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Subject: AMTech Comments
Importance: High

Dear Sir or Madam:

The Society of the Plastics Industry, Inc. (SPI) appreciates the opportunity to provide comments concerning the National Institute of Standards and Technology's (NIST's) "Request for Information on How to Structure Proposed New Program: Advanced Manufacturing Technology Consortia (AMTech)" (Docket Number 110620345-1331-02). I have attached three documents:

1. SPI's comments on the "Request for Information on How to Structure Proposed New Program: Advanced Manufacturing Technology Consortia (AMTech)"
2. The Organisation for Economic Co-Operation and Development's (OECD's) "Innovative Clusters – Drivers of National Innovation Systems" report
3. OECD's "Trade and Innovation Project Case Study" specific to the Finnish Telecom Equipment Industry

If you have any questions or require additional information, then please contact me at (202) 974-5258 or mhockstad@plasticsindustry.org.

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Attachments



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TAD/TC/WP(2008)6/PART2/A/FINAL

OECD Trade Policy Working Paper No. 73

TRADE AND INNOVATION PROJECT

**CASE STUDY NO. 1: MARKET OPENNESS, TRADE
LIBERALISATION AND INNOVATION CAPACITY IN THE
FINNISH TELECOM EQUIPMENT INDUSTRY**

by

Caroline Lesser



Unclassified

TAD/TC/WP(2008)6/PART2/A/FINAL

Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development

29-Jul-2008

English - Or. English

**TRADE AND AGRICULTURE DIRECTORATE
TRADE COMMITTEE**

Working Party of the Trade Committee

TRADE AND INNOVATION PROJECT

**CASE STUDY NO. 1: MARKET OPENNESS, TRADE LIBERALISATION AND INNOVATION
CAPACITY IN THE FINNISH TELECOM EQUIPMENT INDUSTRY**

OECD Trade Policy Working Paper No. 73

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ABSTRACT

There is today a great interest in understanding how governments can promote innovation and the benefits it brings, as evidenced by the discussions at the 2007 OECD Ministerial Council Meeting. Against this background, the OECD Trade Committee decided to undertake a “Trade and Innovation Project”, to gain a better understanding of how trade and investment patterns and policies affect innovation capacity, and interact with other key policies influencing innovation performance.

This paper is one of the five case studies conducted in the framework of this project. It examines how recent trade and investment patterns (including “trade in tasks” resulting from supply chain fragmentation) and Finnish and global policies promoting market openness and free trade have affected the innovation process in Finland’s (mobile) telecom equipment industry. The study illustrates how regulatory, trade and investment policy choices have helped -- alongside other key policies-- provide the right framework conditions for innovation in this country of 5.2 million people. In addition, it examines how the private sector, and more particularly Nokia, has taken advantage of those conditions to enhance its innovation capacity. This study does not constitute an in-depth evaluation of the effectiveness of Finnish public policies nor of Nokia’s business strategy. Rather, it provides an illustration of how certain public policy choices and business strategies can contribute to a country’s innovation performance.

Keywords: Innovation, trade reform, intra-industry trade, foreign direct investment (FDI), deregulation, Finland, Nokia, telecom equipment industry, information and communication technologies (ICT), R&D investments, Information Technology Agreement.

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The Working Party of the OECD Trade Committee discussed this study and agreed to make the findings more widely available through declassification on its responsibility. The study is available on the OECD website in English and in French: <http://www.oecd.org/trade>

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EXECUTIVE SUMMARY

1. Innovation relates to a process connecting knowledge and technology with the exploitation of market opportunities for new or improved products, services and business processes compared to those already available on the market. There is today great interest in understanding how governments can promote innovation and the benefits it brings, as evidenced by the discussions at the 2007 OECD Ministerial Council Meeting. To gain a better understanding of how trade and investment policies and patterns, in particular, affect countries' innovation performance, and interact with other key policies influencing the "framework conditions" for innovation, the OECD Trade Committee decided to undertake a "Trade and Innovation Project". This paper is one of the five case studies commissioned in the framework of this work. Its objective is to examine how Finnish and global policies aimed at promoting market openness and trade and investment liberalisation have affected the innovation process in Finland's (mobile) telecom equipment industry, and more particularly in Nokia.

2. Finland is a country that has successfully transformed itself from a resource-driven economy to a "knowledge economy" in a relatively short period of time. It has, in particular, developed a strong sectoral specialisation in the manufacturing and export of telecom equipment. By 2005, the sector's exports actually represented 8.4% of the country's GDP. The relatively rapid rise of this industry has been accompanied by the emergence of a competitive ICT and mobile telephony cluster, which has encouraged co-operation, learning and technology transfer among a wide range of (domestic and foreign) manufacturing companies, service providers, academic and research institutions and public certification and standardisation authorities. This cluster -- which has been heavily dominated by Nokia -- has acted as a main conveyor of innovation in Finland, helping also smaller firms to get involved in innovation processes.

National innovative capacity: the role of Finland's public policies

3. National innovative capacity is in part constrained by past technological sophistication, but also reflects a series of government policy choices that affect the (private sector's) incentives for R&D, productivity and commercialization activities in a country. Finnish public policies have helped spur innovation activity in the economy, and in the telecom equipment sector more particularly, by exposing firms to the right set of market incentives and by establishing adequate "framework conditions" for innovation.

4. In the early 1970s, Finland's state-owned Post, Telegraph and Telephone (PTT) operator developed the Nordic mobile telephony (NMT) standard, in collaboration with the Swedish, Norwegian and Danish PTTs, making it the first country worldwide to launch a digital network for mobile communications. In 1991, the successor of the NMT, the world's first Global System for Mobile communications (GSM) was launched in Finland. It subsequently also became the European standard for mobile telecommunications. As a result, Nokia and other Nordic telecom equipment suppliers benefitted from first mover advantages in the mobile telecom industry worldwide. In addition, in the mid-1980s, thus well before its European neighbours, Finland started to deregulate its telecom sector, which resulted in a decentralised system of (Finnish and foreign-owned) telecom operators. Increased competition, in turn, provided continuous incentives for upgrading different components of the telecom network and for introducing a variety of technological solutions and innovations among firms participating in the mobile telephony cluster.

5. After the collapse of the Soviet Union in 1991, Finland redirected its trade to the West. In 1995, it joined the European Union (EU) and its Single Market, which implied a full removal of trade and investment barriers and a substantial increase of trade volumes with other EU member states. Trade in intermediate and finished telecom equipment, more particularly, was facilitated between Finland and its EU trading partners thanks to the harmonisation of "essential" product regulations and specifications and the introduction of the EU Suppliers' Declaration of Conformity for telecom and electrical equipment and

parts among EU countries. As an EU member, Finland has also benefitted from the regional trade arrangements and the mutual recognition agreements concluded between the European Commission and third parties -- many of which allow the acceptance of conformity assessments for telecom and electrical equipment and parts conducted in exporting countries-- enabling as such some reduction in non-tariff barriers to trade in finished and intermediate telecom equipment with third parties.

6. As a member of the World Trade Organisation (WTO), Finland has also participated in the negotiations on basic telecommunication services (1994-1998) whose results are consolidated in the 4th Protocol of the General Agreement on Trade in Services (GATS). The negotiations led to the opening of telecom markets to competition in basic services (e.g., fixed and mobile voice telephony) in 69 WTO members (and, nowadays, in over 100 member countries), and to the creation of a Reference Paper which includes regulatory disciplines on competition, interconnection, independent regulation, transparent licensing procedures and non-discrimination in telecom services. Finland has also been a party to the WTO Information Technology Agreement (ITA), which required the elimination of tariffs and other similar duties and charges on ICT products, including telecommunication equipment and parts, with certain exceptions, by 1 January 2000. Finally, in view of reducing non-tariff barriers to trade in telecom equipment and parts on a global scale, Finnish officials and experts have also been active in international standardisation efforts, for example through participation in the International Telecommunications Union.

7. All these endeavours have facilitated the import of intermediate goods and parts for Finnish telecom equipment manufacturers (i.e., intra-industry trade), which has been crucial to encourage technology transfers and maintain the competitiveness of the industry. The telecom equipment sector has been characterised by a fragmentation of the production process between contracting firms and a large number of external sub-contractors. In Finland, imports of telecom equipment and parts have actually almost been multiplied by ten, in absolute terms, between 1990 and 2006, to reach a value of USD 5.1 billion in 2006. While in 1990, the import of telecom equipment and parts represented 0.8% of GDP, in 2006 it represented over 3%. On average, 80% of such imports have represented telecom equipment parts, which are likely to have contributed to the innovation capacity of the Finnish telecom industry.

8. The fragmentation of the manufacturing process in the telecom equipment industry has also implied a growing importance of intra-firm trade, i.e., trade between multinational corporations' headquarters and their foreign affiliates. Such a pattern has been able to emerge in part thanks to the liberalisation of international investment flows. In Finland, restrictions on foreign ownership of Finnish firms were removed in 1991-93 and remaining restrictions on capital flows were subsequently lifted, which promoted investment in general (including the emergence of domestic venture capitalists) and the inflow of foreign capital in particular. Between 1990 and 2000, the stock of Finnish inward foreign direct investment (FDI) as a share of GDP was multiplied by more than five times (increasing from 3.7% of GDP in 1990 to 20.2% in 2000). Increased inflows of FDI, particularly in the ICT sector, in turn, enabled Finnish telecom equipment enterprises to get access to more capital and knowledge required to develop the industry and enhance its innovation capacity. By 2001, over 2,000 foreign-owned companies operated in Finland, of which around 25% specialised in ICT and the development and commercialisation of mobile technologies or services.

9. The degree of market openness, achieved through deregulation and trade and investment liberalisation, has thus played a key role in the innovation performance of the Finnish telecom equipment industry, by enhancing competitive pressures, facilitating technology transfers and generating economies of scale for R&D investments. Yet, market openness has not been a sufficient condition for triggering the *absorption* of technology and innovation, which is necessary to increase an economy's productivity and growth. Significant R&D investments, but also effective education policies and strong links between industry and academia have all contributed to nurturing a favourable environment for innovation, helping convert R&D to commercial applications and enhancing the application of new technology and innovative practices to domestic industries.

Successful firm-level strategies: the case of Nokia

10. While the Finnish government has played an important role in creating adequate framework conditions for innovation, it is ultimately *companies* that have introduced and commercialised innovations. Nokia, in particular, has played a major role in the transformation of the Finnish economy and in the performance of the Finnish innovation system. Increased competition in the telecom equipment market and rapid technological progress have shortened the life cycle of products, placing additional pressure on Nokia to find new and more rapid ways to innovate. As a result, the company has made significant R&D investments to remain competitive. While in 1991, R&D spending represented approx. 5.5% of total net sales, this share more than doubled in 2005 to reach 11.2%. Furthermore, in the 1990s, Nokia internationalised its R&D function, by setting up research centres abroad. By 1998, half of the company's R&D was conducted outside of Finland. Some of these centres, located in regional clusters of scientific excellence (e.g., Silicon Valley), have helped Nokia tap knowledge from rivals and foreign markets. In addition, Nokia has forged collaborations with leading universities in Finland and abroad (e.g., Massachusetts Institute of Technology) and has participated in various international R&D projects, in view of expanding the scope of its long-term technology development. By the end of the 1990s, co-operation with other companies, research institutes and universities had become a central part of Nokia's global R&D strategy. This approach triggered two-way knowledge transfers, enabling Nokia to exploit external expertise and technology.

11. Furthermore, Nokia has set up ten plants for the manufacturing of its mobile devices in nine different countries. These plants have handled huge amounts of parts (e.g., more than 100 billion in 2006). The challenges of managing such huge volumes are enormous, but Nokia has turned high-tech manufacturing, supply chain management and logistics into one of its core competencies. In addition, the company has also been working with a selected number of external suppliers in Finland and abroad to procure electronic and mechanical components, and software. Collaborating with such a diverse base of suppliers worldwide through a horizontally-integrated supply chain model has generated (two-way) knowledge and technology transfers between Nokia and its partners, helping it to multiply its technological capacities. Moreover, Nokia's long-term supplier relationships have functioned as a growth engine for the entire Finnish ICT sector as it served as an international marketing channel for many smaller Finnish companies. The increasing significance of Nokia's foreign operations in the company's global business strategy has however implied potentially greater risks and higher costs from changes in tariffs and other obstacles to trade affecting the import and export of mobile device components.

12. Finally, in the early 1990s, Nokia adopted an export-based sales strategy. As a result, between 1990 and 2006, Finland's position as Nokia's dominant geographic market declined dramatically at the expense of other European countries, the Asia-Pacific and the Americas. In recent years, emerging markets (e.g., China, India and Russia) have been Nokia's main markets. In addition to the changing composition of key markets, the volume of net sales also dramatically increased (+ 209% over 8 years, increasing from a total €13,326 million in 1998 to €41,121 million in 2006), which enabled Nokia to recoup its R&D investments more easily.

Conclusions and ways forward

13. To conclude, the transformation of Finland into a knowledge-based economy and its relatively strong national innovative capacity has, to a large extent, been a business-driven process. Yet, effective public policies have made a meaningful contribution too, by fostering a competitive market structure, ensuring market openness, establishing incentives and support networks for firm-level innovation. It is however difficult to dissociate the particular effects of trade and investment policies from the effects of other domestic policies, as it is the collection and co-ordination of all those policy choices that have facilitated industry-led innovation in Finland, and more particularly in the telecom equipment industry.

14. The current competitiveness and national innovative capacity of Finland does of course not guarantee success for the future. Today, despite its leadership position, Nokia faces greater competition in

the mobile phone industry, both from traditional and new competitors. To remain competitive, it needs to remain flexible and constantly innovate and adapt (to new standards as well as to evolving consumer taste). One of the key challenges for the Finnish ICT and mobile telephony cluster more generally is to keep up with the ongoing technological convergence between data and voice communications, IT and consumer electronics. This challenge is particularly acute in light of the fact that Finland is not in the same leadership position today in terms of standard development as it used to be in the early 1990s. To respond to these challenges, the government recently decided to develop a new *National Innovation Strategy* and a related Action Plan (June 2008). The strategy aims to be broad-based, enabling the adoption of a systemic and comprehensive approach to innovation policy.

15. In the area of trade and investment, Finnish policies should continue to ensure that resources can flow easily between “tasks” (i.e., subsidiaries or suppliers), in light of the increased fragmentation of production, by promoting a stable and predictable trade and investment environment. In this regard, the recent Proposal for a National Innovation Strategy indicates that incoming [trade and investment] flows are essential to enable Finland to influence and take part in global value chains, which, in turn, are crucial to promote the country’s competitiveness in global markets. Finland should continue to promote the successful conclusion of the Doha Development Round and the expansion of the ITA to cover more products and countries, in view of ensuring the relevance of this agreement in a context of rapid technological change and convergence. In addition, Finnish policies should encourage further international harmonisation of product specifications and mutual recognition of conformity assessment procedures for telecom and electrical equipment and parts globally, to further facilitate trade in intermediate products, which is crucial to sustain the competitiveness and innovative capacity of the Finnish telecom equipment industry.

I. Introduction

1.1 Background

16. Innovation and technological progress are key determinants of economic growth. Innovation can also help address major global challenges such as climate change, energy, security and health, by boosting income and productivity growth, which are key to fighting poverty and other social ills. By strengthening innovation capacity, countries, regions, cities and firms can become more competitive and better prepared to face the challenges of globalisation. Innovation though is more than just the result of research and development (R&D); it is about the successful exploitation of new ideas and the invention, development and commercialisation of new technologies, services, business models and operational methods. Innovation is thus related to a process **connecting knowledge and technology with the exploitation of market opportunities** for new or improved products, services and business processes compared to those already available on the market.

17. There is today great interest in understanding how governments can promote innovation and the benefits it brings, as evidenced by the discussions at the OECD Ministerial Council Meeting in 2007. At the meeting, the OECD was mandated to develop an *OECD Innovation Strategy*, drawing on relevant work in several policy domains, including in the area of trade policy. Effective market openness, trade and investment policies can indeed influence the “framework conditions” for innovation and entrepreneurship and, as such, affect a country’s innovation performance. To gain a better understanding of how exactly trade and investment patterns and policies affect innovation performance, and interact with other key policies influencing innovation performance, the Trade Committee mandated the Secretariat to undertake a “Trade and Innovation Project” (see TAD/TC/WP(2007)11). In the framework of this project, Members decided to examine the innovation performance of a number of specific countries and industries -- including the Finnish (mobile) telecommunications equipment industry-- alongside a more general analysis. This paper is one of the five case studies that complement the general analysis.

1.2 Objective, structure and methodology

18. The objective of this study is to examine how recent trade and investment patterns (including “trade in tasks” resulting from production and supply chain fragmentation) and Finnish and global policies promoting market openness and free trade have affected the innovation process in Finland’s (mobile) telecom equipment industry, and more particularly in Nokia, the leading firm in that industry worldwide. The study illustrates how regulatory, trade and investment policy choices have helped, alongside other key policies, to provide the right framework conditions for innovation in this country of 5.2 million people. In addition, it examines how the private sector, and more particularly Nokia, has taken advantage of those conditions to enhance its innovation capacity. This study does not constitute a comprehensive and in-depth evaluation of the effectiveness of Finnish public policies nor of Nokia’s business strategy. Rather, it provides an illustration of how certain public policy choices and business strategies can contribute to a country’s innovation performance.

19. The study is structured as follows: *Section II* briefly explains the structural changes the Finnish economy has undergone since the early 1990s to become a “knowledge economy”. It also outlines the fast rise of the Finnish (mobile) telecom equipment industry, the emergence of a competitive information and communication technology (ICT) and mobile telephony cluster and the innovation activity of Finnish firms. *Section III* then examines the key public policy choices, including in the area of deregulation, trade and investment, which have strengthened the country’s innovation capacity and performance. The success of the Finnish (mobile) telecom equipment industry is of course due to the strategies and performances of key Finnish companies, particularly of Nokia (Steinbock, 2006). Nokia’s business strategy (particularly in relation to its global R&D, manufacturing and sourcing strategy) is therefore examined in *Section IV*. Finally, *Section V* outlines the key conclusions, lessons learnt, and challenges ahead. The study builds on a

review of existing literature, including relevant OECD studies, as well as on semi-structured interviews with selected public officials, Nokia staff and representatives from industry associations.

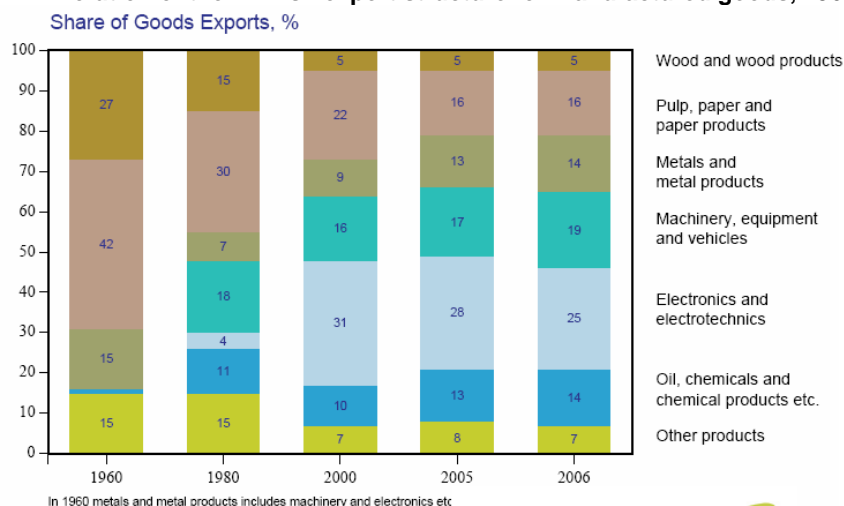
II. Finland's Transformation into a Knowledge Economy

20. Finland is a country that has successfully transformed itself from a resource-driven economy to a knowledge economy in a relatively short period of time. In the mid-1990s, knowledge and innovation became the driving forces of economic growth and transformation (Dahlman et. al., 2005). Today, the country ranks as second (out of 117 countries) in the 2006/7 *World Economic Forum's Competitiveness Index*, and as fourth (out of 122 countries) in the 2006/7 *World Economic Forum's Networked Readiness Index* which measures the degree of preparation of a country to participate in, and benefit from, ICT developments (WEF, 2006 and WEF, 2006a). Such an achievement is remarkable in light of Finland's economic situation in the early 1990s. The country then went through a severe economic recession characterised by a 10% GDP reduction in only three years (1990-1993), a major banking crisis, unemployment rates rising to nearly 20% in 1994 and the accumulation of government debt from modest levels to over 60 % of GDP in the same period (Steinbock, 2006). This section briefly outlines the key shifts in production and trade structures and the innovation activity which characterise Finland's structural transformation.

2.1 Structural changes in the economy

21. Before the 1990s, manufacturing and exports were dominated by the forest-related industries (i.e., paper, wood and pulp products), which still play an important role in the Finnish economy.¹ In the late 1990s, ICT and consumer electronics -- including telecom equipment-- became the leading sector of the economy, accounting for an average 21% of total manufacturing value added and 31% of total manufactured exports in 2000², followed by pulp, paper and paper products (15% of value added and 22% of exports), and machinery, equipment and vehicles (9.5% of value added and 16% of exports) (Porter, 2002 and Figure 1).

Figure 1. Evolution of the Finnish export structure for manufactured goods, 1960-2006



Source: Finnish Board of Customs and Confederation of Finnish Industries

1. In 1988, paper, cork, wood and pulp represented 38% of total Finnish exports, while in 2005 they represented 18% of total exports. Source: UN COMTRADE, SITC Rev.3 classification, codes 64, 24, 25.
2. ICT exports alone accounted for 25% of total manufactured exports in 2000. Source: OECD International Trade Indicators.

22. The rise of the ICT sector in the Finnish economy, in particular, occurred relatively fast in comparison with other OECD economies. Between 1995 and 2003, the share of ICT manufacturing in total Finnish manufacturing rose by 13.4 percentage points, the **largest increase among all OECD countries**.³ Structural changes were possible largely thanks to the persistent priority given to higher education, linkages and spillovers among various industries and the emergence of new knowledge-based industries. The origins of the Finnish knowledge economy can be traced back to user-producer linkages between the forest-based industries as early users of high technology, and the emerging engineering, electronics and ICT industries in the 1960s and 1970s. Furthermore, the ICT sector has benefitted from heavy investments in technological innovation. Between 1981 and 2005, R&D expenditure (primarily led by the private sector) more than doubled in this sector. The emergence of the ICT sector has, in turn, played a major role in the innovation process and in the development of the Finnish society and economy as a whole. The **efficient application of ICT in the private sector** has enabled Finnish businesses to expand their production and trade globally.

2.2 Emergence of a competitive telecom equipment industry and mobile telephony cluster⁴

23. Within the ICT sector, Finland has in particular developed a strong sectoral specialisation in the manufacturing and export of telecom equipment (EC, 2007 and Figure 2). In 2003, manufacturing of telecom equipment represented 90% of total ICT manufacturing value-added in Finland (EC, 2007). Finland's "revealed comparative advantage" in telecom equipment – which measures its degree of trade specialisation in that sector – has been the **strongest across the OECD for the last 10 years** (Figure 2 and OECD 2007e). By 2000, the Finnish telecommunications industry as a whole employed some 83,000 people in over 4000 firms, representing 6.9% of GDP (Porter, 2002). By 2005, the sector represented 8.4% of GDP (Figure 3).

Figure 2. Revealed comparative advantage in telecom equipment, in 1996 and 2005

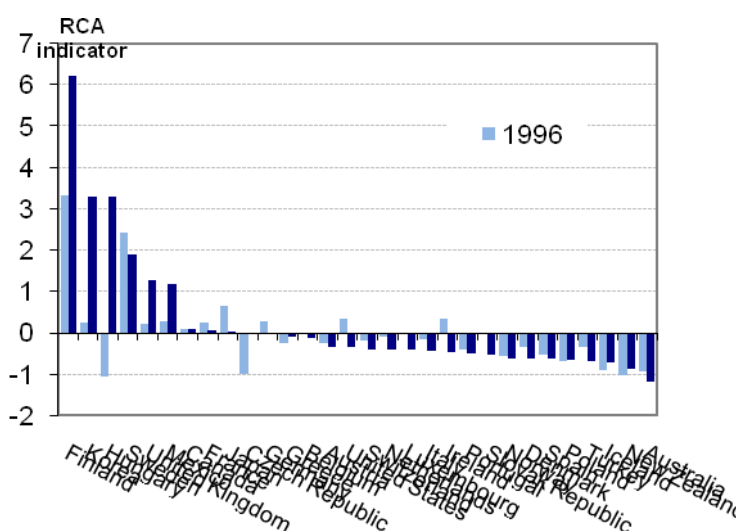
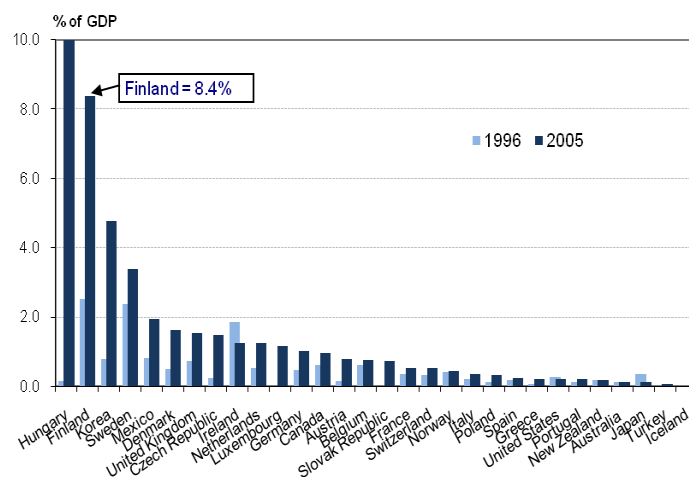


Figure 3. Ratio of telecommunications equipment exports to GDP, in 1996 and 2005



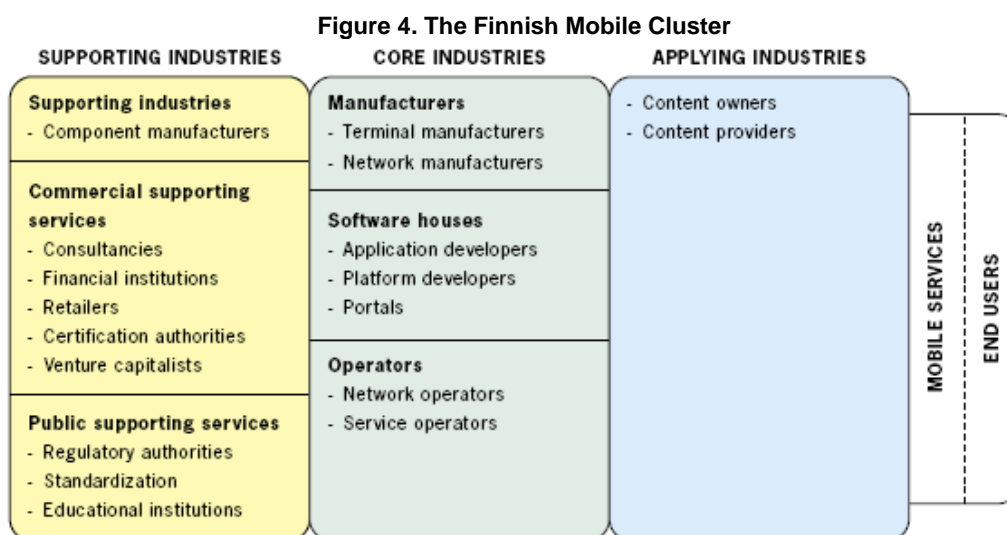
Source: OECD ITCS Database, based on HS1996. Calculation method: Share of country telecom equipment exports out of total country exports, divided by the share of world telecom equipment exports out of total world exports (here: OECD).

24. Dahlman et. al. (2005) highlights that the rise of the Finnish telecom equipment industry was in part possible thanks to the ability for businesses to access foreign capital and knowledge required to develop the industry and thanks to the early deregulation of the sector, which spurred greater competition

3. In contrast, the share of ICT services in total Finnish services only increased by 3.3 percentage points over the same period (OECD, 2007). For a definition of ICT goods and services, see the *Guide for Measuring the Information Society*, OECD (2005c).

4. For a detailed account of the goods included under telecommunications equipment, see OECD (2005c).

and incentives to innovate (these factors are further examined in the next section). In addition, the rise of the Finnish telecom equipment industry was also possible thanks to the emergence of an ICT cluster, which encouraged co-operation among a wide range of manufacturers and service suppliers, which in turn enabled to produce customised solutions for complex end products such as mobile phones (Maguire, 2003). In 2005, this cluster comprised approximately 6,000 small, medium-sized and large companies, 300 of which were Nokia's first-tier subcontractors. From the start, **Nokia has dominated** the cluster by its size and effect, contributing significantly to its growth. Nokia has been operating in the cluster both as a **producer** and as a **user** of innovation resources (Ali-Yrkko, et.al., 2002). The **mobile telecom cluster** (sometimes referred to as "Finland's Wireless Valley"), which is a subset of the ICT cluster, also includes many start-up companies which are niche leaders in mobile technology. Being part of a cluster has helped these firms foster formal and informal linkages with other SMEs, larger companies, support institutions and academia, which, in turn, has helped them participate in global value chains and penetrate global markets. The cluster includes a wide range of stakeholders: mobile application developers, equipment manufacturers (e.g., Nokia, Ericsson, Benefon), component manufacturers and electronics contract manufacturers (e.g., Elcoteq Network), content owners and content providers for mobile applications, mobile network operators (e.g., Sonera and Telia), academic and research institutions, consultancy firms, public certification and standardisation authorities and financial service providers, including venture capitalists (Figure 4 and Steinbock, 2000). Nowadays, the size of the Finnish mobile development community is actually one of the largest in the world in proportion to the country's population (Invest in Finland, 2005).



Source: Invest in Finland, 2005

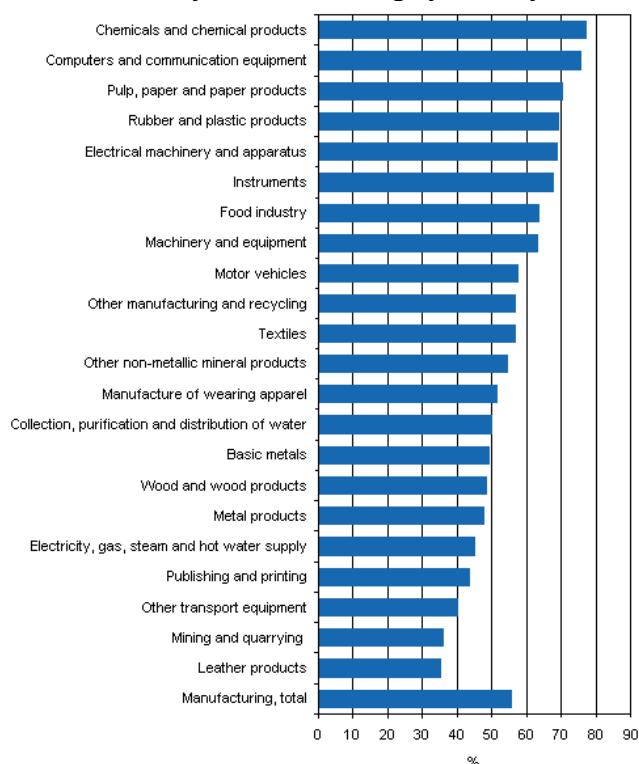
25. Clusters can be seen as one of the **main conveyors of innovation** for companies: they facilitate co-operation, learning and technology transfers between larger and smaller companies, research centres, public authorities and service providers. In this regard, EuroChambers, the Association of European Chambers of Commerce emphasises that the concentration of necessary resources is necessary but not sufficient to promote synergies and knowledge transfer. Clusters also need a favourable environment, i.e., adequate infrastructure, business support services and human resources. Moreover, real interaction between all actors sometimes need to be triggered (e.g., through a cluster animation or co-ordination body). In this regard, Furman et. al. (2002) explains that "*in the absence of strong linking mechanisms, upstream scientific and technical activities may spill over to other countries more quickly than opportunities can be exploited by domestic industries*". In Finland, both **Nokia** and the **government** have actively promoted such linkages to ensure a dynamic ICT and mobile telephony cluster, as is explained in the next section. Interestingly, the European Commission (EC) has also recently committed to support the development of clusters throughout Europe, in the framework of its Competitiveness and Innovation Framework

Programme (FP7) and its Regional Policy for 2007-2013 (EuroChambers, 2006). It has also emphasised the important role SMEs play, alongside multinational enterprises, in (cluster-based) innovation processes in its successive Framework Programme for Research and Technological Development.⁵

2.3 Increased innovation activity in the private sector

26. The national statistics office of Finland, *Statistics Finland*, has been monitoring innovation activity among Finnish enterprises since 2002.⁶ The latest data it released shows that 51% of firms had an activity connected with product or process innovations between 2004 and 2006.⁷ This represents an increase of almost 20% compared to 2002-2004. Interestingly, in the manufacturing sector, the share of firms with innovation activities rises to 55%. Innovation activity was the most widespread amongst computer and **telecom equipment manufacturers** and chemical products manufacturers: 75% of the surveyed enterprises in these industries had engaged in an innovation activity over the reviewed period (Figure 5). Finally, *Statistics Finland* found that the majority of enterprises engaged in an innovation activity (either for product or process innovation) have also entered into **innovation-related co-operation** (e.g., with component suppliers, customers or enterprises belonging to the same group, in Finland and, to a lesser extent abroad) (Statistics Finland, 2006). While these statistics do not distinguish between firms of varying sizes, other sources of information pinpoint that both multinational enterprises (MNEs) and SMEs (which account for the large majority of Finnish businesses) are involved in innovation activities. In fact, in the IT and telecom equipment industry, SMEs are often key suppliers of new technologies (<http://ec.europa.eu/research/>).

Figure 5. Prevalence of innovation activity in manufacturing by industry, 2004-2006 (share of enterprises)



Source: Statistics Finland, 2006

5. See <http://ec.europa.eu/research/sme>
6. An innovation activity has been defined as a new or improved good or service launched by an enterprise on the market, or a new or improved process introduced by an enterprise.
7. When taking also account of organisational and marketing-related innovations, this share rises to 57%.

III. National Innovative Capacity: The Role of Finland's Public Policies

27. National innovative capacity, often defined as “*the country's potential to generate a stream of commercially relevant innovations*”, is in part constrained by past technological sophistication, but it also reflects a series of investment and policy choices by the government that affect the (private sector's) incentives for R&D, productivity and commercialization activities in a country (Steinbock, 2006). Policy makers can help spur innovation, by ensuring that prospective innovators are exposed to the right set of market incentives and benefit from adequate “framework conditions”. This section looks into the policy choices which have contributed to boosting Finland's innovation capacity and examines in more depth the importance of market openness and trade and investment liberalisation for Finland's innovation performance, particularly in the telecom equipment industry. Finally, the section gives some insights into the institutional aspects of Finnish policy-making which have contributed to the national innovative capacity.

3.1 Finland, a first mover in the mobile telephony industry

28. Finland was the **first country** to launch a digital network for mobile communications. In the early 1970s, the Nordic Post, Telegraph and Telephone operators (PTTs) of Finland, Sweden, Norway and Denmark developed the Nordic mobile telephony (NMT) standard, the first fully-automatic analogue cellular phone system.⁸ The standard was subsequently opened for service in Sweden and Norway in 1981 and in Denmark and Finland in 1982. This enabled **Nokia** to introduce the world's first car phone for the NMT standard. By 1985, the network had grown to 110,000 subscribers in these Nordic countries, which made it the world's largest mobile network at the time. In 1991, the successor of the NMT, the world's first Global System for Mobile communications (GSM), a digital standard for mobile networks, was launched in Finland by telecom operator Radiolinja, with commercial operations starting in 1992. The first GSM call was made with a Nokia phone over a Nokia-built network (operated by Radiolinja, a private telecom operator). This brought Nokia an important reference for the future (Ali-Yrkko, et. al, 2002). Thanks to the strong support of the EC, GSM then also became the European digital standard and Nokia won contracts to supply GSM networks in other European countries. The success of these standards was possible thanks to the decision to create open and flexible technical specifications for the NMT standard, the tradition of Nordic collaboration and the entrepreneurial spirit of Nordic PTTs. Given that the Nordic mobile telephony standard incorporated technological advances over the original cellular concept developed in the US, the implication was that Nokia and other Nordic equipment suppliers benefited from **first mover advantages** in the mobile telecom industry (Palmberg, 2002, Invest in Finland, 2005 and Nokia 2007).

29. The popularity and relative rapid diffusion internationally of the NTM standard helped turn first-mover advantages into business opportunities in Finland and the Nordic region⁹, and later on to a competitive advantage on global markets. Nordic equipment manufacturers developed invaluable experience from manufacturing NTM networks and phones. In the specific case of Nokia, this standard formed an absolutely crucial springboard for the successful diversification of the company into the mobile phone equipment and cellular network business (Palmberg, 2002 and section IV).

8. The NTM standard, which is based on analogue technology, is often referred to as the 1st generation (1G) standard for mobile telecommunication networks. The Nordic topography favoured mobile communications due to the dispersion of much of the population in remote areas. Source: Steinbock, 2000.

9. Finland enjoyed a high rate of mobile penetration. By the end of 1998, for example, it stood at 57.1%, or more than twice as much as the European average (which stood at 28.3%) (Steinbock, 2000). The success of the mobile phone can probably be attributed to the fact the Finland (as other Nordic countries) had a dispersed population for which the mobile option was cost-efficient in comparison to fixed telecom services. Most experts also agree that the Finns have been early adopters of technological innovations.

3.2 *Enhanced market openness in the telecom sector*

30. A recent OECD report highlights that the degree of openness of the economy plays a key role in the innovation performance of a country, by increasing competitive pressure, enhancing technology transfers and triggering economies of scale (OECD, 2006a). In Finland, the early deregulation of telecom market, the integration of the country into the European Union (EU) Single Market and the global economy and the liberalisation of capital flows all contributed to the emergence of an innovative and competitive Finnish telecom equipment industry and to Nokia's success.

3.2.1 *Deregulation and increased competition*

31. On the regulatory front, Finland undertook significant reforms in the late 1980s and early 1990s to foster stronger competitive pressure and improve the performance of many sectors of its economy. The country lowered barriers to market access by introducing structural regulatory reforms and new competition rules (OECD, 2003). Interestingly, these reforms were introduced relatively early on (and before Finland joined the EU), making the Finnish telecom industry one of the most liberal of such industries in OECD economies at the time.

32. The deregulation of the telecom sector, which started gradually in the mid-1980s, and the resulting **decentralised system** of (Finnish and foreign-owned) telecom operators, is a key factor that facilitated the introduction of technological innovation in the Finnish telecom equipment industry (Ministry of Transport and Communications, Finland, 1999 and Box 1). By enabling private operators to grow along the national telecom operator, the government played an important role in creating a **competitive environment** in Finland's telecommunications industry – be it for network operators, telecom service providers or equipment manufacturers (OECD, 2003 and OECD, 2003a). This stood in stark contrast with the dominance of state monopolies in other OECD countries at the time. Only by the mid-1990s did other European countries undergo similar regulatory reforms, liberalising monopoly telecom environments and introducing the GSM standard as the pan-European standard (Steinbock, 2000).

Box 1. Key milestones in the deregulation of the Finnish telecom sector, 1987-1997

- **1987:** Adoption of the Telecommunications Act, which, among others, dissociates commercial telecom operations and regulatory functions and liberalises the terminal equipment industry. Administration of the telecommunications sector is transferred from the Transport Executive in the department of Economic Affairs to the Ministry of Transport and Communications.
- **1988:** Adoption of a new Radio Act. Competition in corporate networks and data transmission is partially liberalised.
- **1990:** The special rights of the National Board of Post and Telecommunications are abolished. Free competition in data and GSM networks is introduced.
- **1990-1991:** Licenses to regional radio-telecommunications networks are granted. Corporate networks are subject to free competition.
- **1992:** Switched data transmission is exempted from licences. Competitive licenses to long-distance and local telecommunications are granted.
- **1994:** Local and international telecommunications are subject to free competition.
- **1995:** Competing licenses to distributed control system networks are granted.
- **1996:** The Telecommunications Act is amended.
- **1997:** Adoption of the Telecommunications Market Act (which repeals the Telecommunications Act).

Source: Ministry of Transport and Communications, Finland, 1999 and Steinbock, 2000.

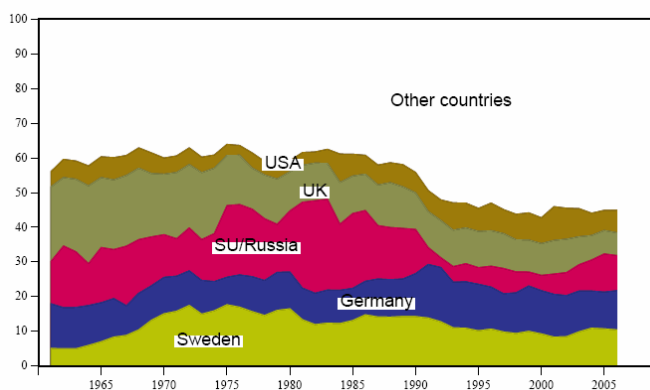
33. Competition among telecom operators provided continuous incentives for the upgrading of different components of the telecom network as well as for competitive procurement of technology. In addition, it spurred the **introduction of variety in technological solutions and innovations** among firms

participating in the mobile telephony cluster. Such firms, and particularly Nokia, have been forced to develop a range of technical solutions and related competencies to satisfy diverse functional requirements regarding mobile telecom equipment and be able to compete effectively.¹⁰ Often, the Finnish home market operated as a large test-trial laboratory prior to internationalisation—a breeding ground for innovations that continually enhanced firms' response to rapid technological change (Palmberg, 2002). These regulatory changes brought benefits for consumers who enjoyed lower prices for a broader range of fixed-line and mobile services, and for companies, which put R&D at the centre of their business strategy (Palmberg, 2002).

3.2.2 Trade reorientation and integration into the world economy

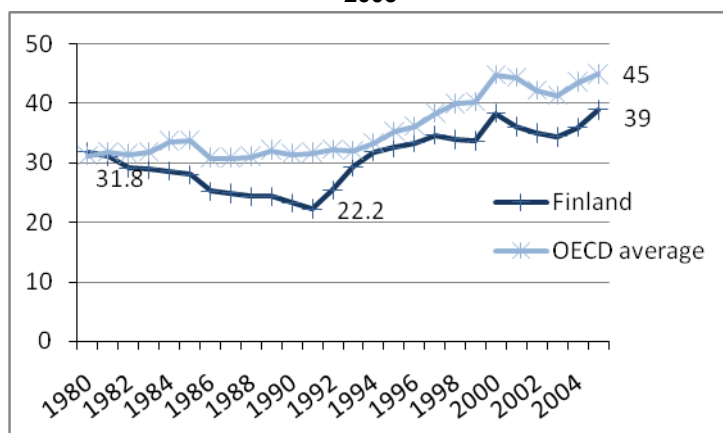
34. After the collapse of the Soviet Union in 1991, Finland redirected its trade to the West. Trade with the former Soviet Union fell by 61% between 1985 and 1991 (from US 2.9 billion in 1985 to 1.1 billion in 1991, UN Comtrade). In 1993, Finland joined the European Economic Area, which led to the **removal of many trade and investment barriers to other European countries**. In 1995, the country subsequently became a member of the EU, which implied its full integration in the European Single Market and a substantial increase of trade with other EU member states (as well as a transfer of competence in most trade policy issues to the EC). Germany, Sweden, the UK, but also the US became Finland's most important export markets in the 1990s (these countries have also been the top importers into Finland) (OECD, 2003). The Russian Federation however regained a position of key export destination in the mid-2000s (Figure 6). Finland's geographical proximity to the Russian Federation and the Baltic countries has actually given Finland an advantage as a gateway to the east. In 2003, over 40 % of the EU's road shipments to Russia were shipped from Finland or arrived via Finland.

Figure 6. Major destinations for Finnish exports 1965-2005



Source: Finnish Board of Customs and Confederation of Finnish Industries

Figure 7. Trade in goods and services as share of GDP, 1980-2005



Source : OECD, 2007

35. Finland's integration in the EU also led to an increase in the relative importance of international trade for the Finnish economy. In 2005, Finland's trade-to-GDP ratio stood at 39% -- almost twice as much as in 1991-- signalling a deeper integration in the world economy (this ratio is however lower than the 2005 OECD average, Figure 7). In addition, as a result of the opening of its economy to foreign competition, the **import penetration ratio** in the manufacturing sector reached **38%** in 2005 (compared to 32% in 1995) while the export ratio was at **48%** (compared to 43% in 1995 (OECD, 2005b).

36. The Finnish government highlights that the EU negotiating power significantly strengthened Finland's trade policy position (Ministry of Foreign Affairs of Finland, 2005). As an EU member, it has

10. Steinbock (2000) notes that "toward the late 1990s, the Finnish telecom and mobile cluster was characterised by increasing rivalry among direct competitors and intense product development."

also benefitted from the regional trade arrangements concluded by the EC. Moreover, as a member of the World Trade Organisation (WTO), Finland has benefitted from global liberalisation achieved through multilateral trade negotiations. The WTO negotiations on basic telecommunication services (1994-1998) -- the results of which are consolidated in the **4th Protocol of the General Agreement on Trade in Services (GATS)**-- led to the opening of telecom markets to competition in basic services (e.g., fixed and mobile voice telephony) in 69 WTO members.¹¹ In addition, the negotiations resulted in the creation of a Reference Paper which included regulatory disciplines on competition, interconnection, independent regulation, transparent licensing procedures and non-discrimination in telecom services. Finland has also been a party to the **WTO Information Technology Agreement (ITA)** since its inception in 1997. In accordance with the ITA, the contracting parties have undertaken to eliminate tariffs and other similar duties and charges on ICT products, including telecommunication equipment and parts, software and semiconductors and related equipment, with certain exceptions, by 1 January 2000.¹² The Finnish government as well as Nokia have indicated that the conclusion of the ITA has been an important development for the Finnish ICT sector, as import tariffs on, for example, electronic components had risen substantially after the entry into the EU. The Government however deplores the slow implementation of the work programme designed to eliminate non-tariff barriers in these ICT industries (<http://www.formin.finland.fi>). Nokia for its part has stressed the importance of **expanding the scope of the ITA** to cover consumer electronics products and other high-tech products used in mobile telephony, in view of ensuring the relevance of this agreement in a period of rapid technological development and convergence. The company is also encouraging countries in Latin America, Africa and the Middle East which have not signed the ITA yet, to do so (information provided by Mr. Kaunistola, Nokia).

37. Some reduction in **non-tariff barriers** to trade in telecom equipment has also been possible thanks to mutual recognition agreements (MRAs) concluded between the EC and third parties, which are applicable to telecom terminal equipment and electrical components used in such equipment (Table 1). Through such agreements, products can be tested and certified before export (against the regulations and specifications of the importing country), thus entering the importing country directly without having to undergo similar conformity assessment procedures, hence facilitating trade in finished and intermediate products between parties (Lesser, 2007). The EU Suppliers' Declaration of Conformity (SDOC) has further facilitated trade in telecom equipment and parts between Finland and other EU countries (TAD/TC/WP(2008)3). In regards to "essential" mandatory product regulations and specifications for telecom and electrical equipment and parts, Finland has adopted EU harmonised standards (e.g., EC Directives 1999/5/EC for radio and telecom terminal equipment and 2004/108/EC for electromagnetic compatibility), which has facilitated the exchange of intermediate and finished goods with other EU countries, as well as with third parties which have adopted EU standards, e.g., several Eastern European and North African countries (see <http://www.newapproach.org/> and http://ec.europa.eu/enterprise/rtte/index_en.htm). On a global scale, Finland has also been active in international standardisation efforts, for example through participation in the International Telecommunications Union.

11 . At present, over 100 WTO Members have commitments to open markets in some or all telecommunication services. See http://www.wto.org/english/news_e/pres08_e/pr517_e.htm

12 . Because of differences in the level of ambition among WTO members, both the 4th Protocol to the GATS and the ITA were initiated on a voluntary basis. The Reference Paper is also a voluntary instrument which provides policymakers with valuable guidance on how to introduce sustainable competition in telecom markets. Source: Engman et. al., 2006.

Table 1. EC MRAs relevant for the telecom equipment industry

| Partner country | Date of signature | Relevant products covered ¹ |
|-----------------|-------------------|--|
| US | 1998 | Telecom terminal equipment ; Electromagnetic compatibility; Electrical safety |
| Australia | 1998 | Telecom terminal equipment; Low voltage equipment; Electromagnetic compatibility |
| Canada | 2001 | Radio and telecom terminal equipment; Electromagnetic compatibility; Electrical safety |
| Japan | 2001 | Electrical products ; Radio and telecom terminal equipment |
| New Zealand | 1999 | Telecom terminal equipment ; Electromagnetic compatibility; Low voltage Equipment |
| Switzerland | 2006 | Telecom terminal equipment ; Electromagnetic compatibility; Electrical safety |

Source: EC DG Enterprise and Industry website as well as OECD (2003)

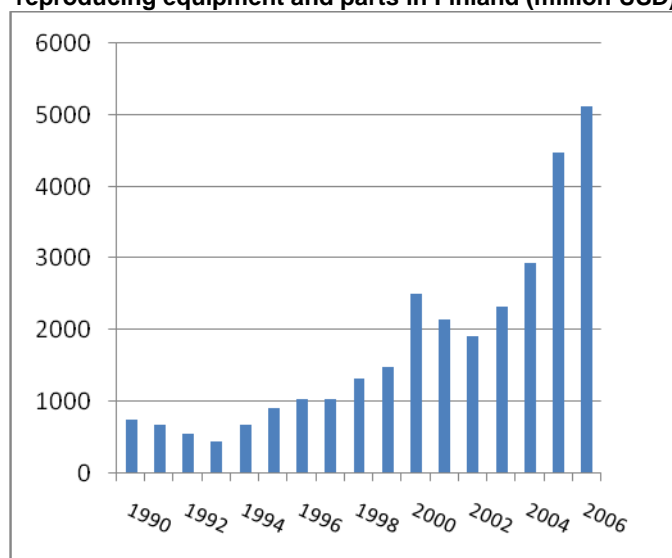
Note 1: For a full list of products covered by the MRA see EC website

38. All these schemes and efforts have facilitated the import of intermediate goods and parts for Finnish telecom equipment manufacturers, which has been crucial to maintain the competitiveness of the industry (Ministry of Foreign Affairs of Finland, 2005). Indeed, recent global production and trade patterns in the telecom equipment industry have been characterised by a fragmentation of the supply chain, which can only function with relatively open trade and investment regimes. The 2007 *OECD Communications Outlook* (OECD, 2007e) further explains that the fragmentation of the production process in the telecom equipment industry worldwide was made possible thanks to businesses' increased industrial specialisation, prompted by product innovations and innovations in production processes. The fragmentation between contracting firms, which handle design, marketing and in many cases research, and a very large number of external sub-contractors, has in turn led to a substantial **increase in international trade in intermediate goods**, and has fuelled the most recent rise in the trade/GDP ratio worldwide.¹³ The Outlook, for example, notes a 13% increase in trade in vertically differentiated goods in telecom equipment among OECD countries between 1996 and 2004, meaning that trade in telecom equipment goods of different quality or trade in intermediate goods has increased among OECD countries (OECD, 2007d and OECD, 2007e).

39. In Finland, imports of telecom equipment and parts have almost **been multiplied by ten**, in absolute terms, between 1990 and 2006, to reach a value of USD 5.1 billion in 2006. While in 1990, the import of telecom equipment and parts represented 0.8% of GDP, in 2006 it represented over 3% (UN Comtrade, SITC, Rev. 3, code 76, and Figure 8). On average, 80% of such imports have represented telecom equipment parts, which are likely to have contributed to the innovation capacity of the Finnish telecom industry (UN Comtrade, SITC Rev. 3, code 764 and Figure 9). A number of studies such as Keller (1998) and Eaton and Kortum (2001) indeed confirm that imports of intermediate goods can play a significant role in **international technology transfer** and innovation capacity in the destination country (OECD, 2007f). Most imports of telecom equipment parts between 1990 and 2006 have originated from Sweden, Estonia, Germany, Hungary (which are all members of the EU) as well as from non-EU members, namely Japan, the US and, most recently, from China (UN Comtrade, SITC Rev. 3, code 764). Finland has also been an important exporter of telecom equipment parts: between 1990 and 2006, the volume of such intermediate goods increased, in absolute terms, by 1225% (from USD 873 million to 11.5 billion). Their share as part of total telecom equipment exports has averaged 93% over that same period (UN Comtrade, SITC Rev. 3, code 764). More generally, exports of telecom equipment and parts (code 76) represented 1% of Finland's GDP in 1990 while 7% in 2006 (UN Comtrade Rev.3, code 76)

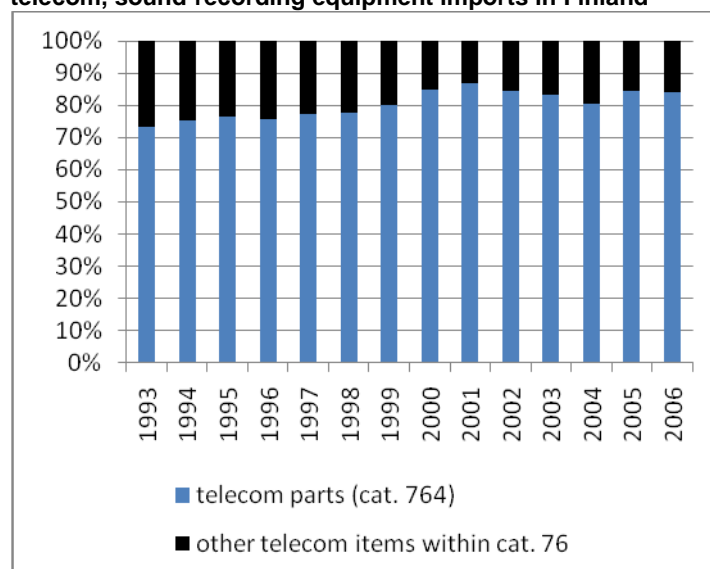
13. More generally, trade in manufactured parts in all industries has grown faster over the last decade than trade in finished manufactured goods (Amighini, 2002).

Figure 8. Imports of telecom, sound-recording and reproducing equipment and parts in Finland (million USD)



Source: OECD International Trade Statistics and UN Comtrade SITC Rev. 3, code 76

Figure 9. Import of telecom equipment parts as share of total telecom, sound-recording equipment imports in Finland



Source: OECD International Trade Statistics and UN Comtrade SITC Rev. 3, codes 764 and 76

3.2.3 Liberalisation of foreign direct investment

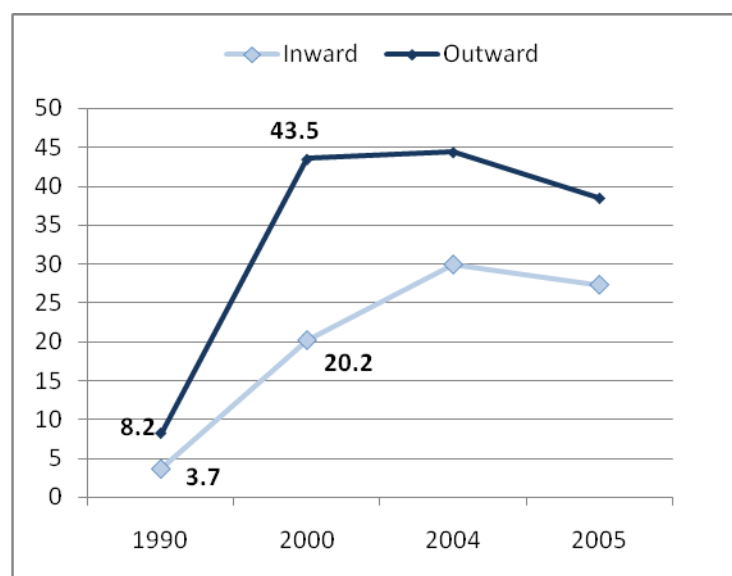
40. The fragmentation of the supply chain has also implied a growing importance of **intra-firm trade**, i.e., trade between multinational corporations' headquarters and their foreign affiliates. Such a trend could not have developed without the gradual liberalisation of investment flows worldwide.

41. In Finland, restrictions on foreign ownership of Finnish firms were removed in 1991-93 and the remaining restrictions on capital flows were lifted, which promoted investment in general (including the emergence of domestic venture capitalists) and the inflow of foreign capital in particular. Between 1990 and 2000, the stock of Finnish inward foreign direct investment (FDI) as a share of GDP was **multiplied by more than five times** (increasing from 3.7% of GDP in 1990 to 20.2% in 2000) (Figure 10).¹⁴ Most of this increase consisted in "greenfield investments", i.e., direct investment in new production and R&D facilities or the expansion of existing facilities in Finland, which helped create new production capacity and jobs and triggered transfers of technology and know-how (Invest in Finland, 2005). Increased inflows of FDI, particularly in the ICT sector, have enabled Finnish telecom equipment enterprises to get **access to more capital and knowledge** required to develop the industry and enhance its innovation capacity (Dahlman, et. al. 2005). The main sources of inward FDI have originated from other European countries. At the end of 2000, for example, Sweden was the biggest foreign direct investor in Finland.¹⁵ By 2001, over 2,000 foreign-owned companies operated in Finland, employing 176,000 persons and having a total turnover of EUR 45 million. It is noteworthy that around 25% of these companies were **ICT firms**, many of which focus on the development and commercialisation of mobile technologies or services (Invest in Finland, 2003 and 2005). The ratio of outward FDI to GDP has even been more significant, illustrating Finland's position as a net exporter of FDI (Figure 10, and next section). During the 1990s, Finnish venture capitalists emerged, stimulated in part by government-sponsored incubators, and technology co-operation and transfer could finally evolve with other countries, such as the UK and the US (Porter, 2002 and Steinbock, 2006).

14. In comparative terms though, Finland's inward FDI stocks have been on average lower than in other Nordic countries (Sweden, Denmark and Norway) between 1990 and 2004. See OECD, 2007.

15. The share of accumulated FDI by the 25 EU member states reached almost 90% in 2003, with Sweden capturing over 50% of investments (Ministry of Foreign Affairs of Finland, 2005). In this regard, a recent OECD report highlights that intra-EU FDI flows are almost completely unrestricted (OECD, 2006b).

Figure 10. Finnish inward and outward FDI stocks in 1990-2005, as percentage of GDP



Source: UNCTAD, 2006

42. Increased FDI and the resulting technology transfers and technology co-operation schemes which benefitted the Finnish economy, were possible in part thanks to a favourable domestic business environment and the conclusion of bilateral investment promotion and protection agreements with third parties, which have helped stimulate Finnish investments abroad as well as foreign investments in Finland. In the latest World Bank Doing Business report, for example, Finland is ranked 13 out of 178 economies on the ease of doing business in the country (World Bank, 2008). Furthermore, by early 2008, Finland had 58 investment agreements, with countries in all regions of the globe (Table 1 in Annex 1). It is also noteworthy that foreign-owned companies located in Finland have been eligible for government support on an equal footing with Finnish-owned companies (Invest in Finland, 2005).

3.3 Other relevant policy choices

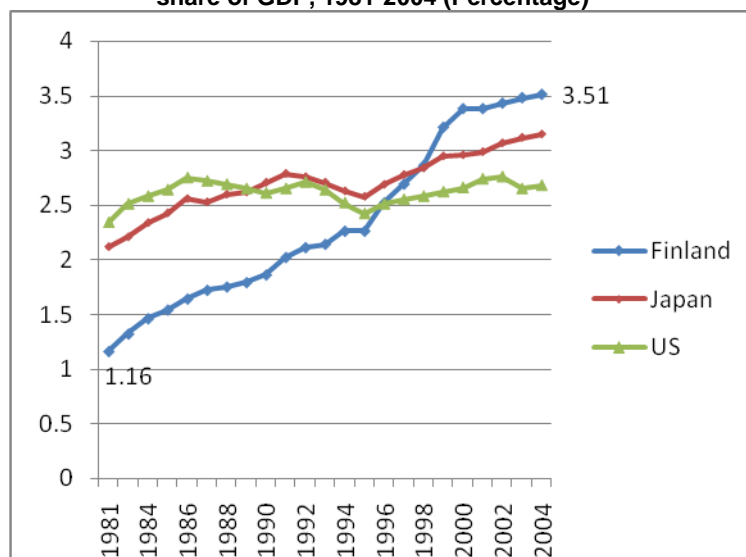
43. While the openness of the economy has been an important factor for improving Finland's innovation performance, it has by no means been the only one. Open trade and investment regimes are not a sufficient condition for triggering the development and absorption of technology and innovation, which is necessary to increase productivity (OECD, 2006a). Important R&D investments but also effective education policies and strong links between industry and academia have contributed to nurturing a favourable business and investment environment (triggering technology transfers and access to additional finance) and played an important role in enhancing the absorption and application of new technology and innovative practices to domestic industries.

3.3.1 Significant public and private R&D expenditure

44. Investment in R&D is a major source of technological progress and innovation, though R&D investments alone cannot explain the rapid increase in Finland's innovation capacity. In Finland, gross domestic R&D expenditure (GERD, covering both public and private sources of financing) has increased substantially during the past decade, to reach **3.5 % of GDP** in 2005 (Figure 11). Finland is as such on average the OECD country that has spent the highest share of its GDP on R&D after Sweden in the 1990s and 2000s (OECD, 2007). Even during the recession of the early 1990s, the government continued to increase public expenditure for R&D, which financed both public research and provided incentives and grants for private firms to invest in R&D (see section 3.3.3). Interestingly, an average 40% of R&D

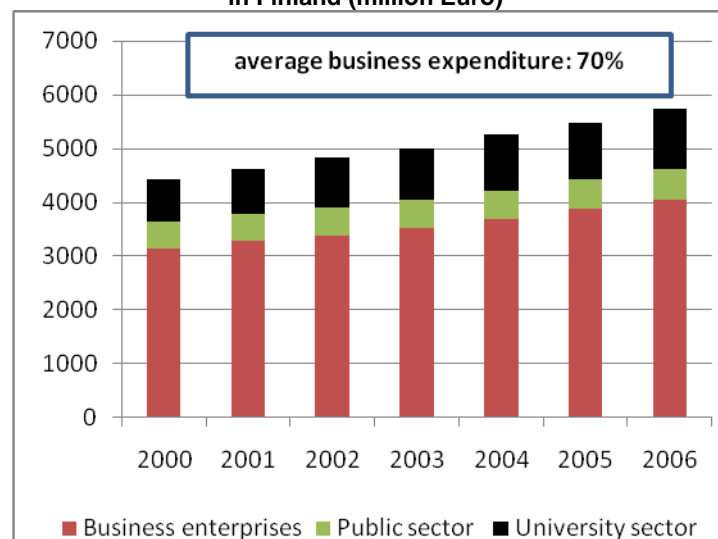
expenditure in Finland has been directed to **ICT and mobile technology related projects** in that period (Invest in Finland, 2005).

Figure 11. Evolution of the gross domestic R&D expenditure as share of GDP, 1981-2004 (Percentage)



Source: OECD Main Science and Technology Indicators, 2007

Figure 12. Composition of gross domestic R&D expenditure in Finland (million Euro)



Source: Statistics Finland 2008. Note: Public sector: Incl. private non-profit sector. University sector: Incl. central university hospitals and polytechnics

45. A large share of R&D investments has been privately funded. In 2000-2006, **business enterprise R&D spending accounted for an average annual share of 70%** of Finland's GERD (Figure 12). The increase in private R&D spending is attributable, above all, to **Nokia's** investments (Dahlman, et. al., 2005).¹⁶ The significant volume of private R&D spending in Finland can in fact be explained by the importance of the ICT and mobile telephony industries in the Finnish economy and increased competition in those sectors, which incited firms to invest more heavily in R&D. Ali-Yrkko et. al (2002) emphasises that in Finland, the centrality of the private sector in domestic R&D financing has been more important than in any other OECD and EU country.

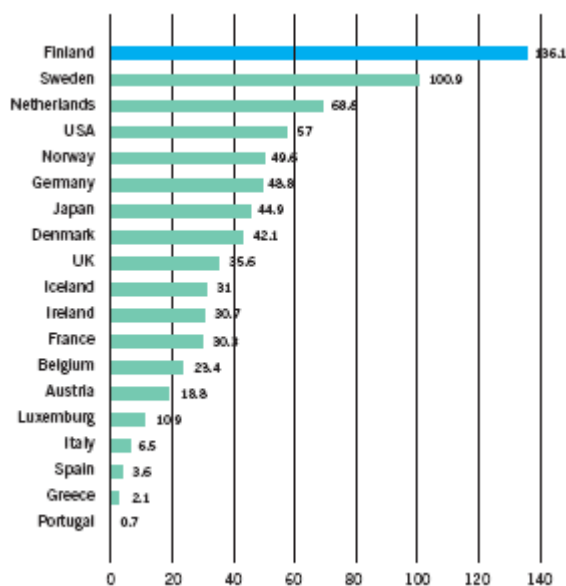
46. Thanks to its strong position in R&D, Finland has also become a main net technology exporter, as such contributing to international technology transfers to third countries. In 2003, its "technology balance of payments"¹⁷ represented 0.2% of its GDP, one of the highest shares across the OECD (after the UK, Belgium, Denmark, the US and Japan, OECD, 2005b). Finally, the number of patents attributed to a company or a country can be used as one measure of innovation too. In 2003, Finland issued 634 triadic patents, which represented an increase of 428% compared to 1990.¹⁸ In the ICT and high-tech sector more specifically, Finland has been one of the leading European issuers of patents in recent years (see Figure 13). Strong levels of patent protection in Finland are, in turn, likely to have contributed to the inflow of ICT and telecom equipment imports and related investments in these sectors in Finland (Park and Lippoldt, 2008).

16. Indeed, in 2003 for example, Nokia accounted for around 33% of Finland's GERD and 47% of private sector spending (Invest in Finland, 2005 and Ali-Yrkko, et. al., 2002).

17. Technology balance of payments (in the form of receipts and payments) measures international technology transfers: licence fees, patents, purchases and royalties paid, know-how, research and technical assistance.

18. Using patenting as an indicator of technological productivity has however limited use as not all inventions are patented (for secrecy, cost or timing reasons). Source: OECD, 2005.

Figure 13. Number of European (EPO) high-tech patent applications per million inhabitants, 2001



Source: Invest in Finland, 2003

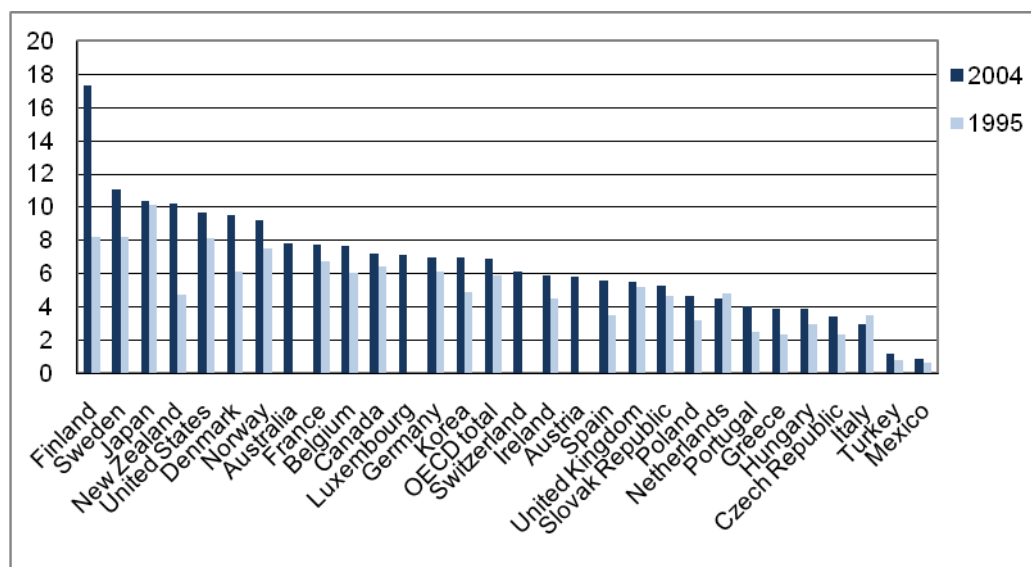
3.3.2 A well-educated and highly skilled workforce

47. Education is also a key element of an innovation-driven economy. It affects both the supply of and the demand for innovation. Human capital and skilled labour complement technological advances. New technologies cannot be adopted in production without a sufficiently **educated and trained workforce** (Dahlman, et. al., 2005). In the OECD's recent Program for International Student Assessment surveys (PISA 2003 and 2006), Finland was ranked as the highest-performing country in terms of learning skills among 15-year-olds in mathematics, science, and reading literacy. Basic, secondary and tertiary education is free of charge (since they are publicly funded) and the social security system in Finland also exerts a strong incentive for young people to continue educating themselves after the secondary school. Between 1993 and 1998, the total intake of students in universities nearly doubled, and in polytechnics it nearly tripled (Porter, 2002).

48. Finland has set up and invested in a number of technical universities and public research institutes, such as the Helsinki University of Technology and the Technical Research Centre of Finland. Over the 1990s, the number of study places available in technical education has increased at an annual average rate of 2.5%, which facilitated the emergence of a large number of well-qualified engineers who have been crucial for generating and sustaining Finland's leading position in the ICT and telecom equipment sectors (Ali-Yrkko, et. al., 2002). Since the mid-1990s, the number of researchers in both the public and private sectors has risen significantly and Finland **ranks first across the OECD** when compared to total employment (Figure 14, and Dahlman, et. al., 2005). Finland also ranks second in the *Science and Engineering Manpower Subindex* developed by the World Economic Forum (Steinbock, 2006). In addition, a recent OECD report highlights that Finland ranks amongst the best performers as regards to ICT training and skills in schools and in working places, facilitating as such the adoption of ICT in businesses (OECD, 2003a).

Figure 14. Number of researchers

(Per thousand employed, full-time equivalent, 1995 and 2004)



Source: OECD Main Science and Technology Indicators, May 2007

3.3.3 Strong research-industry linkages

49. Finally, strong linkages between public research organisations and universities, on the one hand, and business, on the other, have been essential to promote research suited to the needs of the business sector and to facilitate knowledge and technology transfer between them (OECD, 2006a). Such linkages can facilitate the **conversion of R&D to commercial applications**. Institutional and governance factors, though harder to measure, have therefore also had an important impact on Finland's innovation capacity. In 2006, the IMD World Competitiveness Yearbook in fact ranked Finland as the best country in knowledge transfer between universities and companies (IMD, 2006). The Finnish government undertook a number of initiatives to actively increase collaboration among various public agencies, and between those agencies and the private sector. In addition, several agencies supporting public and private sector R&D and innovation have also been established (Invest in Finland, 2005):

- The *National Technology Agency* (TEKES) is the principal source of public funding for applied technological research and industrial R&D (through grants and loans). Operating under the Ministry of Trade and Industry, it contributes to the competitiveness of Finnish industry and the service sectors (including the ICT and mobile telephony sector) by promoting research and application in the field of technological development. TEKES prepares, funds and coordinates national technology programmes and funds applied technical research and risk-carrying R&D ventures. It also contributes to the preparation of national technology policy. Interestingly, foreign companies located in Finland are eligible for the same TEKES funding and services as Finnish companies.
- The *Science and Technology Policy Council* is responsible for the strategic development and coordination of science and technology policies. It also coordinates science and technology policy with other policy areas. The Council is a high-level body made up of Ministers (Education, Trade and Industry, and Finance) and chaired by the Prime Minister.

- *The Academy of Finland* finances basic academic research, is under the authority of the Ministry of Education. Approx. 15% of all government research funding is channelled through the Academy.
- The *Technical Research Centre of Finland (VTT)* is an applied research centre. Develops applied technology solutions for firms and participates in national and international research programmes and collaborative networks
- The *Finnish National Fund for Research and Development (SITRA)* is an independent public foundation under the supervision of the Finnish Parliament. Its activities are designed to promote the economic prosperity of the Finnish people. Sitra focuses its operations on programmes. The methods used are: research and training, innovative projects, business development and corporate funding. Sitra's activities are financed by the yield from its own endowment capital and the return on its venture-capital investments.
- The *Finnish Science Park Association (TEKEL)* consists of 20 science parks throughout Finland, based in university towns. Those parks aim to facilitate exchanges between academic institutions and businesses. The Science parks housed in 2003 approximately 1,200 companies with more than 12,000 employees (Invest in Finland, 2003).
- *Finnvera* is a specialist financing company owned by the Finnish state which provides services to supplement the Finnish financial market. Finnvera's task is to promote the development of enterprise, regions and the exports of Finnish companies. Finnvera carries out this task by improving the range and versatility of financing options available to enterprises through loans, guarantees and export credits.

50. Finally, in view of strengthening the **co-ordination of public policies** aimed at promoting and strengthening Finnish innovation and information society, the Government set up in 2003 a ministerial group for information society issues ("Information Society Council"), chaired by the Prime Minister (OECD, 2003a). The Council's objectives were to steer the development of the Finnish information society, monitor the 2003-7 Information Society Programme and coordinate cooperation both between relevant public bodies, and between public and private bodies (Finland Government Policy Programmes, Information Society, 2003). Yla-Anttila (2005) also highlights the important role the "Committee for the Future" of the Finnish Parliament has played in creating consensus on information society and innovation-related policy issues. One of the Committees' objectives has been to ensure that Finland becomes the "best innovative environment in the world" (Committee for the Future, 2005)

IV. Successful Firm-Level Strategies : The Case of Nokia

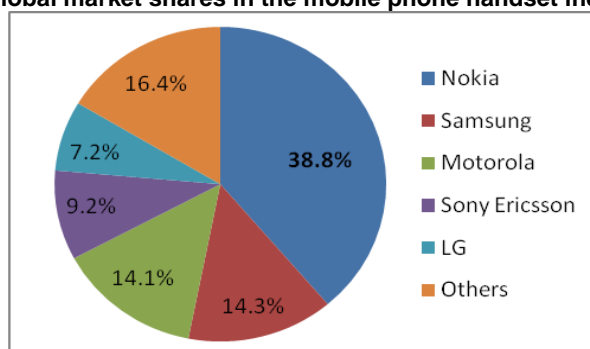
51. Finnish companies have of course also played a central role in strengthening Finland's innovation capacity. While the government has provided the framework conditions for innovation, it is ultimately companies that have introduced and commercialised innovations. Nokia, in particular, has played a major role in the transformation of the Finnish economy and in the Finnish innovation system. The company's operations have had an important effect on Finnish exports, GDP, gross domestic R&D expenditure, and their growth rates (Steinbock, 2006 and Ali-Yrkko et. al., 2002).¹⁹

52. This section does not aim to provide an in-depth analysis of Nokia's business strategy and its success factors. Instead, it examines how Nokia has taken advantage of deregulation, access to new markets and investment liberalisation to become one of Finland's most innovative companies and the world's leading mobile phone manufacturer. In addition, it looks at the contribution Nokia has made to the Finnish innovation system. The section starts with a brief account of the company's evolution and then focuses on Nokia's strategies in international R&D, manufacturing, sourcing, supply chain management, sales and distribution. (Other key determinants of Nokia's success include its market segmentation approach, a strong branding and marketing strategy and an effective human resource management. These elements will however not be examined in the framework of this study).

4.1 Evolution of the company

53. The Nokia Corporation (further referred to as "Nokia") is today the largest Finnish enterprise, representing more than half of the value of the Helsinki stock exchange, and is one of the world's leading telecommunications companies (Mer, 2004). It is the largest manufacturer of mobile devices, with a global market share of **38.8%** in 2007 (representing 437 million mobile devices sold), selling more handsets than its three closest rivals combined (Figure 15). Net profits in 2007 reached €7.2 billion, up 67% from the previous year, while sales rose by 24% to €51.1 billion. Nokia makes a wide range of mobile devices with services and software that enable people to experience music, navigation, video, television, imaging, games, business mobility and more. A key focus area for Nokia consists in developing its offering of consumer Internet services, as well as its enterprise solutions and software. The company also provide equipment, solutions and services for communications networks through the Nokia Siemens Networks.²⁰

Figure 15. Global market shares in the mobile phone handset industry in 2007



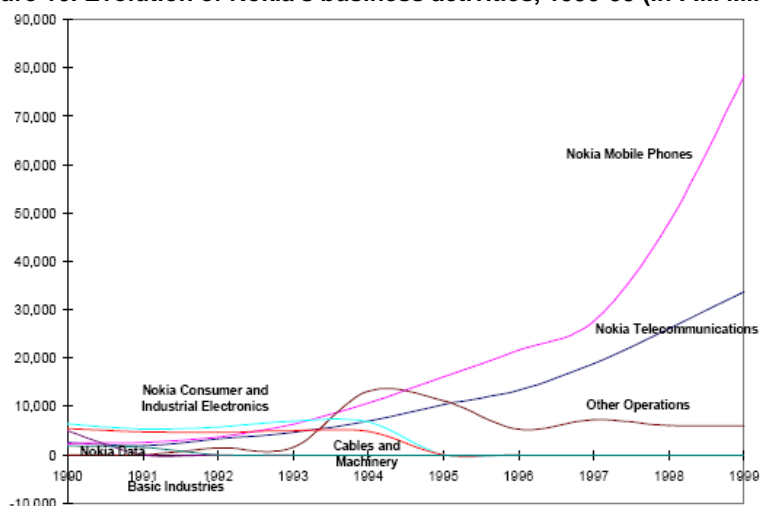
Source: Les Echos, January 2008

19. In 2003, for example, Nokia captured 25% of total Finnish exports and 3.7% of GDP (Steinbock, 2006).

20. From January 1, 2004 through March 31, 2007, Nokia had four business groups – Mobile Phones, Multimedia, Enterprise Solutions and Networks. On April 1, 2007, Nokia's Networks business group was combined with Siemens' carrier-related operations for fixed and mobile networks to form Nokia Siemens Networks, jointly owned by Nokia and Siemens and consolidated by Nokia. As of January 1, 2008, Nokia's three mobile device business groups and the supporting horizontal groups have been replaced by an integrated business segment called Devices & Services. Source: information provided by Nokia.

54. Nokia's success is particularly noteworthy in light of two factors: first, the company's relatively small domestic market (Finland has a population of 5.2 million people) and, second, its origins. Nokia was founded in 1865 as a wood pulp mill. In the late 19th century and early 20th century, Nokia diversified its business and moved into the manufacturing of rubber boots, tyres and other rubber products (through Finnish Rubber Works Ltd., established in 1898) and into the production of telephone and power cables (through Finnish Cable Works Ltd., founded in 1912), to become an industrial conglomerate. It entered the telecom equipment market in 1960, when an electronics department was established at Finnish Cable Works to concentrate on the production of radio-transmission equipment (Nokia, 2007). At the time of the economic crisis in Finland, Nokia was a large diversified conglomerate that had been growing through mergers and acquisition. Only in the early 1990s, with the end of the Cold War and the collapse of the Soviet Union did the company take the strategic decision to divest most of its traditional business to make telecommunications, and **mobile telephony**, in particular, its core business. As a result, Nokia evolved to consist of two main business groups, Nokia Mobile Phones and Nokia Networks (Steinbock, 2001 and 2006, Nokia, 2007 and Figure 16).

Figure 16. Evolution of Nokia's business activities, 1990-99 (in FIM Million)



Source: Steinbock (2006). Note: Nokia Telecommunications is now called Nokia-Siemens Networks.

55. Nokia launched its first mobile phone, the Talkman, in 1984. The company has always been forward looking. It identified early on the fashion aspect of mobile phones, and the importance of focusing on usability. Nokia has in fact defined the mobile phone not just as a technology product but also as a fashion item and consumer good. Nokia's strategy has been to serve distinct customer segments with differing needs, using technology that is compatible to any standard used in a particular market (Porter, 2002).²¹ The extremely rapid growth in business for Nokia in the 1990s has been a result of many people buying mobile phones for the first time, and there are still millions of people in emerging markets (e.g., in Africa, India and China) who long for their first phone, which Nokia wants to sell to them. However, in developed countries the majority of people have already got a mobile, so to grow its business Nokia must persuade them to replace their kit with something more sophisticated, such as high-end multimedia devices.

21. Nokia Mobile Phones had dedicated business units focusing on the needs of specific customer segments: "broad appeal" which focuses on mid-range devices, "lifestyle products" which concentrates on top-end devices, "entry" which focuses on cheap devices for markets with low mobile penetration levels, and "Vertu" which focuses on handcrafted, luxury mobile phones (Nokia, 2007a).

4.2 A forward-looking global business strategy

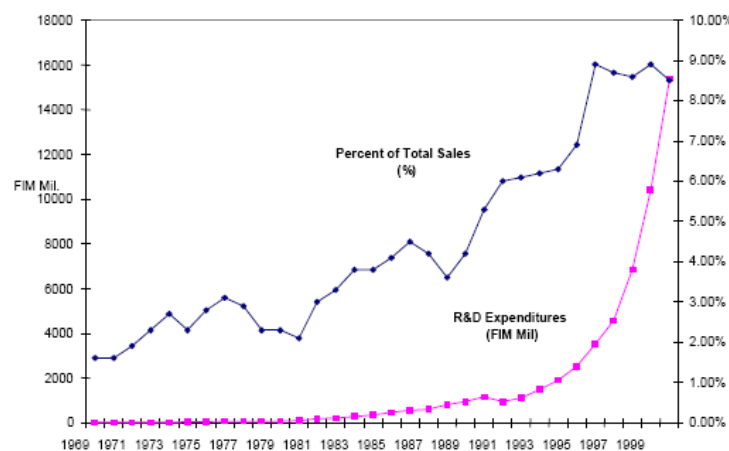
56. In the early 1990s, Nokia decided to concentrate its activities on mobile telephony while adopting a global growth strategy. It decided to exploit the new international market opportunities that arose thanks to Finland's trade reorientation and integration into the EU, with a product that had universal appeal. Nokia first established its dominance in the business-to-business telecom equipment market in the early 1990s and then expanded its reach to tap consumer markets worldwide in the latter half of the 1990s (Steinbock, 2001). Today, Nokia offers a broad range of mobile devices, targeting all major consumer segments and price ranges.

4.2.1 R&D strategy

57. Increased competition in the telecom equipment market, due to early deregulation of the Finnish telecom industry, and rapid technological progress worldwide have shortened the life cycle of products, placing additional pressure on firms to find new and more rapid ways to innovate. Against this background, Nokia has had to make significant R&D investments to remain competitive since the early 1990s. The company introduced innovative functions and sleek design to its phones, which contributed to their competitive differentiation (Steinbock, 2001). Nokia's efficient product and process development -- which lie at the heart of its competitiveness -- were possible in large part thanks to the company's R&D approach.

58. *First*, Nokia **increased its R&D expenditure** dramatically. While in 1991, R&D spending as percentage of total sales represented approx. 5.5%, this share almost doubled by 2000, to reach approx. 9% (Figure 17). Most spending was concentrated in the Mobile Phones and Networks business subsidiaries, with most in-house technological developments focussing on chipset and software platforms. In 2003, Nokia's R&D spending represented approximately 33% of the total gross domestic R&D expenditure in Finland, and 47% of private sector R&D expenditure. Furthermore, over 70% of the stock of Finnish patents issued in the US accrued to Nokia (compared to 39% in 1997). Nokia has therefore had a significant impact on Finland's overall R&D intensity (Steinbock, 2006). In 2005, Nokia's R&D expenses totalled €3.8 billion, representing 11.2% of Nokia's net sales that year (Nokia, 2007). Interestingly, Ali-Yrkko, et. al. 2002 notes that while the amount of public funding Nokia received increased, in absolute terms, over the 1990s, Nokia's own expenditure over the same period grew more rapidly. In 1981, for example, over 14% of Nokia's total R&D was financed by TEKES, while at the end of the 1990s, this share had declined to an average 0.3%. The authors also highlight that the share of TEKES finance in Nokia projects has been smaller on average than in other company projects

Figure 17. Nokia's R&D expenditure as share of total sales, 1969-2000



Source: Steinbock, 2006

59. In order to recoup its R&D investments, Nokia has had to generate increasing sales volumes. Due to its relatively small home market, this could only be done by generating volumes of sales abroad (Steinbock, 2006). Furthermore, in order to safeguard such investments, Nokia has had to adopt adequate intellectual property rights protection (IPR), by registering patents, design, trademark and copyrights. Nokia has started to build its IPR portfolio since the early 1990s. By the end of 2006, it owned over 11,000 patent families, extending across all major mobile telecommunications standards and data applications, as such having one of the broadest patent portfolios in the mobile equipment industry (Nokia, 2007a).²²

60. *Second*, in the 1990s, Nokia **internationalised its R&D function**, by setting up research centres abroad. By 1998, more than half of the company's R&D was conducted outside of Finland (though the main Nokia Research Centre remained in Finland). At the end of 2006, Nokia had 11 R&D centres in several foreign countries.²³ It then employed approximately 21,000 people in R&D. R&D staff represents nowadays approximately 27% of Nokia's total workforce (information provided by Mr. Kaunistola). Most R&D centres are located in close proximity to Nokia's offshore production sites. Such centres aim to support manufacturing facilities and help adapt standard products to the needs of customers in the host countries and regions (i.e., "home-base exploiting sites"). Yet, other R&D sites (e.g., in the Americas and other Western European countries) are located in regional clusters of scientific excellence (e.g., Nokia has set up a research centre in Palo Alto, in the Silicon Valley) and **aim to tap knowledge** from rivals, markets and universities around the globe (i.e., "home-base augmenting sites").²⁴ Nokia's global R&D strategy has facilitated technology transfer to host countries yet has also enabled Nokia to benefit from spillovers and positive externalities from these countries. Foreign R&D centres have helped Nokia exploit foreign research talents, tap knowledge regarding foreign markets and other technologies, and commercialise its products in those countries faster, as such reducing time-to-market and enhancing Nokia's competitive position (Steinbock, 2001).

61. *Third*, Nokia has maintained strong global contacts to monitor and influence worldwide technological developments. Nokia's main Research Centre has actively participated in the work of standardisation bodies, helping **create standards and specifications for the telecommunications industry** through coalitions and alliances with other firms (e.g., client companies and suppliers), in view of improving interoperability between different systems, solutions and components (Steinbock, 2001). This approach has given the company a considerable advantage by contributing to the shape of future industry standards (e.g., the GSM but also the Wireless Application Protocol or WAP, which enables to access Internet content through mobile devices, and Bluetooth, which enables short-range communication between different electronic devices). Its leading position in standard development coupled with the deregulation of European telecom markets in the 1990s has been, in its own view, the cornerstone of its international success, helping the company enlarge existing markets and open up new ones (Nokia, 2007a).

62. *Fourth*, at Nokia, **R&D has been applied to the entire value chain** (and to all business units) rather than to the traditional engineering department. Innovation therefore influenced not only product development but also upstream company processes – such as operations, supply chain management and logistics—and downstream processes, such as marketing and sales (Steinbock, 2001). Nokia has for example introduced a sophisticated software system to manage effectively the procurement and delivery of the huge amount of components it produces or sources abroad (see 4.2.2 below). In addition, Nokia also introduced **organisational changes** in its R&D department that contributed to its success. Researchers have, for example not been centralised in a single R&D unit but have been spread throughout the firm, to

22. Since Nokia is a holder of a number of essential patents for various mobile telecom standards, it also receives royalties from other companies under its patent portfolio.

23. E.g., China, Germany, Japan, the UK and the US.

24. In home-base exploiting sites, information mainly flows from Nokia's main Research Centre to these units, and information flows mainly focus on market and manufacturing-related data. In home-base augmenting sites, information mainly flows from the foreign units to the main R&D centre and consists mainly of technology-related data (Steinbock, 2001).

encourage creativity. Moreover, researchers have been incited to bring forth ideas for new business development (Nokia website). Nokia's **organisational structure was also made flatter**, which has encouraged greater communication, efficiency and creativity among the staff. In addition, Nokia promoted the emergence of **tightly knit teams** and close co-operation between employees of R&D product development and sales, in view of creating products that meet customer needs (this approach has often been referred to as "concurrent engineering")²⁵ (Steinbock, 2001). Finally, at the end of the 1990s, Nokia established "living labs" to test in real conditions future innovative products with the greater public (during these experiments the user is at the heart of the innovation process). The success of this experience encouraged the Finnish government to promote the adoption of this approach all over the country in 2006 (La Tribune, 20 February 2008). The decisions depicted above illustrate well that enhanced innovation capacity requires an organisation-wide effort beyond the mere introduction of new technology (White, 2007).

63. Furthermore, Nokia has forged collaborations with leading universities in Finland (e.g., University of Technology of Helsinki and Tampere) and abroad (e.g., Massachusetts Institute of Technology, Stanford University and Cambridge University) and has participated in various international R&D projects, together with other academic and research institutes and firms, in view of expanding the scope of its long-term technology development (Nokia, 2007a). To extend its collaborative activities in Asia, the company also accelerated research co-operation with academic institutions in China, India and Japan (Steinbock, 2001). By the end of the 1990s, **co-operation with other companies, research institutes and universities** had become a central part of Nokia's global R&D strategy. Nokia's approach (often referred to as an "open innovation model")²⁶ has triggered two-way knowledge transfers, enabling the company (but also its partners) to exploit external expertise and technology (OECD, 2007b and Ali-Yrkko, 2002). The emergence of such a co-operative R&D model has been facilitated by the government's support for close research-industry linkages and its vision of a cluster-based innovation model (see section II). Nowadays, Nokia promotes an "open technology" development approach, where essential software is made available free of charge. Nokia sees open source development as a way to foster innovation in the longer run and works with the open source community on several projects, in view of better taking account of customer and consumer needs (Nokia, 2007).

4.2.2 *Global production, sourcing and supply chain management strategies*

64. As seen above, lower trade barriers and transportation costs and enhanced ICT have also resulted in greater fragmentation of the global telecom equipment production process and in the emergence of niche markets demanding tailored products and services. As a consequence, many companies have invested in overseas subsidiaries and/or have leveraged on offshore outsourcing providers to lower operational costs. Nokia has both relocated some its production activities abroad by establishing **factories** in 8 foreign countries (i.e., "in-house sourcing" or "relocation") and has been working with a selected number of **external suppliers** in Finland and abroad to procure electronic components, mechanical components and software (i.e., "domestic, regional and global outsourcing or subcontracting") (OECD, 2007a).

65. By the end of 2006, Nokia was operating 15 manufacturing facilities in a total of 9 countries for the production of mobile devices and network infrastructure (Nokia, 2007a). The production of mobile devices, in particular, is being conducted in 10 Nokia plants in 9 different countries (i.e., Brazil, China,

25. Concurrent engineering is a business strategy which replaces the traditional product development process with one in which tasks are done in parallel and there is an early consideration for every aspect of a product's development process. This strategy focuses on the optimization and distribution of a firm's resources in the design and development process to ensure effective and efficient product development process.

26. The central idea behind open innovation is that in a world of widely distributed knowledge, companies cannot afford to rely entirely on their own research, but should instead buy or license processes or inventions (i.e., patents) from other companies. In addition, internal inventions not being used in a firm's business should be taken outside the company (e.g., through licensing, joint ventures, spin-offs).

Germany, Finland, Hungary, India, Mexico, South Korea and the UK).²⁷ In some of these same countries, Nokia also established R&D centres (see para. 60). BusinessWeek reports that in 2006, Nokia handled more than **100 billion parts across its 10 factories**. Thus, every day, its plants took in an average 275 million components, and then split out 900,000 finished mobile phones at the other end of the supply line. On average, one phone includes up to 400 components. The challenges of handling such huge volumes are enormous, but Nokia has turned high-tech manufacturing, **supply chain management and logistics into one of its core competencies** (BusinessWeek, August, 2006). As a result, Nokia has been particularly attentive to regulatory changes that might affect the trading of components, e.g., changes in customs and import/export procedures. Interestingly, the company has become a “partnership customer” of Finnish Customs in view of improving and speeding up Nokia’s customs processes (press release of 24/08/2007, Nokia website).

66. Besides an effective supply chain management strategy, Nokia’s internationalisation of production has been possible thanks to a strong corporate culture across all of Nokia’s subsidiaries. Nowadays, the Mexican and Brazilian mobile devices plants primarily supply the North and South American markets, the three European plants (Finland, Germany and Hungary) principally supply the European, Middle East and African markets (EMEA); and the plants in China, India and South Korea principally cater the Asia-Pacific market. Finally, the UK plant produces the Vertu, Nokia’s latest, high-end mobile device (Nokia, 2007a). Each plant is however capable of making devices for most of the world’s major standards for mobile networks (e.g., European as well as US standards), and thus for all of Nokia’s target markets, giving the company the flexibility to respond to rapidly changing consumer needs in any market (Nokia, 2007a). Beyond enhanced flexibility and lower operational costs, this strategy has also enabled Nokia to step up production substantially in order to meet increased global demand for mobile devices, generating economies of scale for its heavy R&D investments.

67. The increasing significance of Nokia’s foreign operations in the company’s global business strategy implies that Nokia subsidiaries abroad have experienced increasing import and export intensities. In fact, this holds true for the Finnish manufacturing sector as whole, as is illustrated by the recent OECD study “*Staying Competitive in the Global Economy: Moving Up the Value Chain*” (OECD, 2007d). The study highlights that in 2001 over 50% of the manufacturing output of foreign affiliates of Finnish enterprises was exported. Similarly, it notes that Finnish manufacturing enterprises have increasingly relied on *imported* intermediate goods.²⁸ This “internationalisation” has been particularly acute in the ICT and telecom industries. Increasing import and export intensities, in turn, imply that Nokia faces potentially **greater risks and higher costs from changes in tariffs and other obstacles to trade** than in a “traditional” trade environment.

68. In addition, in line with industry practice, Nokia has also sourced a proportion of components for its mobile devices from a **global network of external suppliers** and contract manufacturers within and outside Finland (BusinessWeek, August, 2006). Component suppliers are located across a wide range of countries, including Austria, Brazil, China, Chinese Taipei, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, India, Ireland, Israel, Japan, Korea, Malaysia, Mexico, Morocco, The Netherlands, The Philippines Portugal, Singapore, Slovakia, Spain, Sweden, Switzerland, Thailand, the UK and the USA (Nokia website). This suppliers’ network includes manufacturers of electronic components (e.g., microprocessors, chipsets, cameras, batteries and charges) and mechanical components (e.g., covers, connectors and antennas) (Nokia, 2007a). Recently, Nokia, for example, decided to outsource the development of chipsets for third generation (3G) networks to STMicroelectronics, a global leader in the development of semiconductor solutions, instead of pursuing the in-house development of such

27. In January 2008, Nokia announced it would close down the plant in Germany. Two plants are established in China. Finally, some 22% of Nokia’s personnel are involved in manufacturing.

28. In 2005, the ratio of *imported* to *domestically* produced intermediate goods in Finland stood at approximately 30%. Source: OECD, 2007d.

components (Le Monde, 7 August 2007).²⁹ Nokia mobile phones also incorporate software provided by third parties (Nokia, 2007). Recently, Nokia has for example sealed a partnership with Microsoft in view of integrating its digital rights management platform, *PlayReady*, into Nokia's software platform for mobile devices. Such a move should enable Nokia to expand its current music and video offer (La Tribune, 7 August 2007). Working with such a diverse base of suppliers worldwide has generated **(two-way) knowledge and technology transfers** between Nokia and its partners, helping it to generate and multiply technological capacities (see Box 2). Furthermore, Nokia's long-term supplier relationships have functioned as a growth engine for the entire Finnish ICT sector as it served as an international marketing channel for many companies, and particularly for SMEs (Steinbock, 2001). Finally, in view of further improving its offering and enhance its competitiveness vis-à-vis emerging operators, Nokia has also acquired a number of technology companies, such as Navteq, a provider of digital maps, and Loudeye Corporation, a digital music platform, to provide new innovative services to current and prospective customers (Le Monde, 2 October 2007 and Les Echos, 29 August 2007).

Box 2. Nokia's outsourcing strategy

In the 1980s, Nokia used subcontractors mainly as buffers to stabilise its manufacturing capacity. In the 1990s, it turned to outsourcing through **long-term co-operation agreements with a limited number of key suppliers**. In the latter part of the 1990s, the co-operation was gradually expanded from accessories to other electronic and mechanical components and software. Recently, Nokia has however endorsed a multi-sourcing strategy for the supply of chipsets (i.e., having multiple suppliers). It did so in order to address increasing concerns about supply chain risks related to reliance on one key supplier whose technology might become obsolete, who might face delivery problems or be unable to deliver sufficient quality components, just-in-time to respond to Nokia's growing demand. In addition, multiple suppliers for one component enable to lower costs (by having a larger choice of cost competitive solutions to source) and promote innovation within the chipset industry.

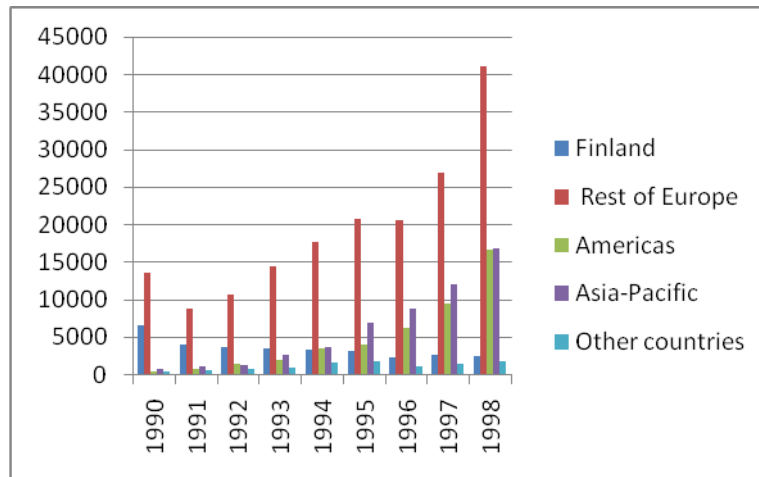
The relationship between Nokia and its external suppliers involves a high **degree of cooperation** in R&D, product design and manufacturing. Nokia has adopted a **horizontally integrated model** in which it cooperates with its suppliers during the whole product life cycle. Such an approach is said to help reduce inter-organisational interfaces, to foster greater responsiveness to shifts in demand and to be conducive to a more rapid industrialisation and commercialisation of new products (i.e., shorter "time to market"). Moreover, close R&D cooperation with suppliers has contributed to **enhancing the company's innovative capacities**.

Source : Porter, 2002, Bengtsson and Berggren, 2004, Nokia, 2007a, SupplyChain Digest, 15 August 2007

4.2.4 International sales and distribution strategy

69. In the early 1990s, Nokia adopted an export-based sales strategy. Between 1990 and 2006, Finland's position as Nokia's dominant geographic market declined dramatically. Its share in the group's total net sales shrank from 30% (FIM 6.6 billion) to 1% (€387 million). In the 1990s, sales in other European countries (e.g., Germany and the UK), the Asia-Pacific and the Americas soared. By 1998, customers in other European countries generated over 50% of the group's net sales (Figure 18). The years 2000-2007 however saw the rise of emerging markets— such as China, India and Russia— as Nokia's main customers. In 2006, China was actually Nokia's major market (Table 2). In addition to a changing composition of key markets, the volume of net sales also dramatically increased (+ 209% over 8 years, increasing from a total €13,326 million in 1998 to €41,121 million in 2006) (Nokia annual reports). Larger sales quantity, in turn, enabled Nokia to recoup its R&D investments more easily. Today, Nokia sells its mobile devices in 150 countries. Most of its mobile device business derives from sales to operators, distributors, independent retailers, corporate customers and end-users. The percentage of total sales volume for each channel varies by region. In the Asia-Pacific, for example, distributors and retailers account for more than 50% of total sales volume while in Latin America and North America, sales through telecom operators represent the greatest share of total sales (Nokia, 2007a).

29. Other chipset suppliers include: Texas Instruments, Broadcom and Infineon Technologies. Source: information provided by Mr. Kaunistola.

Figure 18. Nokia net sales by market, FIM million, 1990-1998

Source: Author's calculations based on Nokia's annual reports.

Table 2. Nokia's 10 major markets, 2004-2006

| Net sales, EUR Million | | | |
|------------------------|-------|-------|-------|
| | 2006 | 2005 | 2004 |
| China | 4 913 | 3 403 | 2 678 |
| USA | 2 815 | 2 743 | 3 430 |
| India | 2 713 | 2 022 | 1 369 |
| UK | 2 425 | 2 405 | 2 269 |
| Germany | 2 060 | 1 982 | 1 730 |
| Russia | 1 518 | 1 410 | 946 |
| Italy | 1 394 | 1 160 | 884 |
| Spain | 1 139 | 923 | 768 |
| Indonesia | 1 069 | 727 | - |
| Brazil | 1 044 | 614 | - |

Source: Nokia, 2007a

V. Conclusions and Ways Forward

5.1 Main findings

70. Finland's innovation performance has been marked by an impressive production of new technology (through heavy R&D investments) but also by the successful application and diffusion of new technology and new ideas and their commercialisation worldwide. Today, the country ranks second (out of 117 countries) in the *2006/7 World Economic Forum's Competitiveness Index*, and fourth (out of 122 countries) in the *2006/7 World Economic Forum's Networked Readiness Index* which measures the degree of preparation of a country to participate in, and benefit from, ICT developments (WEF, 2006 and WEF, 2006a). Such an achievement is remarkable in light of Finland's economic situation in the early 1990s.

71. Finnish **public policies** implemented in the course of the 1990s and 2000s have played an important role in reinforcing the country's innovative capacity, by creating adequate framework conditions for innovation. The determining developments which have helped foster these conditions and encouraged the emergence of a successful telecom equipment industry include: (1) the government's role in the *early development* of the mobile communications industry (through the development of the NMT and GSM standards) which enabled Nokia and other key industry players to benefit from first mover advantages; (2) the *early liberalisation and deregulation* of the Finnish telecom market, which created a competitive market structure with numerous local and foreign operators and generated incentives for the introduction of technological innovations; (3) important *investments in R&D* together with the establishment of an effective network of public agencies supporting public and private R&D and a *cluster-based approach to innovation*, which encouraged numerous interactions and knowledge and technology transfers among small (start-up) and larger firms, service providers, research institutes and universities; and (4) effective *education policies*, which fostered a skilled workforce that facilitated the absorption of new technology in production processes and generated an important pool of researchers and engineers needed for the development of the telecom equipment industry.

72. Finnish **trade and investment policies** and global trade and investment liberalisation in the last two decades have also significantly contributed to fostering adequate framework conditions for innovation in Finland. It is however difficult to dissociate their effect from the effects of other domestic policies, as it is the *collection and co-ordination* of all those policy choices that have facilitated industry-led innovation in the country, and more particularly in the telecom equipment industry. The integration of Finland in the EU and in the WTO, multilateral trade liberalisation endeavours in the telecom industry -- including the adoption of the WTO Information Technology Agreement—and ongoing international standardisation efforts, alongside bilateral and regional trade liberalisation efforts (led by the EC) have all facilitated trade in finished and intermediate telecom equipment goods between Finland and third countries. Finnish companies have, as a result, been able to import components and parts that embodied new technology in greater volumes. More generally, thanks to lower trade and investment barriers, reduced transportation costs and enhanced ICT, large corporations such as Nokia have been able to establish integrated supply chains across borders and work with a range of in-house subsidiaries and external suppliers worldwide to invent, design, manufacture and distribute their products. These new production and trade patterns have not only enabled Finnish companies to lower operational costs but have also generated (two-way) knowledge and technology transfers which are known to have strengthened firms' innovation capacity. In addition, increased liberalisation and deregulation of telecom markets worldwide created more intense competition among telecom operators and equipment manufacturers and thus more incentives to invest in innovation. Finally, global trade liberalisation has also given Nokia access to a greater number of customer markets, which enabled the company to trigger economies of scale and recoup its R&D investments more easily.

73. Certain Finnish companies have of course been more successful than others in taking advantage of this new environment to strengthen their competitive edge. Nokia has managed to develop close relationships with its own subsidiaries as well as with selected external suppliers for R&D, product design and manufacturing, which has enabled it to generate and **multiply its technological capacities** and

strengthen the entire Finnish ICT sector. Thanks to its horizontally integrated supply chain management model, it has also become more responsive to consumer taste and market changes and more rapid in bringing new products to the market. Nowadays, Nokia's effective supply chain management strategy actually constitutes one of its strongest advantages over its competitors. Such a development would have been inconceivable without the gradual liberalisation of trade and investment in Finland and globally. Furthermore, this implies that reversals in these policy areas could be extremely detrimental to Nokia's innovation performance and to the growth of the Finnish telecom equipment industry.

74. The experience of Nokia illustrates well how **businesses** can contribute to strengthening national innovative capacity. Their key role lies in improving internal capabilities and organisational and managerial processes for creating and commercialising technology and ideas on the market. Beyond developing an effective supply chain and logistics strategy, Nokia has heavily invested in R&D and adopted a collaborative and open innovation model characterised by close co-operation, interactions and knowledge spillovers with other firms, universities and research institutes, which enabled it to expand the scope of its long-term technology development. In addition, it has introduced a number of organisational changes – such as a decentralised R&D function, concurrent engineering and a flatter organisational structure-- to trigger greater creativity and develop technological products that meet customer needs. Last but not least, Nokia has also been at the forefront of international standard development for telecom equipment and parts, which has given it a first-mover advantage over its competitors.

75. To conclude, the Finnish transformation to a knowledge-based economy and the strengthened national innovative capacity has, to a large extent, been a business-driven process. Business leadership, firm-level first mover advantages, close linkages with the research and academic world and innovative organisational changes have been determinant in enhancing innovation (Yla-Anttila, 2005). Yet, effective public policies have made a meaningful contribution too, by fostering a competitive market structure, ensuring market openness and establishing incentives and support networks for firm-level innovation. What also clearly emerges from the Finnish case study is the **two-way relationship** that exists between market-oriented policy reforms, on the one hand, and the innovation process on the other. As shown, product market deregulation and the liberalisation of trade and investment have had a positive impact on Finland's innovative capacity. At the same time though, technological innovation --particularly in the ICT and transport sectors-- has facilitated the internationalisation of production and triggered greater volumes of international trade (particularly intra-industry and intra-firm trade) and international investment that accompany it.

5.2 *Challenges ahead*

76. The current competitiveness and national innovative capacity of Finland does of course not guarantee success for the future. Today, despite its leadership position, Nokia faces greater competition in the mobile phone industry, both from traditional competitors (e.g. Motorola, Samsung and Sony-Ericsson) as well as from new ones (e.g., Apple, Palm and Research in Motion). New competition is particularly fierce for multimedia and enterprise devices that are most technologically sophisticated. To remain competitive, businesses, such as Nokia, need to be flexible and **constantly innovate and adapt** (to new standards, e.g. 3G standards, as well as to evolving consumer taste). One of the key challenges for the Finnish ICT and mobile telephony cluster is to keep up with the ongoing technological convergence between data and voice communications, IT and consumer electronics. In such a context, the focus on telecom equipment might weaken in favour of applications and content (Dahlman et. al., 2006).

77. The challenge of keeping up with convergence is particularly acute in light of the fact that Finland is not in the same leadership position today in terms of standard development as it used to be in the early 1990s (with the NMT and GSM). Nowadays, there is competition among various third generation (3G) mobile telephony standards (e.g., UMTS, CDMA2000 and TD-SCDMA) and between those standards and wireless Internet technologies (e.g., Wi-Fi) (Dahlman, 2006). Moreover, Nokia does not rank anymore amongst the top performers when comparing penetration internationally for more recent emerging

technologies, such as wireless broadband and 3G mobile telephony (OECD, 2003a). A recent Finnish parliamentary report actually emphasises that there is still room to introduce improvements in Finland to turn a greater number of innovations into successful commercial products on international markets and to enhance the use of ICT in *all sectors* of the economy, including in the public sector (Committee for the Future 2005).

78. To respond to these challenges, the government recently decided to develop a new National Innovation Strategy and a related Action Plan (Proposal for a National Innovation Strategy, June 2008). The strategy aims to be broad-based, enabling the adoption of a **systemic and comprehensive approach** to innovation policy, and to trigger demand-driven (user-oriented) innovation, as competitive strengths are often based on the ability to realise the needs of consumers ahead of competitors. For this purpose, the strategy recommends, among others, to:

- Increase *co-operation between all government entities* working on policies that impact innovation performance. The Cabinet Committee on Economic Policy will, for example, be expanded into the Cabinet Committee on Economic and Innovation Policy, which will act as a forum for the strategic management and co-ordination of innovation-related reforms; and a Research and Innovation Council will be established to monitor and review broad-based innovation policies. The use of innovative products and processes will also be promoted throughout the public administration.
- Further promote *open and co-operative innovation models* to better involve consumers, customers and other firms in product development. Strategic partnership and co-operation frameworks with other innovation networks will be reinforced; European innovation networks and programmes better leveraged; and regional innovation centres or hubs of expertise established, to attract new talents, firms and venture finance from all over the world and “market” Finland as a pioneering environment for innovation.
- Encourage *creativity, entrepreneurship and innovation-based productivity* in all sectors of the economy, for example, through the establishment of a consolidated public entity that will co-ordinate the delivery of business and financial services to entrepreneurs and innovative growth companies; by reforming the educational system to ensure it nurtures entrepreneurship, creativity and innovation; and by providing additional continuous learning and training opportunities for adults. All proposed public policy reforms will also be systematically reviewed to assess their likely impact on entrepreneurship and innovation.
- Enhance the *research capacity* of universities, polytechnics and research institutes and further strengthen the linkages between universities, research institutes and the private sector, as to make Finland an internationally competitive environment for R&D. Enhance international mobility among students and researchers, to ensure more linkages and mutual learning opportunities.

79. In the area of **trade and investment**, Finnish policies should continue to ensure that resources can flow easily between “tasks” (i.e., subsidiaries or suppliers), in light of the increased fragmentation of production, by promoting a stable and predictable trade and investment environment. In this regard, the recent Proposal for a National Innovation Strategy emphasises that “incoming [trade and investment] flows will add to the prosperity of [the] country”. It also indicates that such flows are essential to enable Finland to influence and take part in global value chains, which, in turn, is crucial to promote the country’s competitiveness in global markets. Furthermore, Finland should continue to promote the successful conclusion of the Doha Development Round and the expansion of the ITA to cover more products and countries, in view of ensuring the relevance of this agreement in a context of rapid technological change and convergence. In addition, Finnish policies should encourage further international harmonisation of product specifications and mutual recognition of conformity assessment procedures for telecom and electrical equipment and parts globally, to further facilitate trade in intermediate products, which is crucial to sustain the competitiveness and innovative capacity of the Finnish telecom equipment industry.

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La Tribune, 7 August 2007

ANNEX I

Table 3 Finland Investment Promotion and Protection Agreements

| Country | Date |
|------------------------|------------|
| Albania | 24.06.1997 |
| Algeria | 13.01.2005 |
| Argentina | 05.11.1993 |
| Armenia | 05.10.2004 |
| Azerbaijan | 26.02.2003 |
| Belarus | 28.10.1992 |
| Bosnia and Herzegovina | 01.11.2000 |
| Bulgaria | 03.10.1997 |
| Chile | 27.05.1993 |
| China | 15.11.2004 |
| Croatia | 01.06.1999 |
| Czech Republic | 06.11.1990 |
| Dominican Republic | 27.11.2001 |
| Ecuador | 18.04.2001 |
| Egypt | 03.03.2004 |
| El Salvador | 20.05.2002 |
| Estonia | 13.02.1992 |
| Ethiopia | 23.02.2006 |
| Guatemala | 12.04.2005 |
| Hungary | 06.06.1988 |
| India | 07.11.2002 |
| Indonesia | 13.03.1996 |
| Iran | 04.11.2002 |
| Kazakhstan | 29.09.1992 |
| Kuwait | 10.03.1996 |
| Kyrgyzstan | 03.04.2003 |
| Latvia | 05.03.1992 |
| Lebanon | 25.08.1997 |
| Lithuania | 12.06.1992 |
| Malaysia | 15.04.1985 |
| Mexico | 22.02.1999 |
| Morocco | 01.10.2001 |
| Mozambique | 03.09.2004 |
| Namibia | 31.10.2002 |
| Nigeria | 22.06.2005 |
| Oman | 27.09.1997 |

| | |
|---|--------------------------|
| Peru | 02.05.1995 |
| Philippines | 25.03.1998 |
| Poland | 25.11.1996 |
| Qatar | 12.11.2001 |
| Republic of Korea | 21.10.1993 |
| Republic of Moldova | 25.08.1995 |
| Romania | 26.03.1992 |
| Russian Federation | 08.02.1989 57-58/1991 |
| Slovakia | 06.11.1990 |
| Slovenia | 01.06.1998 |
| South Africa | 14.09.1998 |
| Sri Lanka | 27.04.1985 |
| Thailand | 18.03.1994 |
| The Former Yugoslav Republic of Macedonia | 25.01.2001 |
| Tunisia | 04.10.2001 |
| Turkey | 13.05.1993 |
| Ukraine | 07.10.2004 |
| United Arab Emirates | 12.03.1996 |
| United Republic of Tanzania | 19.06.2001 |
| Uruguay | 21.03.2002 |
| Uzbekistan | 01.10.1992 73-74/1993 |
| Viet Nam | 13.09.1993 |

Source: Ministry of Foreign Affairs of Finland



September 20, 2011

Via Electronic Delivery Submission

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**Re: Request for Information on How to Structure Proposed New Program:
Advanced Manufacturing Technology Consortia (AMTech) (Docket Number
110620345-1331-02)**

Dear Sir or Madam:

The Society of the Plastics Industry, Inc. (SPI) appreciates the opportunity to provide comments concerning the National Institute of Standards and Technology's (NIST's) "Request for Information on How to Structure Proposed New Program: Advanced Manufacturing Technology Consortia (AMTech)" (Docket Number 110620345-1331-02). SPI's members represent the entire plastics industry supply chain, including processors, machinery and equipment manufacturers and raw materials suppliers. The U.S. plastics industry is the nation's third largest manufacturing sector, employs over 900,000 workers and provides more than \$327 billion in annual shipments.

When NIST announced the proposed AMTech Consortia in July 2011, it noted that the program is a new public-private partnership initiative that would provide federal grants to leverage existing consortia or establish new ones focused on long-term industrial research needs. The grants would fund development of research road maps and projects in advanced manufacturing and enhance the research productivity of consortia members through improved coordination and efficiencies. The program's goal is to accelerate the innovation process — discovery to invention to development of new manufacturing process technologies — that creates skilled, high-wage manufacturing jobs.

SPI supports the creation of the AMTech Consortia to enhance research and development in advanced manufacturing, with the goal of strengthening long-term U.S. leadership in the development of critical technologies that lead to sustainable economic growth and job creation. SPI believes that the AMTech Consortia can work towards eliminating critical barriers to innovation, may increase the efficiency of domestic innovation efforts and reduce the time scale to deliver new products and services based on scientific and technological advances. We agree that this strategy has the potential to drive economic growth, enhance competitiveness and spur the creation of jobs in the U.S. economy.

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SPI would like to provide the following comments for consideration by NIST.

I. Focus on Broad System Developments Supplied by Multiple Industries

As part of the development of the AMTech consortia, NIST is considering if the consortia focus should be on developments within a single existing or prospective industry, or if its focus should be on broader system developments that must be supplied by multiple industries. As NIST has noted that a key goal of AMTech is to foster a robust U.S. innovation system through wide-ranging participation, SPI suggests that NIST consider a broader systems development approach due to the complexity and interdisciplinary requirements needed for today's manufacturing solutions. Clusters are considered to increase the productivity with which companies can compete, nationally and globally.¹ By investing in a systems approach or cluster model, the funding would be focused on building off of foundational elements of manufacturing and would leave the market to "pull" the most competitive solutions (i.e., interest for a specific product or service is created within a target audience that then demands the product from channel partners, which subsequently causes the product to be "pulled" through the appropriate delivery channel).

II. Eligibility to Participate and to Receive Research Funding

We appreciate NIST's consideration regarding who should be eligible to participate as a member of an AMTech Consortium. SPI recommends that the consortium be open to a wide range of participants including small, medium and large companies in the U.S. as well as non-governmental organizations (NGOs), government laboratories and universities.

With respect to who should be eligible to receive research funding from an AMTech Consortium, SPI recommends that funding also should be available to a range of participants including small, medium and large companies in the U.S., NGOs, government laboratories and universities. SPI does not recommend limiting the industry eligibility criteria based on company size or sales. In addition, SPI recommends that funding is available equally for all qualified entities and not specifically dedicated to any one category (e.g., universities only).

III. Criteria to Evaluate Proposals for AMTech Funding

While federal agencies have criteria for evaluating proposals, SPI proposes a few additional ideas for consideration. One recommendation would be to evaluate how the proposed project connects to a growth industry (e.g., health care, alternative energy, transportation, or infrastructure building and construction) thereby having the potential to increase job creation or GDP, as examples, in the U.S.

Another suggestion would be to include corporate sustainability criteria which would measure a more holistic impact of the manufacturing process. As noted by the Dow Jones

¹ Competition and Economic Development, Sept. 2011. Harvard Business School. 16 Sept. 2011
<<http://www.isc.hbs.edu/econ-clusters.htm>>.

Indexes,² “corporate sustainability is a business approach that creates long-term shareholder value by embracing opportunities and managing risks deriving from economic, environmental and social developments.” SPI advocates continuous innovation and improvement in applying sustainability principles in the manufacturing, distribution, use and disposition of plastic materials. SPI recommends that sustainability considerations (e.g., what is the potential impact of the project on the economy, environment and society) be part of the evaluation process.

Lastly, SPI recommends that part of the evaluation process should include a determination as to the make-up of each consortium to ensure a range of participants. The evaluation process should include opportunities for all eligible candidates and should not be weighted towards any one entity (e.g., universities only, NGOs only, etc.). Having consortia teams with a range of participants can provide the strongest efforts to ensure a rational path from idea to commercialization as these teams would have the scale to bring the solution to market.

IV. Conditions for Research Awards

NIST has requested feedback regarding whether conditions should be placed on research awards to ensure funded activities are directed toward assisting manufacturing in the U.S. As a starting point, SPI agrees that the research awards should be directed at activities in the U.S. including the creating of U.S. based manufacturing jobs. SPI does acknowledge the globalization of manufacturing (e.g., a new technology may be designed in one country, produced in another country, and used in a different country). However, for the sake of the AMTech program, focus initially should be on a project’s impact on U.S. activities. Once a project is validated and/or intellectual property filed, then consideration as to how this project could be translated outside of the U.S. can be considered.

As additional background, SPI has included two documents with these comments: (1) the Organisation for Economic Co-Operation and Development’s (OECD’s) “Innovative Clusters – Drivers of National Innovation Systems” report and (2) OECD’s “Trade and Innovation Project Case Study” specific to the Finnish Telecom Equipment Industry. The work reported in these publications demonstrates the increasing importance of clusters (i.e., consortia) in determining the innovative performance of firms, nations and regions and in structuring international linkages among national innovation systems as well as sample criteria used in evaluation processes. They provide guidance about how the reality of consortia can be better utilized in designing and implementing innovation policy. The case studies provided by the documents have been successful models for funding innovation for manufacturing.

V. Ways to Facilitate Involvement of Small Businesses

SPI supports NIST’s interest in facilitating the involvement of small businesses in AMTech Consortia. As small businesses may not always be aware of new programs like the

² Dow Jones Sustainability Index. Sept. 2011. SAM Indexes GmbH. 15 Sept. 15 <http://www.sustainability-index.com/07_html/sustainability/corpsustainability.html>.

proposed AMTech Consortia, outreach and dedicated support are critical to help such companies navigate and understand such programs.

SPI recommends that as an initial step, the AMTech staff should reach out to associations such as SPI and other manufacturing specific organizations, government agencies such as the Small Business Administration, and additional entities that can provide direct contact with small business. Through such relationships, NIST can develop and implement outreach plans to connect with small business and to ensure their participation in AMTech Consortia.

SPI also recommends that AMTech have a portion of its program dedicated to working with small businesses. Suggestions include having staff liaisons that work directly with small businesses and having sections of the program's website devoted to information specific to small businesses. In addition, NIST should consider maintaining contact with small business through the organization of round table discussions or formerly empaneling a group of small business representatives so as to provide an opportunity for NIST to solicit small business input in a quick and flexible manner.

As noted earlier, SPI appreciates NIST's interest in facilitating involvement of small companies but recommends that a mix of companies (i.e., small, medium and large) are eligible for participation in the consortia.

VI. Planning Grants as Incentive for Industry

NIST has requested feedback as to whether planning grants would provide sufficient incentive for industry to develop roadmaps and initiate the formation of consortia. SPI recommends that planning grants are an acceptable initial step. SPI also suggests that the grants should encompass funding for the consortia, funding for the plan and funding for the project itself. The funding recipients would be held accountable for execution and could be measured against set metrics such as number of jobs created, technical impact of project or project impact on the GDP.

VII. Management Models for Industry-Led Consortia

NIST has solicited input on what types of management models are best suited for industry-led consortia. SPI proposes models it believes may be most effective for industry-led consortia:

- a. Advisory Board Model – this model is based on a group of individuals who have been selected to help advise a business owner regarding business issues, such as marketing, sales, financing, expansion, etc. This body would advise a Board of Directors and management of a corporation but would not have the authority to vote on corporate matters.
- b. Board of Directors Model – the Board of Directors is typically made up of elected or appointed members responsible for the general management of the property, funds and business of the organization. The Board is often the entity charged with (1) policy-making and general supervision of the organization (e.g., establishing the strategic vision and directing the policies governing its property and operating, being

responsible for the expenditure of funds), (2) assigning programs and activities to appropriate committees, (3) review and approval of operating budgets, (4) acting upon matters affecting participation status, and (5) appointing and directing the activities of the lead AMTech staff member at NIST. In an organization with voting members such as a professional society, the board acts on behalf of, and is subordinate to, the organization's full assembly, which usually chooses the members of the board. The legal responsibilities of boards and board members vary with the nature of the organization, and with the jurisdiction within which it operates.

NIST also should ensure that participants in the program and consortia management encompass a range of interdisciplinary competencies that advance manufacturing.

VIII. Evaluation of AMTech Consortium's Performance and Impact

SPI recommends a number of factors that AMTech could use to evaluate a consortium's impact and performance. Part of the evaluation should focus on the project's impact on various economic indicators including new job creation and GDP. The evaluation also could include the consortium's impact on new intellectual capital that is created and available to positively impact the manufacturing economy.

In closing, SPI supports the creation of the AMTech Consortia which can invest in education, training, innovation and job creation for the manufacturing sector and have a positive impact on the U.S. economy. We appreciate this opportunity to provide our views on this important issue and would be pleased to answer any further questions you may have. If you have any questions or require additional information, please contact me at (202) 974-5258 or mhockstad@plasticsindustry.org.

Respectfully submitted,



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Attachments