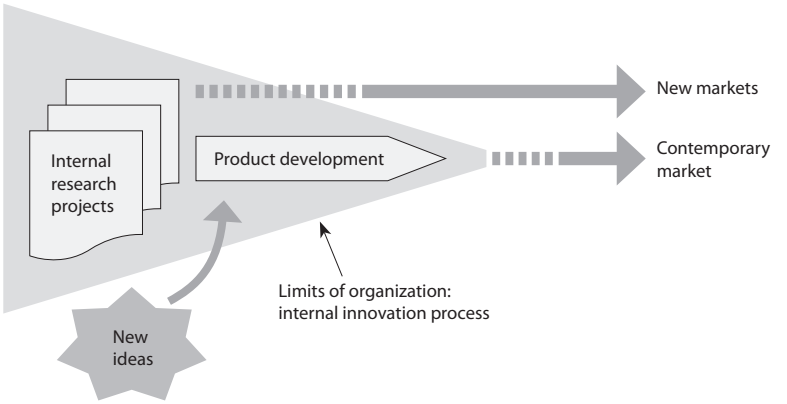

Figure 11.
The open innovation process (drawn from Chesbrough, 2003, p. xxv, FIGURE I-4).

management (the latter is essential, says Chesbrough, 2006). Table 5 shows the significant differences between the open and closed paradigms.

Principles of closed innovation	Principles of open innovation
The main experts in the field work for the company.	Significant numbers of external experts work for the company. Company must work with smart people inside and outside the company
In order to profit from its R&D, the company must invent, develop, and sell the innovations by itself.	External R&D can create remarkable surplus value for the company.
The advantage of inventing internally is that the company is able to take the invention to the markets first and profit.	The company does not need to be the original inventor in order to benefit from the innovation; often, developing a better business model is more useful than getting to the markets first.
If the company creates the most and best ideas, it will profit.	If the company uses the best internal and external ideas, it will profit.
The company must control its intellectual property so that competitors would not benefit from its ideas.	The company may benefit if others use its intellectual property. The company also may profit from buying other's properties, if these advance the company's business model.

Table 5:
The principles of closed and open innovation when adapted from Chesbrough (2003, p. xxvi, TABLE I-1).

In short, the central issue in the open innovation paradigm concerns the ability or willingness of a company to "buy" ideas (technologies, licenses) from the outside and "sell" their own unused ideas to others, who may make them profitable. From this perspective, companies begin to look at their innovation process in the same manner as other company processes and systems: Is it profitable to do the innovation process oneself? What can be externalized for profit? What expertise or ideas are available from the outside?

However, if the buying and selling of ideas is to progress, markets for the exchange of ideas and for innovations need to be formed. Fortunately, these kinds of markets for innovations are slowly taking shape. This type of process has also been undertaken by specific companies that look for and transmit ideas or find solutions to the technological problems of other companies.

InnoCentive is one such transmitter of innovations. It specializes in seeking out solutions for the technological problems in companies' product development processes, especially in the fields of chemicals and medicine. InnoCentive effectively uses the Internet. It posts carefully worked out ideas and problems openly on a Website and any individual or organization registered for the pages can propose a solution to the problem. The best solutions are rewarded financially. Currently,

thousands of people from around the world are registered for this site, half from the United States but others from emerging economies such as India, China, and Russia. Several companies who have tried in vain to solve a particular problem have found the answer rather quickly through InnoCentive. Additionally, a number of companies have saved years of work and significant financial investment (for some, running into the millions of euros) in their product development by using InnoCentive's worldwide nets.

A central concern in the open innovation model and markets of innovation involves copyrights and industrial rights. I will return to this later, but in this context it is worthwhile looking at the complexity of the control of intellectual property rights (IPRs) within the business model of the open innovation. If Company A uses a technology patented by Company B, then Company A becomes dependant on the use of another's rights. Sometimes the situation becomes neutral, if each party uses the other's technologies and licenses, although this kind of cross-patenting is not always possible. Meanwhile, some companies specialized in certain technologies that are outside their primary business focus are more able to offer licenses for ideas they will not develop into products: They can utilize their licensing position to grow their core business with patent income. Of course, when there are multiple actors in the same process within the open innovation model, the situation may become more complicated, and therefore firms have to develop a new management approach (see Chesbrough, 2006; Prahalad & Krishnan 2008).[50]

The generalization and promotion of open innovation rise new challenges for the innovation activity and policy. The main ones are

- The definition of IPRs in the direction of promoting cooperation and flexibility
- To introduce and regulate markets for innovations, patents and licenses
- The development of companies' readiness toward cooperation and being trained in the open innovation.

Public innovations are outside markets

Open source code products, like the Linux operating system, are "common property" that anyone can use freely for their own purposes. They are not owned by any individual or company. And so the creation of open source code products often is seen as an example of the open innovation paradigm. However, this assumption would be incorrect because open source code products are created by voluntary efforts

50 Licensing has always been an everyday matter for companies, but in the open innovation paradigm it becomes the central aspect of innovation activity.

and are outside the innovation market. Their innovation activity has been organized outside of any company and without payment to the creators. In the open innovation paradigm, on the other hand, the rights are bought and sold; the process reflects the normal business activity and, in fact, is a part of it.

Professor Steven Weber (2004) has thoroughly analyzed the production process of the open source code, and concludes that in the open source paradigm ownership is based on the *right to distribute* and not on the right to exclude others from using the product. This is clearly seen in the definition of the open source code:

- The source code must be distributed with the software, otherwise it should be made available for no more than the cost of distribution.
- Anyone can redistribute the software for free, without royalties or licensing fees to the author.
- Anyone can modify the software or derive new software from it, and then deliver the modified software under the same conditions.

With these criteria, the products integrating the open source code should be called *public innovations*. Public innovation differs decisively from the open innovation paradigm on the following points:

- Public innovation, in most cases, is produced by voluntary efforts and outside market negotiations, whereas open innovations are based on selling and buying ideas and intellectual properties.
- Public innovation can be freely used by anyone, whereas users of open innovations are subject to royalty payments to the licensed patent or copyright holder.
- No one has ownership of the public innovation, whereas open innovations are patented and copyrighted by an individual or company, who hold exclusive rights to its usage unless it is licensed.

Naturally, a business can be created based on public innovation. Chesbrough (2006) addressed the "business models" of open source code. For example, a company called Red Hat has prepared tools that help in the installation and functioning of Linux in different computer operating systems. These additional functionalities are not free although the basic Linux code is free. MySQL database software is another example. The basic version is free of charge, but more developed versions come with a cost. IBM is closely linked to Linux and has built a business in helping customers to integrate Linux within their IBM-based technical infrastructure. Nowadays, two thirds of IBM's sales come from the services linked with Linux, while only a third of their business is generated from its own copyrights. IBM also invests remarkable resources in the development of Linux.

Contemporary economic thinking operates within the assumption that a company is the only appropriate way to organize successful product development. But within the last two decades several new products have been created as public innovations. The significance of public innovations is that they are an important way to produce new economic value outside the formal business economy. According to Weber (2004), public innovations such as Linux (Weber uses the term "open source code") are important in that they demonstrate the possibilities for creating complex and successful products apart from centralized, hierarchic organizations (i.e., companies). Notably, Linux and many other public innovations are very complex systems that no one person alone can manage completely. Two other well-known public innovations, among many, are the Apache server software and Wikipedia, the world's largest encyclopedia. Wikipedia, contains already more than 6 million articles, in more than a dozen languages, which continue to be updated by hundreds of thousands people from all over the world.

The clear advantage of these kinds of networked and open innovation environments is the creativity, knowledge, and diverse perspectives of a large number of participants. It is more likely that a solution to a perplexing problem or condition that has stymied ten or a hundred people can be resolved by a thousand or ten thousand people. For example, when thousands of people voluntarily develop software, the weaknesses, deficiencies, and errors—colloquially known as *bugs*—are identified more easily than in the same process conducted by a small team of creators. Thus, Eric Raymond, a pioneer of the open source code, said laconically "in a world of many eyeballs, all bugs are shallow."

Public innovation, first of all, is a way to organize production based on cooperation. None of the innovating parties belongs to a specific organization or work on the project on the organization's behalf. All participate voluntarily, and so the price mechanism does not have a direct role in the process. Of course, there can be some form of organization, but it does not have any centralized control or ordered division of labor. This model of organization could be described by a star shape in which each point functions independently (does what it wants) and gives its products to be freely used and further developed by all others (Figure 12). In fact, we have described the *decentralized innovation model based on networking (distributed innovation*).[51]

This approach to public innovation does not mean that there is neither control nor decision-making processes. In the Linux community, founded by Linus Torvalds, a small executive group retains the right to choose the versions. Torvalds' power is based on the respect of equals. He has no other option than to persuade the other developers to back his own proposal. If a group within the process decides to make its own choices, then Linux's core can break apart and soon new versions will be created that do not fit together.

51 Steven Weber describes this model as "end-to-end network architecture" (2004, p. 234).

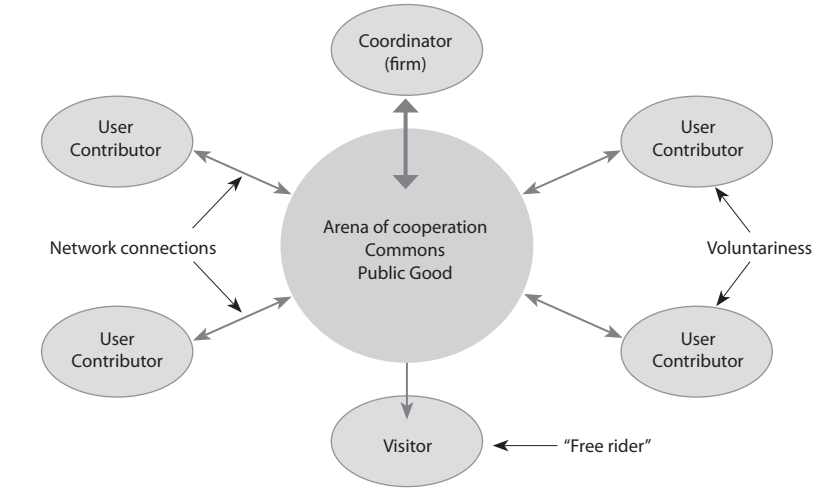

Figure 12.
Model of decentralized innovation: end-to-end architecture (Weber, 2004).

Public innovation is often called "peer production," which is production by equals, or "social production." Yale University professor Yoshai Benkler has analyzed the philosophy and economy of peer production in *The Wealth of Networks*. The development of communication networks, especially access to the Internet and wideband connections, has opened up to the public an unparalleled possibility to create and organize production that is radically decentralized, collaborative, and nonproprietary (Benkler, 2006, p. 60).

This production model is based on the delivery of resources and results between and among units that are scattered or weakly linked and that cooperate with each other separate from market signals or administrative orders. Benkler (2006) calls this "commons-based peer production."

The English word *commons* originally meant a shared pasture, which leads to the concept of the *common good*. Synonymously, the term *public good* is used. The basic characteristic of public goods is the difficulty in excluding users, and thus the possibility for establishing a business and charging the users is weak. Examples of public goods are clean air, roadways, and knowledge. Unlike many tangible public goods, however, knowledge can be duplicated without limit and delivered easily (information is nonrival goods). From the viewpoint of business, there are no incentives for corporations to invest in the production of (public) nonrival goods and therefore they should be provided at public expense (see Scotchmer, 2006, p. 35). This is one of the strongest arguments for publicly financed scientific research.

Benkler (2006) sees as fundamental the characteristic of commons that no single person possesses the private right to control the use of the common good and its resources. In this, the common good differs from the private owner's rights. In the latter, the central position is the owner's right to allow use, to limit use, and to exclude from use. Although the private right to exclusion does not exist in the common good, use can be open to all or only to a specific group, or use can be regulated or not.

An interesting adaptation of these ideas is the *Creative Commons* license, developed by Lawrence Lessig of Stanford University.[52] In it, public goods are created on the basis of private owner's right. Therefore, the maker of a photo, book, teaching material, video, music, and so on, maintains the copyright, but licenses it to be used freely in special purposes and with special conditions. Usually, the maker forbids the user from selling the product. So, here it is moved from a strict control (i.e., "all rights reserved") to a more free form (i.e., "some rights reserved"). We should note here that the copyright rules exist in common goods and are not broken in this process, but the owner of the copyright decides to allow the product to be used freely in the common good purposes.

Peer production,[53] based on the common good is a voluntary and decentralized production model that is not linked to a price mechanism or centralized coordination. In this model, the common good is a new useful product, service, or process that is open to all and free for use. Many researchers have asked why people take part in this kind of production. In the economics, maximizing benefit underpins the usual approach to product development. Economic actors are rational beings who calculate the benefit of their acts for themselves, usually measured in money earned. Yet, to take part in peer production does not result in financial payment or any other economic benefit. This is why the economic sciences see such activity as a paradox.

In reality, peoples' participation in peer production is based on many kinds of motives. Many see participation as ethically valuable. It is important and admirable to do something for the common good. For some, the respect of peers and a good reputation are important, as Pekka Himanen (2001) stressed in his *Hacker Ethics*. Another motive resembles gift giving, similar to the principle of love for one's neighbor that for some stimulates participation in peer production. Here, also, Aristotle's division between action and production plays a role. Action (*poiesis*) is something good and, as such, does not require an external purpose. Production serves something in the outside world. Thus, participation in peer production can be seen as poiesis, an action giving the contributor a simple sense of satisfaction. Voluntary participation in common production provides amusement and joy, too; it is a good way to pass the time. The theory of social capital explains the processes in building up confidence and broadening one's own networks. Although these various mo-

52 See www.creativecommons.org.
53 Peer production is called "mass collaboration" in Tapscott & Williams (2007).

tives can be quantified and utilized, the main point is that some people have many reasons other than economic ones to participate in public innovation and they gain for themselves something important and useful from their efforts.

Innovations created by users and innovation democracy

MIT Professor Eric von Hippel is an experienced researcher who cleared up several years ago the users' role in innovation and the economy. In his 2005 book *Democratizing Innovation* he presented a fuller meaning of users. According to von Hippel, users are persons, companies, and organizations that benefit from using goods and services. The producers, on the other hand, benefit by selling goods and services. Within this concept, users are more than simply customers. Companies and organizations (e.g., municipalities) are as much the users of products and services produced by other companies and organizations as are individuals.

Naturally, users want products and services to correspond better to their specific needs. This can be illustrated by data systems products. Almost every organization develops such programs according to their needs, achieving this either by their own efforts or by ordering additional services. Companies fine-tune the machines and equipment they have bought, improve their qualities, connect them to other equipment, and take them apart and then put them together again. Consumers sometimes do the same with the equipment and domestic appliances they have bought. There have even formed tuners' communities, where young people tune in their cars to correspond their values and ideals. Von Hippel (2005) describes several "innovation communities."

Yet users' development of new ways to employ products can be every bit as important as the uses originally intended. For example, Microsoft's Excel spreadsheet program has been used to maintain a database of names, and the popularity of text messaging surprised the Nokia engineers who invented it. In fact, at times the improvements developed by users are actually innovations, some of which have later become successful products. Examples include several open source programs like Apache for Web servers, tools developed by surgeons, and many types of equipment for outdoor activities, like surfboards and mountain bikes (see von Hippel, 2005; Tapscott & Williams, 2007). Lead users are an especially important group because they are generally interested in the new properties and capabilities of products and they anticipate new markets.

The growing importance of users in product development is a result of production aimed at standardizing to achieve scale advantages. The framework of modern mass production does not address the heterogeneity of users. Nowadays, more products do not correspond well with the specialized needs of users. This is why

technically competent users must fine-tune the products they employ to fit their own needs. From the viewpoint of producers, serving small segments is not affordable. On the other hand, the sophisticated users are willing within reason to use their own time and resources to get the desired product. The theory of transaction costs is a theoretical framework for predicting when certain economic tasks would be performed by firms, and when they would be performed on the market.

While companies are interested in and value user information, it is often difficult to obtain. User information means the actual use of a product or service: how the product is used, how it serves its purpose, which additional characteristics the user wants or develops, and so on. Meanwhile, the user often has difficulties obtaining enough information about products. The environment of asymmetrical information makes it more difficult for users to develop innovations and for companies to discover and utilize them.

According to von Hippel (2005), companies often are unable to utilize users' innovations. However, the lead users' developments might contain realizations that open totally new markets for the companies. The US company 3M, perhaps the most far reaching in its search for and utilizing users' innovations, has developed the foremost method for generating users' ideas. The method has been compared to the typical internal processes of the company; in fact, the adaptation of the method has produced more new ideas and more sales than the standard internal innovation processes of the company. The internal processes have led to several small improvements in the company's current products, whereas, based on lead users' ideas, entirely new production lines have been created (see von Hippel, 2005, for details).

Some companies have begun offering users special tool kits with which they can improve products by themselves and then transfer the results to the company. In this way, the user participates directly in the innovation and development process of the company. The best tools are user friendly and based on the know-how and language of the users, otherwise,the threshold for participation would perhaps be too high. An interesting example is Lego, which nowadays bases much of its product development on users' proposals. Lego's robots are toys for adults as well as youngsters, and Lego has its own users club, where users share their ideas and experiences about their innovation developments.

However, in an interview meeting with me, Peter Coughlan, a director of world-known IDEO design office, criticized the innovations created by users. He said that users are generally bad designers who do not understand the requirements of functionality and good design. This is why users who are not qualified professionals should not be entrusted with design products. Nevertheless, it is reasonable to involve users in the planning process because they bring a diversity of knowledge that the professional designers and product producers do not have. Coughlan stressed that the best results come from the "triangle" model: a collaboration among the producer who knows the qualities of the products, the user who has the specific needs and unique experiences, and the designer who has the conception and experience

of developing different products and services. Eric von Hippel's (2005) idea about the lead users' ability to develop "progressive analogies" is in line with Coughlan. The progressive analogies hint at the direction a company should look to for the product of the future. The final product developed by the company might be a lot different from the prototype concept, but it will be analogous.

Users are often ready to share their ideas and developments freely with their fellow workers and others who are interested. This can be seen readily in the various users' communities, where users converse actively with each other, provide information on new products, and discuss their own inventions. Often, producers monitor these user forums and introduce their new products or their products' qualities and benefits. Of course, the Internet makes this all possible. Von Hippel (2005) sees in this open discussion the same paradox about which Weber (2004) and Benkler (2006), among others, have written. We are witnessing the arrival of new "knowledge communities" that surround and support the intellectual common good, and that all members can use, enrich, and benefit from. These knowledge communities are networks whose members might not know each other personally, but who, nevertheless, communicate confidentially through the Internet. This phenomenon has often been referred to by the terms *social networking* and *Web 2.0*. These communities of the users are part of knowledge communities whose members are motivated to participate for multiple reasons other than direct economic benefit.

Behind the paradigm of public innovation is the idea that citizens or users can take an active role in society and the economy, and specifically that citizens can actively create new products or improve or redirect current products. Thus comes the concept of "professional amateurs" (known as ProAms), as referenced in von Hippel's (2005) *Democratizing Innovation*, who become active innovators in the economy and society. The philosophy of von Hippel's book is the democratization of creative possibilities. However, certain conditions must be realized, von Hippel stresses, so that the abilities, capabilities and information required by the innovation can be disseminated appropriately to users.

Several factors explain the rise of innovation democracy:

- Increasing numbers of people using computers with access to broadband networks and the Internet;
- Access to the web opens avenues (libraries, etc.) for people to search for and retrieve a wide diversity of important information;
- The citizenry of many countries are becoming more educated, and many activists are top experts in their fields;
- Community values are becoming more central to the lives of citizens, and more people are striving to make things better for themselves and their neighbors.

From the rise of innovation democracy comes a new innovation model, which von Hippel (2005) calls *the collective action model*. This model envisioned all actors, that is anyone and everyone involved in the various stages of innovation, creatively collaborating, and everybody waiving their rights to the creative outcomes. The products of such collaboration are public goods, or the common good, which can be used by anybody without restrictions. This model is most suitable for information and digital products, which can be copied inexpensively and delivered with the sole limitation of access to the necessary technology. In other words, von Hippel's model describes the model of public innovation.

Yet the model of collective activity is difficult for companies, as they tend to operate within the other extreme model, which von Hippel (2005) calls the *private investment model*. This model reflects decisions by companies to invest in specific R&D activities only if they are able to benefit fully from them. By extension, then, publicly discussing inventions or "leaking" the information to the public or non-company groups is viewed negatively, and strong ownership rights—patents, copyrights, trademarks, and so on—are sought to safeguard investments. This model describes the established innovation policy in most Western countries, where considerable legislation safeguards the IPRs. Such legislation can be interpreted as the society giving entrepreneurs a type of monopoly on their inventions. But this monopoly is not cost-free for society. Von Hippel stressed that society potentially loses quite a bit when knowledge, inventions, and products remain the property of a company or inventor, and are not spread freely throughout the society to enrich the entire community. The public character of knowledge, as a common good, is important to the well-being of the society in general and to its non-material growth, based on non-material products. Therefore, it is important to find a balance between strong rights ownership and the common good.

Bounded commons and half-public innovation: Innovation alliances

The limited common good—known as "bounded commons"—finds its position between monopolistic copyrights and public goods open to everybody. Eric von Hippel (2005) developed a model that emphasized the space between private investment and collective activity. The *private-collective model of innovation*, addressed the extreme aspects of both traditional models (p. 91):

- The supposition in the private investment model that prohibits freely revealing information about innovations developed with private funds because it leads to a diminished profit for the innovator

is eliminated. The private-collective model, then, presupposes that under certain circumstances such discussions actually might increase the innovator's profit.

- The supposition in the collective action model that the free rider, who does not pay anything for ideas available through the public good, benefits from it as much as the one who has paid for its production and maintenance is eliminated. The private-collective model, then, presupposes that those who invest in a public good naturally benefit more than free riders.

Of course, the elimination of the suppositions of two extreme models is possible only by counterarguments. Although von Hippel does not provide convincing evidence about the credibility of the counter-suppositions, they are intuitively plausible. In *Against Intellectual Monopoly* Boldrin and Levine (2008) argue that intellectual property is more like an "intellectual monopoly" that hinders competition in a free-market system. They show that most innovations have taken place without the benefit of an intellectual monopoly. Indeed, they suggest that talking about an innovation increases its use and may promote the company's markets or market share. In addition, attempting to protect an innovation is often expensive and useless. Communicating about the innovation may be a good alternative. In addition, one reason to contribute instead of free riding is that the contributor who participates in the creation process of innovation understands the real importance of the innovation and is better placed for its adoption and application.

We can also start building cooperative models where the suppositions of the private-collective model are integral conditions. In this respect, Miles et al. (2005) in *Collaborative Entrepreneurship* describes the company cooperative model of the future, which they call the "collaborative entrepreneurship model." In the model, a group of companies cooperate, setting the stage for continuous new innovations. This business community forms a cooperation network of voluntary participation and collaboration. The core of this vision is that the companies freely distribute information within the established community and create together new ideas without restricting or directing toward any specific target or technology. Any member of the community, alone or with others, may initiate a product design or a marketing plan for a product, according to stipulated rules. Such rules are drafted, confirmed, and controlled together through an executive group, which can take various forms. Each member of the community is independently responsible for its own finances and success. The network simply offers peer companies the collaborative services in promoting innovation activities. This network is an *alliance* for innovation.

Based on the stipulated terms, this model reflects a limited common good. Only the members of the network have the access to the ideas, innovations, and new knowledge created together. I call this kind of innovation the *half-public innovation*. It is public, because all members of the innovation network can freely use the

created knowledge and ideas, but it is only partly so because there are limits on access. In this way, it functions considerably within the same logic of voluntarism and public innovation, and its results are the common good. On the other hand, the participating companies seek economic success and wealth, and therefore participants are carefully chosen. The smooth functioning of the innovation network requires the development and maintenance of confidence among all parties and strong social capital. Although Miles et al. (2005) propose the model as a future concept, there are already examples that strongly reflect the elements of the model. In addition to the IBM Corporation, Miles et al. cite the Taiwanese company Acer (see below), the Danish business network Kalunborg, and the Finnish ICT industry as operating examples of half-public innovation organizations.

The Acer Group (see Miles et al., 2005) employs thousands of people in more than 50 countries. Although headquartered in Taiwan, the Acer Group is actually a worldwide federation of companies held together by mutual interests and cooperation. Some units of the federation are owned by Acer, while other units, mostly involved in marketing and delivery, are co-owned by Acer and local actors. In all, Acer has 40 separate businesses, grouped into four global units. Many of these business units carry on R&D activity, primarily in Taiwan, although new products and service concepts surface in all of the federation's units around the world. Each new proposal is evaluated cooperatively by the member organizations of the federation. No individual company is responsible for the complete business process, which means that the joint evaluation process serves as the forum in which the business potential of the proposal and of the network as a unified entity is addressed.

Another vision of the innovation process, the InnovationXchange (IXC), is offered by Chesbrough in *Open Business Model* (2006). Although Chesbrough presents the model as an open innovation concept, it aligns more closely to a half-public innovation.[54] IXC is a service network founded by the industry union of Australia. Each member company of the IXC has a trusted mediator who is employed by the IXC, but who participates in the company's internal team for product development and innovation of a member company. The mediators regularly meet and discuss the needs of various member companies in confidence, yet they are bound to not benefit personally from the knowledge they possess. The aim of the IXC is to help member companies find solutions to their needs and challenges from the know-how and products of other member companies. Here the trusted mediators work collaboratively to produce and utilize the knowledge, know-how, and innovations of the whole network to benefit individual member companies as well as the network (Figure 13). Recently, the mediators have broadened their innovation-seeking activity beyond the network, drawing on the resources and knowledge of outside companies to solve the challenges of individual network member companies.

54 Chesbrough does not distinguish between decentralized innovations, but called all of them open innovations. However, Chesbrough's basic model is one of buying and selling ideas.

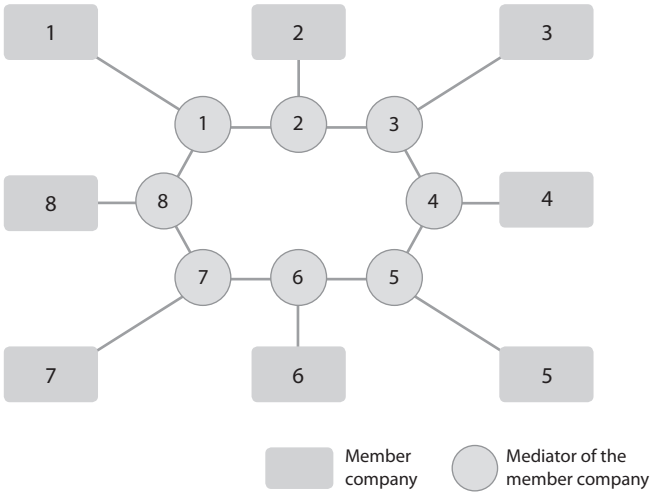

Figure 13.
Action model of InnovationXchange (Chesbrough, 2006, p. 152, Figure 6-1).

A fascinating new example of a half-public innovation is Google's proposal to create a new open software standard for mobile phones (see http://www.android.com/). Google has established the Open Handset Alliance, a new innovation alliance aimed at creating mobile phone software that would be more flexible, innovative, and easy to use than the software bases of Microsoft's Windows Mobile and Nokia's Symbian. The new software basis, called Android, would reconfigure mobile phones into personal computers, which could easily use the Internet (and Google's services, of course). The essential advance is that the alliance has produced a tool kit for all software houses, which makes developing open source applications easier.

This openness is expected to lead to a situation in which the "Google phone" would allow thousands of new applications and services. The Google phone is not a mobile phone technology produced by Google, but rather the Android operating system that mobile phone manufacturer would use, mirroring the process in PC hardware. So while the Google phone resembles Apple's iPhone in the openness of the development environment, it does not bind the development environment with the hardware of any one manufacturer. Google's proposal corresponds to the NMT standard,[55] which was an open system for equipment and software developers. Nokia (at that time Mobira) and Ericsson started producing technology

55 NMT refers to Nordisk MobilTelefoni (Nordic Mobile Telephony in English). It is the first fully-automatic cellular phone system opened for service in 1981 See https://jyx.jyu.fi/dspace/handle/123456789/13478 and http://www.stes.fi/scai2006/proceedings/scai2006_pages_i-xi.pdf.

to this standard and in this way laid the foundation for their current success. A recent news article indicates that Android is successfully challenging Apple's strategy (Reardon, 2010).

Google is also active in the field of social networking and has established a separate alliance to develop the OpenSocial standard for compatible open source services in social networking. The popular social networking site Facebook, founded in 2004, has also opened its basis to the developers of applications and this strategy has been successful. The number of active Facebook users has grown to more than 400 million and there are already thousands of applications.[56] The applications function within Facebook and are shared among Facebook users. The result brings surplus value to Facebook itself, to developers of applications, and to Facebook's customers. Google's open Android and OpenSocial standards and Facebook's open environment are examples how companies are able to innovate together by establishing alliances and opening their development environment to partners.

Forms of decentralized innovation

We have seen that, parallel to the closed innovation paradigm, other types of innovation models have formed, whose line of action and conditions of success are different from the closed paradigm. I have also argued that the so-called open innovation paradigm is only one form of these new models, although the best known and marketed. However, it is important to remember that innovation models look different when viewed from the perspectives of the companies, or one company, versus society. An innovation process that results in the short-term success of a private company can become a loss from the perspective of the overall, long-term benefit to the company or society. On the other hand, a process that benefits all—the common good—might be an excellent starting point for business activity and for opening new markets. Typically, the common good is linked with knowledge generating and spreading and, thus more generally associated with information products.

A critical point when reforming innovation policy is to recognize different innovation forms. The traditional innovation policy has concentrated on supporting the innovation policy of the closed paradigm, in which strong property rights have been based on the suppositions regarding the protection of investments. Therefore, open innovation and half-public innovation can succeed only in business and social environments in which IPRs can easily be moved and divided and where the financing of R&D activity can be transferred flexibly to company networks instead of just single companies.

Table 6 presents the various forms of the innovation activity and their basic character, property rights, company's viewpoint and society's viewpoint.

56 See http://www.facebook.com/press/info.php?statistics

	Basic Character	Property Rights	Company's Viewpoint	Society's Viewpoint
Closed Innovation	Result of company's internal process	Company has IPRs	Company controls whole process and IPRs	Society safeguards IPRs by law
Open innovation	Company uses outside sources of knowledge and ideas in innovation process	Company buys rights and sells unnecessary ideas in the marketplace	Company opens its innovation process to get new ideas	Many companies' know-how are combined and become better utilized
Public innovation	Networked community voluntarily produces products, knowledge, etc. for free use by all	No one has monopoly on a product or right to prevent others from using it	Company can build-up its own products on public innovation, but cannot monopolize the use or further adaptation of the product	People's creative potential available for society's use; society's welfare and wealth is increased

Table 6.
The qualities of different forms of innovation activity.

An essential aspect in public innovation is people's personal willingness to participate in the development of a product. Despite the growing interest in open source innovations, contemporary innovation policies often do not include tools to support properly, for example, the production of open source code products. One could say that tens of products like the Linux system are needed in order to create a basis for, perhaps, the Finnish software industry. The organization of public innovation requires some money and human resources, which can then be recovered when the products are launched for general use. Furthermore, the innovations developed by users are not supported enough. Here as well, the tools of simple social networking (Web 2.0) and their facilitating could function.

Peer production and rolling out public innovation

The success of public innovation and peer production (Linux, Wikipedia, etc.) has furthered the thought that peer production could be an even more general model of action. More than just hype surrounds the issue. Serious research is growing. Tapscott and Williams (2007) subtitled their *Wikinomics* book, *How Group Cooperation Changes Everything*. And Steven Weber (2004), in *The Success of Open Source*, placed a question mark at the end of the last chapter,"The Code that Changed the World?"

Since hardly anything can change everything, we should be ask for what type of production is peer production best suited or in what fields can peer production be expected to become more applicable?

A central issue within all forms of innovation activity is the transaction costs: what is the cost of creating in-house as compared with buying? In other words, is it more profitable to develop for oneself, for example, business administration software or to buy an off-the-shelf package (and fine-tune it as needed)? Is it profitable to self-manufacture a control unit needed for a device or to find a solution from the marketplace? Certainly when contemplating these transition costs one assesses the organization's finances and expertise as much as the market price for an external solution. Moreover, transaction costs are not stable but change as the result of developments in the marketplace and in technologies. For example, the enormous development of the information technology in last decades has lowered significantly the costs of networking and cooperation. In innovation processes, one form of transaction costs is associated with searching for new knowledge (see Chapter 6).

Transaction costs can also be considered from an alternative perspective, that of social relations. Within networks, resources can often be found from peer organizations that can be secured for use through good social relations. Social capital means the ability to mobilize resources within one's networks, and peer production is based on networking and the new resources it offers to all partners. The promise of peer production is mainly based on the information technology: the Internet, social networking, and so on.

According to Weber (2004), peer production—the organization of a decentralized innovation process—is based on four principles (p. 234):

1. Empower people to experiment;
2. Enable bits of information to find each other;
3. Structure information so it can recombine with other pieces of information (modularization).
4. Create a governance system that sustains this process (rules, participation, decision-making, maintenance, etc.).

Modularity deserves special attention. *Modularity* reflects the ability of cutting a project, process or product into small pieces, which are worked on independently, and then reuniting the pieces into a whole. A related term is *granularity*, which refers to the minimal size of the modules, measured by time and exertion required for a person to produce something. A person's willingness to participate in peer production depends on the granularity of the task, or the investment of time and energy required to accomplish the goal is small enough, taking into account the person's other motivations for participation. If the contributions needed are too large, it is probable that voluntary participation will decrease. We should note that information technologies as such promote modularity and can facilitate granularity.

Regarding mutual communication, the costs of equipment and connectivity can have a significant influence on individuals' willingness to participate. While costs nowadays are relatively affordable for most people in the developed world, that cannot be said for all people and companies in emerging economies. In a global economy, peer production can draw on participants from all over the world. These networks with international partners are subject to the wide range of availabilities and constraints of communication technologies. Thus access to communications technologies and their costs can impact both the ability for individuals and companies to join a network and the level of participation within the network. This, in turn, can impact the outcome of the network's collaborative activities. The societies and national ICT policies of these international partners can strongly influence the technical infrastructure that underpins peer production, including broadband connections, wireless networks, public data terminals in libraries and other forums, and computer and ICT literacy, to name a few. But the governments of developing countries and emerging economies often have to balance competing and equally essential needs for budgetary investment in a wide diversity of social, educational, and economic areas. So integrating international partners into a worldwide innovation network for peer production will require creativity, dedication, and perhaps considerable effort to assure mutual communication is possible amid uneven technical capabilities.

In bringing this discussion to a close I turn to Tapscott and Williams (2007). In *Wikinomics* they present three conditions under which the peer production functions best (p. 70):

1. The object of production is information or culture, which keeps the costs of the participation low for contributors.
2. The task can be chunked out into bite-size pieces that individuals can contribute in small increments and independently of other producers.
3. The costs of integrating those pieces into a finished end product, including the leadership and quality-control mechanisms, must be low.

From the material presented above, it is clear that peer production and public innovation function best when the focus of the work is information production. Information in its many forms is definitely a public good. Its duplication and delivery costs in an information society are close to zero. Further, the various tasks in information products often can be decomposed into smaller, self-contained units and, thus, production can be decentralized.

A specific type of information would be electronic products, which can be coded, transmitted, and used digitally. Computer programs, various types of files, e-books, photographs and movies, music and educational programs represent just

some of the types of digital products. This list will surely expand as digitalization processes develop. One example of such progress is in various types of design, such as machine planning or architectural design, as 3D tools slowly replace the pen and paper. In general, programs and tools that allow for the decentralization of the tasks and parallel development support peer production.

The various forms of social networking also raise an interesting phenomenon from the peer production perspective. The process of social networking involves people's willingness to communicate with each other through common sites. Whether about a common interest, professional ties, or a network of interconnected friends and, perhaps, strangers, communities build up and participants exchange opinions, deliver material, publish blogs, share photographs, upload videos, and so on. The social web is a remarkable phenomena; for example, more than 133 million users keep blogs and there are 400 million users of Facebook (2009). Those who have access can transmit messages and discuss anything of importance to themselves and their contacts. Meanwhile, YouTube, one of the newer resources, is incredibly popular, with some individual-posted videos being viewed millions of times all over the world. The significance of the social networking phenomenon is that some of these resources, such as MySpace and YouTube, were created originally by hackers; these sites have since been bought by large, financially sound companies. For example, Google bought YouTube in 2006 for US$1.6 billion from the two young founders[57]. Within the theme of this book, social networking is interesting because most sites on Web 2.0 result from peer production (substance production) and their popularity demonstrates, at least indirectly, that the growth of peer production is possible.

Yochai Benkler (2006) combines peer production with the development of the information economy. Over the last 50 years knowledge and information have become even more central to and the target of production. This lends support to the view that peer production could become commonplace in the global economy. Perhaps this development does not change "everything," but it certainly broadens the circles of participants in the innovation activity. Innovation would no longer reside within the confines of companies but would become an activity available to members throughout civil society and the global community.

The developer of the open innovation paradigm, Henry Chesbrough (2003), states frankly that the open paradigm presumes that not all clever people are working for companies. In fact, it is presumed that they reside primarily outside of a particular company. While this may be a truism, the issue for companies is that they need to be alert to where the best resources are for their business—whether inside or outside the corporate walls. Therefore, an important element of new innovation activity methods is reflected in the *scarcity of experts*.

57 See http://mashable.com/2006/10/09/confirmed-google-buys-youtube/

In the network society, creative and skilled people are becoming a more important—but a more scarce—resource. Networks are useful in surfacing information of all sorts, but a problem exists in the ability to interpret and realize the value of these bits of information. Thus, a skilled and competent interpreter is needed. In an economy based on innovation, the ability to create anew continuously forms the foundation of companies' success. Such a reality requires creative people.

Human creativity is nearly impossible to standardize or to bind with agreements. This explains why companies find it so difficult to recruit and retain creative people. Oftentimes, successful recruiting involves a bit of serendipity. Creativity and talent are personal tendencies or dispositions, and thus are qualities that can be seen only in action, and sometimes require a particular environment. It is impossible to be assured beforehand that a particular person's skills are the right type for a specific task. The same is true when "buying" creativity, either from new hiring or in commissioning consultants or freelancers.

However, a decentralized innovation activity can offer better solutions for success to many of these problems. According to Benkler (2006), peer production provides many more good possibilities to identify the best person to produce a certain component or module because the task is not taken by a person who is not interested in that particular aspect of work. In the same way, Weber (2004) stresses that side-by-side processing, typical in peer production, allows for the decentralization of complicated tasks, geographically as well as functionally. In the decentralized innovation process, workers are not told explicitly what to do, where, when, and how. Rather, a spontaneous, natural division of labor takes place, often with people working toward their strengths, abilities, and interests. The company that uses the decentralized innovation model is able then to secure the best resources through the network.

The Canadian mining company Goldcorp Inc. provides an interesting example (see Tapscott & Williams, 2007). In the 1990s, the company encountered significant problems. It seemed that the company's 50-year old mine in Red Lake, Ontario, was dying. The company explored again their mine and test drillings suggested a rich deposit of new gold. But the company's geologists were not able to provide an accurate estimate of the gold's value and exact location. Inspired by the Linux example, Goldcorp's director general proposed that his geologists put the company's geological data regarding their gold deposits onto the Internet and ask the world where the next 6 million ounce gold deposit could be found. A reward was to be offered for the most promising proposals.

While public access to such secret information had never been publicized before, the company found the process worth the risk. About 1,000 experts from 50 countries downloaded the data. Certainly the material was reviewed by geologists, but also by a very heterogenic group of others, including graduate students, consultants, mathematicians, and military officers. The proposals involved applied mathematics, physics, artificial intelligence, computer graphics, and organic and inorganic

processes. These people identified 110 targets, half of them previously undefined. About 80% of the new targets yielded substantial amount of gold. And, as this process demonstrated, the use of digital data, the Internet, and a global resource of talents and voluntariness, can lead to a fruitful resolution of a problem at hand, with results hardly anyone could have anticipated.

I have shown that decentralized innovation is a viable alternative to closed innovation. Open innovation is accepted in many companies, leading to collaboration between business partners and customers. Public innovation is taking place outside market relations. It is based on networking and voluntary participation. Some scholars even believe that public innovation is a symptom of emerging new economy of "mass collaboration." It is hard to forecast how deeply wikinomics will change the prevailing private-owner market economy. Nevertheless, good arguments are available for the viability of these new models of innovation.

Chapter 6:

GLOBAL NETWORKING IN THE GROWTH OF INNOVATION ACTIVITY

Too much attention has been given in the globalization discussion to the concepts of cheap labor and growing markets in the developing countries. In many ways, it is a natural decision to transfer production to where the markets are, and to use the local labor force. Such approaches, in the long run, benefit both the developing and industrial countries, as well as the environment. Companies in industrialized countries can replace outsourced manufacturing positions with more demanding tasks for labor at home. But this requires these companies maintain the ability for continuous innovation. And here, the wisest strategy to benefit the talents and experts of the developing countries is through decentralized, networking innovation activity. In the global network economy, the sources of knowledge are scattered around the world. Professor Eric von Hippel (2005), who has researched the forms of innovation activity for several years, presented the loci of four main sources of knowledge beyond the company:

1. Suppliers (subcontractors) and customers
2. Universities, public governments, and private laboratories
3. Competitors
4. Other nations.

In the wikinomics concept, *citizens*, by which I mean people who participate in the production of knowledge or in peer production independently and voluntary, must also be included as a source of knowledge. The large-scale participation of people in the production of an information economy creates "mass collaboration," as Don Tapscott and Anthony Williams (2007) describe the production form of wikinomics. The significant principles of this economy are openness, equality, and sharing. I have already dealt with openness, equality, and sharing in previous chapters, so I will now focus on global innovation activity, and on experts and know-how concentrations, in particular.

As the global economy progresses, the governments of developing countries invest more and more in education, research, and innovation. It is only a matter of time until the densely populated and fast growing economies, like India and China,

produce the majority of the innovations. The best strategy for Western countries is to strengthen their cooperation across borders and among cultures, companies, and areas of know-how. Western countries must actively build up innovation networks throughout the whole world.

John Kao (2007) sees the global economy developing in line with several basic "driving forces" (see p. 65-73):

- *Silicon Valley is now everywhere*. Up-and-coming innovation centers or hubs that are integrated into the global economy are located all around the world. Several countries have focused on building up their own "Silicon Valley" as a tool for economic development. Kao points specifically to Otaniemi (in Finland) and Bangalore (in India). Although the Silicon Valley model cannot be simply transferred to other countries, it has provided a vision on how to build up corresponding hubs. The Website of the company Silicon Web includes information on more than 100 "Silicon Valleys" around the world.[58]
- *Talent is now everywhere. Innovation with Chinese Characteristics*, edited by Linda Jakobson (2007), states that China has the second largest labor supply of researchers and engineers, with 2.5 million in total. In 2005 alone, about 15,000 Chinese students graduated with doctorates in the natural sciences and technology; more than 2.5 million new students enroll in universities every year. In some fields, like nanotechnology, China is already one of the leading countries in the world (e.g., in 2006, Chinese researchers published the most scientific articles in nanotechnology; the United States was second). In India a corresponding development is taking place.
- *Capital is now everywhere*. Research capital moves globally, and direct investments in developing countries are being made at record speed. Furthermore, the rather local risk investments of the past are becoming global. For example, capital investments in China have increased from US$325 million to $4 billion. In 2005, Silicon Valley's Sequoia Capital made public a China fund of US$200 million. Additionally, large companies, such as Cisco, GM, IBM, Microsoft, and Nokia, have funded new research institutions in the developing countries with billions of dollars. A good indication of the fact that capital is everywhere can be found in the reality that China has the second highest number of billionaires in the world, right behind the United States. It is estimated that there are 64 billionaires in China, calculated by the stock values of these peoples' companies[59].

58 See www.siliconwebinc.com

59 The companies are able to list in themselves on the Shanghai stock market; see http://news.bbc.co.uk/2/hi/8561433.stm

Tapscott and Williams (2007) emphasize that the real advantage in the use of global talent is not in sparing expenses but in the endless possibilities for growth, innovation, and differentiation. The growth engine of the 21st century is the business network, which links the resources and talents of the developed and developing countries into unbeaten combinations.

AnnaLee Saxenian, of UC Berkeley, provides one of the best analyses of global circulation and cooperation. Her book *The New Argonauts* (2006) takes up the importance of brain circulation as a central global channel of the transfer of knowledge. Learning in the global context is based on the division of labor. Various business and scientific fields differentiate and create knowledge, know-how, and products that others do not have. The specialized know-how within these fields supplements the specialized know-how of the other fields. In this way, a foundation for cooperation is formed, in which the various fields develop together and transfer know-how. People are the conduits of the know-how transfers. Figure 14 presents all of these elements combined. According to this model, the Asian entrepreneurs and engineers working in Silicon Valley have transferred the process functions and innovative knowledge of Silicon Valley to their homelands of China, India, Taiwan and South Korea.

Each ecosystem of innovations has specialized in certain fields of know-how, based on local strengths, circumstances, and companies' decisions on location and conscious innovation policy (see Hautamäki, 2007a). From the global economy perspective, knowledge hubs reflect a global division of labor. The starting point of the division of labor is modularity, discussed in Chapter 5. Products and production

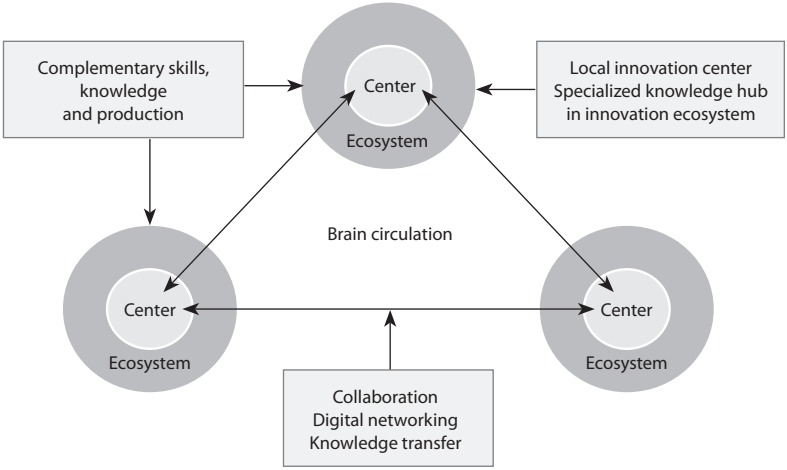

Figure 14.
The global innovation and brain circulation between innovation centers.

processes are divided into separate modules that can be completed independently from the overall process. Companies are then able to specialize in producing specific modules, depending on the size of market.

On the other hand, some companies may specialize only in the product concepts and/or design, or create designs to a buyer's specifications, which the buyer then fulfills elsewhere, in modules or as a whole. In the former case, a company may own the brand and specialize in product development but out-source the actual production either to another company or to component suppliers and manufacturers. Or, the developed technology can be licensed to other producers, who then make products under their own brand. This is the model used by Qualcomm, a mobile phone technology producer, who sells its CDMA technology to mobile phone manufacturers.

In this way, modularity promotes a global division of labor and, at the same time, a concentration of core know-how. The clustering of several companies of the same field and other supporting activities (e.g., research, financing, consultation) creates know-how concentrations. When the local ecosystem of innovations functions optimally, the knowledge hub strengthens itself and supports continuous innovation for the companies specialized in the particular production process, product, or service for industry.

Decentralized innovation requires the mastery of global knowledge

Decentralized innovation in a global economy means that knowledge and know-how are spread throughout the world. On the other hand, what has been said above about the ecosystem of innovations means in this context that the know-how is found, with a high probability, within different innovation centers. For example, Richard Florida has stressed the "spiky terrain of knowledge" with which he criticizes Friedman's thesis about the flatness of the world.[60] I think that both are right: resources are global but concentrated.

Managing decentralized innovation in a company requires the control of two special challenges. The first can be called a seeking challenge, and the second an adopting challenge. The *seeking challenge* concerns where to find an entity (a person, company, research institution, etc.) that could provide a specific know-how that the company needs but does not have. The *adopting challenge* concerns how a com-

60 Florida and Gulden showed in *The World is Spiky* (2005) how regionally concentrated the world economy is, for example, in the area of patenting. T. Friedman's (2005) "flat world" is a world where it is easy access to all places and talents independent of their location in the world.

pany is able to link the new know-how it has received with its existing know-how in such a way that the result is a truly new know-how and innovation. The adopting challenge can also be called a learning challenge.[61]

Each company must be able to find the balance between the seeking challenge and the adopting challenge. Following James G. March's (1991) formulations, the difficulty is the disproportion between the processes of exploration of new knowledge and the exploitation of existing knowledge. Obtaining new knowledge requires exploration and risk taking, experiments and play. Inventions and innovations require this kind of exploration. Meanwhile, the exploitation of existing knowledge and resources is linked with the deepening of the knowledge, intensified production, implementation, and execution.

March's basic message is that the exploitation of existing knowledge offers the quickest results but, in the long run, this strategy will close many opportunities. On the other hand, new knowledge breaks open new possibilities that often cannot be readily seen and reached in the present, if a strong tradition of quality and existing results are maintained. But new knowledge always involves risks and uncertainties. So the dilemma is the following:

- The exploitation of existing knowledge means results are seen quickly, company performance improves, variation in the know-how is reduced, and risks are smaller.
- The exploration of new knowledge means results are often delayed, new possibilities are opened, know-how variation increases, and risks are larger.

Each option presents a distinctly different knowledge strategy. The interconnected global economy and ongoing developments in technology make the activity environment of the companies uncertain and erratic. Such an environment stresses the value of exploiting existing knowledge. By maintaining familiarity with and using existing knowledge and experience, it is easy to stick to the traditions of the business world and be unaware of or underestimate the changing reality. On the other hand, gathering new knowledge keeps a company in touch with the changes within the activity environment. In reality, no company can succeed without utilizing both strategies. The question is only which to emphasize and when.

61 I have discussed these issues in great detail in the article, "Multi-channel Innovation Networks" (Hautamäki, 2007b). This chapter is based on the analysis of that article.

From information to tacit knowledge

Knowledge is central to innovation activity. Innovation activity generates new knowledge, but it must be used and integrated with existing knowledge and experience. This is why the different concepts of knowledge support the key concepts in developing the innovation activity. To simplify this point, I separate the concept of information from concept of knowledge. *Information* represents all of the facts, data, or figures coded physically or digitally: books, papers, pictures, data, and so on. However, information becomes *knowledge* when a person interprets it through the framework of his/her own experiences. Thus, knowledge is personal and intimately linked with a person and often a specific context. This does not mean that knowledge is subjective: Many people have considerable common (i.e., shared) knowledge. So knowledge is often between people. It is inter-subjective.

Some of a person's knowledge can be expressed as thoughts, statements, or arguments: I know that Sacramento is the capital of California. This kind of knowledge is called *know-that, or explicit knowledge*, and it can be transmitted rather easily by being coding to information or by telling it orally. Although explicit knowledge can be easily transmitted, understanding it can be difficult at times. This is why it is useful to separate complicated expert knowledge from the simple knowledge (i.e., data).

People possess different knowledge, depending on their history, experiences and interests. This kind of knowledge is called *know-how or tacit knowledge* (see, Polanyi,1958, 1966; Ryle, 1949). By extension, then, many of our actions—such as swimming, riding a bike, playing the piano, using various tools or equipment—and our thought processes, such as making observations or drawing conclusions, are done without conscious thinking. Language is a good example, in that we apply and understand our native language "automatically," without thinking about the grammar and often without considering the meanings of the words that compose our verbal or written messages. The British philosopher Gilbert Ryle (1949) presented convincing arguments for the fact that know-how and intelligent action do not even require consciousness about the rules guiding them. In the realm of nonverbal expression of tacit knowledge, a portion exists that cannot be expressed at all, and another portion can be learned only through observation and experimentation. Michael Polanyi (1958, 1966), who introduced the concept of tacit knowledge, stated that a tacit dimension exists in all knowledge: we always know more than we can tell.

Within the focus of this book, it is important to note that a part of the expert's knowledge is explicit and analytical, another part is expressed through observable action, and a third part is impossible to express in any form. This reality concerns all experts in all fields, from bus drivers and machinists to doctors, planners, and managers. But it also applies in some respect to processes. Research activities or technological or scientific innovations always contain a tacit element. This is why expert knowledge can be learned only by doing and following the actions of the "master."

We have now spoken about the basic concepts of the management of the knowledge. From these concepts arise two interesting theories. One is Nonaka's (Nonaka & Takeuchi, 1995) SECI model, and the other is the theory of the communities of practice (Brown & Duguid, 2000). Briefly, the SECI model addressed the processes through which knowledge is changed from implicit to explicit, or vice versa, within the organization.[62] While Nanoka explained how he believes this takes place in organizational knowledge sharing, I personally do not agree that knowledge completely changes from one form to another. It seems unlikely to me that complicated knowledge can ever become automatic, and tacit knowledge can ever be made totally explicit. From the perspective of the management of global knowledge, Nonaka's model concentrates too much on the innovation processes within the company. Despite this critique, however, Nonaka's theory remarkably deepened our understanding regarding the creation of knowledge and its use in organizations.

The basic theory of the management of knowledge is the *theory of communities of practice*, which suggests that tacit knowledge surfaces, develops, and is transmitted within communities whose members share the same practice (Brown & Duguid, 2000). Teams functioning closely together are typical communities of practice. They create their own language and identity, that is, a professional profile. In order to adopt the knowledge of the community, it is necessary to take part in the function of the community. The knowledge of an expert is sticky in that it is set in the ways of action of the community of practice (Brown & Duguid, 2002). Therefore, it cannot be easily coded or transmitted to someone who does not have the same background of expertise.

On the other hand, those involved in the same profession or have a corresponding practice can rather easily understand the talk and reports of their colleagues. Brown and Duguid also use the term *networks of practice* to refer to informal networks of professional colleagues. Often, these networks use the Internet and Websites of their professional groups to communicate among participants. In these networks knowledge leaks out. But to "read" the professional information is not possible without a common background, education, and similar labor practice.

The theory of communities in practice helps in understanding the creation, deepening, and learning of professional knowledge. However, from the viewpoint of the innovation activity, communities of practice are problematic because they are often closed and rather homogeneous. This kind of community is not especially open to new ideas and not ready to accept different knowledge. More problematic, however, would be operating within a perspective of competition rather than cooperation: Different communities of practice within one company may view their own teams as proprietary and consider other teams as competitors or decide the others' know-how is not as interesting or valuable.

62 The term SECI comes from the processes of the conversion of tacit (t) and/or explicit knowledge (e): Socialization (t → t), Externalization (t → e), Combination (e → e) and Internalization (e → t).

Rich networks of learning

The SECI model and the theory of communities in practice have stimulated frequent research about the management of knowledge. The more recent research has called attention to the importance of networks comprising multiple companies or organizations in the control and innovation of knowledge. Networks are positioned somewhere between markets and hierarchic organizations. Stanford University's Walter Powell (1990) called attention to the network form of modern organizations. In his more recent research, he concluded that modern companies build up learning networks where know-how and resources have been drawn from beyond the borders of individual organizations, and outside the market relations and hierarchic relations. The learning takes place in the cooperation between and among the organizations, partly through the formal channels and partly within the informal change of ideas and knowledge (Powell et al., 1996).

Based on my own research, I now present a new way to classify the networks of learning and knowledge transfer (Hautamäki, 2007b). As the starting point, I accept Granovetter's (1973) observation regarding the links that connect people. Weak bonds link people of impersonal familiarity, that is, familiarity based on the "nodding acquaintance" that develops as someone sees another person repeatedly, for instance, on the company elevator or at periodic conferences, but of whom he/she knows very little. On the other hand, people have strong bonds with their relatives, close friends, and fellow employees. Granovetter's basic thesis is that people who share strong bonds tend to be similar and share similar opinions: They form a homogeneous group. Furthermore, close bonds limit or define those within a community. Therefore, if a member of a community of close bonds needs new knowledge, new connections, or new possibilities, he/she will more likely achieve these goals through interaction with and inquiry from the fellows with whom he/she has weak bonds.

This general sociological observation about the usefulness of weak ties in the development of a person's knowledge, creativity, and access is also valid for companies. The existence of weak bonds opens a connection between people who might have something new to offer. The work of a broker is an interesting example of such connections. In most cases, the broker, who has varying levels of relationships with people in a variety of companies and organizations, can function as a bridge between otherwise separate and unrelated communities, creating connections that might not exist in any other form or through any unmediated process.

The theory of weak bonds acknowledges that new information can be surfaced in places or situations in which people meet rather accidentally and surprisingly. Groups of strangers or distant acquaintances may meet unexpectedly, at the local marketplace or community events, in shopping centers, restaurants, and exercise centers, on the golf course, or even at events such as arts and cultural events, festivals or parties,. These connections take place via the *agora*, a term I draw from the Greek language that means the marketplace. In the agora, people meet each

other face to face and exchange opinions and convey news on a variety of topics. Corresponding contemporary meeting places include trade fairs, conferences, and seminars. Modern businesspersons come to them sometimes from great distances to see new products, hear the newest research results, establish or renew relations, and buy or sell products, services, and ideas (see Maskell et al., 2005).

As the theory of communities of practice shows, professional knowledge moves rather easily within a particular field. People of a specialized profession and practice often belong to professional unions or organizations, and to related networks. I metaphorically call these networks *guilds*. One component of the guild is its local organizations, while others are national and international. One method of information transmission within the guild is through data connections, such as professional sites. The importance of guilds from the innovation activity perspective is that the newest knowledge of the field is sought and learned through them, especially concerning explicit and analytical knowledge. It is also possible to glean tacit knowledge from the guild, but the adoption of such intangible information requires the mastering of the corresponding practice. So the guilds are, in particular, the channels of professional and explicit knowledge that Brown and Duguid (2000) called networks of practice.

The know-how of networks of practice and guilds aims to become tighter and closer. Because the guilds are fairly homogeneous, shared knowledge is usually deeper but not broader, and thus innovations are very often deviations from the main direction of the knowledge. Innovations often are surprising connections between seemingly unrelated matters.[63] Therefore, networks of practice and guilds need to associate with more heterogenic communities and working groups,[64] with the goal of consciously creating new knowledge. Experts with different backgrounds and knowledge can collaborate and combine ideas and practices in creating new or different know-how. I call these collaborative networks and communities involved in the creation of new knowledge *alliances*. Most commonly, an alliance is a R&D project of two or more actors but where all parties are active.

The alliance is a way to find or create new explicit and tacit knowledge. Alliances succeed because the experts come from different organizations, draw on different knowledge and practices, work together from time to time and, as a result, learn new practices and interpret differently the old and new information in their organizations. Sometimes alliances are based on an outsourcing of the R&D activity. In these cases, tacit knowledge does not migrate from the researcher to the ordering company, although the explicit knowledge is obtained through research results reports.

The development of data and communication technology has been, for the most part, the foundational basis for decentralized innovation, which I described earlier. One aspect of the networks in decentralized innovation is based primarily

63 Serenpidity is needed in innovation processes in order to be open to unforeseeable events and chances.
64 Kai Hakkarainen has, together with other Finnish researchers, created a theory about the new types of heterogenic communities, which they call innovative knowledge communities (see Hakkarainen et al., 2004)

on cooperation through communication networks. The Internet has become an important channel for searching for or delivering new information, as well as a forum for the creation of knowledge. Social networking sites, such as Facebook, are developing as new tools for innovation activity. Because the Internet is an open environment, I use the term *netgora* for the innovation networks active in this global, interconnected framework. Netgora might be called also *virtual agoras*.

The forms of networking and cooperation presented above can be summarized in Table 7. A network connection can be weak, that is, based on a random acquaintance, whether formal or informal, brief or long-term. Strong connections represent interactions and relationships between people who know each other, who work together based by agreement, and usually are stable and longer lasting. Agoras and fairs are the principle channels for delivering information, and participants in such activities can possibly accumulate different, often surprising, knowledge. Professional fairs, seminars, and the like also transmit explicit knowledge, although the guild is the primary channel for this. Professional groups, clubs, unions, and so on have become specialized in order to define, guide, and guard the interests of the profession and support the actions of their members. It is also possible that tacit knowledge flows among individuals here. The alliance is the network of new knowledge creation in which two or more organizations work together, abide by agreed-upon goals and practices, and act within an approved division of labor.

Type of network	**Alliance**	**Guild**	**Agora**	**Netgora**
Characterization	R&D collaboration between the organizations	Professional community, club, union, etc.	Local public place, with a lot of buzz	Common working place or source of information in communication network
Character of connection	Strong, formal and informal	Strong, informal	Weak, random, face-to-face	Weak, random, virtual
Main knowledge delivered	Explicit knowledge	Tacit knowledge	Information (knowledge)	Information

Table 7.
The types of networks of learning.

Several countries have proposed a better and more effective utilization of globally produced knowledge as one of the central targets of their economic development (see, e.g., Tekes, 2006b). However, this goal cannot be accomplished easily. The division between the searching challenge and the adopting challenge as defined at the beginning of this chapter is quite significant. I call these networks the *searching networks* and *utilizing networks*. Both are learning networks, but searching networks are related more to the creation of new knowledge. Their characteristics are described in Table 8.

Features of network	Searching Networks (exploration)	Utilizing Networks (exploitation)
Organization learning	Scanning new possibilities	Utilizing established matters
Type of network	Agora and netgora	Alliances and guilds
Target of network	Access to new information and finding new partners	Develop talents and deliver knowledge among partners
Connections	Weak links	Strong links
Local structure	Clusters, innovation ecosystems	Communities or connections between organizations
Social capital	Bridging, building new capital	Utilizing existing capital
Distance	Local meetings, also face-to-face communication in fairs etc.	Close collaboration locally or in distance working
Information systems	Internet, social media, open communities	Intra- and extranets
Compatibility of knowledge	Supplementing, new knowledge	Similar but deepening
Learning paradigm	Learning by synthesis	Learning by doing
Type of innovation	Radical or disruptive innovations	Gradual innovations
Mode of innovation	Decentralized innovation	Closed innovation

Table 8.
Characteristics of a learning network

Proximity has become an important characteristic in the creation and transmission of knowledge. The opportunity to meet people physically face-to-face increases the effectiveness of the transfer of knowledge and know-how. In particular, tacit knowledge and deep expertise can be transferred only through longer periods together. Additionally, the agora effect, or the leaking of information in local environments, requires physical presence. Thus the essential element of proximity in innovation suggests strategies for companies seeking to capitalize on the knowledge and know-how available in the marketplace. In order to access and utilize the global presence of know-how and knowledge, a company or research institution must create an environment that encourages personal connections with peers within the knowledge concentrations areas of interest to the company. This also can happen via brain circulation, by exchanging experts.

Another way to tap into global knowledge is to position activities in or around knowledge concentrations. I call this form of networking *diasporas*, referring to a remote station, a colony far away. In various offshore models, such diaspora are typical: The local workers are acting side-by-side with those sent from headquarters. For example, Nokia's research centers in Silicon Valley and Bangalore characterize this type of diaspora and integrate their functions within the local ecosystems. Kao (2007) writes aptly that the offshore innovation phenomenon is the most important driving force of globalization, especially when the emphasis is changed from cost savings to utilizing the creativity of foreign employees.

New knowledge learning, when functioning within a rich ecosystem, is also achieved through *buying companies*. The purchase of a company that possesses new technology or business know-how allows the buyer to subsume new knowledge and new networks. In fact, buying a company can create a diaspora for the purchaser, although the diaspora strategy requires also an increase in brain rotation because the movement of the deepest knowledge from the diaspora to the headquarters occurs only with movement of people.

Take this example from the pharmaceutical industry: Pfizer, a pharmaceutical giant headquartered in New York, has founded a new research facility (the Biotherapeutics and Bioinnovation Center) near San Francisco. In establishing its research center near the dynamic ecosystem of biotechnology of the Bay area, Pfizer seeks to maintain an open window to the newest developments in biotechnology. Moreover, Pfizer is able to estimate the functioning and development of other related companies in the area and, when valuable to their innovation strategy, buying them, such as it did in 2006 with the purchase of the biopharmacy company Rinat Neurosciences Corp. The new research center also seeks partners in the area, builds up innovation alliances, and connects with university research. In this way, the new center is a diaspora in the San Francisco area ecosystem and it is able to utilize the rich know-how resources of the region (agora, guilds, and alliances).

One of the most significant challenges for the innovation systems of smaller countries such as Finland is to improve the ability of its companies and research institutions to find and utilize the new knowledge and technology produced in the best knowledge centers around the world. From the viewpoint of companies, it is the question of their knowledge and innovation strategy. Is it aimed at radical or revolutionary innovations, that is, new, unforeseen products and services? Or is it to take existing know-how to strengthen the quality of products and the effectiveness of processes? The types of networks and characteristics of learning networks described above provide a starting point for building up the channels to utilize foreign knowledge and know-how.

It is important to remember that innovation activity both globalizes and localizes. In the globalization process, companies seek knowledge and know-how everywhere, without the constraints of borders. R&D activities are decentralized and located near the markets for products, but also where enough educated personnel can be recruited to collaborate and contribute within the local research centers. Equally, knowledge always has a local dimension, one often full of implicit expectations and behaviors. This reality explains why simply exporting a product to another country may not result in immediate success. The exporter cannot know fundamentally all there is to know about a local culture, particularly its knowledge and product usage. Business can succeed best when the company has a presence—and, more beneficially, workers—in the importing country.

The network types of learning, presented above, can be interpreted in a global context in the following way (Figure 15):

- Agora: It is necessary to be present in multiple and diverse ecosystems of innovations in order to get in touch with the information moving within that unique ecosystem. Additionally, international fairs, conferences, and seminars are channels through which to enhance and adapt current knowledge and to gain access to new information.
- Netgora: It is necessary to be present in worldwide networks of information delivery and to take part in, or establish, open innovation networks. The Netgora also functions in maintaining connections, and thus supports working within worldwide alliances and guilds.
- Alliance: It is necessary to establish cooperation agreements with foreign customers, subcontractors, research institutions, and even with competitors, to order to create new knowledge and to supplement current knowledge capital. Alliances facilitate the transfer of both explicit and tacit knowledge.
- Guild: It is necessary to join to professional networks with one's colleagues and experts of the same field from around the world. Professional conferences and meetings are the primary means of making contacts with such experts and to learn about common projects. Guilds provide the venues from which considerable professional tacit knowledge can be gained.
- Diaspora: It is necessary to locate the activities of innovation centers in multiple settings, both abroad and at home, in order to utilize the local ecosystems and communities (agoras, alliances, and guilds) available there. A global reach also facilitates the opportunity for assessing and buying related or complementary companies and technologies.

Companies should have clear strategies regarding methods to surface and utilize global knowledge resources and a worldwide talent pool. Finding and accessing international knowledge requires a control of various channels of knowledge transfer and learning. Most importantly, company leaderships need to remember that many aspects and types of knowledge can only be obtained by being close to the source of knowledge, either by acting in the local ecosystem or by cooperating with individuals associated with related or complementary systems, knowledge bases, and knowledge implementation processes. Brain circulation, meaning having company personnel working abroad for a period of time, is still the best means to access new knowledge, although communication networks are effective (netgora). Other strategies include off-shoring innovation, which means locating many of the R&D activities in distant innovation centers (the process of building up diaspora), and buying technologies and knowledge through company acquisitions.

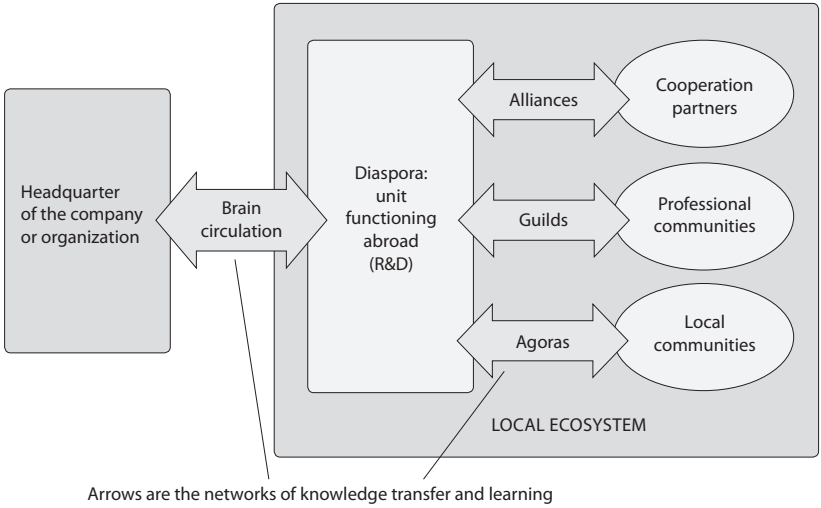

Figure 15.
Global networks of knowledge transfer and learning in the diaspora model.

In light of the analysis presented in this chapter, the traditional concept of a national innovation system no longer sufficiently applies, particularly one that refers to a national system to create knowledge and technology for the benefit of a nation's companies. In the 21st century, knowledge is most often created through international cooperation. In contemporary business, it is as important to adopt or adapt the ideas, processes, and knowledge created by others as it is to create the same within the confines of one's company. Thus, a company is more likely to successfully manage the global economic environment if it can establish, nurture, and collaborate within partnerships around the world.

A main target of innovation policy, therefore, must be the internationalization of the national innovation system. This means that all R&D funding programs have to contain incentives for work to take place in international teams. Also, innovation agencies must be oriented towards collaboration with international partners. In fact, the theses regarding the end of the traditional national innovation system, raised by Charles Sabel and AnnaLee Saxenian in *A Fugitive Success* (2008), are a clear conclusion from the open global knowledge-based economy, where the challenge is the systematic exploration of alternatives. In the future, innovation policy must be based on building world class innovation centers and supporting co-creation in global networks.

Chapter 7:

CONCLUSIONS: TOWARDS SUSTAINABLE INNOVATION POLICY

Humankind has traveled towards increased wealth and well-being for millennia. Along this road, however, challenges have been resolved by determination and inventiveness. Still, global warming and other phenomena linked with the environment have put the international community in a totally new situation. Environmental issues are no longer marginal "externalities" in business and lifestyle but instead have become permanently central to the economic and social systems of every country. Nobel Prize winning climate advocate Al Gore states that a "planetary emergency" should be declared. At the same time, the international community must acknowledge the significant inequality and poverty of many peoples inside many nation/states, as well as the inequality among the nation/states themselves. Poverty and climate are closely linked with each other, especially because of the consumption of energy. It is impossible to reduce the emission of greenhouse gases without solving the problem of poverty.

Reactions to the various environment challenges differ immensely. Some environment organizations support a policy of restrictions where the consumption of energy must be reduced through legislation and a tightening of control. Some activists propose that economic growth must be abandoned absolutely and changed economies focused on zero-growth. Certainly, the integrity of the environment must be guaranteed, but these kinds of policies are based on threats and restraints. Thankfully, other approaches abound.

The point of this book is that the challenges of atmospheric warming, the depletion of environmental resources, and poverty can be addressed through sustainable innovation. The innovation activity of nations and companies must be directed toward solving the most dramatic and threatening issues facing humankind. Means of controlling energy consumption might succeed only with the development of new technologies, ones that use less energy (particularly nonrenewable energy), allow for recycling, and reduce greenhouse gas emissions. Sustainable innovation, therefore, relies on the abilities of people to solve the any number of challenges ahead in new and creative ways.

The cleantech revolution, which takes into account the action logics and interaction of the economic, social, and natural systems, must be the foundation for

immediate and future planning. The sustainable society of the future develops all of its capitals—industrial, human, social, and natural—in a balanced way so that the well-being of all people can be maximized in long-run and at the planetary level. This requires industrial and social innovations, and new products and services. Restricted economic thinking and the quantitative growth of the GDP must be subordinated to larger, indeed more humanistic, goals that include promoting the well-being of people everywhere, strengthening social justice for all, and maintaining and valuing the natural environment for future generations.

Sustainable innovation starts with positive thinking, a belief that creativity and innovations can overcome the pending challenges linked with the environment and society. Negative threat scenarios and dwelling on the critical aspects of the situation do not change people's behavior or move them in a more constructive direction. On the contrary, the result might be people's withdrawal or an increase in selfishness. Instead, it is important to rely on people's goodness and cleverness and provide a reasonable and inspiring vision to motivate them toward positive and productive actions.

Management leading change

The challenges for management are a suitable theme on which to end this book. Over the previous chapters, I have described a variety of challenges facing our societies and companies. In order to successfully confront these challenges, companies and governments need to transition toward sustainable development. Yet, even with the goal taking shape and the means to achieve it in the process of development, nothing permanent happens without good management. In this case, I am speaking about the management at all levels and in all organizations. Good managers can be found in all aspects of society, as well in the private and public sectors. On the other hand, we must be tempered by the reality that reforms proceed slowly and that on occasion even promising strategies fail.

The difficulties in managing change are related to two factors. On the one hand, the changes within the global action environment have been unparalleled in their depth and swiftness. On the other, organizations and their personnel nowadays require totally new abilities, which take time to learn. Thus, organizations operating in the contemporary global economy are often unable to leave behind the processes of the past—even if such practices appear unproductive or impractical—to become something very different and adaptable to the changing times.

Now there is a real demand for leaders who manage the change. In our continuously changing business environment, the ability to manage one's organization in the traditional way is no longer acceptable. Contemporary leaders must be able to recognize challenges in the marketplace, to see opportunities in the future, and

to manage the organizational changes to meet and address these two realities. Currently, the leap into the future seems a bit too overwhelming for many companies.

Surely sustainable innovation is one of the largest challenges for management. The principles of sustainable innovation involve sustainable development, participative, continuous, and global innovation, and innovative management. At its core, sustainable development completely changes the line of action for companies (management and personnel), as well as the structures of the society and economy. Sustainable innovation requires the increase of well-being as a basic goal of an innovation policy in parallel with economic growth, or, perhaps, instead of it. The scope of the challenge encompasses the point that quality of life should valued more highly than the consumer mentality or the emphasis on raising the standard of living. All new proposals to solve problems or to find better lines of action are important. Participative innovation offers a promising way to generate enough quality ideas regarding how the new perspectives should be addressed (as known as innovation democracy).

Encouragingly, some companies have stepped up briskly to meet the challenges. Sustainable innovation is transforming business life. Global competition and the demands of customers mean that companies cannot operate peacefully in the business patterns of old. Social responsibility is becoming the norm for successful business. One further challenge is how the public sector could be turned toward the new sustainable direction. Considerable inertia resides in the public sector, and the previous success might hinder recognition of the challenges ahead. For example, Finland's innovation policy has been successful, but several researchers and company managers agree that Finland's competitive ability will be diminished and the challenges increase in the coming years (TEM, 2009a). The practices and visions seem to be clearly in contradiction. So where can enough pressure be found to encourage radical reforms in the innovation policy?

Sustainable innovation as competitive advantage for firms

The strategic agility is becoming the central challenge of management in the global economy, as Doz and Kosonen (2008a) show. Agility is the ability to respond to the changes within the action environment easily and without delay, almost instinctively. Small companies are often naturally more agile than big ones. Yet, strategic agility in big companies is an essential factor for success. Developing such capability requires strategic observation, resource flexibility, and the uniformity of management (Doz & Kosonen, 2008a). Common clear values and an open culture of discussion, with free and valued dialogue among the various company units are also important.

Reaction to the competitive situation can take a variety of forms. Personally, I see sustainable innovation as an important competitive advantage for companies. From the viewpoint of companies, it means, especially, the following:

- **Sustainable development** challenges companies toward the development of products and services for the new cleantech markets, better control of the life cycles of products, using recycled materials, energy effectiveness, and increasing services. One must be one step ahead of the others and be able to anticipate where the market will demand sustainable development in products and services. A company must also be ability to stand clearly against the narrow interests of owners while binding the mission and practices to social responsibility.
- **Participative innovation** challenges companies to develop their personnel's know-how and mobilization, seek and develop the ideas of customers and users, utilize of the activity of citizens and experts through the decentralized innovation processes, and embrace open innovation. Participative innovation is in line with an emerging human-centered approach to innovation.
- **Continuous innovation** challenges companies to emphasize creativity as the basic norm of operations, to question, allow free imagination, support innovative projects, and inoculate units and employees against the always lurking jealousy and fear of the new, and to avoid the "innovator's dilemma," by sticking to practices, products, and processes deemed good and successful.
- **Global innovation** challenges companies to open their internal innovation processes to global cooperation, to possess the ability to find the best ideas and experts from all around the world, build up and control various innovation networks, develop the ability to transform all investments, externalizations and acquisitions into learning and innovation processes, learn the tacit knowledge of the various markets and cultures, and properly manage diversity within the company as well as in partner relations and markets.
- **Innovative management** challenges companies to continuously develop and test new models and methods of management, manage effectively the decentralized innovation processes, and motivate and stimulate their personnel toward creativity and innovation, strategic agility, and the ability to grasp quickly to the possibilities opened by the action environment.

In short, sustainable innovation challenges companies to emphasize their social responsibility and corporate citizenship. Plenty of cynicism exists, on the part of

both companies and individuals, regarding some companies' attitudes and actions of social responsibility. Some still see, as Reich (2007) does, irreconcilable conflicts between the economic goals of companies and ethicality. I do not agree. Rather, I believe the long-term success of companies—and economies—requires that they function in the society according to ethical values. Moreover, the strengthening consumer movement increases pressures on companies to take into account ethical viewpoints, because the treatment of labor force, emissions of greenhouse gases and other pollutants, energy use, and recycling are all consumer-beneficial means of establishing a sustainable strategy and brand of a company.

Another growing trend involves the ethical orientation of small owners.[65] More often, nowadays, small owners are questioning in company meetings the ways of action of the company and its managers. This is true even for the management of insurance and pension companies, who are the biggest owners of many public companies. Their members—the insured—have begun requiring that their company follow ethical investment principles. In this way, the big owners—public companies—are pressured into developing social responsibility.

I believe that many companies will assume a self-imposed, genuine strategic goal of sustainable innovation. Only in this way will a company able to develop logically and effectively the products and services of the new generation. The highest managements of several companies have personally promised to try "to make good." A philanthropic attitude is becoming more common and the owners of companies donate huge sums of money to charitable organizations that aim to address issues of poverty and sickness, especially in developing countries. The most well-known example is Microsoft's Bill Gates. Corporate donations to universities are considerable. Thus, sustainable innovation is a positive strategy of companies as it allows a wise and suitable business strategy without compromising ethical principles.

The Finnish way

After observing Finland from the United States for two years I have begun to see things in a new way. Finland is really a small player in the global economy and is geographically distant from the world's growing markets. The European Union, which Finland joined in 1995, is an enormous economic area, but its relative position is declining. Asia is rising, while the United States seems to be maintaining its position, despite its many challenges (its economic deficit, national and consumer indebtedness, crises in schooling and health care, uncontrolled illegal migration, the wars in Afghanistan and Iraq, and, lastly, the global economic crises).

65 By owners I mean not only business or organization management, but also stockholders and investment portfolio holders, etc.

Nevertheless, Finland can compensate for its smallness in at least two ways. First, it needs to take an open attitude toward the world beyond its borders. This means, succinctly, that it must "open its doors" and invite, persuade, and welcome talented and energetic individuals into the country—to study, research, enterprise, and reproduce. Currently, Finland's foreign students number only a few percentages of total higher education enrollment, as the numbers in other countries in Europe and the United States are many times that. Openness also means that native Finns are moving abroad, experiencing new cultural and business practices and tapping into new and different knowledge, and then bringing those new things back home. One of the biggest challenges of Finland's innovation environment is its internationalization—both inbound and outbound. And since innovation is so global and happens amid cooperation and collaboration with the best experts, no matter where in the world they are, Finland needs to improve its networking skills.

Another way for Finland to compensate for its smallness is to utilize it. It is easier to build up local networks in a small democratic country. Cooperation often functions better in smaller countries than in bigger ones because it is easier in principle to mobilize the know-how and creativity of the whole nation. Quality, tuition-free education and social advantages for students open to everyone the possibility for education and for using their talents irrespective of location, wealth, and ethnic background. The right to be creative must be a basic right of the innovation economy, and this must be maintained without compromises.

Finland's strategy to safeguard its sustainable and balanced social and economic development is easy to support. Moreover, the means toward this end—education, knowledge and know-how—are clearly the right ones. Disagreement and pressure arise, however, in considering how Finland should change its know-how into successful products and services. When we compare the Finnish situation to that of the United States, the difference is obvious.

In the United States, companies and entrepreneurs seeking success draw the entire innovation system forward. They eagerly seize new ideas and technologies and develop them into products and services not seen before. Companies try to recruit the best possible experts, and create a high demand for new knowledge produced in universities and top experts graduated from universities. Private capital investors are, for their part, interested in investing companies having the best ideas and best experts. The innovation system is demand based and profit driven. Incentives function as the motor.

In Finland, the public sector impels the innovation system. The government and its agencies give money and persuade people to become entrepreneurs. Entrepreneurs are surrounded by an army of public actors. Despite this, few individuals want to become entrepreneurs, and only some entrepreneurs are interested in growth.[66] In fact, a growing number of workplaces are found not in the established

66 According to Global Entrepreneurship Monitor, between 2002–2008 about 12% of Finnish early stage entrepreneurs were growth-oriented, whereas this share is about 16% in European countries (TEM, 2009b, p. 158).

companies but in growth companies. It is clear that for Finland to truly succeed in this competitive global economy public R&D financing and private capital investments are needed. Yet it has been difficult to create incentives with them. The core challenges are the Finnish cultural and business attitudes toward risks and failures, but also toward success. There is a Finnish proverb that says "one who has tried is not punished," when in fact in the contemporary Finnish business context, one who tries and fails is punished. Acceptance of failure as a central part of business climate is one of the primary differences between the United States and other countries, as Charles Vest (2007) stresses.

Much discussion has taken place in Finland about the role of the acceptance of failures and willingness to take risks, but very little has changed. The lack of willingness to take risks is linked in a complicated way with the welfare society. Many Western welfare societies are "over-ripe," meaning their citizens are doing well and do not feel the need to risk too much for comfortable living. In the capitalist English-speaking countries, however, entrepreneurship is strong, especially where there are rather good safety structures and considerable wealth. Therefore, willingness to take risks and acceptance of failures are clearly cultural features and held deeply in the citizens' values and attitudes toward society, the economy, and the role of the individual and the government.

However, the willingness to take risks is not fostered using the "stick" but rather using the "carrot." Thinking that a weakening in the safety structures of the welfare society would force people to become bolder and ready to take risks is unreasonable. A more promising way is to strengthen people's positive motives for risk and creating the mechanisms to support them, especially during those stressful early steps. When I returned Finland after my lengthy stay in the United States, I could see clearly the negative attitudes of many Finnish people. All initiatives and enthusiasm are labeled as stupid: one is expected criticize and doubt everything. But this exaggerated negativity kills creativity and entrepreneurship.

The principle of sustainable innovation involves participative, continuous, and global innovation. Its core is the value of human beings and it encourages and stimulates people of all classes, education levels, cultures, and talents to take up their best capabilities and ideas. Such approaches result in innovation that is increased by positive stimulations. The basic law of the new innovation economy is collaboration, in organizations as well as between them, in one's home country and abroad. The success of the collaboration depends significantly on the nation's social capital, which means exactly the mutual reliance between people and their willingness to collaborate and cooperate. In a personal discussion I held with Raymond Miles, he stressed that Finland has a strong social value basis, a benefit strongly needed in the new innovation economy based on cooperation. In Miles' view Finnish social capital creates an atmosphere of confidence and the role of the common good, attitudes that are worryingly disappearing in the United States. So in this, Finland has the advantage.

Sustainable innovation policy

The aim of this book is to awaken thinking about innovation activity and its development in new ways. It is not intended as a reasoned presentation on innovation policy, considering its brief and eclectic overview of a very complex topic. To be fair, the innovation policy based on the concept of a national innovation system has functioned well. This concerns also the innovation policy, which has been developed in Finland with skill and justifiably.[67] But we are living and working in an important period of transition, when critical assessments of the dominant way of thinking about business and innovation can help avoid fatal errors. This is why, even though this book and its concept is not fully developed at this point, I venture to put on paper my own theses: I want to contribute to the building of an environment of sustainability and innovation for the future. This vision of the economy and business practices for the coming decades are outlined in my advocating a *sustainable innovation policy*. To see the benefits of a sustainable innovation policy, I will compare it with the traditional innovation policy that still prevails in many industrialized countries. The talk about traditional versus new is always a simplification, because the new has usually developed under the domination of the old and no clear turning point can be seen. So there is no sharp cut between the old and new innovation policy, and yet something new is emerging, especially concerning sustainable development.

For the time being, however, economic growth and the growth of productivity promoting it are the central goals of Finland's—and many other countries'—innovation policy. In this light, the innovation system is a kind of "growth machine." The fundamentally important goal of a sustainable innovation policy is well-being, which includes sustainable development. Such an approach leads to new types of innovation activity, those that promote well-being by renewing all capitals, but specifically social and natural capitals. Well-being depends in part on economic growth, but economic growth is not the same as increased well-being. In many industrialized countries, the citizens' well-being in general has not improved in spite of continued economic growth over several years. It is true that there currently are no proposals on how the well-being could be actively promoted or measured and, so, we can only estimate the success of well-being in an innovation policy. As a result, limiting the measured indicators for success in innovation policies to economic growth and standard of living is seriously misleading.[68]

Through its innovation policy, a nation can change from 20th-century thinking to 21st-century thinking. In the 1990s, the dominant catchword was technolo-

67 In Finland, the new innovation strategy (Aho, 2008) and the Government's Communication on Finland's National Innovation Strategy to Parliament" (TEM 2008) contain a number a new principles and proposals that are compatible with the sustainable innovation policy.

68 The issue of measurement well-being is raised by a resent report of the Stiglitz Commission (Stiglitz et al., 2009).

gy, while at the start of the 21st century the catchword is innovation.[69] Now, in front of new challenges and in the increasing environmental consciousness, sustainable innovation is becoming the basic concept. Globalization and the need for networking now strongly influence how innovation policies are formed. Because the value chains of companies can be global, where almost any activity now can be produced in the optimum way possible externally, companies manage large networks of partners. Product development can be undertaken with the best partners, no matter where they are situated around the world. Moreover, many companies specialize and try to position to those network partners in ways to attain the most added value. As a result, innovation activity is organized more often along this model. Nevertheless, decentralized innovation processes and global cooperation pose significant challenges for companies.

In addition, the public sector creates the preconditions for the development of the innovation activity. In the central positions are the elementary, secondary, and vocation education systems and the universities together producing talents; and, on the other hand, the financing of R&D activities and improving the preconditions of activities of companies, which enables entrepreneurship. Besides these national functions, the role of regional development is increasing. While we can talk about distinct national and regional innovation policies, in fact they are different components of the same national focus. Whereas the preconditions mentioned above are organized at the national level of a national innovation policy, the development of the regions (as provinces) by special actions is the regional innovation focus of the same national policy.

Therefore, national and regional innovation policies often experience some tension and can work at cross-purposes. The national innovation policy must stress, for example, directing the nation's strengths toward its quality fields and supporting its top units and growth centers. Clearly, a small country cannot be world class in more than just a few fields of know-how. At the same time, Florida (2003) and other researchers have shown that development is promoted through dynamic provinces and city areas that have their own strengths, initiatives, and culture of creativity. Here, size alone is not decisive. Rather, the development of a regional innovation policy must take into account spontaneity and regional needs (demand). But not all regions are equal in their potential, resources, and preconditions for growth, and competition among them will be uneven. Therefore, national and regional leadership must be able to take an honest and fair look at what specific regions have to offer and support that growth toward the overall national benefit.

Table 9 presents the central themes of this book. I have compiled a comparison between a traditional innovation policy and a new sustainable innovation policy.

69 For example, the activity of Tekes stressed the development of industry by the means of technology. Now, the mission of Tekes is to promote the development of industry and services by the means of technology and innovations. The new English name of Sitra, The Finnish Innovation Fund, reflects the same tendency.

Traditional innovation policy	New sustainable innovation policy
Economic growth as the basic goal	Well-being and sustainable development as the basic values, where economic growth has only an instrumental value
Basic concept: national innovation system (NIS)	Basic concept: innovation ecosystem
Direction and control from above (top down)	Enabling spontaneous processes and experiments, and competition (bottom up)
Creative accumulation, incremental innovation	Creative destruction, radical innovation
Isolated public institutions	Systemic development and social innovations
Supply-driven	Demand-driven, with the customer as the center
Paradigm of closed innovation	Decentralized innovation
Corporate model of business: Principal-agent-approach	Network model of business: Partnership approach
Technology emphasized	Knowledge and competencies emphasized
Product centrality	Service centrality
National level dominates	Regional level gets autonomy
National field of action	Global field of action
Culture in the margin of innovation policy, superficial industrial design	Culture as essential and dynamic part of innovation environment, creative industry, and design thinking

Table 9.
The differences between the traditional and sustainable innovation policy.

While the table is strongly simplified, I hope it provides a framework from which one can consider the current rhetoric on innovation policies.

As the global environment becomes more closely networked, and countries and industries play to their strengths, with the emphasis more on human and environmental success rather than simple profit, sustainable innovation will prove to be an essential element of business success—and social stability. Surely the early 21st century is a period of transition, when companies must learn anew a holistic approach to business success. Global collaboration and cooperation, sustainable development, human-centered technologies and practices, and ethical approaches to business are the new keys to economic growth for nations and regions within an interconnected and mobile, and environmentally fragile, world. Thus national and regional innovation policies—and the leadership that guide their development and implementations—must awaken to the challenges and new conceptualizations, as well as practices and frameworks, to make the vision of sustainable innovation a reality.

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This book examines sustainable innovation and the new landscape of the global economy. Its focus is on presenting the emerging view of innovation, which is characterized by creativity, openness, networking and responsibility. The aim of the author is to introduce to a large audience and decision makers a new concept: sustainable innovation policy. *Sustainable innovation* refers to the requirement of promoting sustainable development within the means of the innovation process. Sustainable innovation also means participative, continuous and global innovation, as well as innovative leadership.

Several changes in Finland's innovation system have taken place in the past two or three years. Non-Finnish audiences may benefit from knowing about new developments in Finland. This book sketches Finland's innovation environment and evaluates innovation policy in terms of the ground-breaking themes of sustainable innovation.

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