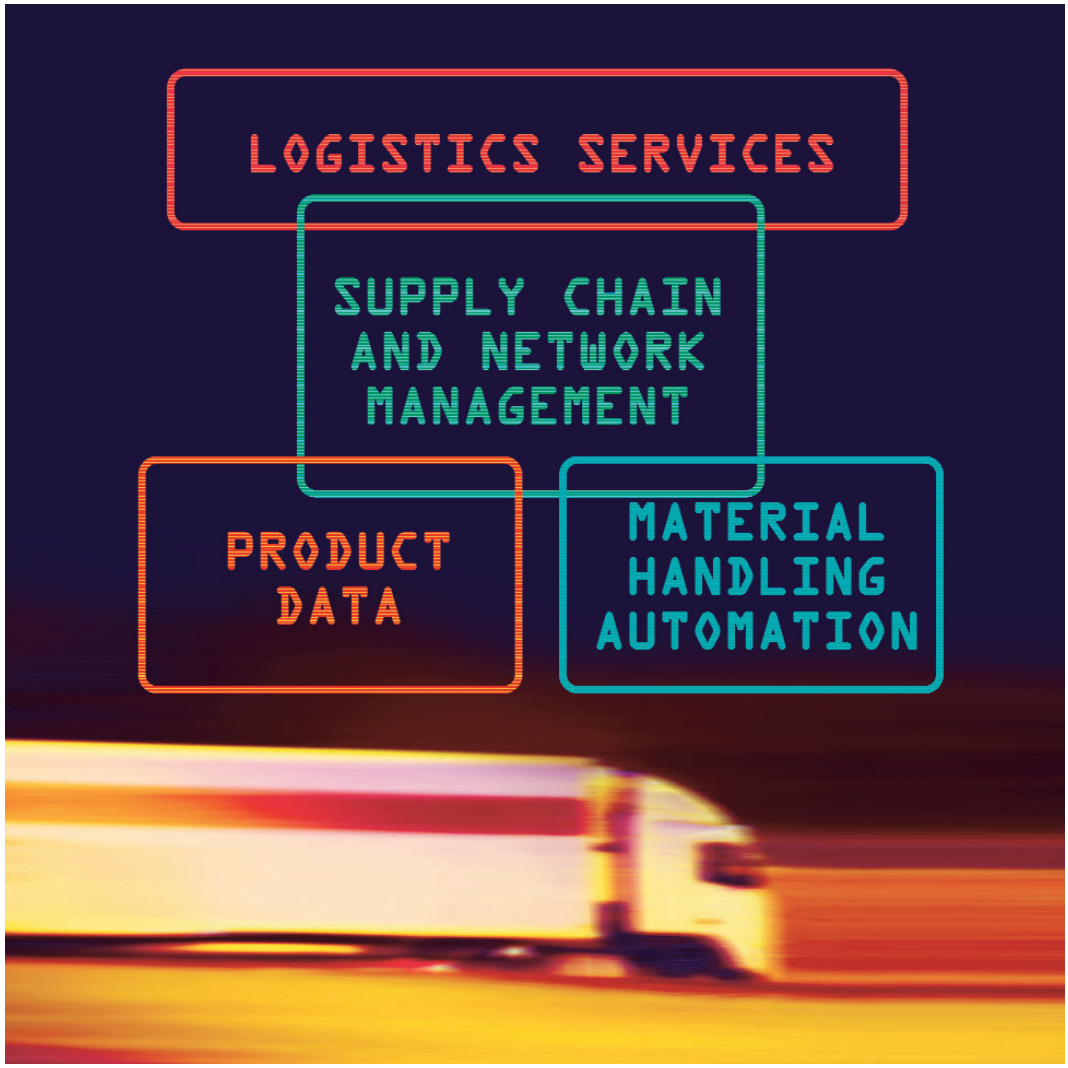
E-Business logistics, visions, innovations and research

ELO – E-Business Logistics Technology Programme 2002–2005

Editor Heikki Kekäläinen

Technology Review 196/2006



Tekes

E-Business logistics, visions, innovations and research

ELO – E-Business Logistics
Technology Programme 2002–2005

Technology Review 196/2006
Helsinki 2006

Tekes – Your contact for Finnish Technology

Tekes, the Finnish Funding Agency for Technology and Innovation, is the main funding organisation for applied and industrial R&D in Finland. Funding is granted from the state budget.
Tekes' primary objective is to promote the competitiveness of Finnish industry and the service sector by technological means. Activities aim to diversify production structures, increase production and exports and create a foundation for employment and social well-being. In 2006, Tekes will finance applied and industrial R&D in Finland to the extent of 460 million euros. The Tekes network in Finland and overseas offers excellent channels for cooperation with Finnish companies, universities and research institutes.

Technology programmes – part of the innovation chain

Tekes' technology programmes are an essential part of the Finnish innovation system. These programmes have proved to be an effective form of cooperation and networking for companies, universities and research institutes for developing innovative products, processes and services. Technology programmes boost development in specific sectors of technology or industry, and the results of the research work are passed on to business systematically. The programmes also serve as excellent frameworks for international R&D cooperation.

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Foreword

In the beginning of 2002, Tekes, the Finnish Funding Agency for Technology and Innovation launched a research programme on the challenges of E-Business Logistics (ELO). The programme was expected to yield answers to such questions as what kind of challenges do electronic business and collaborative networks place on logistics and what kind of possibilities do new emerging technologies offer for management of physical material flow.

The financing of the programme amounted to EUR 31.8 million, out of which Tekes financed EUR 15.5 million. Altogether 25 research organisations and more than 200 enterprises in Finland participated in the programme. Some technology reviews (in Finnish) were made and a logistics technology roadmap LTRM was created during the programme that ended in December 2005. This technology report contains an English summary of the ELO Programme final report and an English version of the Logistics Technology Roadmap LTRM.

Many individuals have contributed to the success of the ELO programme by participating in seminars, workshops and projects as well as in the creation of the technology reviews and the LTRM. One of them is Director Pekka Aaltonen of Logy Competence Oy. His contribution to the preparatory stage of ELO and his support during the execution of ELO is of great value. Tekes would like to thank him and all other individuals and their organisations who have contributed to the success of ELO.

We have also had many valuable international contacts to notable persons in Europe, USA, Japan and China. These experts have given us many new ideas and viewpoints for the questions in Supply Chain Management and E-Business Logistics. During the programme a deeper co-operation with Stanford University and Massachusetts Institute of Technology has also been established. We would like to express our gratitude to all of these experts for their contribution to the ELO programme. Especially we would like to extend our warmest thanks to Dr. Shoumen Palit Austin Datta, Co-Founder and Research Director at the MIT Forum for Supply Chain Innovation. Dr. Datta's support and contribution has been invaluable from the beginning of ELO programme.

We would like to thank the Management Board of the programme and its chairmen for their valuable guidance during the ELO. Special thanks will be given to the Programme Manager Heikki Kekäläinen of Logistra Consulting Oy for his innovative and effective management of the programme and its operations, and to Ms. Leena Roine of Logistra Consulting Oy for her assistance with the practical matters.

Helsinki, September 2006

The Finnish Funding Agency for Technology and Innovation, Tekes

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1 E-Business Logistics ELO – Technology Programme 2002–2005

1.1 Introduction – Challenges of E-business for Logistics

What type of challenges do electronic business and collaborative networks place on logistics? What kind of possibilities do new and emerging technologies offer for the management of physical material flow?

The answers to these questions were sought as part of the Finnish Funding Agency for Technology and Innovation (Tekes) technology programme e-Business Logistics (ELO). The programme lasted for four years (2002–2005) with a total budget of 32 million euros.

The emphasis of the programme was on executing and directing physical material flow. A central viewpoint was how electronic business brings about new demands on logistics and yet also provides opportunities for the management of physical logistics.

The E-Business logistics programme (ELO) was looking to enhance business know-how in the networking business environment, which is one of the strategic development areas determined by Tekes. The influence of logistics upon the networking business environment is remarkable. E-business is rapidly evolving as requirements grow in areas such as material deliveries, transportation and material flow control.

E-Business also enables new business models and improvements in material flow management.

Goals for the ELO-Programme:

- To develop logistic functions that will improve the competitiveness and profitability of Finnish industry, trade and service sectors
- To develop logistics services and solutions required in the business networks environment which better comply with the future needs of customers

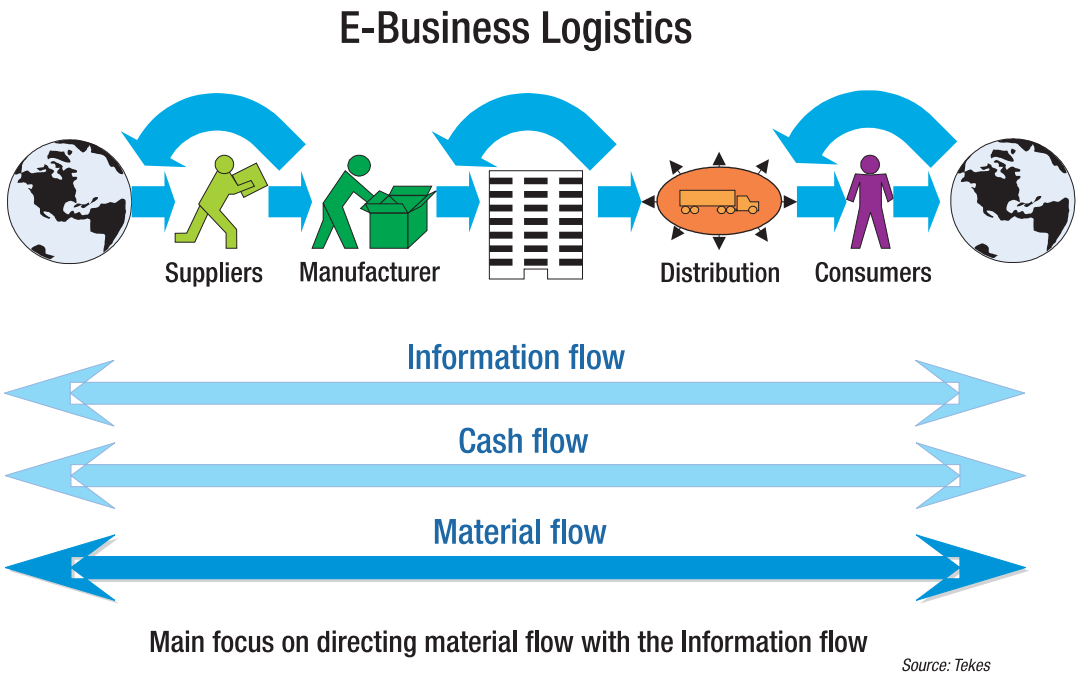


Figure 1. ELO technology programme focused on controlling material flow with the aid of information technology.

- To develop transparency in demand supply chains resulting in increasingly rapid deliveries and optimisation of inventories
- To reduce work and routines in material flow management in logistics chains
- To develop products suited for export in addition to services and software for logistics in cooperation with other Tekes technology programmes
- To improve and increase the resources in logistics´ research in Finland and to increase international research cooperation

The ELO technology programme focused on four key areas: supply chain and network management, logistics services, product data and material handling automation (Figure 2).

The focus areas have been selected in order to enhance Finnish logistics research, thus enabling expert logistics knowledge and competitiveness in the future. The major focus was upon the supply chain and network management. This is regarded as an improvement area, which will increase e-business knowledge in general and will be strongly supported by the other selected areas.

The Finnish logistics environment is very challenging. It is characterised by long distances, low population density, a high standard of living (customer requirements) and difficult climatic conditions. All these make the management of logistics a specially challenging task and logistics is one of the main factors in the cost structure of goods and services. Logistics also plays a key role in the international competitiveness of Finnish exports of goods and services. It also has a direct impact on profitability in virtually all sectors of the economy. Logistics affect and have a direct impact on our daily lives.

One target was also to develop products suitable for export and services and software for logistics in co-operation with other Tekes technology programmes. A special emphasis has been placed upon solutions based on portable and wireless technologies. The know-how in portable and wireless technologies is particularly prevalent in Finland and logistics is a prime field for making initial applications for new technology. The volume of portable equipment is high and material flows are substantial. The potential for growth in this area is huge.

Sustainable development presumes that in the future transportation distances for goods will not be extended and that management systems will be efficient enough to combine reduced material flows in an effective manner.

The increasing prevalence of business networks has created new needs in the logistics field. For example, the demand for different value-added services in logistics is increasing. Traditions in the field and its status make it difficult to find services to fulfil these new needs. One of the

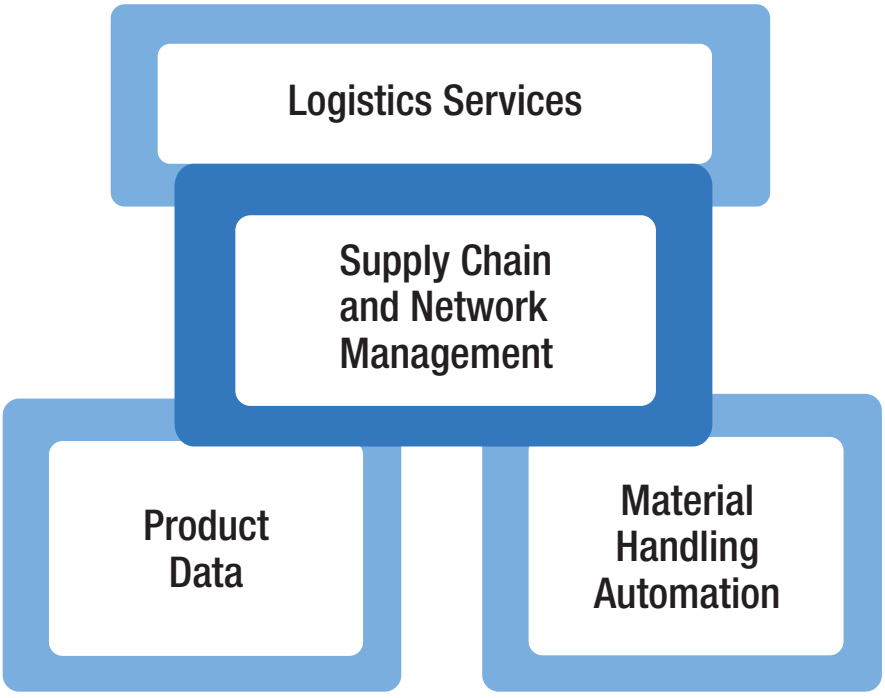


Figure 2. Four focus areas of the ELO programme.

principal goals of the programme is to improve the status of logistics in the future as the relevance and significance for businesses increases.

During the programme new, larger, research teams were created to meet the research needs. Now as the programme has ended, the size, knowledge and internationality of the teams has improved and they are able to continue their work with challenging research projects. Ultimately this will guarantee the extension of knowledge in this most challenging of fields. It also means that the providers and users of logistics services will have competent people at their disposal.

1.2 Programme Effects

The overall logistics costs are on average over 13 % of companies annual turnover in Finland, equating to around 26,4 billion euros. These costs could be diminished, but more important than cost, is the operation of logistics on the whole – service level and reliability. The programme has improved the general know-how of managing the entire logistics chain. Measuring logistics costs is not always clearly defined. Different partners define the contents in many different ways. Today's view of logistics is that of a larger field with more varied services.

This is one of the reasons why logistics costs in the last few years have had a tendency to increase rather than decrease. Even if logistics is an added cost, it is not sensible to set a target for diminishing logistics costs. Consequently, the target set was to provide logistics operations in such way that a businesses optimum result will be achieved.

1.3 Programme Contents

Prior to the ELO programme, the funding of logistics research in Tekes was most often included as a part in another programme. The jointly launched technology programme KETJU (Transport Chain Development Programme) by Tekes and the Ministry of Transport and Communications was one of the first targeting logistics issues. The KETJU programme focused on international transport chains by assessing them from functional and technological aspects. ELO is the first Tekes programme looking at logistics from a wider perspective, not only from a transport viewpoint.

The growth of electronic business and the networked way of doing business are both changing the environment for logistics operations. Logistics will grow in importance as entire value chains from earth to earth must be managed. With growing outsourcing of business operations grows the importance of managing the whole process that brings added value to the end client.

The domestic and international studies carried out in the programme disclosed that better and more versatile services are required in the logistics field. E-business provides the means for data transfers in ordering, delivery, production, supply etc. almost in real-time. However, the products' manufacture and transport cannot be done at the same speed. Speedy and accurate deliveries without added costs represent a great challenge in the future. Complexity grows in networked businesses in relation to how well optimised the chains are.

2 Programme Implementation

2.1 Management Board

Tekes invited a group of experts to act as a management board in the ELO programme. The management board was in 2002–2003 chaired by Dan Österberg of Libri-Logistiikka Oy (since 2003 of Kuehne & Nagel Oy) and in 2004–2005 by Björn Pundars of Wärtsilä Group.

Other members were Heidi Lindroth, Tekes, Harri J. Vesa, UPM, Aki Latvanne, Nokia Networks Oy, Risto Salminen, Inex Partners Oy (06/2005–), Jyrki Räsänen, Inex Partners Oy (2002–06/2005), Lassi Hilska, Ministry of Transport and Communications and Heikki Kekäläinen, Logistra Consulting Oy.

Heikki Kekäläinen acted as ELO Programme Manager with Leena Roine as Programme Assistant, both from Logistra Consulting. Heidi Lindroth, Senior Technology Advisor, was responsible for Tekes. The ELO programme had a major IT link, where Senior Technology Advisor Jouko Hautamäki as Tekes' Software and Telecommunications Technologies expert was invited to join the programme.

2.2 Seminars

2.2.1 Kick-off seminar 2002

The kick-off seminar in Dipoli Congress Centre introduced the ELO programme's core areas and central viewpoints to the 200 participants present.

2.2.2 Annual seminar 2003

The first annual seminar entitled "E-logistics in Supply Chains" was held in HTC Conference Centre.

Figure 3. ELO technology programme management board. From left, Aki Latvanne, Harri J. Vesa, Heidi Lindroth, Risto Salminen, Björn Pundars, Heikki Kekäläinen. Members Lassi Hilska and Dan Österberg not in the picture.

The event concentrated on the logistics issues of electronic business and supply chain networks, revealing a versatile, wide scope for examining logistics issues.

The keynote speaker *Jacob Bangsgaard*, Director of External Affairs and Communications at ERTICO-ITS Europe, described the "European Research on e-Fulfilment". He spoke passionately about a growing European cooperation in this field and expressed a desire that Finnish organisations would participate in great numbers – additional information can be found at www.ertico.com and www.e-thematic.org.

2.2.3 Annual seminar 2004

The ELO Annual seminar in 2004 at the House of the Estates presented "Logistics Innovations & Future Technologies". The focus was about introducing the latest news and projects in e-business and logistics in Finland. The number of participants – around 160 – clearly witnessed the significance of the topics on the agenda. *Dr. Kenth Lumsden* of Chalmers University of Technology, Gothenburg, Sweden, presented the E-Log research project. Research scientist *Jouni Kauremaa* (BIT Research Centre, Helsinki University of Technology) presented the results of the ELO report "The Use of ICT in Logistics Networks – Experiences from Finnish companies", describing the use and application of e-business technologies in Finnish enterprises (English summary at ELO website www.tekes.fi – Publications and links) . The evidence from the study shows that electronic information and communications technology is widely used in the field of logistics. It is interesting to note that many of the electronic solutions in companies are relatively new. The development of e-business logistics in businesses is clearly underway.

In conjunction with this seminar, a logistics technology road map workshop was held, with the purpose of updating the LTRM report.

2.2.4 Annual seminar 2005

Again at the House of the Estates, the ELO seminar in 2005 concentrated on the international aspects in logistics, especially in the future challenges in Asian logistics. Professors *Takao Enkawa*, Tokyo Institute of Technology and *Ru Yi-hong*, Beijing Jiaotong University were invited to visit in Finland as ELO seminar keynote speakers. A full house of Finnish logistics representatives enjoyed the opportunity to learn from the Asian logistics challenges, future visions and collaboration opportunities and models.

The ELO-report "The Use of ICT in Logistics Networks, Experiences from Europe" was presented by researchers *Petteri Pohto* and *Ilkka Sihvola* (LTT Research Ltd). The report studied the use of ICT in the manufacturing industry by logistics service providers in Europe. The results proved that the application of these new innovative technologies has significant effects upon improving corporate logistics processes.

2.2.5 Final seminar 2006

The ELO Technology Programme Final seminar was held on March 15, 2006 in the House of the Estates. The enterprise and research projects with the best results were selected and honorary diplomas were awarded to these organisations. In their speeches the members of the ELO Management Board emphasised the importance of continuing logistics improvement efforts. LTT Research Ltd, re-

Figure 4. The Chinese visitors (Professor Ru Yi-hong in the middle) were inspired by planned collaboration – Tekes' technology advisor Heidi Lindroth (left and second from right) acted as intermediator. Professor Takao Enkawa (far right) of Tokyo Institute of Technology listened to colleagues' presentations with interest. Professor Enkawa´s presentation covered the state of SCM in Japan, the development of SCM Scorecard and the Japanese Finnish Scorecard results comparison.

sponsible for the ELO Programme evaluation, reported on the evaluation principles and preliminary results. Keynote speaker *Robbert Kuppens*, Managing Director EMEA, Internet Business Solutions Group of Cisco Systems International, spoke on "Keeping up with innovation: Predicting the Future and the Role of Enabling Technologies". The presentation is available for downloading from the ELO-web pages. The EU-project "e-Thematic. A network on e-fulfilment and e-logistics" was presented by Director *Karel Vanroye*, Buck Consultants International, Belgium.

2.3 Cooperation with Tekes Technology Programmes & Other Programmes

2.3.1 Seminars

A number of joint events and seminars were organised with Tekes technology programmes and with the development programmes of the Ministry of Transport and Communications (below MINTC).

In September 2002 the ELO took part in a technology programmes' joint seminar entitled Management of Complexity. ELO was responsible for a technology session "Supply Chain Management", with keynote presentation "Collaboration in Supply Chain Management: learning by doing and doing by learning" by professor *Ton de Kok*, Eindhoven University of Technology & European Supply Chain Forum Director.

Improving Logistics in the Supply Networks seminar 3.4.2003 Dipoli

In the joint seminar with VALO-programme (MINTC) several research and enterprise projects were presented. The concept of the ELO Logistics Technology Roadmap project was also presented.

Global Challenges in Logistics seminar 17.11.2004 Valkea Talo

ELO and EGLO (MINTC) jointly presented a wide range of logistics projects that are currently underway in both programmes.

The keynote speakers updated people upon current global logistics issues: Mr *Alessandro Leverano* of Fiat Research Center and *Dr Sandor Boyson* of Supply Chain Management Center, University of Maryland. Dr Boyson in "In Real Time – Managing the New Supply Chain" introduced supply chain mega-portals on the Internet – where clients, distribution, production and suppliers are able to cooperate in e-supply chain, real-time. Another visiting speaker, *Dr Chris O'Brien*, Nottingham University, covered issues of return logistics and its importance for sustainable economy.

A major theme for the day was RFID – and the newly established RFID-lab. Via video conference the seminar was connected with the UCLA (professor *Bob Foster* and Dr *Elwin Svenson*) who gave a presentation on the Tekes' GAP or Global Access Program – partners.

Efficient Logistics – The Key for European Competition – seminar 24.5.2005 House of the Estates

The second ELO & EGLO (MINTC) joint event presented current e-business and logistics projects and the challenges European competition will face with growing globalization.

Professor *Roger J. Jiao*, Nanyang Technological University, Singapore dealt with the competition between Europe and Asia, the changing aspects in China and the building of new value chains in the global economy. Professor *Alan McKinnon's*, Heriott-Watt University, presentation "European Logistics 2015 – Forecasts and Speculations" concentrated on the powers of change in logistics and supply chains: techniques, technology, business trends and governmental measures. The vulnerability of globally networked supply chains emphasises the growing importance of risk management in the future. Many already visible changes will demand a more resilient and agile supply chain, better adjusted to the environmental challenges.

The afternoon theme concentrated upon "Technology programmes – a key for logistics competitiveness" presenting new technologies, solutions and tools for the around 100 participants of this event.

Global Track and Trace – Event 9.2.2006

GE Global Research and MIT (Dr. *Shoumen Palit Austin Datta*, MIT Forum for Supply Chain Innovation) presented the results of a joint research project. Dr. *Joseph J. Salvo*, Pervasive Decisioning Systems Laboratory, GE Global Research HQ headed GE experts' group visiting Finland: Dr. *Lynn Derose*, Group Leader, RFID Systems, Pervasive Decisioning Systems Laboratory and *Charles Theurer* (GE Global Research HQ), *Jesper Skjoedeberg Almind*, General Manager, *Willem Duijf*, Manager, *Kimmo Lindqvist*, Manager and *Marcel Schnatmeier*, Technical Manager, (GE Equipment Services Europe).

Project Co-ordinator *Sirkka-Leena Holmberg* of VR Ltd Finnish Railways presented the RailTrace-solution and services. The event was organised by the ELO and VAMOS (Value Added Mobile Solutions) technology programmes (Tekes) and the EGLO-programme by Ministry of Transport and Communications together with the Finnish Association for Logistics.

Most of the seminar presentations listed above (some in English) are available at the ELO home page www.tekes.fi/elo.

2.4 Publications

2.4.1 International study

An international study was carried out when preparing the ELO-programme. The study comprised reports on Japan and the United States. Finpro prepared studies covering the United Kingdom, Germany and France. The studies concentrated on the scope of logistics field research activities and targets in the United States, Japan and in Europe.

- Report of the Finpro European Logistics study: "Logistics of electronic business; the international preparation of the technology program, Study in United Kingdom"
- Report of the Finpro European Logistics study: "Logistics of electronic business; the international preparation of the technology program, Study in Germany"
- Report of the Finpro European Logistics study: "Logistics of electronic business; the international preparation of the technology program, Study in France"
- Report of Electronic Logistics in Japan, Tekes 2001.

These publications are posted at ELO home page www.tekes.fi/elo.

2.4.2 The Use of ICT in logistics networks – Experiences from Finnish companies

This study, commissioned by the ELO ("E-business logistics") research program investigates the use, benefits, obstacles and further development areas of electronic information and communications technology in logistics networks.

Logistics in this report refers to inter-organisational management of materials and related information. The study is based upon a telephone inquiry and face-to-face interviews with Finnish industrial companies. A total of 48 progressive companies from differing industry sectors were selected for the telephone inquiry. 21 companies were interviewed on a more detailed level in face-to-face interviews. In addition, nine management consultants and information technology suppliers were interviewed.

The evidence from the study shows that electronic information and communications technology is widely used in the field of logistics. A typical company in the study utilised electronic solutions if only as part of buying or selling transactions. Logistics services providers used technologies in buying, sales, and material flow transactions marginally more than the companies in manufacturing and trade.

Some companies have applied technology to create a competitive advantage through new operating models. In these kinds of situations the use of technology is linked to the management of larger entities, not just automating single activities, with the help of timely and correct information. Five example cases of such practices are presented in the appendix of the report. It is interesting to note that many electronic solutions employed by the companies are relatively new. The development of e-business logistics in companies is clearly underway.

The companies that were interviewed recognized the following obstacles and challenges to the use and implementation of technology: scarce financial resources for investments, management of process changes, lack of capabilities of network parties, resistance to change, challenges in integrating inter-company information systems, lack of standards, and the absence of evidence of the use of completely new technologies. On the other hand, the key success factor for employing technology in network logistics seems to be business process re-engineering skills, using technology to support business processes.

In conclusion, future research and development efforts in the area of e-business logistics should be focused on creating new operating models at network level. Other more specific development areas are: improvement of coordination and information sharing with the help of technologies, integration of logistics services providers to supply chains, development of completely new technologies, implementation of existing, but still not widely used technologies, and finally the use of demand forecast information in supply chains more efficiently. Development ventures in these areas support the ongoing development in e-business logistics.

2.4.3 The Use of ICT in logistics networks – Experiences from European companies

This study has been conducted as a part of the ELO e-business logistics program. The objective of the study is to survey the use of electronic information and communication technologies in advanced European companies involved in industry and logistics services. The report consists of 12 case studies of companies in various industry sectors that have adopted information and communication technologies as part of rationalising their logistics processes. In addition, a few unsuccessful development projects are also briefly analysed. An attempt is made to form a general view of the common factors that have led to successful development projects. As part of the initial search for relevant examples, nearly one thousand company cases were identified through public sources. In order to help the reader to obtain a clear picture of the success factors involved, an attempt was made to include only case studies for which the advantages could be measured or where the benefits were otherwise readily apparent.

List of Cases

UNILEVER
CARREFOUR
SCHENKER AB
DUCATI MOTOR
ADIDAS-SALOMON
OTIS ELEVATOR
TESCO
ZARA
MARKS & SPENCER WINES
FREIGHT TRADERS
PAN EUROPEAN FISH AUCTIONS
SCANMARKET

Based on the results of the study, we can state that the significance of information and communication technologies in rationalising current logistics processes and creating more innovative processes is substantial. However, the mere utilisation of ICT does not necessarily result in a company's immediate success. Rather it is the company's operations models which guide the use of the innovations and the fundamental business concepts that are often more essential than the use of technology itself. Therefore none of the demonstrated technologies as such guarantees that a company will have an advantage over its competitors. The insights related to the logistics functions in many of the successful cases may be small, but in terms of the functionality and success of the services, they have proven to be essential. Some of the factors that support the successful introduction of ICT in a logistics project include management support and genuine commitment to the development project, sufficient resource allocation, education and communication with workers, partners and customers as well as development of measures of the project's costs and benefits. Furthermore, customer and user orientation seems to be an important factor in successful logistics projects. For changes in the company's and at the same time its interest group's (customers, partners etc.) operations models to be successful, all parties must realise the benefits of using a new technological innovation in the process. For example, a seller's declining sales margins due to a buyer's more efficient procurement process can be compensated by an increased customer base, decreased marketing costs or longer contracts. The advantages from the logistics projects can also be indirect including improved service quality, an enhanced image or, in the long run, increased sales. Also, when all parties benefit one way or another from the changes in the operations model, it is possible to carry out the changes faster and more efficiently.

Figure 5. Tekes technology review 173/2005 (Finnish)

2.5 International Relations and Aspects in ELO

One major target of the ELO programme was the finding of potential research collaboration partners in the United States and in Europe plus Japan. United States as the leading country in many logistics issues arouses most interest. As for Europe, the market potential for new products will be examined.

The study proved that the programme target area is internationally interesting. The results, in a nutshell, demonstrated that the Internet did not provide simple solutions for logistics issues but instead, much development work will be required to bring out the real benefits. There is a need for improved transparency in the logistics and supply chain. The management of longer supply chains and networks adds complexity, which increases the demand for steering, design and control. The burst bubble of "Dotcom" companies brought confusion but also provided direction for solving the problems that should be addressed to secure profitability.

The existing logistics research groups in Finland have been rather small and the research in general has not been conducted at an international level. The programme set out to create and attract research with real working relations with U.S. research institutes and increased cooperation with EU countries. The programme further strengthened present research cooperation in Europe.

Some research institutes had already made initial contact with U.S. research organisations and new relationships were made during the preliminary study with e.g. the Massachusetts Institute of Technology (MIT). The Auto ID Centre, Centre for Transportation and Logistics (CTL) and the MIT Forum for Supply Chain Innovation aroused most interest. One of the ELO contacts is the University of California Berkeley with which Tekes already had a collaboration agreement, in addition to the Stanford University.

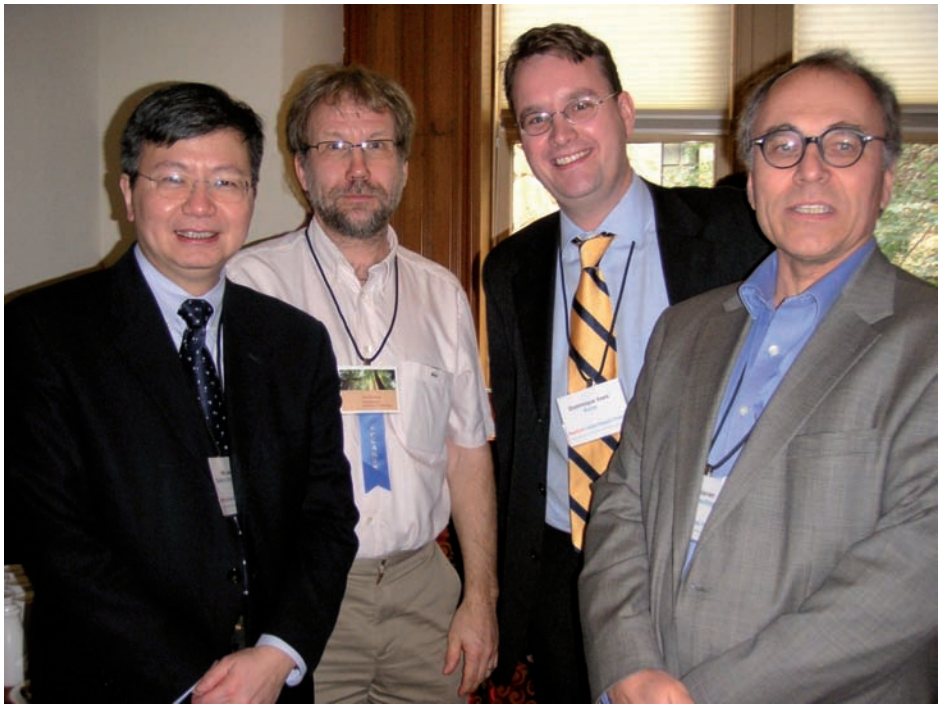


Figure 6. The ELO programme initiated collaboration with the Supply Chain Management research of Stanford University. ELO representatives visited Stanford in February 2006. Above (from left) *Hau Lee*, Stanford University, *Eero Eloranta*, Helsinki University of Technology, *Dominique Vaes*, Kone International, Heikki Kekäläinen, Logistra Consulting Oy. Heidi Lindroth, Tekes and *Jari Collin*, Nokia Networks were also present, though not in the picture.

EU and the United States are the most potent markets. As for Japan, the programme decided on keeping up with the technology level and the mobile solutions in which Japan is a global market leader. Japanese logistics solutions differ greatly from those in Finland and with this in mind; no real potential for research cooperation could be seen.

Some contacts had also been made with the Eureka LOGCHAIN umbrella. The Finnish contingent contributed to the selection of electronic business logistics as one of the subjects in its management board. Eureka is suitable for projects needing standards or standardised solutions.

2.5.1 Excursions

ELO in the United States

In October 2002 a visit to the United States was included in the ELO programme. The objective was to study the state of corporate e-logistics and current e-logistics research programmes in the leading institutes – and to build a "bridge" for logistics research collaboration within the ELO programme. A further target was to advance the researcher scientists exchange.

Locations of visits: Council of Logistics Management 2002 Conference, New United Motor Manufacturing, Inc.—NUMMI, Ross Stores, Inc, Stanford University, CIFE (Centre for Integrated Facility Engineering), Stanford Global Supply Chain Management Forum, University of California, Berkeley, International Computer Science Institute, ICSI, MIT Centre for Transportation Studies, The MIT Forum for Supply Chain Innovation (FSCI), The Auto-ID Center, National Institute of Standards and Technology (NIST).

ELO in Japan

In November 2003 a group of ELO programme members visited Japan. Locations of visit: Toyota L&F, AIM Japan, RF Solutions (RFID), Kokubu (Wholesaler), TEDI Club, Sony Logistics, NTT DoCoMo, JILS (Logistics Association), METI (Ministry of Trade and Industry), Tekes, Finpro, Finnish Embassy, Sagawa Ryutsu Logistics Center, Ecom (E-Commerce promotion council), Sumidenso Loginet (1st tier supplier for Toyota, Nissan and Honda), Toyota Motor, Nissan Motor, Tokyo Institute of Technology.

The visit to Japan was followed by cooperation with the Tokyo Institute of Technology initiated in 2005 with the Ministry of Transport and Communications EGLO programme. The project, carried out with the Finnish Association for Logistics, was" Supply Chain Management Self Assessment, Metres and International Benchmarking (SCM-Scorecard)". The second phase of this project will

Figure 7. ELO team visiting TEDI Club (Trade EDI) in Tokyo. In front TEDI Club´s Industrial partners.

be carried out in 2006 with the Tokyo Institute of Technology and the BIT Research Centre Logistics Research Group at Helsinki University of Technology.

Visits included attending the yearly CLM Council of Logistics Management (since 2005 CSCMP Council of Supply Chain Management Professionals) Conferences in the United States. These journeys were supplemented by visits to local companies and universities.

In 2004 ELO took part in the second US – European Logistic workshop in Berkeley, organised by the International Technology and Strategy Forum. The ELO programme and Logistics Technology Roadmap were presented in the workshop "Logistics and Supply Chain Management – An International Research Perspective".

2.5.2 International cooperation in ELO projects

The cooperation on international level was best evident in the projects with research institutes. Many of these institutes already had international working relations in the field of logistics. The VTT Technical Research Centre of Finland has a tradition of EU joint projects with various international research institutes. The ELO programme further reinforced this cooperation with Finnish research scientists and their foreign colleagues.

Many research projects included collaboration with foreign research institutes and companies. Major targets were the United States, the United Kingdom, the Netherlands, Germany, China and France. The types of collaboration included

- researcher exchange
- research collaboration
- co-operation in EU projects
- journeys, visits, presentations.

ELO research project scientists took part in researcher exchange, visiting e.g. the University of California Los Angeles (UCLA), University of California Berkeley, MIT Auto-ID Lab and INSEAD. More detailed information on this subject in connection with the research projects abstracts.

2.6 Workshops & MIT Collaboration

Workshops for Finnish logistics researchers were organised annually.

Dr. *Shoumen Palit Austin Datta*, Massachusetts Institute of Technology (MIT) was invited to visit the first ELO workshop in 2002. His presentation was entitled "Agents – Where Artificial Intelligence meets Natural Stupidity". Further presentations were the Ecomlog project "Efficient collaboration solutions for e-business logistics" and the Dialog project "Making physical objects 'intelligent' – the case of tracking and tracing."

The ELO programme established collaboration relations between Finnish companies, researchers and research insti-

Figure 8. Dr. Datta inspiring the audience in "the White House" in ELO workshop.

Figure 9. In the center SCMF V keynote speaker professor David Simchi-Levi from MIT accompanied by Helsinki School of Economics professors Katariina Kemppainen (left) and Ari Vepsäläinen (right).

tutes and the MIT Supply Chain Innovation Forum (MIT FSCI). Close collaboration with Dr Shoumen Datta and the MIT FSCI has been continued throughout the entire ELO programme. As a result, e.g. the representatives of the Finnish company Stockway were invited to present the results of their ELO project in MIT FSCI Board Meeting.

Professor *David Simchi-Levi* and several MIT FSCI Board members and other leading Supply Chain Management innovators (*Franz Dill*, Procter & Gamble, *Steven Harman*, Amazon. com, *Peter Koudal*, Deloitte Research, *Andy Mulholland*, CapGemini, *Alexander Renz*, Microsoft Research, *Joseph J. Salvo*, GE Global Research Center and *John C. Stine*, Intel) were visiting speakers at the Supply Chain Management Forum V in 2005. The annual SCMF event is organised by Logistra Consulting Oy and the Finnish Association of Logistics. The MIT FSCI collaboration will continue in the 2006 SCM Forum in Helsinki in October 10–11, 2006.

Figure 10. The SCMF V brought together a full house of SCM experts and researchers.

3 Research Projects

3.1 Machine Industry Establishment in China (CHIFILOG)

Project Organization	Lappeenranta University of Technology
Project Leader	Anita Lukka, Professor anita.lukka@lut.fi
Duration	2005–2006

Project Summary

The project is a Finnish-Chinese research cooperation with exchange of researchers. The targeted area is Finnish machine industry, currently establishing in China. Their products will be sold both in China and in the global markets-therefore one key aspect is creating effective logistics operation models from production plants situated in China. Partnering universities in the project (outside China) are the University of Nottingham, the University of Liverpool and the University of Cambridge.

The participating research units in China are the Beijing Jiaotong University, the Hongkong University, the Shanghai Jiaotong University and the Shanghai Maritime University.

The partipating enterprises are Kalmar Industries, Wärtsilä, Euro-Hydro, Savcor Group, UPM Rafsec and TNT.

Technological Pilot Case – Summary

The first case study has already been constructed with Beijing Jiaotong University, concerning EPC, in product coding, identification, and tracking and tracing and also improving the efficiency of the information management. An international standard solution is sought for. At the same time the logistical value chain management is improved, but most important is the product safety for the customer.

This pilot case study has been started by the Food and Drug Administration of P.R.China. A special problem area in medical production and distribution and the quality of these processes will be targeted. Research projects will continue until year 2009 if this pilot study is successfully performed. First preliminary investigations are already on the way in China. In this case study, RFID and EPC technologies will be applied. The Chinese partners are interested in applying Finnish technology. Finnish companies have a good opportunity to develop their own business and gain new business at the same time. The cooperation is very technologically oriented. The first application area is pharmaceutics and medicines, as its continuation is the food industry, where Finnish models can be used as examples.

3.2 CYCLOG – Product and Life Cycle Logistics

Project Organization	Logistics Research Group, BIT Research Center, Helsinki University of Technology
Project Leader	Kari Tanskanen, Professor kari.tanskanen@tkk.fi
Project website	http://www.tuta.hut.fi/logistics/cyclog.html
Duration	2004–2006

Project Summary

The purpose of logistics is to manage and control material and demand information flows through the chain of value adding activities, all the way from raw-material suppliers to end users and consumers. According to this definition, the key concepts are the supply chain and the flows. However, logistics can also be approached from the point of view of the objects being controlled. When we do this, we notice that the objects of control are product individuals or delivery units that need to navigate the supply network and value adding processes efficiently and speedily.

The requirements for logistics control information at different levels of the supply network (i.e. the manufacturer, distributor, end-user) and at different stages of the lifecycle coincide when products become more complex and customized. At all levels and stages, there are requirements linked to the product individual. The manufacturer has requirements regarding the product individual's configuration, the distributor regarding the final destination and handling instructions, and the end user regarding installation, use and maintenance. However, until the advent of Internet and automatic identification (e.g. RFID), providing the required information on product individuals across organizational boundaries has been difficult.

Approaching logistics from the point of view of the objects being controlled represents a paradigm shift that makes it possible to provide new types of logistics services. This is especially the case in supply chains where the life-cycle of products is long, requiring service, maintenance and disposal. The aim of the project was to develop new ICT-supported processes for the control and management of product and service logistics. The starting point was the product individual perspective, enabling common solution platforms to be developed for the different levels of the supply chain (i.e. manufacturer, distributor, user) and for the different lifecycle stages (manufacturing, distribution, installation, maintenance, disposal). The main results of the project are:

1. The development of effective logistics management practices for the production of products and services across the product-lifecycle, including reuse and disposal
2. The development of logistics information services in challenging environments, such as project delivery, service and maintenance in multi-company networks
3. The development of effective logistics management practices for supplier collaboration in product introductions

3.3 ELOCORE – E-business logistics in theory and practice

Project Organization	Logistics Research Group, BIT Research Center, Helsinki University of Technology
Project Leader	Jan Holmström, Dr. Tech. jan.holmstrom@hut.fi
Project website	http://www.tuta.hut.fi/logistics/elocore.html
Duration	2003–2006

Project Summary

The objective of the ELOCORE project was to develop theoretical frameworks, models and synthesizing propositions that draw together research results from the different topic areas of the ELO technology program. The key results of the project are in the area of collaborative supply chain practices, innovative RFID-based planning and control solutions, best practice in efficient logistics and in e-business logistics.

In the area of collaborative supply chain practices the Vendor Managed Inventory concept, i.e. VMI-concept was studied in detail. Five successful dyads were analyzed in an extensive empirical field study. The results of the study illustrate that business relationship benefits, rather than operational efficiency benefits predominate. Despite gaining only limited operational benefits the case dyads perceived high value from introducing collaborative practice. In the development of research propositions and the theoretical models the primary research partner was the Cardiff Logistics Dynamics group.

In the area of innovative RFID-based planning and control solutions the focus of the project was to develop the Dialog-concept. The Dialog-concept is an open source solution for identifying and tracking items and product individuals across enterprise boundaries and over the life-cycle. The concept is based on an ID@URI notation of items and instances that are managed by a network of loosely coupled instance agents. The basic concept is described in a forthcoming paper by Kary Främling in the prestigious Communications of the ACM.

In the area of efficient logistics the project focused on the best practices developed in the European grocery industry. In a field study of best practices in 12 European retail chains practical examples of the most innovative and effective practices were described. The results are presented in a report written by European researchers participating in the international Consortium for Operational Excellence in Retailing initiated by Marshall Fisher of the Wharton School of Business. The report is available on the web-site of the research group.

Finally, in the area of best practice in e-business 48 implementation cases in Finland were systematically reviewed and the most successful were selected for detailed study. The results are described in a report available through both the web-site of the research group or through Tekes. In this area the primary collaborators were experts from Tekes as well as the logistics research group of the Helsinki School of Business.

In addition the project has worked in the area of reverse logistics with INSEAD of France, where results are still to be published.

3.4 SYSCORE

Project Organization	Logistics Research Group, Department of Business Technology, Helsinki School of Economics (HSE)
Project Leader	Aimo Inkiläinen, Director of Corporate Relations aimo.inkilainen@hse.fi
Project website	Project results http://www.hkkk.fi/~sarpola
Duration	2005–2005

Project Summary

Efficient management of supply chains often requires the employment of information systems for the facilitation of information exchange between supply chain partners. Using empirical data from the supply chain relationships of Finnish companies, SYSCORE (Interorganizational Information Systems and Supply Chain Coordination in Different Business Environments) project aimed to identify profiles for information systems use in different business environments. Further, by combining the assessment of enabling information technologies with the exploration of the different organizational integrative and coordinative practices employed in the supply chain relationships, the project developed conceptual frameworks for the unified assessment and planning of both information systems and organizational supply chain practices.

SYSCORE project was carried out in collaboration with five Finnish companies – Atoy, Finnlines, Kone, NCC Construction and Finnish Post – and their supply chain partners. In addition, empirical data from 16 Finnish industrial and service companies was used for the purposes of the project. The research team in the project consisted of the researchers M.Sc. (econ.) Sanna Laukkanen and M.Sc. (econ.) Sami Sarpola, the scientific supervisors professor Ari Vepsäläinen and professor Katariina Kemppainen, and Ph.D. Aimo Inkiläinen, who acted as the director of the project.

The findings of the SYSCORE project emphasize that in order to improve integration and coordination between supply chain partners, improved transparency – shared understanding of data, practices etc. and a common sense of direction – in addition to development of information sharing is needed between the partners. In other words, to realize more fully the potential benefits of supply chain management, companies need to proceed past the mere information sharing and strive towards better understanding of the operations and business of their supply chain partners. What is more, while information systems are an important tool for facilitating information sharing between supply chain partners, the development and use of information systems in the supply chain context needs to be coupled with other integrative and coordinative mechanisms. For this purpose two conceptual tools – *integration and coordination mechanisms framework* and *information integration framework* – were developed in the SYSCORE project to facilitate the unified assessment and planning of information systems and organizational integrative and coordinative practices.

3.5 Smart Bullwhip Eliminators

Project Organization	Institute for Advanced Management Systems Research IAMSR / Åbo Akademi
Project Leader	Christer Carlsson, Professor christer.carlsson@abo.fi
Project website	http://iamsr.abo.fi/smartbulls/
Duration	2003–2005

Project Summary

The overall goal of the SmartBulls project is to find effective ways to deal with the bullwhip effect, which are anchored in theory and proved to work. These ways will then be tested in actual case work and a good practice system will be developed.

The technology to be used will be developed in two strains: (i) optimization tools using fuzzy number theory and (ii) an ICT platform to support the work with the optimization tools and to distribute process-relevant information throughout the supply chains. The SmartBulls project will improve the handling of the bullwhip effect in supply chains in 2–3 industries, and will as a consequence reduce the buffer inventories throughout the supply chains. The ICT platform will make it possible to better handle the bullwhip effect in the future. The project will further enhance IAMSR's ability to handle complex optimization problems with ICT platforms.

The participating industry enterprises were M-real, MetsäTissue, Amerpap and UPM-Kymmene. The project researcher Kaj-Mikael Björk has been a visiting researcher at UC Berkeley.

3.6 SoftLogs – Software Agents in Logistics

Project Organization	Institute for Advanced Management Systems Research IAMSR / Åbo Akademi
Project Leader	Christer Carlsson, Professor christer.carlsson@abo.fi
Project website	http://iamsr.abo.fi/
Duration	2004–2005

Project Summary

The research themes of the SoftLogs project are defined as follows: Through an adaptation of software agent solutions to the requirements of logistics networks, the research will focus on increasing the intelligence and autonomy of the agents to meet the demands set by the logistic environments.

The research will create theory, methods and prototypes based on the case studies. Find multi-agent system solutions to enable CPFR systems (Collaborative Planning, Forecasting, and Replenishment) in a demand-supply chain. The focus is to develop the whole chain towards agility by applying process integration, the use of ICT modules, enhanced co-operation between companies and networking. Work on change management in order to find critical factors in the evolution from a production oriented approach to a customer oriented approach (e.g. models in implementing e-business).

To develop a practical roadmap for these issues in a production network. The targets and tasks of the project are developed from these research themes.

The theoretical and technological state of the ”intelligent” agents as well as the agents’ building multi-agent systems have been reported on:

- The Challenges of Building Smart Multi-Agent Systems [MAS]
- Agents Interactions in Semantic Web Environment: A State-of-the Art Survey
- An Overview of Ontology Building and Ontology Integration and Some Future Prospects

SoftLogs project has cooperated with RWTH Aachen, professor Hans-Jürgen Sebastian, as they have designed similar optimizing tools for Deutsche Post’s logistics. SoftLogs-project presented multi agent solutions in the US-European Logistics and SCM Workshop in Berkeley, October 2005. A Memorandum of Understanding – agreement with BISC/UC Berkeley was made in 2004. Dr. Kaj-Mikael Björk has been a visiting researcher at UC Berkeley.

3.7 Electronic Supply Chain Identification with Passive RFID (eSCID)

Project Organization	Tampere University of Technology, Rauma Research Unit VTT Technical Research Center in Finland (Espoo) VTT Technical Research Center in Finland (Tampere)
Project Leader	Antti Permala, Chief Research Scientist antti.permala@vtt.fi
Project website	http://www.rauma.tut.fi http://www.vtt.fi/rte/transport/tutkimus/logistiikka/telematiikka.htm
Duration	eSCID 1 2002–2003 eSCID 2 2003–2004 eSCID 3 2005–2006

Project Summary

When developing supply chain management towards more efficient and cost-friendly operation, automation is a dominant factor. On the other hand, identification is an essential part of automation. Radio Frequency Identification (RFID) is a potential solution for the future and will in time replace manual solutions, e.g. bar codes. Furthermore, RFID may also be applied to a wide variety of new objects.

Electronic Supply Chain Identification with Passive RFID (eSCID) is a cooperation project of two Finnish research organizations: Tampere University of Technology, Rauma Research Unit (TUT), and Technical Research Centre of Finland (VTT). In the eSCID project, RFID models and methods are developed and logistics identification solutions are studied. The division of activities in the project is as follows:

TUT will study tag technologies. There are two major application fields in tag research: spare part logistics of after sales services and paper reel logistics. In after sales service logistics, the object of research is the attachment of tags to metal component surfaces, and the elimination of disturbances caused by the metal surface to radio waves. In paper roll logistics, the research is aimed at finding a practical and operational antenna solution for tags that are to be attached to paper reels. The research work will start with the study of tag attachment to the metal surface and, as the work proceeds, the paper reel will be included in the research work. TUT also has another research project related to RFID readers, and together these two projects cover the whole area of RFID technology.

VTT will develop and pilot services using passive RFID in logistics applications. New passive UHF tags, which are appearing on the market, have extended reading ranges up to 4 meters at an affordable price level, hence creating new possibilities for optimizing and automating the supply chain. One main objective is to reduce manual identification in logistics processes. The use of RFID for identifying and tracking transport units (vehicles, containers), handling units (roller cage, returnable plastic containers) and individual parcels will be piloted and tested, and the possibilities for the integration of these technologies in the logistic system will be assessed. The technologies will be piloted in food supply chain and in logistic services. The results will bring users proper experiences of the implementation and operation of RFID technologies.

Cooperation will be performed at national as well as international level. Besides the active project participants, e-Business Research Center (eBRC) at Tampere University and TAI Research Centre at Helsinki University of Technology will take part in the national cooperation. The international cooperation will be coordinated mainly with the Auto-ID Center at MIT. Besides MIT, cooperation will be performed with English, French and Swiss universities, which also are members of the Auto-ID Academic Alliance.

Researcher exchange

Pekka Salonen visited the UCLA (University of California Los Angeles) AntLab in 1.9.2003–1.9.2004, concentrating in the EBG (Electromagnetic Band Gap) – antennas.

Leena Ukkonen visited the MIT (Massachusetts Institute of Technology) Auto-ID Labs in 2.1.2004–12.8.2004. The research subject was RFID-reader antenna solutions for metal package products.

Figure 11. Measuring reading distance at the paper mill.

3.8 Speech Control in Logistics

Project Organization	VTT Technical Research Center in Finland
Project Leader	Jarkko Lehtinen, Senior Research Scientist jarkko.lehtinen@vtt.fi
Project website	http://www.vtt.fi/rte/transport/tutkimus/logistiikka/toimitusketju.htm
Duration	2004–2005

Project Summary

The partnering enterprises were Indoor Group, KWH-Freeze, Logia, Mercantile, SHW- logistiikka and Suomen Kotijäätelö.

The research generated a great deal of data and information for the use of the research partners. This resulted in advancing the speech control technologies into a major improvement target in logistics, amongst alternative technologies – of which RFID and bar code techniques are most important.

3.9 Man, Enterprise, Internet Applications

Project Organization	Tampere University of Technology, Pori Unit
Project Leader	Hannu Vanharanta, Professor hannu.vanharanta@pori.tut.fi
Duration	2001–2004

Project Summary

The participating enterprises were The Finnish Association of Logistics, Nokia Networks, Power – IT, Ramse Consulting, Sonera Solutions, Teollisuuden Voima and TietoEnator.

The project target was to

- Find a working solution for managing the entity of man, enterprise and Internet applications
- To adapt the framework of comprehensive understanding of human beings into practise.
- To build a practice minded and operational model describing how the Internet applications support the various parts of enterprise value chain.
- To study how equipment and software should be developed towards a more user friendly direction, taking the user into account more comprehensively

3.10 Supporting E-Business Process Development (SPEDE)

Project Organization	Tampere University of Technology
Project Leader	Hannu Vanharanta, Professor hannu.vanharanta@tut.fi
Project website	https://tuta.pori.tut.fi/spede/
Duration	2004–2005

Project Summary

In the research project the theoretical framework and the modeling method were formed for competence mapping purpose in the context of e-business environment. With the help of the created framework, the Internet based software application was created for describing the resource ontology of the organization. The resource ontology was formed from the stakeholders' current and future point of view.

3.11 E!2727LOGCHAIN Pol-Corridor

Project Organization	Project coordinator: Institute of Transport Economics, Norway (TØI)
Project Leader	Pekka Leviäkangas, Senior Research Scientist VTT Technical Research Center in Finland pekka.leviakangas@vtt.fi
Project website	www.toi.no
Duration	2002–2005

Summary

Pol-Corridor LOGCHAIN Study concentrates on finding out the prospects of a new trans-European freight supply network stretching from the Nordic countries to Central, Southern and South-eastern Europe. The northern part of the corridor consists of sea-land connections from Sweden, Finland and Norway to an intermodal hub in Poland. From there, the corridor connects via a regularly scheduled block train – the "Blue Shuttle Train" – to an intermodal hub in Vienna. The southern part of the corridor comprises the existing land connections to destinations in most of Central, Southern and South-eastern Europe.

The competitive benefits for the users of Pol-Corridor freight carriage services will come from utilizing the existing track infrastructure and rolling stock abundant in Poland, Czech Republic, Austria and Hungary. These resources will be combined in an innovative manner in order to operate and efficiently manage high-speed, high frequency and high-precision Blue Shuttle Train.

It was assessed that by combining the Finnish, Swedish, and Norwegian freight flows, there is a potential for about 10 return shuttle trains. Paper industry could increase the potential even more, but the paper industry's independent logistical solutions are a challenge. Overall, the problems and challenges lie in the following issues: return cargo, choosing the transport mode, shipping companies' routings, and the IT solutions for the Blue Shuttle Train.

It has been concluded that Pol-Corridor and Blue Shuttle Train will be an alternative for international logistics provided if either of the following clauses is fulfilled: 1) many countries at the south-end of Pol-Corridor will direct their Northbound flows to Blue Shuttle Train instead of to trailers on roads or 2) Austrian and Italian exports will use Blue Shuttle Train and Pol-Corridor in their Northbound transport.

Pol-Corridor has been chosen as a business case in REORIENT-project (6th FP), where different aspects of corridor operations, market potential, and service supply will be explored. REORIENT started in spring 2005.

3.12 Modelling and Controlling of Supply Chain with Systems Theory

Project Organization	Tampere University of Technology, Automation and Control Institute
Project Leader	Hannu Koivisto, Professor hannu.koivisto@tut.fi
Project website	https://ae.tut.fi/projects/systema/
Duration	2002–2004

Project Summary

The aim of the research project was to model and control supply chain in an e-logistics environment. The conducted research can be roughly divided in three different topics: systems theoretical modeling and control, business process modeling and demand forecasting.

The systems theoretical part of the research focused on modeling tools and control algorithms. During the project a set of basic building blocks were developed and implemented in Simulink® simulation and modeling environment. Basic modeling blocks can be used in modeling of various types of supply chains. Control and optimization algorithm research included development of approximation methods for stochastic dynamic programming problems. The research covered model reference and model predictive control for supply chain optimization as well as open-loop feedback control policies for control of perishable items production. Also some preliminary studies were done with use of new reinforcement learning algorithm in control of supply chain.

The Business process modeling research focused on modeling of multi-project environment as well as logistic costs. The research was mainly conducted with case studies and results include modeling guidebook as well as several other step-by-step guides for companies. Also some qualitative demand forecasting and market analysis methods were tested in this part of the project.

The third part of the research project focused on demand forecasting methods. The suitability of traditional forecasting methods were examined and based on these results some new modeling methods were developed. Especially for highly skewed short cycle demand processes Mixture Density - and Probabilistic Fuzzy Density – models were constructed. Subsequently Probabilistic Fuzzy Density – GARCH model was developed for the use of density forecasts, which also has promising prospects in the field of finance.

When implementing the forecasting models in practice we noticed that the final expert adjustments on forecasts could be done in a more sophisticated and accurate manner, than the current practice using the spreadsheet. We built a Visual Demand Planning - prototype were the actual expert corrections could be directly made into the model.

Researcher exchange

Juuso Rantala visited the University of California Berkeley's Supply Chain Management Initiative Unit in 1.10. 2003–30.09.2004 concentrating in the Demand forecasting research.

3.13 VALOSADE – (Value Added Logistics of the Supply and Demand Chain)

Project Organization	Lappeenranta University of Technology professor Anita Lukka's VALORE research group
Project Leader	Anita Lukka, Professor anita.lukka@lut.fi
Project website	www.lut.fi/tutkimus/valore
Duration	2002–2005

Project Summary

VALOSADE-projects

- EDYNET (E-Business and Dynamic Networks in Alliances and Partnerships)
- SMILE (SME Sector, Internet Applications and Logistical Efficiency)
- PIPELINE
- COSTFIX

The research consortium: Caterpillar Logistics, Imatran seudun kehitysyhtiö, JTT Konepaja, Kalmar Industries, Lappeenranta University of Technology, Libri Logistics, M-Real, Rei-Ke, Scandinavian Mill Service, Sonera, StoraEnso Consumer Boards, Suomen Posti, Tekes, TietoEnator, TNT International Express, YIT Service Imatra.

International cooperation

International cooperation was widened and deepended – especially with China (Beijing Jiaotong University and University of Hongkong), the United Kingdom (University of Nottingham and University of Liverpool) and with the Fiat Research Center in Italy.

Research seminars were organized with the Nottingham University, both in Lappeenranta, Finland and in Nottingham. A joint research project with China started in Autumn 2005 which included the visit of professor Ru with assistant researcher, to give a presentation at ELO seminar.

A joint project named SERVIISI started with VTT (The Technical Research Centre in Finland). It aims at creating new logistics service models for enterprise networks and continuing the development of international cooperation in Europe. A further research project with VTT is under way, studying the use of mobile technology solutions in industry VMI models.

3.14 ELPRO – The Rationalization of Food Supply Processes in the Public Sector

Project Organization	City of Espoo
Project Leader	Raili Hilakari, Director raili.hilakari@espoo.fi
Duration	2003–2004

Project Summary

The objective of the ELPRO-project is to strengthen the long-term customer-supplier relationships in the public sector and to enhance the ordering and delivery processes of the participating organisations. The project consortium consists of three public organisations (*the cities of Espoo, Vantaa and Turku*) and seven food suppliers (*Atria Oyj, Heinon Tukku Oy, Kespro Oy, Saarioinen Oy, Tapiolan leipomo Oy, Valio Oy and Wihuri Oy*). *LTT Research Ltd.* (LTT-Tutkimus Oy – a research company owned by the Helsinki School of Economics) is responsible for the research and reporting on the project.

Municipalities and other public procurement organisations are important clients for Finnish food producers, industry and wholesalers. Typically, one third of all food deliveries are directed to kitchens in the public sector including schools, kindergartens, hospitals etc.

Despite the quite similar needs and obligations of public institutions, the whole food service can be organized in many ways. In some municipalities the kitchens have been divided into manufacturing and delivery units, while in some others the whole service has been outsourced, incorporated or organised as a public utility. Furthermore, the information systems and every day operation models related to ordering, delivery and invoicing may vary significantly. This phenomenon can be seen even inside a single municipality where the food procurement personnel may have various methods for choosing the needed product mix, ordering channel (phone, fax, e-mail, EDI) and delivery cycles. It is evident that some public procurement organisations work more cost efficiently than others.

The variety of different operation models automatically increases the cost of logistics and administration for both the customer and the food supplier. It has been calculated that the share of these costs can be over 20% of the total value of the food products delivered. The potential of the cost savings that could be achieved by harmonising the different operation models, and by exploiting modern technology are estimated to be substantial.

The new operating model for the public sector food supply will be based on the extraction of certain bottlenecks discovered in the supply chain as well as the implementation of process improvements. Depending on the organisation, the biggest modifications will be focused on the existing processes or information system re-engineering followed by the mobilization of different operation models now in use. The improvements may be related to different phases in the supply chain such as the bidding process (e.g. the use of common 'Request For Proposal' templates), the ordering process (giving guidelines to purchasers, implementing electronic ordering), the utilisation of ahead planned menus or electronic invoicing etc. New process models and information systems developed should be multipliable to be used in other public procurement organisations as well. This means that the information systems to be implemented should not be dependent on the technology currently in use. The systems should also be scalable in order to accommodate new participants as well as flexible to fit the smaller suppliers. The sequence and priorities of the implementation phase will be determined later during the project.

3.15 Web-Pilarcos: Production and Integration of Application Systems with Web Technologies

Project Organization	Helsinki University, Dept. of Computer Science
Project Leader	Lea Kutvonen, Professor lea.kutvonen@cs.helsinki.fi
Project website	http://www.cs.helsinki.fi/group/web-pil/
Duration	web-Pilarcos: 2003–2003 web-Pilarcos II: 2004–2005

Project Summary

In an increasingly globalised market situation, companies are becoming more and more dependent on their business partners, while competition is forming between operational networks.This is why the ability of business IT systems to provide an automated solution to the arising communication needs is a focal key to success.

The Pilarcos projects are developing middleware solutions to support the management of distributed applications used in different companies and with different technologies. The middleware encapsulates the company applications

and internal technology solutions, offering a standardized interface for inter-company communication. The components to be managed and the control of them are separated from each other. As its new middleware service, Web-Pilarcos is developing a mechanism based on both Web Service technology and inter-company workflow models.

The practicability of the emergent architecture and prototype middleware will be evaluated through demonstrations. The management of logistics is a suitable object for applications.

The project group consisted of the University of Helsinki and VTT Technical Research Center in Finland. The projects of Elisa Communications and SysOpen were linked to the consortium.

3.16 NETLOG – Re-engineering the Business Network Environment

Project Organization	BIT Research Center, Helsinki University of Technology
Project Leader	Jan Holmström, Dr. Tech. jan.holmstrom@hut.fi
Project website	http://www.tuta.hut.fi/logistics/netlog.html
Duration	2002–2004

Project Summary

Effective solutions for information transfer across company boundaries are available today. Moving and sharing information is becoming increasingly easy in an e-enabled environment. What still is a considerable challenge is to put the information provided by outside partners into productive use.

The situation calls for a finding a new approach for organizing across many organizations. The required network re-engineering builds on process and integration work. What is still lacking is practical solutions for solving the logistics of where and how to distribute information in a network environment. The challenge is making information useful in relationships where you cannot afford collaboration to develop the process, nor make investments on direct system integration or system customization.

The NETLOG project aims to identify and develop supply chain solutions that enable productivity and service improvements on the business network level, i.e. creating a more flexible and efficient logistics for an extended network of businesses. The project is organized around companies that have on-going projects and articulated development plans in key areas for supply chain research.

International academic partners were the University of Cardiff Logistics Dynamics Group, professor Marshall Fisher with the COER (Consortium for Operations Excellence in Retailing) network, the Global Supply Chain Forum in Eindhoven and the University of Lausanne. A visiting researcher was Roberta Adami of Bologna University.

3.17 Wireless Control and Tracking of the Logistics Chain

Project Organization	VTT Technical Research Center in Finland, Information Technology Media
Project Leader	Olli Kuusisto, Senior Research Scientist olli.kuusisto@vtt.fi
Duration	2001–2004

Project Summary

Wireless Control and Tracking of the Logistics Chain -project studied what kind of functionality is needed for the demands of geographically and organisationally outspread operation. The subject was approached by practical tests in real environment in early delivery of newspapers, which is a case of a networked logistics chain consisting of several parties. The pilot areas were the communication required by the night-time transport and delivery process, and electronic delivery book including the delivery and route information. In addition, alternative models for data transmission were defined based on the demands from the circulation and distribution operations.

Intelligent interactive delivery book is an overall concept for a portable mobile device which shows the delivery addresses of the various newspapers within the joint distribution to be delivered to, and information of the delivery route in form of text, electronic maps, positioning and/or voice control. Interactivity makes real-time mobile communication possible between the various parties within the distribution logistics chain. Safety features can easily be added to the device, eg. easy transmission of requests for help in accident or crime situations. The approach to electronic delivery book as well as the field pilots has been assessed from two directions: mobile communication and delivery book information.

The pilots confirmed the presumption of the technical functionality of PDAs in both mobile real-time communication and in multiform presentation of the delivery and route information. The use of such aids facilitates the control and execution of distribution. The most useful features were automated update of the delivery book information and the functioning in trouble situations when the foreman could now easily inform via mobile system all the deliverers in the field about the situation. The cost-benefit analysis showed that the current cost effect with savings from only distribution organisation would be negative. When the savings of the main daily paper in the delivery area were taken into account, the calculation turned to be positive within a couple of years depending on the magnitude of changes needed for information systems.

The present situation with problem areas of the data transmission in the newspaper distribution chain was documented, and new operations models presented. SWOT-analysis's of the present situation and two alternative operations models were made. Both new operations models offer benefits for both publishers and delivery organisations. The size and sign digit for the total effect depends on both the extent of the delivery area and the present state of the company-specific information systems.

3.18 SteelNet – Software Agent Applications in Steel Product Supply Chain SteelNet2 – Control of Network Supply Chain with Multi-agent System

Project Organization	SteelNet – University of Oulu SteelNet2 – VTT Technical Research Center in Finland, Electronics
Project Leader	Steelnet Harri Haapasalo, Professor harri.haapasalo@oulu.fi SteelNet2 Pentti Vähä, Professor pentti.vaha@vtt.fi
Project website	http://www.pbol.org/projects/steelnet/fi/ http://www.pbol.org/projects/steelnet2/fi/
Duration	SteelNet 2002–2004 SteelNet2 2004–2006

Project Summary

Networking is a common trend in business research and industry practice today. Companies are seeking competitiveness by concentrating on their core competencies and by networking with others complementing their competence. Networking seems to be part of every project. This arises mainly from the development path of companies or more likely from the development of manufacturing networks. The trend towards tightening competition in markets has had several changes in the way of doing business.

Changes in business environment have become recently even faster. Reasons for tense competition arise mostly from globalization and technological development and their consequences. Scale, cost, quality and time in a row are the paradigms where business is managed. And in the 21st century the accelerating rate of change will continue to be driven principally by the exponential growth and global availability of information, technologies and technology-based infrastructure.

However, the network economy is in the beginning of its development, which of course causes problems. One of the greatest challenges seems to be the control of information in the demand-supply chain. The problem usually is that information exists, but it cannot be utilized effectively. This in proportion means waste of resources into non-value adding activities.

The purpose of the SteelNET project is to respond to these challenges from the steel product industry point of view. It pursues to develop a framework for supplier network allowing increasing business. The network should be easy and open for new companies to enter and uncomplicated to withdraw. The technical implementation is realized with an information network based on intelligent software agents. During the project a prototype application based on agent technology will be created.

The business environment of the SteelNET project is steel product industry and its business network. It is geographically located in Ostrobothnia in Raahe region. The project contains roughly one big steel producer, seven engineering workshop companies, one software house and one engineering design company.

The project will be carried out as a joint research project by: Pehr Brahe Software Laboratory (www.pbol.org), VTT Electronics (www.vtt.fi) and the University of Oulu, Industrial Engineering and Management. (www.tuta.oulu.fi)

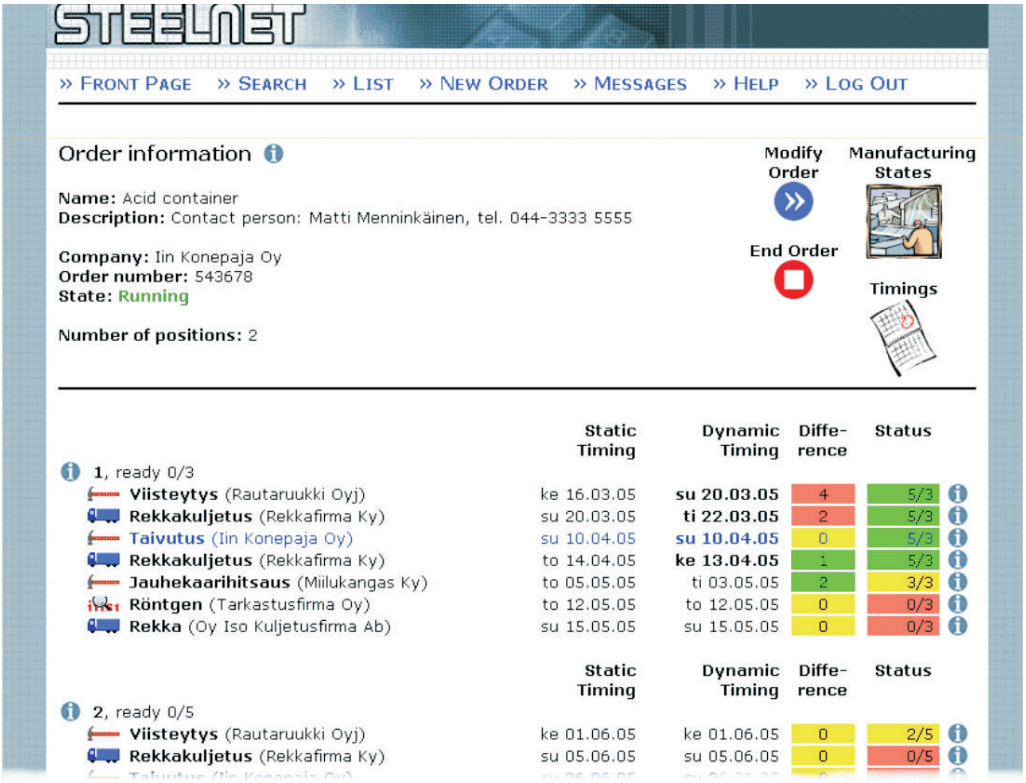


Figure 12. User interface of SteelNet solution.

3.19 Smart Store

Project Organization	University of Art and Design, Helsinki DESIGNIUM
Project Leader	Eija Nieminen, Dr. Tech. eija.nieminen@uiah.fi
Project website	www.uiah.fi
Duration	2002–2004

Project Summary

The aim of the research is to create significant new business for the textile and fashion industries in Finland. The objective of the project is to improve the competitiveness of these industries by better management of logistic chains and production technology, and by creating a completely new e-business concept. The concept is based on mass customization and on creating new user experiences in the shop.

The first phase of the new e-business concept development is to build up the logistic and material chains from shops to the producers. The concept places a major emphasis on the development of user experiences in the shop, including a virtual mirror and body scanning for personal measurements.

The research was carried out in co-operation with the University of Art and Design, Helsinki, and the University of Technology, Tampere, as well as with the following companies: SOKOS department stores, L Fashion Group, Turo Tailor and Major Blue.

Participating research institutes were Harvard University, North Carolina State University and Massachusetts Institute of Technology (MIT)

3.20 DIALOG – Distributed Information Architectures for Collaborative Logistics

Project Organization	Helsinki University of Technology, BIT Research Center (formerly TAI Research Centre)
Project Leader	Kari Tanskanen, Professor kari.tanskanen@hut.fi
Project website	http://dialog.hut.fi/
Duration	2001–2002

Project Summary

Tracking and tracing of shipments and product items is relatively easy to manage as long as it is done inside one company or organization because all related information can be stored and made available in one single information system. In practice, the flow of materials often passes through increasingly complex networks of organizations. In such networks, managing information about shipments and product items becomes challenging because the information systems of different organizations are often unable to communicate with each other.

Virtual Private Network (VPN) or other Extranet solutions can be used for highly integrated and static organization networks. However, in more loosely-coupled and dynamic organization networks, this is not a feasible solution. In the DIALOG project of Helsinki University of Technology, information systems were developed that would make tracking and tracing feasible also for such loosely-coupled organization networks. The basic idea of the DIALOG approach is that information about shipments and product items should be associated with the items themselves instead of being associated with a specific organization. With the help of Internet, it is sufficient to attach a globally unique identifier to the item that provides a link to the product information that cannot be stored on the item itself. An "agent" that resides at the Internet address stored in the identifier can then handle tracking and tracing as well as other information requests and updates concerning the item.

The DIALOG software has been used in two successful, multi-organizational and international real-world pilot installations. Results of the DIALOG project have been published in numerous journal and conference articles. The technologies developed in the DIALOG project have also been the basis for the participation of Helsinki University of Technology in two EU projects of the 6th framework, called PROMISE and TraSer.

All articles published are posted at http://dialog.hut.fi/ and http://www.tuta.hut.fi/logistics/.

The software applications source code has been published and is hosted by a "open source community" (OSC) at "http://dialog.hut.fi".

4 Results – Enterprise Projects

4.1 Security and Safety Critical Supply Chain Risk Management

Responsible Organization	Tuotekehitys Oy Tamlink
Project Responsible	Jari Erkkilä jari.erkkila@tamlink.fi
Duration	2005–2006

Abstract

The goal of security critical supply chain risk management -project is to create innovative solutions in the supply chain network for security and safety critical deliveries by developing a delivery model covering the whole logistic chain.

A possibility to utilize new technologies in order to improve supply chain risk management of security and safety critical products and to prevent criminal acts against them is studied in the project. Further, the possibilities of applying new mobile technology for monitoring the product risks during deliveries are studied as well as new logistic control systems and tools are created.

The research work in TurvaTH was carried out by a group of enterprises from the logistic value chain and VTT Technical Research Centre in Finland.

4.2 RFTUNLOG – Improving Logistics Using RFID

Responsible Organization	Technopolis Oyj, Logistiikan osaamiskeskus
Project Responsible	Mikko Punakivi mikko.punakivi@technopolis.fi
Duration	2005–2006

Abstract

The research objective in RFTUNLOG -project is to identify the potential benefits of using RFID systems for automated product and transport unit level identification in company as well as supply network level. In RFTUNLOG -project the aim is to develop and pilot new logistics operations models based on RFID utilisation together with our company partners. The results of RFTUNLOG project will support and enhance implementation and utilisation of RFID technology generally in Finnish supply networks.

4.3 Logistics Improvement Project

Responsible Organization	Finnmirror Oy
Project Responsible	Hannu Pälä hannu.pala@finnmirror.fi
Duration	2005–2006

Abstract

Finnmirror's Logistics Improvement Project aims to improve the whole logistics process from delivery planning to manufacturing, packing, and finally to delivery tracking. The logistics solution that is created during this project will use mobile networks, vehicle systems and RFID technology to enable good interaction with the different actors in the delivery process and the main system in order to make the whole delivery process more reliable and faster than before. The solution will allow all different parties involved in the delivery to get access to accurate delivery information: end-customers and resellers can acquire this information from the Internet, office staff from the main system itself, and delivery staff from the driver's interface. The RFID technology is used to identify and track the delivery items accurately, so all items are delivered correctly.

4.4 Logico Sales Forecast Software

Responsible Organization	Oy Logico Solutions Ab
Project Responsible	Jan Österman jan.osterman@logicosolutions.fi
Duration	2005–2006

Abstract

The Logico project will generate a software based on the Category Forecasting method created by Jan Holmström in BIT Research Centre. With the new method and software the client organizations will be able to save both time and money, thanks to more exact forecasting figures and forecasting process. The basic difference compared to traditional methods is the holistic approach taken to product group forecasting. This results in a faster forecasting process and better observation of internal interactions in product groups.

4.5 Virtual Open Logistics Traffic Control

Responsible Organization	Neviso Oy
Project Responsible	Pekka Metsäranta pekka.metsaranta@neviso.fi
Duration	2005–2006

Abstract

The aim of VIOLET (Virtual Open Logistics Traffic Control) project is to develop a service concept for transport control and communication, targeted especially for food industry. The VIOLET concept connects different parties into one virtual organisation. All actors of the virtual organisation can transparently send and receive status information for transport actions and communicate effectively. This can be done across the organisational borders. Actors in the virtual organisation will be e.g. a factory, transport operator, transport company, driver, terminal organisations and shops.

4.6 Vilant Control

Responsible Organization	Vilant Systems Oy
Project Responsible	Antti Virkkunen antti.virkkunen@vilant.com
Duration	2005–2006

Abstract

The Vilant Control project aimed, in it's first stage, to pinpoint industrial supply chains that can benefit from the adoption of RFID technology. The Vilant Control concept is then elaborated to a technology solution for RFID-based automation and integration of logistics processes in identified industrial supply chains. The project is ongoing but it is obvious already that the new concepts adopted have generated significant savings in selected industry fields.

4.7 Development of Tuoretie Logistics Network

Responsible Organization	Tuoretie Oy
Project Responsible	Kari Annala kari.annala@tuoretie.fi
Duration	2005–2006

Abstract

The aim of the project is to develop the food logistics network managed by Tuoretie Oy and to create a new virtual management model for the network. This new model combines the know-how of the companies and allows the network to act like a single company. The processes of each participating company and the whole network are modelled, analysed and developed in order to improve the transparency of the network.

4.8 Product Control and Intelligent Robotics

Responsible Organization	Vest-Wood Suomi Oy
Project Responsible	Martti Pernanen martti.pernanen@vest-wood.com
Duration	2005–2006

Abstract

The project aims at developing a new production automation system to be combined with a modern product control system. Intelligent robotics solutions for manufacture use will be examined. Radio frequency technology solutions best suited for product control will be tested.

4.9 e-Inventory Services

Responsible Organization	Suomen Teollisuusosa Oy
Project Responsible	Sami Kortelainen sami.kortelainen@steo.fi
Duration	2005–2006

Abstract

The project aims at automation of the receipt, distribution, inventory, supply and electronic data handling of all products at the warehouse. This will result in improved product and item tracking with no more missing products. Team work will benefit from the use of real-time warehouse management system.

4.10 Real-Time Delivery

Responsible Organization	Tehojakelu Oy
Project Responsible	Olli Luukkanen olli.luukkanen@tehojakelu.fi
Duration	2005–2006

Abstract

The project aimed at designing a data system that will enable a near-to real-time service for product suppliers, improvements in transporting and a better quality control for all transports. Software design and operative testing will be carried out by Tehojakelu – thus gaining a competitive edge in this field.

4.11 Supply Chain Management by Combined Demand-Production Control

Responsible Organization	Atria Oy
Project Responsible	Ville Ruuskanen ville.ruuskanen@atria.fi
Duration	2005

Abstract

The project set out to study a theoretically optimal iterative decision making process with which to improve the profitability in the supply chain. This meant that the forecasting and control methods built in the Systema research project would need to be further developed and integrated into Atria's present production control system. The target was

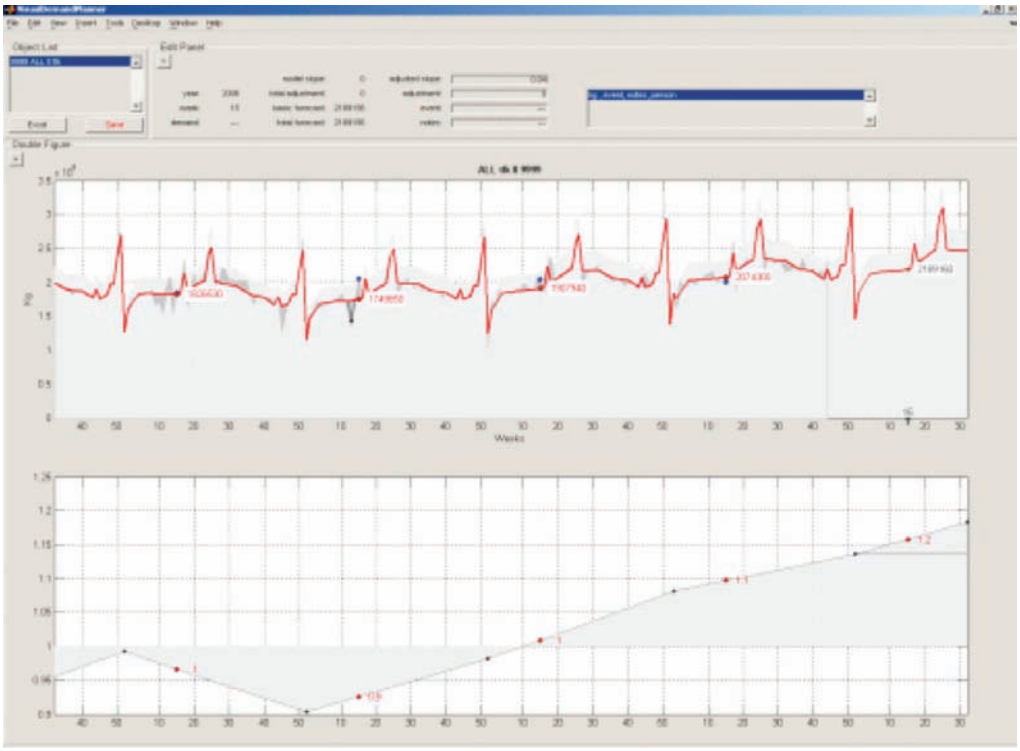


Figure 13. Demand forecasting and control tool designed in the Systema Project.

creating a new decision making model and developing the supporting technology.

The forecasting methods created in the Systema project have been implemented with success. The system interface combines expert knowledge and numerical information into a set of forecasting figures.

4.12 Delivered Intact

Responsible Organization	Castlepak Oy
Project Responsible	Marko Heinonen marko.heinonen@castlecontainers.com
Duration	2004–2006

Abstract

The manufacturing industry packing operations have not been improved in recent years to comply with the needs and new ways of operation in e-business. This project set out to create new methods for packing and logistics to utilize the benefits offered by electronic business. The Delivered Intact project is carried out in a joint effort with clients.

4.13 Software Solution Development for Networking Transport Companies and Their Customers

Responsible Organization	Mepco Oy (formerly Savinia Solutions Oy)
Project Manager	Heikki Kontuniemi heikki.kontuniemi@mepco.fi
Project web site	http://www.saviniasolutions.fi/ tuotteet_palvelut/savinia_iwaybill/
Duration	2004–2005

Abstract

The objective of the project was to develop a software solution for networking transport companies and their customers. The main focus lies in facilitating the process of collecting electronic waybill data and transferring it over the Internet. Project participants include Finnish transport companies Kiitolinja and Transpoint as well as a chosen group of their customers. The software is developed using the Microsoft .NET technology, the Microsoft Office System and server products - including InfoPath 2003, XML Web Services and Windows SharePoint Services.

The solution built in the project has been taken into daily use by the transport companies and pilot customer companies. The customers have discarded waybills in paper form. The implementation of the new solution was fairly easy and did not include any significant costs for the customer companies.

4.14 Smart Store II

Responsible Organization	SOKOS-tavarataloketju
Project Responsible	Reijo Kaltea reijo.kaltea@sokos.fi
Duration	2004–2005

Abstract

The goal of the Smart Store project was to create significant new business activity for the Finnish textile and clothing industry and trade by improving efficiency in the management of supply chains, networks and manufacturing technology and by creating a completely new e-business concept. One of the key components of the concept is production based on mass customisation and on creating completely new experiences in the shop.

The first phase of Smart Store was carried out in 2002–2004 as a research project in ELO programme. The objective was to improve the profitability in Finnish textile industry and retail, improve the entire supply chain, minimize the faulty forecasting figures in shops and support the overall sales by giving customers new kind of shopping experiences and more fitting garments.

The cooperation started in Smart Store I with Harvard Graduate School of Design research project continued.

Another relationship was established through Tekes with MIT Forum for Supply Chain Innovation. Smart Store project has been noticed widely on international level. The exceptional feature in Smart Store lies in the combination of two innovative technologies – hydrid space solution combined with best fit- and / or mass tailored supply chain. The knew know-how and technology consepts created in this project can be adapted to suit various services and various retail areas.

Figure 14. SmartStore concept was presented in the Fashion -05 Fair in Helsinki.

4.15 Trackway Smart Package and Product Autentification

Responsible Organization	Stockway Oy
Project Responsible	Jari Kaitera jari.kaitera@stockway.com
Duration	2004

4.16 HUB Model Utilisation in Inbound Logistics

Responsible Organization	Filtronic Comtek Oy VTT Technical Research Center in Finland
Project Manager	Anne Vesala anne.vesala@filtronic.fi
Research	Jukka Hemilä jukka.hemila@vtt.fi
Duration	2004–2005

Abstract

The Halo project is about inbound logistics development at Filtronic Comtek Oy, which is a globally-operating electronics manufacturer. Generally, the outsourcing of some functions of production to sub-contractors creates new nodes in the supply chain and makes supply chain management more complicated. If sub-contractors commit their capital on material, then the principal needs to pay extra in the form of material coverage. In an alternative model, the principal takes risk of materials by owning the material also during subcontract work.

In this project we developed a new logistics model, which utilises an inbound logistics hub. In addition, we analysed some logistics and material costs related on the supply chain. Changes in material flow create a challenge for information management. It is not useful for the small and medium sized companies of the supply chain to implement IT-solutions for the management of production or material flows. In many cases information from the principal is enough for the suppliers to manage the material flow and fulfil the needs of the principal. In this project we utilised the principal's information systems in order to share information in the supply chain and create visibility through the whole chain. The research partner in the project is VTT Industrial Systems.

Conference papers & presentations

1. Hemilä, Jukka; Jarimo, Toni (2005): Hub-Model Utilisation in Inbound Logistics – A Case Study from the Finnish Electronics Industry. Conference Proceedings of the ICIL2005, International Conference on Industrial Logistics, Montevideo, Uruguay, Feb. 14-18, 2005. Available at www.vtt.fi/cobtec/
2. Jarimo, Toni; Hemilä, Jukka (2005): An Inbound Logistics Hub Model for Supply Chain Management. EurOMA International Conference on Operations and Global Competitiveness, Budapest, Hungary, June 19-22, 2005. Available at www.vtt.fi/cobtec/

4.17 Transport Control System Principles for Next Generation

Responsible Organization	AffectoGenimap Oyj (formerly Genimap Oy)
Project Responsible	Vesa Raulos vesa.raulos@affectogenimap.fi
Duration	2004–2006

Abstract

Genimap set out to improve the basics for creating a transport design and control system for SMS transport companies. The objective of the project is to create implementation methods for design tasks and build interface solutions and vehicle software with used friendly data input. All these for use in various companies providing a wide range of transport services – and for implementation without costly resources or specific need for tailoring.

4.18 Category Forecasting Concept

Responsible Organization	Candyking Finland Oy
Project Manager	Jan Österman jan.osterman@logicosolutions.fi
Duration	2004–2005

Abstract

The Category Forecasting project seeks to specify the actors affecting category decision making and marketing measures and their implications on the forecasting process and forecasting accuracy. In practice this means combining three processes – category decisions, marketing measures and forecasting. The project studies the scope of the method application and the benefits to be received by adapting this tool for forecasting and product category net margin maximization.

The Category forecasting method is one of the major research innovations created in the ECOMLOG-project by Dr. Jan Holmström in Helsinki University of Technology.

4.19 DLS (Data Logistics System)

Responsible Organization	Solenovo Oy
Project Responsible	Marko Ruuska marko.ruuska@solenovo.fi
Duration	2004–2005

Abstract

DLS - Data Logistics System: A sophisticated software for dynamic information exchange and control. DLS is targeted for medium to large size enterprises for simple, yet powerful, integration solution. DLS uses mainly J2EE -technology for user-access and integrates tightly to operating system services within Unix/Linux machines.

The DLS GUI, is a web-based user interface for handling, configuring, viewing and scheduling point-to-point data transfers and information conversions. The DLS GUI can be operated with major internet browsers.

DLS dataprocessing is done via automated external programs, for the controlling web-application. This enables large scale expansion of processing power simply by adding more processing nodes to the DLS system. DLS has an easily extensible file based message formatting and conversion system which uses XML based configuration for information handling. DLS requires a Oracle or PostgreSQL -database as a backbone for control, and for medium of complicated data transfers and conversions.

4.20 RFID – Technology in Inbound Logistics

Responsible Organization	ABB Oy, Drives
Project Responsible	Harri Heimonen harri.heimonen@fi.abb.com
Duration	2005–2005

Abstract

The project will develop a RFID based identification platform for inbound logistics purposes e.g. kanban containers between the final assembly factory and supply chain. In addition, a feasibility study will solve whether this platform can be used for non standard packing and tracing of the components and subassemblies.

Figure 15. RFID tags are read when components are delivered to factory.

The system adds transparency to the supply chain by speeding up order impulses, product receipt and clearing malfunctions. In addition, it provides accurate statistics for products transfers. The result is improved materrial flow and the possibility of freeing capital in the entire supply chain.

4.21 Development of Work Guidance and Logistics of Technical Service Industry

Responsible Organization	YIT Primatel Oy, Mobile Network Services
Project Responsible	Jaana Saarela jaana.saarela@yit.fi
Duration	2004–2005

Abstract

From the aspect of the Finnish service industry, there is a need to develop planning and guidance of technical services and related logistics. Due to the growth of the service sector, there is an increasing need to invest in the service sector's development in the field of production management, processes and tools.

In this project YIT Primatel Ltd developed new models for work management and logistics. The aim was to create a new kind of action model and tools enabling efficient management of production. The project targets were reached almost 100 percent.

4.22 Weather Forecasts vs. Demand Forecasts in Retail Trade

Responsible Organization	Tradeka-kiinteistöt Oy
Project Manager	Aleksi Virkkunen aleksi.virkkunen@tradeka.fi
Duration	2004–2005

Abstract

Three years weather data and point of sale (POS) data was analysed to find out if weather information could be utilised to improve weather sensitive retail trade and logistics (e.g. ice gream, brewery and barbecue products). The project findings were encouraging and a model which comprises promotions, weather effects, different customer segments on the shop level should be constructed.

4.23 Logistics Risk Management in Supply Networks – LogRH

Responsible Organization	Tuotekehitys Oy Tamlink
Project Responsible	Jari Erkkilä jari.erkkila@tamlink.fi
Project web site	http://www.vtt.fi/tuo/45/projektit/logrh/
Duration	2004–2006

Abstract

The main purpose of the project is development and integration of an intelligent measurement and risk management system for the transport supply chain.

Publications

Jani Ojala, TTY; "Design and implementation of a data logger for stress monitoring in logistics". MSc Thesis.

4.24 Logistics Development Project

Responsible Organization	Urho Viljanmaa Oy
Project Responsible	Antti Jokisalo antti.jokisalo@jalas.com
Duration	2003–2005

Abstract

Urho Viljanmaa Oy:s project includes modelling the supply chain starting from demand forecasts and it's effects to the entire company operations. The project will put into practice a theory of modelling that has been created in the Systema research project.

The objective of modelling is to increase the company's competitivity in logistics. As a result of this project continuous observation for various logistics meters to support making decisions will be made. The set results were reached – a study and measuring of logistics costs as well as the creation of a meters control system with Visual Basic. The system now allows the monitoring of a few most important logistics meters, inventory cycle speed and accurate delivery.

4.25 Spatially EnhanceD ERP

Responsible Organization	Gisnet Solutions Oy (nowadays Fifth Element Oy)
Project Responsible	Mikko Kiviniemi mikko.kiviniemi@fifthelement.fi
Duration	2003–2004

Abstract

The aim of the spatially enhanced ERP-project is to provide a solution(s), which enable spatial information solutions and ERP-solutions to be used together to steer the companies' business processes and logistics.

4.26 Improving Transparency in Cost Structure

Responsible Organization	GNT Finland Oy
Project Manager	Esko Heinonen esko.heinonen@gnt.fi
Duration	2003–2004

Abstract

GNT develops analysing tools for its operations in collaboration with the Tampere University of Technology. The objective is to improve logistics control and transparency in the entire supply chain and thus support the profitability in business processes.

4.27 Supply Chain Management by Conwip-system

Responsible Organization	GE Healthcare Finland Oy, Imaging
Project Manager	Mikko Kaipia mikko.kaipia@med.ge.com
Duration	2003–2004

Abstract

The aim of this project is to improve methods and processes of the supply chain in Instrumentarium Imaging Tuusula factory. This development consists of extensive utilisation of the state of art e-commerce solutions. A supply chain framework for the networking business environment is modelled and piloted taking advantage of a 'Conwip' production and inventory control system, which will be built up during this project.

4.28 Smart, Cost-Effective and On-time Project Deliveries

Responsible Organization	Wellquip Oy
Project Responsible	Sakari Oja sakari.oja@wellquip.fi
Duration	2003–2004

Abstract

The main objective of the project is to develop and test advanced and highly automated solutions to manage real-time technical information, deliveries and shipments within a global project supply network. Further on, optimization of information flow within the supply pipe is an important part of the project. Enabling technologies are open and distributed IT solutions, automatic identification technologies and mobile solutions. As a result of the project, a pilot type of "plug and play" type of project management system is tested in an investment project.

4.29 Prosec Security Logistics System (Prosec SLS)

Responsible Organization	Encore Ympäristöpalvelu Oy
Project Responsible	Tero Peltomäki tero.peltomaki@paperinkerays.fi
Project web site	www.prosectotal.fi
Duration	2003–2004

Abstract

Prosec Data Security Service has 20 000 confidential material disposal containers, which undergo tens of thousands service events yearly. Containers are delivered to customers, picked up on demand and the contents disposed of in a secure monitored and documented process.

The aim of the project was to create an automated process tracking system that minimizes manual errors and increases traceability, including container weights. The solu-

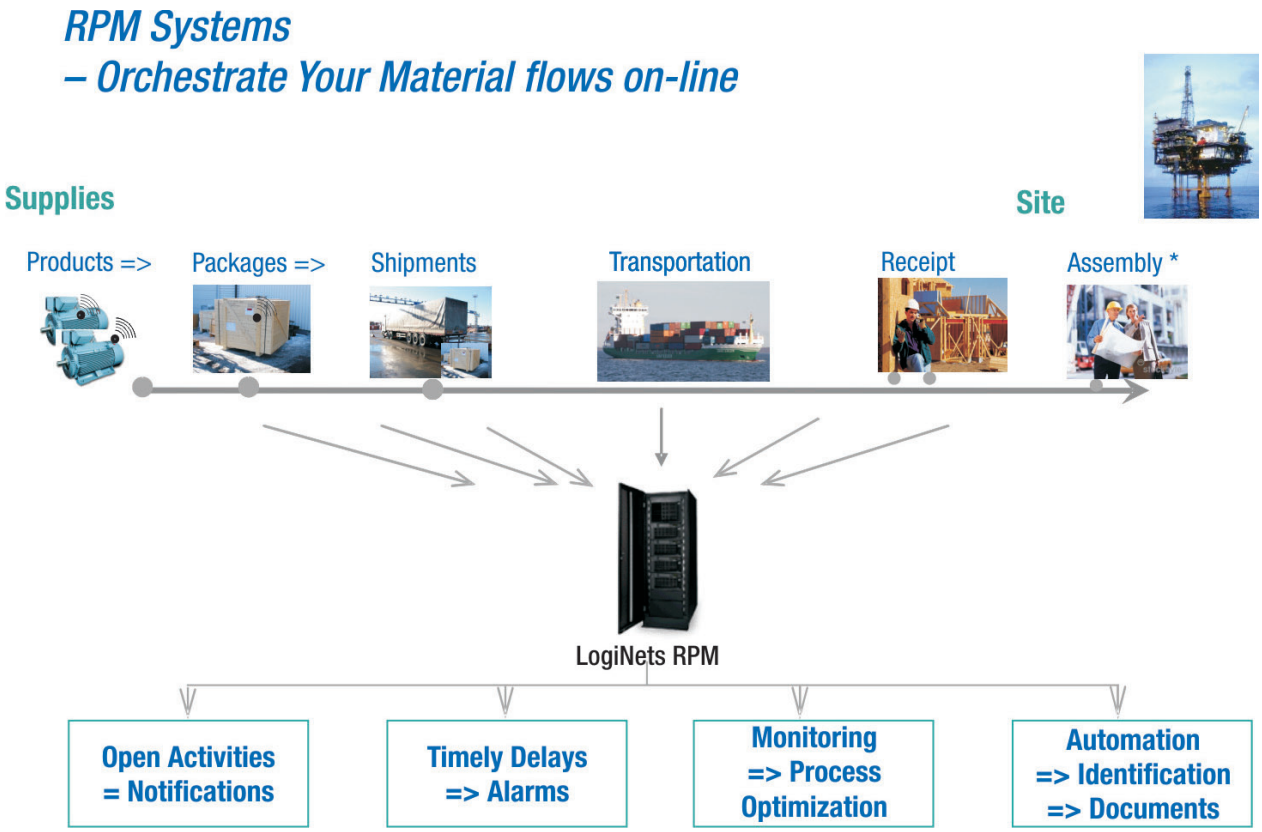


Figure 16. The structure and functionality of RPM enables Wellquip´s shipments frictionless execution and follow-up.

Figure 17. Containers of confidential material are handed over to Prosec personnel in the beginning of the disposal process.

tion was an RFID based tracking system that enables personnel and customers to monitor the movements of single containers in the different steps of the process. Service requests are fed from the ERP system into rugged PDA's with RFID readers. With these handhelds single RFID tagged containers can be identified. Authorized customer representatives with RFID cards can sign service events. Back at the service points containers are identified and weighed with RFID enabled scales.

The system was also integrated to Prosec's billing system enabling fulfilled service events and material amounts to be billed automatically. Customers have access to detailed service information on Prosec's extranet site. The system was succesfully taken into full production use in 2004, and currently still is the largest RFID application for returnable asset tracking in logistics in Finland.

4.30 WEMI's Strategic Value Chain

Responsible Organization	Wemigroup Oy
Project Manager	Teemu Anttila teemu.anttila@wemi.fi
Duration	2003–2004

Abstract

The goal of this project was to create a strategic supplier net to meet the demands of the markets. The net is based on fast reaction, short lead times and cost reduction.

4.31 Logistics and Control Systems of Distribution Network

Responsible Organization	Polar Electro Oy
Project Responsible	Ilkka Moring ilkka.moring@polar.fi
Duration	2003–2005

Abstract

The goal of the project was to model a new distribution network and develop a control system for it with help of the simulation model. Logistics control and ownership are changed from local to centralized in the new network. Change of the control and responsibility and bringing this change to the operations are the main challenges. Following the project results, a major supply chain improvement project has been established. The project emphasizes the growth of logistics efficiency by management of distribution network – thus creating the prerequisite for the entire business operations further development.

Publications

1. Hemilä, J., Pötry, J., A Case Study of Marketing Effects on Global Distribution Logistics Development. Conference Proceedings of the Society of Operations Management VIII Annual International Conference. Mumbai, India, December 17-21, 2004, (http://virtual.vtt.fi/virtual/proj3/cobtec/results.html)

4.32 Web Pilarcos – Production and Integration of Application Systems

Responsible Organization	Elisa Oyj
Project Responsible	Kari Lehtinen kari.lehtinen@elisa.fi
Duration	2003–2004

Abstract

In an increasingly globalised market situation, companies are becoming more and more dependent on their business partners, while competition is forming between operational networks.This is why the ability of business IT systems to provide an automated solution to the arising communication needs is a focal key to success.

The Pilarcos projects are developing middleware solutions to support the management of distributed applications used in different companies and with different technologies. The middleware encapsulates the company applications and internal technology solutions, offering a standardized interface for inter-company communication. The components to be managed and the control of them are separated from each other. As its new middleware service, Web-Pilarcos is developing a mechanism based on both Web Service technology and inter-company workflow models.

The practicability of the emergent architecture and prototype middleware will be evaluated through demonstrations. The management of logistics is a suitable object for applications.

4.33 e-Fullfilment Concepts

Responsible Organization	Metsä Tissue Oyj
Project Responsible	Vesa Röyskö vesa.roysko@metsatissue.com
Duration	2003–2004

Abstract

The e-Fullfilment Concept project set out to simulate the cost structure in various functions (e.g. picking, inventories and transport) and especially the adaptation of various concepts to various product groups. In short studying where to keep inventories, where to pick and where to merge products with product flow generated from other suppliers. The objective was to generate cost savings by creating a framework for grouping concepts and products – thus improving the competitive edge of Finnish industry and trade.

Two concepts were chosen for closer study: Exact quantity replenishment (EQR) ja Cross-docking with labels. The results favoured Cross-docking with full pallet loads. Full pallet loads could be combined with other goods and transported to shops via existing terminal and delivery network.

Figure 18. Order picking at the distribution center.
Picture: Tekes, Niko Nurmi

4.34 Production System Design and Optimization of Inventories

Responsible Organization	GNT Finland Oy
Project Responsible	Esko Heinonen esko.heinonen@gnt.fi
Duration	2003–2004

GNT developes its logistics using the latest academic research work of the task. The target is to develop more effective models to manage warehouse logistics and the whole supply chain from vendor to end user level based on the results from the ELO group research project GNT is involved in and in cooperation with the Institute of Production Engineering at the Tampere University of Technology.

The key issues are information techniques in process management and the automation of physical warehouse logistics. Based on the new models to be created, the target is to reduce the amount of capital tied up to inventories and simultaneously to increase the offered service level. The target is not merely to increase GNT-group´s net income but to create added value along the whole logistics and business chain.

4.35 Process Plant Life-Cycle Logistics

Responsible Organization	Jaakko Pöyry Oy
Project Responsible	Mikko Höynälänmaa mikko.hoynalanmaa@poyry.fi
Duration	2002–2005

Abstract

In addition to the traditional forest cluster, a strong information technology and telecommunication cluster (ICT) has developed in Finland. Even though long-term effects of ICT are revolutionary, ICT is still only a catalyst enabling companies to develop their business operations further and even more important to create new business models. This project set out to develop new business models using new ICT technology possibilities. The new business model is based on the strong forest industry cluster know how.

The project's main work packages are:
1. Technology trends and models of virtual organisations
2. Model of the future business processes
3. Information logistic manager
4. Visualisation of the logistic information
5. Mobile technology business applications in networked environment

4.36 Systems and Processes in Networked Business

Responsible Organization	Piiroinen Oy
Project Manager	Veijo Hovi veijo.hovi@piiroinen.com
Duration	2002–2006

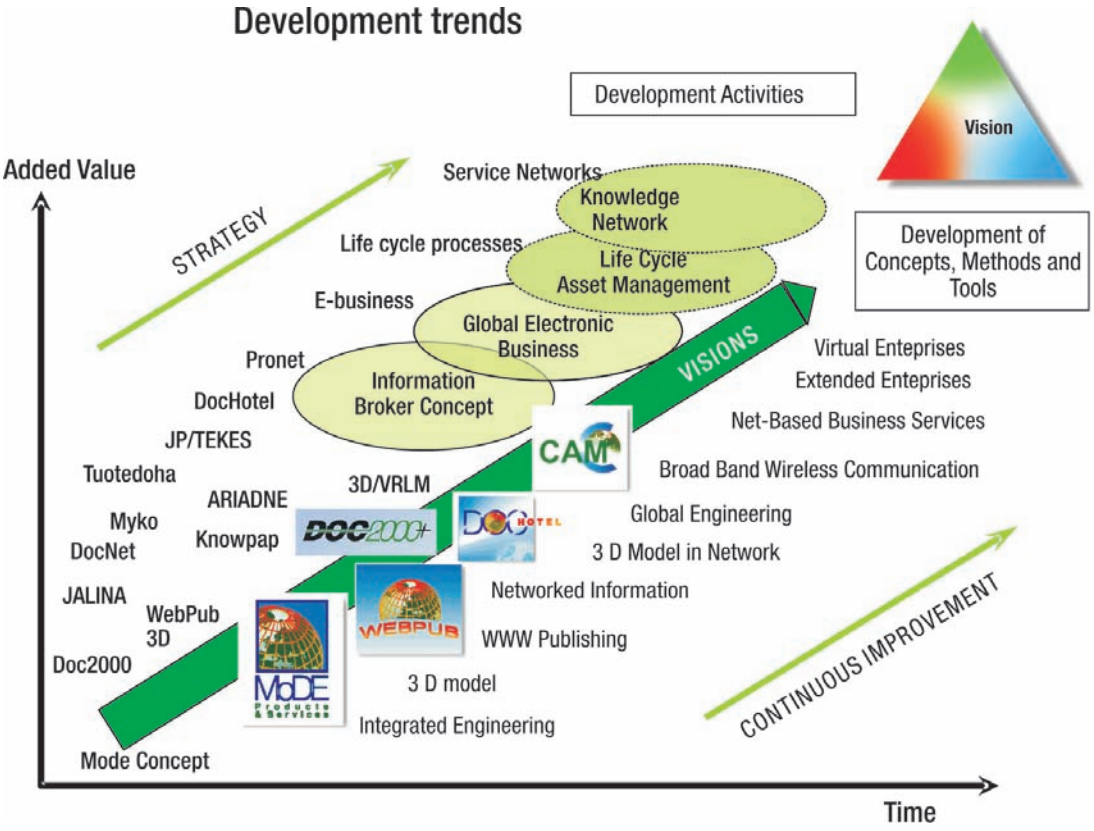


Figure 19. Development trends

Abstract

The project set out to develop Piiroinen company's logistics material management by improving the information flow. The pilot project was carried out with chosen clients and suppliers. Following the pilot experiences gathered, an e-business total concept for a SMS furniture company will be created.

Using electronic data transfer solutions has improved the production processes. The new concept increases the speed and security, improving the entire process management. The networked supply chain integrates the furniture cmpany processes with those of clients and suppliers. A further objective would be getting the furniture trade companies into a joint network, collaborating for improved business efforts in international markets.

4.37 Eletronic ANI Network PDM Service

Responsible Organization	Anilinker Oy
Project Responsible	Tuomas Koljonen tuomas.koljonen@anilinker.com
Duration	2002–2004

4.38 Electronic Control of Product Information

Responsible Organization	Stockway Oy
Project Responsible	Jari Kaitera jari.kaitera@stockway.fi
Duration	2002–2003

4.39 E-Farm

Responsible Organization	Suomen Rehu Oy
Project Responsible	Simo Urpio simo.urpio@suomenrehu.com
Project web site	www.suomenrehu.com – Palvelut ja tuotteet – Signaali24
Duration	2002–2004

Abstract

The deliveries from feed industry to farms are more than 1 million tons a year in Finland. The distances between plant and farms are often long wherefore delivery costs are a no-

Figure 20. Automating the order information flow for refilling the silos.

table part of all feeding costs. The focus of the E-Farm project is in the use of new information and communication technology (ICT) to reduce costs of ordering and delivering. Tools for more effective handling of management data are also provided. Using ICT requires co-operation between farms and feed industry. Integrating order systems help in planning deliveries and production more effectively. The benefits are realized as well in the farm, the feed industry and the environment.

The new E- Farm solution has been launched in 2004 as a Signal24-service and has since been in daily use. The Signal24-service has aroused much interest among the feed industry in Europe and North America. Patent pending.

4.40 New Operating Model for Furniture Industry Logistics (HULTOKE)

Responsible Organization	Indoor Group Oy
Project Responsible	Markku Henttinen markku.henttinen@indoorgroup.fi
Duration	2002–2004

Abstract

The project aims at developing a new operation model to strengthen Sotka's business concept, to be based on the network cooperation of the Indoor Group Ltd and its partner organizations.

4.41 Truck Data Manager

Responsible Organization	Rocla Oyj
Project Responsible	Kyösti Sarkkinen kyosti.sarkkinen@rocla.com
Project web site	http://www.rocla.com/page.asp?Section=1078
Duration	2002–2004

Abstract

The goal of the project was to develop a product, which analyses the use and state of forklift trucks and study possibilities to help warehouses to use that data to become more efficient. Possibilities to use this data in research and development and in service were also studied.

The end result of the project was a product called Abbot. Abbot collects information of the use and state of forklift trucks wirelessly and is connected to Internet. Warehouses can use the data to increase safety, decrease damage costs and to analyze warehouse operations. The finished product is sold to many warehouses and has won the Finnish E-business Forum reward "New Business Award".

Abbot gives accurate real time information about use of the trucks. Rocla is now developing a totally new forklift truck service concept based on online Abbot information.

Figure 21. Abbot solution provides detailed reports and analyses for each forklift truck.

4.42 Control System for Logistics Services

Responsible Organization	PR-Logisticar Oy
Project Responsible	Tuomo Tolvanen tuomo.tolvanen@logisticar.fi
Duration	2002–2003

Abstract

The goal of LogServ project was to develop a business concept that enables outsourcing the conduct of a customer's logistic process. A practical goal of the concept was to give a customer necessary control parameters and reporting tools to achieve significant improvements in logistics, including reduced storage value and administration costs combined with the good availability of products.

The results in general were as expected. The LogServ-system offers a base platform for creating outsourced logistics control in various environments. The system is integrated with client's ERP via Logisticar data base, which in turn has an interface with all major ERP-solutions.

4.43 HIIPS – Heavy Industry Intelligence Project System

The HIIPS project consortium was formed by major Finnish metal industry project organizations: Alstom Finland Oy, Andritz Oy, Finnlines Oyj, ISI Industry Software, Kvaerner Power Oy, Oy Mercantile KSB Ab, Metso Paper Oyj, BIT Research Centre (formerly TAI Research Centre), Wärtsilä Corporation, LogiNets Oy

On global investment projects deliveries arrive at the construction site from thousands of suppliers from all over the world. Right and on time deliveries, cost effectiveness and effective change management are key success factors for the entire supplier network. Due to the global nature of the business, multiple party involvement, uniqueness, complexity of the products, vast material and information flows and capital intensity, effective supplier network operations plays a vital role for the project companies. The vision of HIIPS is to increase collaboration, information exchange and efficiency of common processes in the project delivery chain. The mission of HIIPS is to increase project delivery chain visibility and the availability of related information. The focus is to reduce losses occured through poor quality and inefficiency by deploying best practices and advanced work methods.

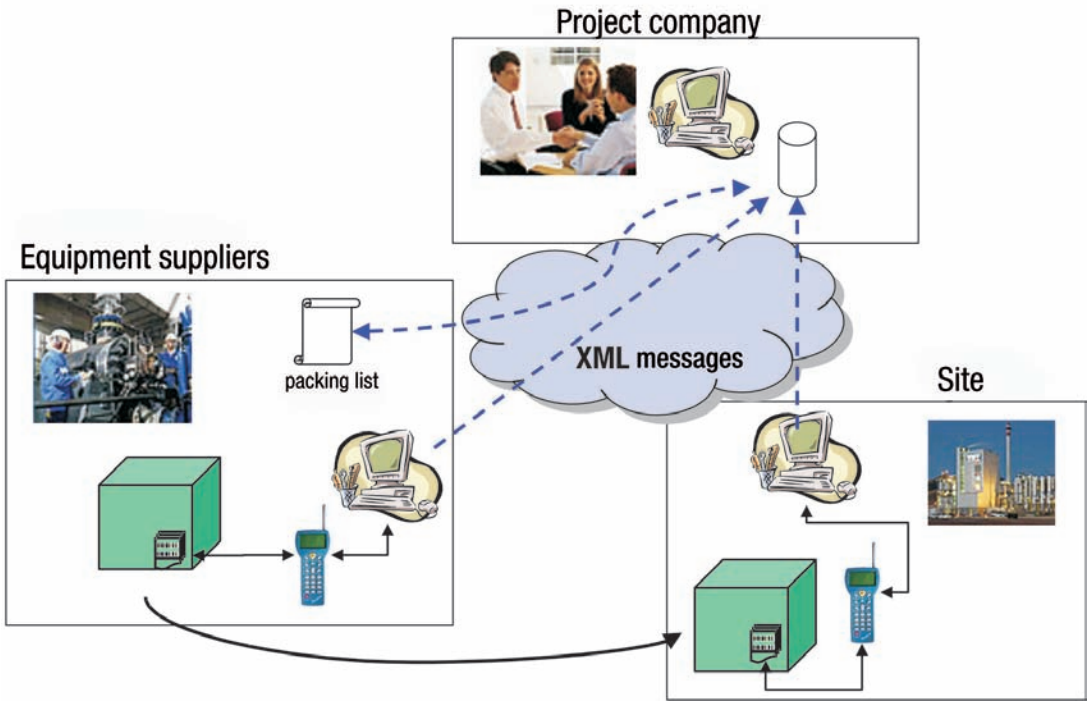


Figure 22. A Sample about the system description.

4.44 Material Logistics Models in Maintenance

Responsible Organization	YIT Service Oy
Project Responsible	Timo Kolmonen timo.kolmonen@yit.fi
Duration	2002–2004

5 Charlie's Skypeout Strategy: The Chocolate Factory Relocates to Tallinn

Dr *Shoumen Palit Austin Datta,*
Research Scientiest, School of Engineering
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139 and
Co-Founder & Research Director
Forum for Supply Chain Innovation
Massachusetts Institute of Technology
shoumen@mit.edu

Figure 23. Dr Shoumen Palit Austin Datta.

5.1 Epilogue

On 17th November 2005, during a conversation in my office at MIT, I was requested to write a short article, on future trends in e-business, to be included in a publication to accompany the successful completion of the Tekes supported e-logistics program (ELO) in 2006. It was suggested that I send the completed article in about six weeks to allow for translation in Finnish.

Nearly a fortnight later, on 30th November 2005, while waiting at the airport en route to Taipei (Taiwan), I started to work on this article by extracting some pieces from other articles that I had authored in the recent past. The sterility of my article (in progress) was increasingly obvious because synthesizing a new article without any refreshing context is merely an editorial regurgitation that only demonstrates proficiency in "cut and paste" using Microsoft Word. My quest for a fresh contextual relevance (in order to discuss my suggestions) simmered while travelling from Boston to Frankfurt. While settling down in seat 83K on the connecting Lufthansa flight from Frankfurt to Hong Kong, the "contextual relevance" jumped in front of me at the moment the air hostess came around to offer magazines before the flight departed. As I reached out for The Economist of 3rd December 2005, it was clear that I should find examples of business and government processes in this issue which may connect to my suggestions, if, at least some of my ideas, were to offer solutions for the evolving global thought process.

5.1.1 Introduction

My suggestions for the future are not new, at least, not anymore, since I posted my article (1) on the web during August 2003. However, my original article and the various versions since 2003 are not really about e-business or logistics or supply chain management. My rambling thoughts may be classified as the future of decision systems that hints about the combinatorial convergence of tools, technologies, concepts and ideas to catalyse innovation in order to make better decisions. I hasten to caution the readers that I have invented nothing new. The "tools, technologies, concepts and ideas" are the discoveries of others based on centuries of visionary research. I have simply assembled them in the context of various decision systems that may be applicable to processes used in business, government, manufacturing, defense, healthcare, security, logistics, services, finance, supply chain, customs operations and related pursuits.

More innovations can and shall arise from borrowing and combining ideas rather than from isolated inventions. Better decisions (including the profitable ones) stems from an informed convergence of several processes that culminate in an action or transaction that leads to an improved outcome. It is often and erroneously assumed that informed convergence is directly related to and dependent on or even proportional to data (assuming data is accurate and available). Analytical introspection suggests that data is not equivalent to information and even if information may be extracted from data, it does not imply that that information is valuable or it may trigger actionable decisions that may offer value.

Inability to generate value from data may be rooted in the fact that the analytical tools in use (software, algorithms) are simply inadequate, unable to adapt to changes and/or are simplistic representations of complex real-world scenarios. The cumulative inefficiencies stemming from the lack of insight with respect to analytical handling of data, information, transaction and decision may be traced back to the inability to ask the right questions at the right time. Such inabilities are pervasive and are irrespective of the investment in technology (for example, to facilitate the acquisition of real-time data). For the global logistics sector alone, more than US$3 trillion have been spent in 2004 and this represents almost 12% of the global GDP. Given the enormity of this spending, inefficiencies in the global logistics network, estimated at 20% or more, indicates losses (due to inefficiency) of at least US$600 billion. The latter is a glaring example representing an immense opportunity for organisations to improve decision making. However, businesses cannot grow by "saving" money, hence the prudence of the aphorism that growth occurs mostly through innovation.

Innovation in this domain (of dynamic interdependence of data, information and process with actionable decision making) may be the only plausible road to the future of how a broad spectrum of interoperable (software) systems may utilize such innovation to their advantage to improve profitability, aided or unaided by humans. It is this theme that I shall discuss in this article. Hopefully, I may even succeed to provoke the readers to consider how pivotal this theme of logical interdependence may be because we might find that this interplay is reiterated, in some form or the other, in the context of random global cases (non-fiction) selected from a magazine with above average credibility (The Economist, 3rd December 2005).

5.1.2 Connecting Bits To Atoms: Does it Guarantee Value From Use of Resulting Information?

Information (bits) about goods (atoms) is therapeutic to consumer product businesses and their friends (retailers, distributors, suppliers, manufacturers). Therefore, connecting bits to atoms, in a systemic sense, may be the holy grail for all those involved in producing and consuming physical goods but only if they also learn to become experts in "bit dribbling" or the ways in which to use the bits to gain value from atoms. Certain characteristics of goods (colour of iPod, storage temperature of milk, percentage of titanium in an alloy) are important to select sectors of consumers (my daughter Emma, Tesco, Boeing) who may choose a variety of channels to gain to such information (customer relationship). Online retailing is one example of bits connected to atoms and the growth of the internet serves increasingly as the medium or channel of choice for consumers to seek or exchange such information (2).

Therefore, the "now-classical" model (barely a decade old) of Amazon to sell books without any physical inventory is undergoing an evolution where once-warehouse-less Amazon can no longer claim to hold zero inventory or succeed without warehouses. The convergence of brick-and-mortar stalwarts on the dot.com channel is evident from increasing number of online visitors to tyrannosaurus establishments such as Wal-Mart. As shown below, figure 24 (modified from The Economist, 3rd December 2005) offers interesting clues for future developments. I shall briefly comment on the following:

a. Shopzilla and comparison-shopping
b. Amazon and its foresight to collaborate
c. Apple and the inevitable communication convergence
d. Why American Greetings and Target are indicators sweeping demographic changes.

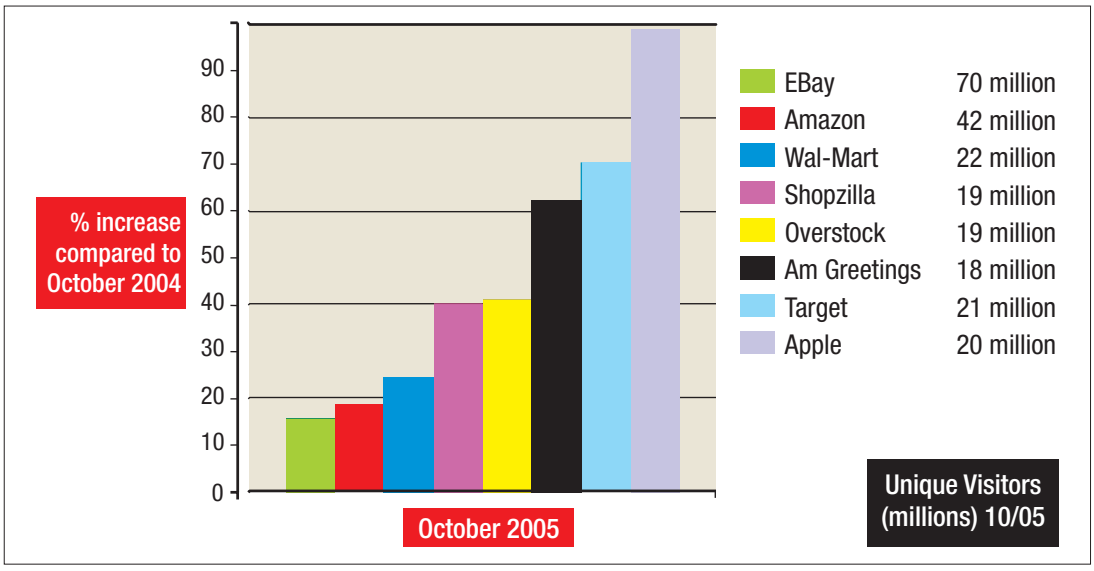


Figure 24. Connecting Bits to Atoms: A Model of the Physical World?

a. Shopzilla and comparison-shopping

Buying the same brand from stores located in two different parts of the same city may offer a considerable price differential. But the cost of savings is diminished if time and travel expenses are taken into consideration. This age old concept is now facilitated by the internet and anyone can take advantage of e-comparison provided one has made a basic investment to access the services. If H&M were to disclose its database of items and prices to a 3rd party (such as Shopzilla in the US and/or Ciao in EU) then the threat of such competition may catalyse M&S to do the same. The growth of such comparison shopping may make the end-user (consumer) the principal beneficiary. The operating scale of Shopzilla is still in its infancy although its ability to attract visitors is appreciable (40% increase when comparing number of unique visitors for October 2004 vs October 2005, see figure 24).

Consider the scenario that Arrow brand shirts, a respectable US mid-market brand, are sold for €50 in Dublin's Brown Thomas and for 45 in Helsinki's Stockmann. However, comparison-shoppers also find a No-Name outfit in Dhaka (Bangladesh) selling the identical Arrow SKU for €15 and advertises that the shirts are authentic Arrow brand being sourced from the manufacturers of Arrow, who are in fact in Dhaka. Globalization and its discontent cannot be more aggravating for Arrow shirt-makers! Should Arrow continue to outsource its manufacturing to Dhaka? Should WTO-like organisations empower Arrow to prosecute No-Name and its partners in Dhaka? Will the tide of ethical globalization disable Arrow to procure shirts at €5 from the East and sell for €50 in the West?

Suddenly comparison-shopping and its intended transparency meets the conundrum of global supply chain or the dilemma that your online Christmas shopping can be completed in China. Ciao Target! Ciao, Ciao Wal-Mart!

However, in the short term, Shopzilla or Ciao's potential for success may be minimally affected by the forces of ethical globalization. Rather, the possibilities for comparison-shopping are limited by the chasm in interoperability of systems that must be accessed by Shopzilla or Ciao to offer true value to online comparison-shoppers. If H&M and M&S are the only two entrants in this transparency battle then Shopzilla or Ciao remains an unattractive service to serious bargain hunters given the proliferation of discount stores or pre-scheduled major sales events (Yellow Bag Day in Stockmann, Helsinki or January Sales in the US). The number of online hyper-enthusiasts may fail to offer sufficient economies of scale for survival of comparison-shopping unless the problem of systems interoperability can be addressed to gain credible transparency of inventory across a critical mass of stores and multiple brands with minimum effort but maximum security.

Technology sympathizers and analysts may offer a grossly different perspective celebrating the 19 million unique visitors to Shopzilla.com during October 2005. In keeping with what is in vogue, this will be touted as the reason why item level radio frequency identification (RFID) tags may increase consumer savings through comparison shopping services. Several assumptions must be made in promoting this line of thought but that is nothing new given that the entire hype curve of RFID usage catalysed in part by MIT's Auto ID Center, made blatantly irresponsible assumptions (for example by Price Waterhouse Cooper Consulting white paper "Focus on the Supply Chain: Applying Auto-ID within the Distribution Center" in 2002) and predicted with confidence fall in RFID tag prices to under 5 cents (US) by 2005. In reality it is the not the cost of technology (for example, RFID tags) that matters in the long run but the value that it delivers to its users. Peering through the lens of history, it appears that lack of imagination fueled by short term corporate gains has plagued the adequacy of value extraction from several technologies and RFID may not be an exception. The immense potential for judicious use of RFID tags (in various forms) as a data acquisition tool remains to be realized but item level tagging for comparison-shopping on Shopzilla is not my recommended knee-jerk reaction.

b. Amazon and its foresight to collaborate

Mr Jeff Bezos and Mr Jeff Wilke at Amazon headquarters may be less than ecstatic with less than 20% increase in traffic over the same period a year ago despite the 42 million unique visitors to Amazon.com during October 2005. For growth of Amazon in line with the imagination of its senior management, a bit more than paranoia is required. I shall borrow from Mr Andy Grove's "only the paranoid survives" and add a string of adjectives to suggest that only the "insightful collaborative paranoid" shall triumph by exercising their imagination to adapt, consistently.

Hence, Amazon can no longer be classified as an online retailer despite the fact that on face value its online business model is the subject of a multitude of mimicry. To the millions of end-user or consumer it shall continue to grow as an online store for anything they wish to buy, with peace of mind. To a vast number of small and medium businesses who aspires to be an Amazon but cannot, it serves as a channel to sell their wares as individual businesses operating under the credibility of the Amazon Mall that also offers the ability for comparison shopping. In this respect, eBay is nearly a carbon copy of the Amazon Mall except for the method of price determination. The astute use of centuries-old auction pricing sets Pierre Omidyar apart as the innovator sine qua non.

Amazon Mall is essentially an internet-catalysed Sumerian Bazaar and the plethora of such markets that existed 7000 years ago along the banks of the Indus River in the cities of Mohenjodaro and Harappa. But, the complexity of the interactions have undergone a radical change and calls for interoperability. Collaborative transparency may describe one aspect of Amazon Anywhere. It banks on innovative

use of standards (and its brand credibility) that are emerging to catalyse the transition of the syntactic web to the semantic web. In view of the evolution of Semantic Grid Web Services (1), as a first step, Amazon is offering programmers virtually unlimited access to the foundation of Amazon's business: its product database. Developers can grab product data, reformat it, add related services and use it to attract visitors to their own sites. These parallel Amazons may have added marketing features for niche customers which may be an otherwise expensive proposition if Amazon wanted to control its content and reach those segments. Imagine the variations necessary to be a global online retailer in several languages catering to multiple interests. By opening up its product database, Amazon is probably the first to practice the nearly-one-to-one marketing that is pragmatic only through the internet. For this access, Amazon demands that visitors to satellite sites complete purchases through Amazon (site owners receive a commission). Exposing the world's largest product database — along with editorial content and personalization functions — is a counterintuitive business strategy but one which may distinguish Amazon as the pioneer in collaborative innovation.

Amazon is an example of how foresight, investment in new tools and use of standards may converge to generate software that acts as a vehicle for interoperability for thousands of developers who may be using varying markup languages leading to a cacophony of impotent proprietary systems. Amazon's web server software mitigates this diversity by creating (API) interfaces that could retrieve product data and reformat it for select devices (PDA). Amazon's success is rooted in its human capital, that is, software engineers attuned to the emerging Semantic Web and XML, SOAP, OWL standards. Amazon, therefore, is a set of independent parts, including the database, shared interfaces for access and repackaging data (XML) for the site-specific layout preferred by a developer or site owner.

c. Apple and the inevitable communication convergence

20 million visitors to Apple's website in October 2005 do not signal a revival of the PC buying craze, if ever there was one. Doubling of unique visitors since October 2004 suggest that the lure of the Apple may be in the flavour of the iPod du jour. Hence, the PC assembler and interface innovator (Apple Inc) is blurring the compartmentalization along industry lines in ways that earlier device manufacturers (Sony, Phillips) failed to penetrate. Apple did not stop at providing the receptacles for music, video and movies (iPod) but has organized services (iTunes, iMovies) that shall continue to prod Mr Steve Jobs to make frequent visits to the bank, online, of course. In other words, it is a rehash of the old system where you get the telephone for free but pay for services or the reason why Xerox is eager to offer you a discount on the purchase of a photocopier only to sell you products with high profit margins (ink cartridges, paper). The uncanny innovator in Mr Jobs has extracted the service model through iTunes and may be poised to compete with the likes of Nokia or NTT DoCoMo. Skype-like features in an IPv6 enabled iPod will come with built-in 802.11g, 802.15.4 and 802.16 features (WiFi, Zigbee, WiMax) but aesthetically engineered to expose the crème de la crème of human-machine interface that is central to Apple's innovation. Wave your iPod.femto at a Marks & Spencer store to compare the price of the "collezione" charcoal grey pure cashmere scarf that you saw at Tie

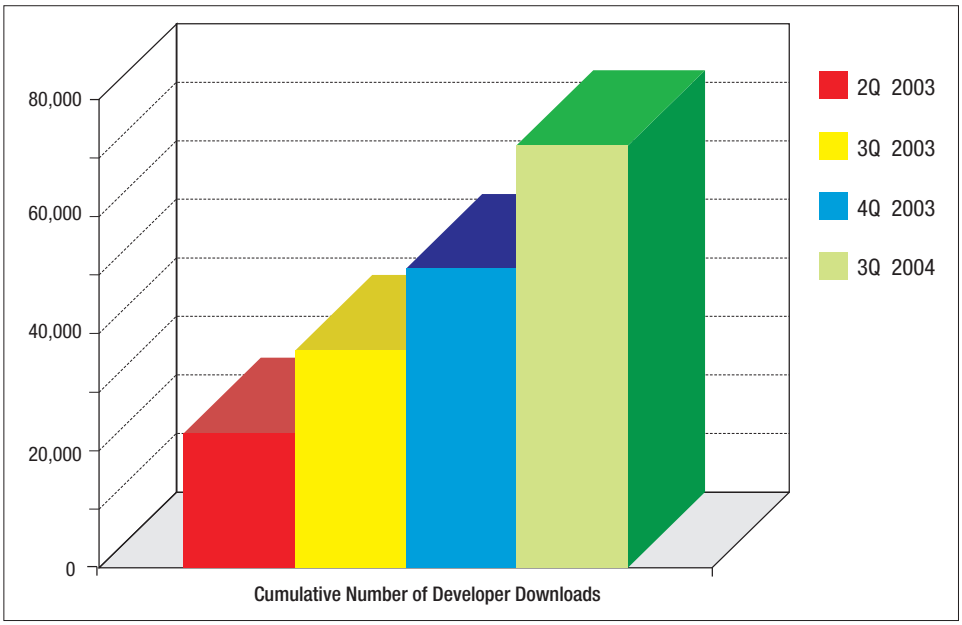


Figure 25. Profit from Amazon: Give Away the Store (from MIT Technology Review, January 2005)

Rack, buy petrol and pay for groceries at Tesco or pause "Sleepless in Seattle" if Mum is Skype-in mode to you.

The scenario above is as incredible as the time you found a 12 megapixel digital camera under the Christmas Tree last year (movie screen resolution is achieved with 8 megapixels). Exponential growth of megapixels after CCD commoditization made that possible and feasible. Pervasive cell broadband with WiMax (802.16) and the inevitable merger of GSM with 3G will aid infrastructure interoperability. Location awareness (GPS, RTLS), identity of goods (UWB, RFID), multilingual speech, biomedical monitoring (nano-sensors) and their computational needs are all possible with enterprise-wide ontologies facilitating contextual understanding as well as increasing bandwidth between components (multi-core microprocessors and memory) with sharp drop in processing cost (Sony's new PSP3 due to hit the retail stores in the summer of 2006 packs in a 8-core processor co-developed with IBM that operates at 2 teraflops for only $399).

The iPod of the very near future can hold more than 40 petabytes (40,000,000 gigabytes) of data. But, only 10,000 gigabytes will be needed for the 20 million books in the US Library of Congress. With all that remaining storage capacity why not download all of the nearly 500,000 movies currently available in the world? The irony is that it is not inconceivable that all this is possible but it is truly incredible that these scenarios represent a march of reasonable convergence of innovation at hand and in progress. To see a world in a grain of sand and hold infinity in the palm of your hand is not only the innovation of iPod in action but poetry (of William Blake) in motion as well as locomotion (see figure 26) when the iPod evolves as your secure-car operation platform.

d. Why American greetings and target are indicators sweeping demographic changes

My friend Helena in Boston insisted on sending us an actual paper greetings card by mail. It is rare but still deeply appreciated. Every time I am away from home, I, too, find it pleasant to write a few lines to my wife even though we speak at least six times each day on the phone no matter in which time zone I may be. Except for these fond exceptions, the remainder of our communications including birthdays, anniversaries and get well greetings are internet enabled. The 70% increase in number of unique visitors to American Greetings is a sign of the times and for the prudent observer a signal of what to expect with changing habits of a 'grey' demography.

With nearly equal number of unique visitors clicking on Target and Wal-Mart during October 2005, it is interesting to note that the number represents a 70% increase for Target but only a modest 20% increase for Wal-Mart. The visitors to Target may prefer better quality or wish to support enterprises with progressive corporate policies over the sole criterion of rock-bottom prices. Target shoppers may be clustered in geographies with higher broadband penetra-

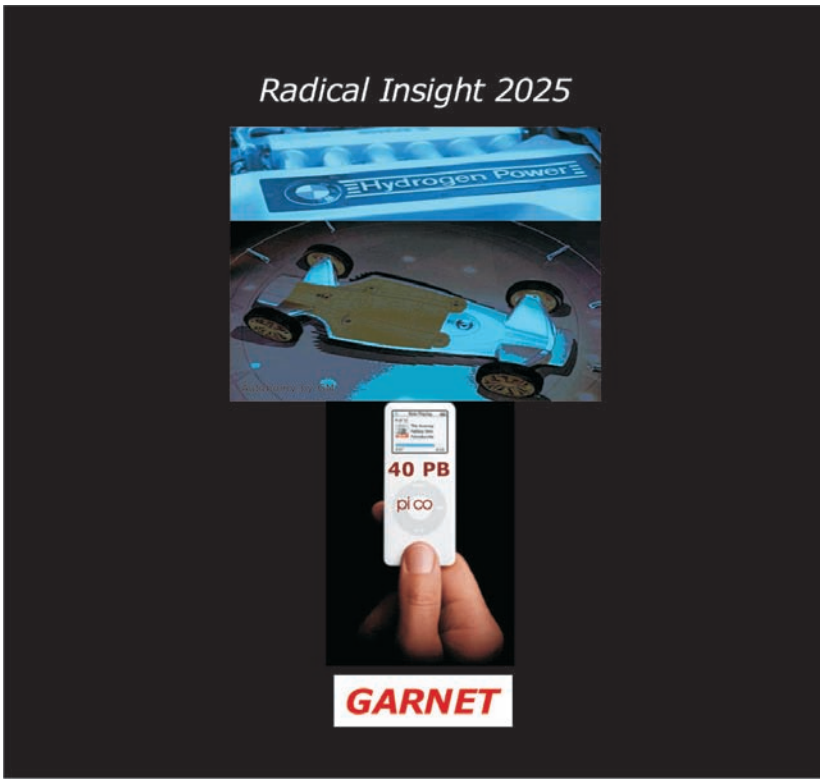
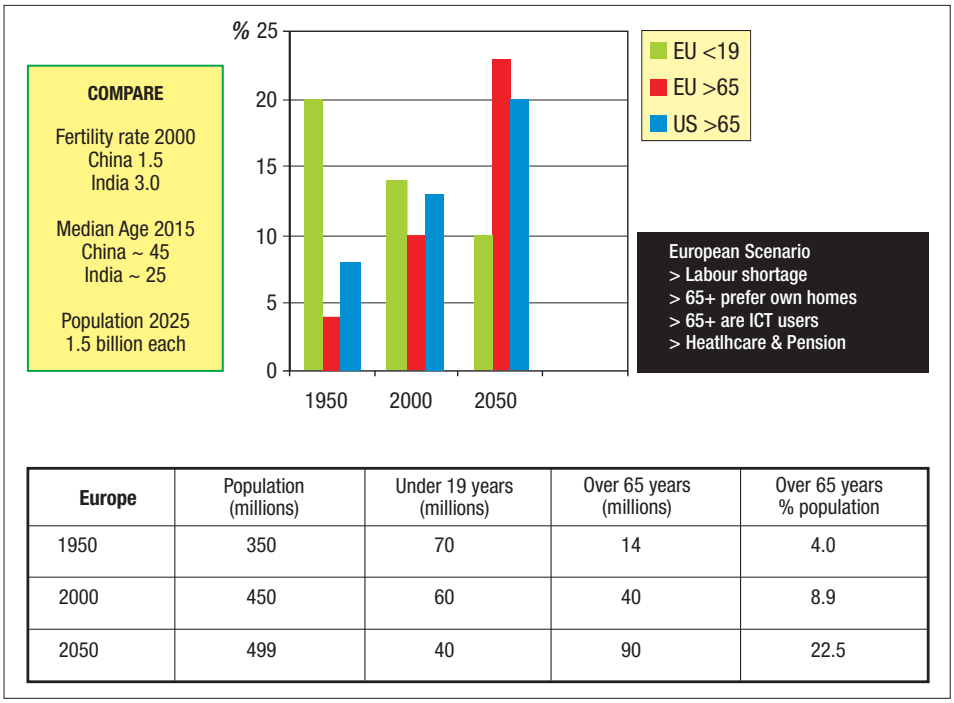


Figure 26. Radical Insight?



Europe	Population (millions)	Under 19 years (millions)	Over 65 years (millions)	Over 65 years % population
1950	350	70	14	4.0
2000	450	60	40	8.9
2050	499	40	90	22.5

Figure 27. Is Age an Asset in the "Grey" Market ?

tion (urban or metropolitan zones) compared to Wal-Mart locations in non-urban or rural markets (USA).

The demographic spread of the point-and-click shoppers are rapidly changing as is the profile of video gamers. Semi-retired septuagenarians are increasingly the partners or opponents of the teenagers and grand-children in networked video games. The aging baby-boomers are mentally agile, physically active and ICT-philic. It is this change that shall create new markets for products and services in a manner that will be driven by indicators outlined in figure 27. In my article (1), the issue of healthcare was prominently mentioned and it appears that some countries are following similar paths, particularly Japan.

What fascinates me about Japan is the fact that they seem to rapidly create proof of concepts (POC). It is therefore rewarding to find at least two of my ideas already as POC projects in Japan. In the year 2000–2001, during weekly visits to Tokyo, I had discussions with a variety of strategic think tanks on use of RFID. One suggestion concerned data sharing as a mobile service for RFID tagged objects. Several months later, SAP Labs Tokyo forwarded me a link to NTT DoCoMo that unveiled a service for RFID tagged objects.

The suggestion (1) to use nanosensors in remote healthcare "sense and then respond" mechanism may have found an outlet through Synclayer, a Nagoya based cable TV & LAN integrator. According to the Economist of 3 December 2005, it has developed a means for the elderly living in their own homes to use a device that takes basic medical measurements (such as, blood pressure) and transmit them to a local health database. Synclayer also makes a sensor that can be placed, for example, on the refrigerator door, to send a message when ever the door is opened. The latter is similar to an Intel initiative in Oregon (USA) which uses strategically placed RFID tags on kitchen cabinets and other areas to monitor eating or other indoor activities of Alzheimer's patients who stay in their home.

In Japan, with over 25,000 people over the age of 100 and another 30 million (25% of population) waiting in the wings to join the over 65 club by 2015, the "grey market" offers attractive business opportunities, such as, for Synclayer. Importing "gaijin" nurses may not be a long term solution in an immigration averse political climate. However, in 2004 the Government of Japan issued 80,000 visas for "entertainment" purposes to young Filipinas.

But the suitable high tech response to the needs of the Japanese elderly are evolving from the research on anthropomorphic robots developed for service. Already precursors are available in the market, such as the Snuggling Ifbot and Primo Puel, an interactive doll, which has become an unexpected hit with elderly single women although it was designed for boy-friend-less young girls. Equally appealing are the common sense solutions pioneered by the appliance maker Zojirushi, a brand trusted by millions of Japanese for rice cookers and electric kettles. iPot, developed by Zojirushi in collaboration with NTT DoCoMo and Fujitsu, has a wireless device which transmits a message to a NTT server each time the water-dispensing button is pressed. Then, twice daily, the usage record is sent to designated

mobile phone or email address of family, friend or health care provider.

The implication for e-business or any business is that making targeted products for an ever expanding 'niche' is one mechanism for businesses to grow profitably through innovative collaborative services. Elderly in Japan and in other affluent nations are likely to live healthier lives and may spend more on services than on goods. The average Japanese in their 60's has total net assets of ¥21 million (USD 200,000).

5.1.3 Connecting Bits to Atoms: Is Auto "Mobile" Platform an Innovation Down the Toilet?

In 2004, losses of €2 billion ($2.5billion) in cars for Fiat (passenger cars account for just under half the company's €49 billion in sales) dragged the whole Fiat group into a €1.6 billion loss. In 2005, the car division of Fiat may report an operating loss of around €360 million (but the Fiat group as a whole is expected to make a pre-tax loss of about €129 million buoyed by profits from its truck and tractor divisions). In October 2005, Sergio Marchionne, the Canadian-Italian who is the new chief executive of Fiat Group, reported a 70% fall in the group's third quarter loss (compared with a year earlier). With $2 billion from GM (penalty paid to Fiat in 2005 to scrap the ill-fated GM-Fiat alliance) and the conversion of €3 billion-worth of maturing bank loans into equity, Mr Marchionne is trying to rebuild Fiat's passenger automobile business, panel by panel. Instead of closing plants, Mr Marchionne is taking advantage of the surplus workers parked in state-run unemployment schemes to engineer an investment of €10 billion over the next four years to bring out 20 new Fiat passenger car models.

Risk pooling and collaboration are the drivers. Future Alfa Romeo's (Alfa 159) will be made from the same basic platform, to reap economies of scale. Maserati will be repositioned at the top end of the Alfa range in the spirit of risk pooling to share components with the Alfa platform. The spirit of collaboration is in high gear at Fiat with three alliances with PSA Peugeot, a new venture with Ford to build cars in Poland, a licensing deal with Suzuki and talks of cooperation with China's Shanghai Automotive. Fiat may introduce even more changes in Europe's fast lane by transforming its vision into reality to build cars in collaboration with India's Tata not only in India but also extending the Fiat-Tata collaboration to build automobiles in South-East Asia as well as Europe.

Should we be impressed with this story from The Economist of 3rd December 2005 outlining the unimaginative traditional risk-averse re-engineering of Fiat's passenger car division through Method Marchionne? It may be what the strategic gurus at Harvard Business School may pontificate or the bean counters in McKinsey may prescribe. It may be worth a reminder that according to Prof Clayton Christensen of Harvard Business School, McKinsey "is able to crank out high-quality work year after year because its core capabilities are rooted in its processes and values rather than in its resources (vision) … these capabilities of McKinsey also constitute its disabilities. The rigorously analytical, data-driven processes that help it create value for its clients in existing, relatively stable markets render it much less capable in technology markets" (page 168-169 in The Innovators Dilemma). Critics might argue that getting out of the 'red' is more urgent than exploring new vistas. The critics may be right, too, in the short term. But what shall fuel the flame for potential Fiat car buyers?

The progress of classical automobile engineering (double wishbone suspension, antilock brakes) is slow and increasingly stirs less enthusiasm from buyers. Supply chain optimization and modular engineering doesn't influence Joe Fox. Electronics on the other hand is a high "clockspeed" subset of the automobile industry with remarkably impressive marketing impact. Thus we have witnessed the evolution of NorthStar and similar extensions of GPS in addition to NeverLost or other road navigation aids. Voice-dialing is standard in a few luxury sedans and the status of tire pressure may be monitored by the car "computer" and projected on the screen in a BMW. GE's VeriWise system tracks transportation equipment and vehicles with the aid of onboard monitors, GPS, RFID and other technologies. Music in the car is pre-recorded in some format (CD) or radio-station controlled. Although Norway first implemented the use of RFID tags in vehicles for toll collection several decades ago, not much has changed in the use of transponders for such purposes.

Technology appears to be a driver for automobile sales and thus a multitude of vendors have created individual products or services or diagnostics, with limited or no ability for interoperability or divorced from the use of a common platform that can aggregate products or services for the automobile industry and the consumer. You cannot Skype-out or Skype-in or have access to email (if you need to). If you are 65 and recovering from a myocardial infarction, perhaps your physician would like to keep an eye on you while you are driving but (at this present time) he cannot. Your onboard diagnostic LCD panel may alert you to decreasing level of fuel but cannot guide you to a nearby petrol station (retail gasoline pump). Your authorized Lexus dealer can call you to alert you for service but has no clue whether you have driven 3000 miles since your last oil change.

The innovation in consumer vehicles and automobiles that may precipitate the dispersed services is likely to be catalyzed, as a first step, simply by the introduction of a platform. It could be as unimaginative as a laptop PC in the car with the mouse and menu driven features that every PC user is already familiar with. If I have music downloaded on my iPod and wish to hear it on the speakers, the USB port of the iPod plugs into the PC. If the pressure gauge

reading is alarming, then an auto-Agent locates the nearby service station and offers direction. You can emergency Skye-out if you are trapped in a ditch or Google the license plate of the car in your next lane to get the name of the glorious being driving the convertible Mini Cooper! (OK, you shouldn't do that!)

Are you impressed with my unimaginative suggestion to get a PC to aggregate auto products and services? Is that innovative? Note: innovation may also arise from using common things. Think different! Think disruptive! To think about the next innovation in the automobile industry let us take a lesson from bathroom fixtures by TOTO. What TOTO has done for the everyday toilet offers a template for consideration by the auto industry.

The porcelain toilet bowl (top right hand corner in figure 28) may not have changed over the centuries but TOTO of Japan has certainly created an intrigue for its use. The dashboard (bottom left) for the toilet bowl may be mistaken for modern car control panel with its shiny knobs, buttons, switches, USB port, LEDs, radio, LCD panel, digital clock and several other functions inscribed in Japanese. Could I read my e-newspaper on the LCD panel while on the throne? Gives a whole new dimension to reading in the toilet, doesn't it? However, I had to request the cheerful help of the Duty Manager at the Sheraton Taipei in Taiwan to enable me to operate the controls.

TOTO has created an aggregate platform that not only flushes the toilet on command but offers the potential to accomplish a whole slew of chores and can act as a conduit of services. The automobile in the affluent world is emerging as an extension of our home or office. We already know how to do to turn on the dishwasher from the car or read the electronic grocery list (1) on the refrigerator before arriving in the grocery store pick-up bay on the way home. What mobility needs is not a separate set of rules and multiple handlers (point of contacts) but an "organizer" that acts as a central clearinghouse. The automobile industry may need this platform as an aggregator for service providers to converge and product manufacturers to integrate. Automobile manufacturers can upgrade the fuel injection algorithms through software downloads to the PC platform or you can insert the memory stick in your PC and hit "install" to get the job done. Send your blood pressure reading to the physician without getting out of the car. Evolution of the e-business model in the automobile industry for services, diagnostics, maintenance and new product marketing is in need of innovation and we need to look no further than the toilet to be inspired to innovate.

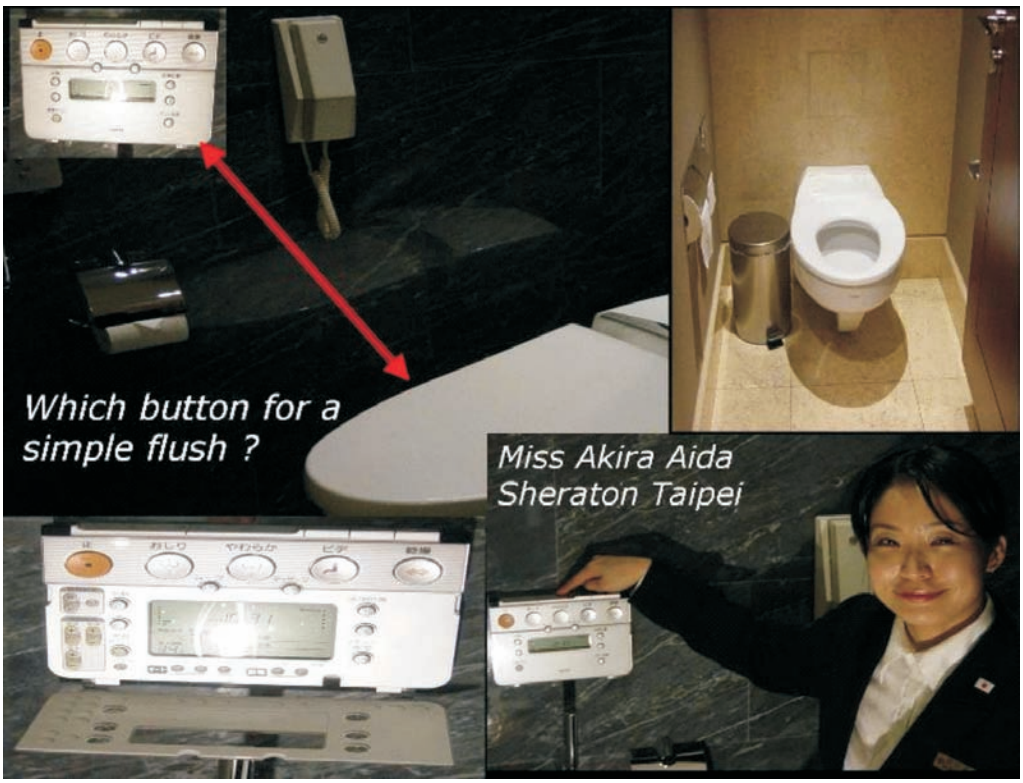


Figure 28. Innovation Down the Toilet?

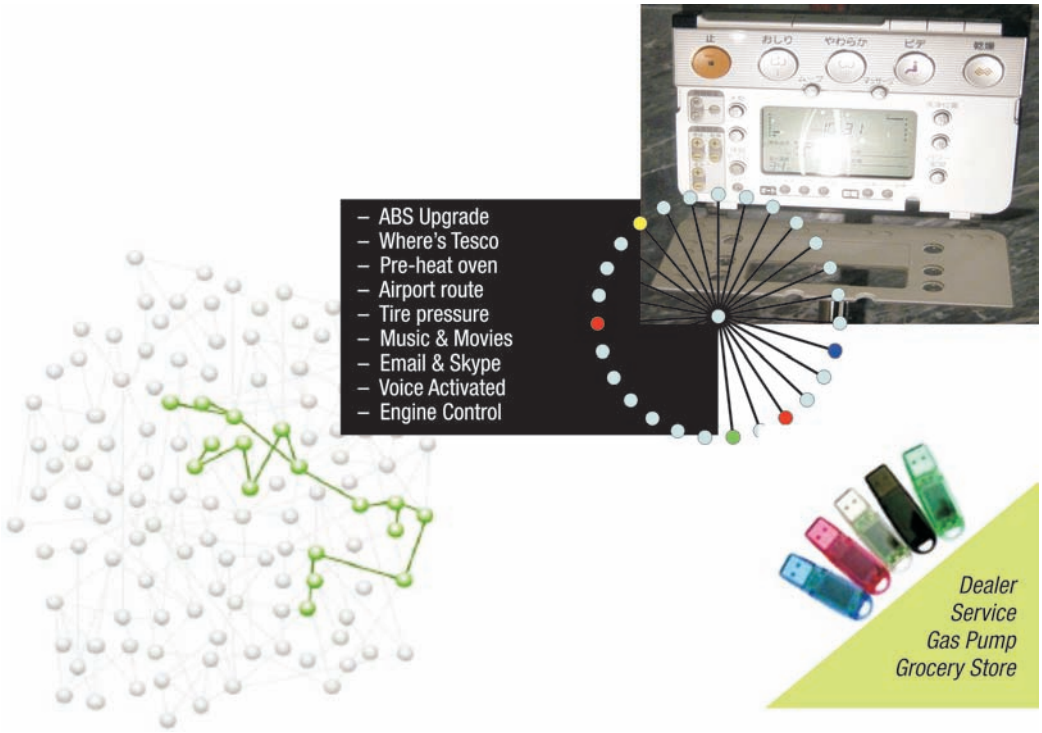


Figure 29. Paradigm Shift in Interoperability?

5.1.4 Is Interoperability a Catalyst for Change or is Change a Pre-requisite for Interoperability?

Interoperability may help the onset of pervasive computing with significant benefits for the commercial sector from reduction in information asymmetry. The $600 billion savings opportunity cryptic in the global logistics operation mentioned in the 'introduction' is one example. However, software peddlers eager to sell products are at the heart of the vicious cycle of problems that lead to further inefficiencies through lack of interoperability stemming from proprietary systems. While the latter is a business strategy of software vendors to "lock in" customers, the inability of users (businesses) to successfully challenge such efforts are not primarily technological, but sociological. In the narrowest sense, if we consider innovation to promote interoperability, it is possible to make it happen but the movement necessary for adopting such innovation will be minimal unless innovation is connected to change (hence, our cultural heritage). Without change, innovation belongs to the problem set rather than the solution set.

Critics may cite the scholastic research of William Easterly in the Elusive Quest for Growth and vociferously argue that social or cultural heritage are lesser impediments than economic incentives. As evidence, critics may choose to point out the quantum leap of the open-source world wide web browser demonstrated in 1990 by Tim Berners-Lee of MIT (while still at CERN, Geneva) and compare it to the pathetic rate of progress of Linux (first entirely GNU operating system) released by Linus Torvald in 1991. The world wide web consortium (W3C) standards (HTTP, HTML, XML) provides a platform for vendors to build for-profit services and hence the business incentive for adoption of W3C standards.

In sharp contrast, Linux OS is a "free" operating system if one can use it but the marketing avenue for Linux OS is feeble given that the sale of Linux OS is not supposed to be for-profit. In addition, the services that most users expect to use (word processing, database, spreadsheet, powerpoint) are stunted in their development because developers have almost no incentive (except altruism) to create products that cannot be used unless the platform on which the product is based (Linux OS) has reached sufficient penetration to create market demand. Thus, it reasons to forward the opinion that economic incentives are the true catalysts for growth from innovation.

Economic incentives for interoperability are necessary to stimulate the innovative forces dormant within ubiquitous computing. We have talked about ubiquitous computing in the industrialized nations for decades but the conventional reasons for its sluggish growth may be readily attributed to the "dead weight of old technology" and archaic forms of educational thought as well as resistance to change of hab-

its. However it is more than likely that lack of proper economic incentives has paralyzed the progress of ubiquitous computing. Ubiquity of computing cannot reach pervasive status unless systems are interoperable enough to exchange, understand, compute and distribute information. Such architecture calls for standards of interoperability that are globally acknowledged. For the past 15 years, the open-source Linux operating system has languished while the Win-Tel duopoly operates as the dominant monopoly.

It is remarkable that the new emerging economies (but not the Western nations) are pushing the envelope through their practise of some forms of ubiquitous computing, albeit, limited in current scope, in selected areas and between pre-organized users, using selected open source platforms that are largely incompatible with the mainstream. Leaving aside the socio-economic parameters, in general, widespread practice of ubiquitous computing requires ubiquitous programming. Ubiquitous programming is of necessity popular programming. It is disquieting that the populace in industrialized nations is not yet with the program. While ICT affinity within the elderly is gaining grounds, it remains a fact that a significant percentage of people above a certain age rely on their children to program their VCRs while arm-chair computer science policy wonks continue to pontificate about the magic bullet that will cause people to script correct programs without having to think. Instead, we need policies to enable how to teach people (students) how to think, provide tangible building blocks to create (ad hoc) valuable programs and learn how to ask the right questions to better utilize the cheap processing power of microprocessors.

The role or question of change repeatedly alluded to (above) is difficult to gauge, initiate, manage and measure. But change happens. Several observations discussed here provide some evidence. For example, economies that were teetering on the verge of hyperinflation only 15 years ago are now preparing to adopt the Euro. A decade ago, simply getting a truck to Poland may have involved a weeklong wait at the congested and corrupt border crossing. But that view of Eastern Europe (“it is like Africa but closer”) is changing. Supply chain adaptability is a driver for increasing interest in Eastern Europe despite lower cost of operation in China, India or South-East Asia. Zara is changing time to market trends through its “fast fashion” trend. eBay’s purchase of Skype for $2.6 billion bodes well for its Scandinavian founders who used programmers from Tallinn, Estonia rather than California’s Silicon Valley or Bangalore, India. Skype employs 130 highly paid under-thirties mostly (four fifths) from Estonia. On the other side of Tallinn is Elcoteq, makers of mobile phone handsets for Nokia and other behemoths. Elcoteq’s middle-age workforce of 3000 performs repetitive, semi-skilled tasks, is modestly paid and entirely local. However, increasing prosperity may force changes. Elcoteq may have less than 5 years before it could become necessary to switch production to Russia to reap similar cost benefits.

Of course, lack of change in bureaucracy is still the single most overwhelming deterrent for locating operations in Eastern Europe despite its crucial geographic proximity to major affluent European nations. For example, Sciant, a Bulgarian software company, is opening offices in Vietnam plagued by administrative burdens in Bulgaria. Sciant employs three full-time employees necessary to deal with arcane record-keeping requirements for the state and getting the right stamps on the right paper for the sleepy customs service which takes two days or longer to release an incoming shipment. “I have a friend whose things were stuck in customs for four months” comments Steve Keil, chief executive of Sciant in Bulgaria. How can interoperability help without changes in the bureaucracy?

5.1.5 Can Standards Drive Interoperability?

It is rather difficult to institutionalize change and hence the quest for alternatives to bypass this quagmire in order to avidly pursue interoperability. Ironically, a standard is impotent without adoption and resistance to change delays adoption of standards. Thus, more than a century later we still have to switch between 110 Volts and 220 Volts or frequently seek electrical adaptors when travelling between countries even on the same continent. Therefore standardization is not the panacea that one is lead to believe yet it serves a fruitful reductionism approach. It reduces the chaos to an acceptable number of choices and allows a handful of mechanisms to be created that ensure ‘connectivity’ between standards, that is, interoperability, between a group of standards. In other words, it is better to be a part of an ecosystem of global standards and optimize collaborative processes or systems interoperability based on such an ecosystem. Hence, it may be an useful exercise to appreciate the process of emergence of various standards through the lens of history (excerpts from Tom Gibbs address to the GCI).

In 1855, Henry Bessemer established the metallurgical process which allowed the manufacture of high grade steel. Rapid improvements in rail technology were possible with steel but several forces held back the introduction of the railroad in a manner not uncommon from the Luddites who opposed introduction of technology in the textile industry. The railroad dissenters came from a number of public avenues including Canal owners who had only recently finished enormous investments to develop the Erie Canal in New York State (which arguably led to the creation of New York harbor as the port to the world). Canal owners of the day were quoted in the Boston Globe in the late 1820’s that “there would as likely be a rail road to the moon as one that would link Boston to New York.”

Finally, railroads were made possible by the use of two standards: rail track gauge and time zones. The evolution of rail transportation was largely funded by individual entrepreneurs and they attempted to compete by winning share with unique gauge which locked the other company out, in much the same manner that software vendors use proprietary practices, today. The issue with time zones stems from the reluctance of the general population to adopt a standard time citing the need to optimize local agriculture to the position of the sun.

Great Britain was the first country to adopt one standard time. William Hyde Wollaston (1766–1828) suggested the idea and it was popularized by Abraham Follett Osler (1808–1903). The first railway to adopt London time was the Great Western Railway in November 1840. On 22 September 1847, Railway Clearing House, an industry standards body, recommended that GMT be adopted at all stations. By 1855 the vast majority of public clocks in Great Britain were set to GMT. The last major holdout was the legal system, which stubbornly stuck to local time for many years, leading to oddities like polls opening at 08:13 and closing at 16:13. The legal system finally switched to GMT when the Statutes (Definition of Time) Act took effect through the Royal Assent on 2nd August 1880.

Standard time zones were instituted in US and Canada by the railroads on 18 November 1883. However, Detroit kept local time until 1900 when the City Council decreed that clocks should be put back twenty-eight minutes to Central Standard Time. Half the city obeyed, half refused. After considerable debate, Central time was adopted by city vote in 1905. Standard time zones were established in the US by the Standard Time Act of 19 March 1918.

It is interesting to note that standardization of time in specific time zones in US and UK required 30 years or more for adoption. A study conducted by Norman Poire also reveals (see figure 30, below) that it takes about 30 years for new technologies to be adopted. One reason may be that it takes an active generation to retire before the younger generation can adopt the advances from and reap the benefits of innovation.

5.1.6 Concluding Comments

Scores of personal computers linked together can outperform a giant mainframe, argued Chancellor Angela Merkel in her first speech to the Bundestag on 30th November 2005. That was the image this former physicist chose to describe a fragmented programme that promises many little steps in the general direction of reform, rather than one big leap.

Innovation is a collective process that stems from confluence of ideas, concepts, tools and technologies rather than one Big Bang. Biology provides important lessons in this regard. Distributed computing, alluded to by Chancellor Merkel, is a rudimentary form of our understanding of the memory and visual system of Octopus that leads to high maneuverability of the arms and the capacity of the peripheral nervous system to perceive and process chemical and tactile information. The coordinated propagation of the bend and the neuronal activity is achieved by local feedback from propreioceptors in the muscles.

In other words, the Octopus is coordinated in its local and global optimization. The latter is extremely difficult to

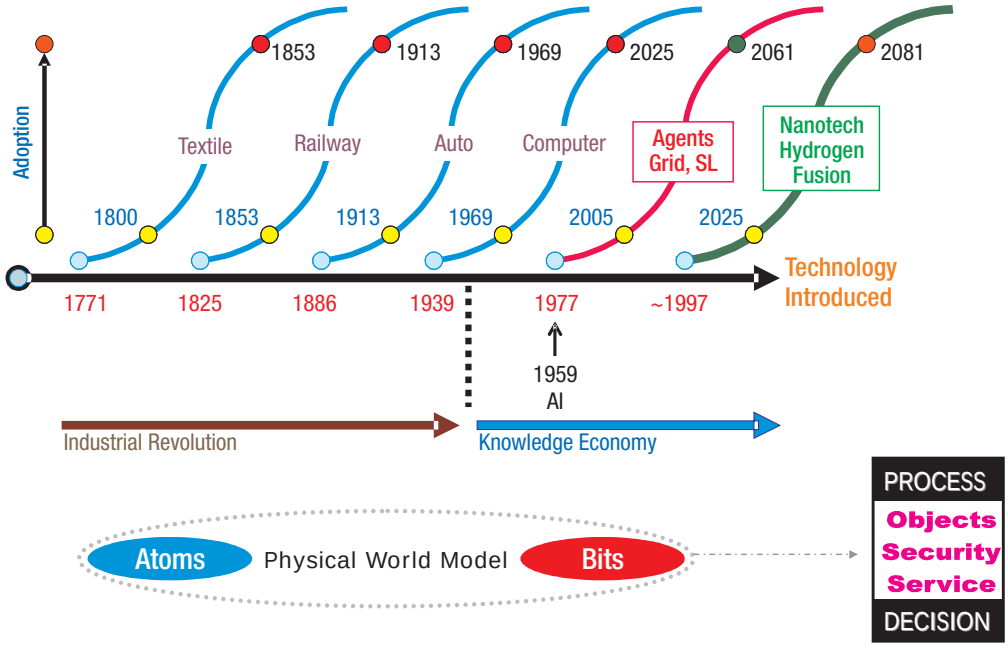


Figure 30. Why does it take three decades for adoption?

achieve for decision systems and leads to monumental inefficiencies. The stomata in plant cells also offer an advanced system for distributed computing. The ability of ants to help routing algorithms is well documented but there are many more lessons from the ant. Decision systems and the humans involved in their design might find it stimulating to explore biological systems in search of innovation and interoperability which is key to global business.

References

1. Datta, S. Adopting Decisions, Optimizing Facts and Predicting Figures.
2. The concept of connecting bits to atoms may be traced back as far as Claude Shannon (in 1948 he was the first to use the word "bit" in his paper) and J. R. Licklider (MIT) who lead the DARPA team to create the internet in the 1950's. At MIT, these topics have been explored by Sanjay Sarma and David Brock in the article "The Internet of Things" as well as Nicholas Negroponte and Neil Gershenfeld (Media Lab).

Dr Datta is a Research Scientist with the Engineering Systems Division and the Department of Civil & Environmental Engineering at the School of Engineering at MIT. He is the Co-founder and Research Director of the MIT Forum for Supply Chain Innovation which is a joint endeavour at MIT between faculty at the MIT School of Engineering and the MIT Sloan School of Management. The Forum is a global consortium of industry, governments and academia at MIT since 2001. Dr Datta acts in a research and innovation strategic advisory capacity to major industries, governments and multinational agencies. Dr Datta is a past-member of the Technology Board of the Auto ID Center at MIT and currently the Research Co-Director of MIT Data Center that addresses systems interoperability and effective use of high volume data acquired through automatic identification technologies (for example, radio frequency identification or RFID).

6 E-Business Logistics Technology Roadmap

6.1 Introduction

The ELO management team decided to anticipate the prospected future technologies relating to the ELO programme and hence establish a working group to develop a Logistics Technology Roadmap (LTRM). The group of logistics professionals started working during the autumn of 2002. The report describes the goals set and the implementation achieved as well as providing detailed information on the design of a technology roadmap. This English translation is the third version of the report, which has been updated during 2004–2005 according to the feedback received. The original objective was a continuous updating of the LTRM till the end of the ELO programme in 2005. In 2005 the vision was extended until year 2010.

Additions to the ELO technology roadmap have also been made based on the ELO researchers' seminars throughout the last two years of ELO and on the basis of a public workshop organised on 18th March 2003. The last public workshop was held on 17th March 2004, concerning the SMEs' role and how they cold benefit from the development of SCM in general and how logistics service providers could support their business case.

The Logistics Technology Roadmap (LTRM) is an initiative of E-Business Logistics (ELO) Technology Program with the support of Tekes. The report reflects the views of the working groups. It aims to assess technologies, innovations and conditions that have the greatest impact on the e-logistics sector and to develop an action plan for industry, academia and ELO Program.

Working group

The first roadmap was prepared 2002 in a working group consisting of the following logistics researchers and other professionals:

- Pekka Aaltonen, Logy Comptence Oy
- Jari Gröhn, Ministry of Transport and Communications
- Heikki Kekäläinen, Logistra Consulting Oy
- Heli Laurikkala, Tampere University of Technology
- Heidi Lindroth, Finnish Funding Agency for Technology and Innovation (Tekes)
- Anita Lukka, Lappeenranta University of Technology
- Vesa Salminen, Technology Industries of Finland
- Kari Tanskanen, Helsinki University of Technology
- Tiina Aaltonen, Logistra Consulting Oy (secretary)

The following people have contributed to the latest update in addition to the workshop participants:

- Heidi Lindroth, Finnish Funding Agency for Technology and Innovation (Tekes)
- Heli Laurikkala, Tampere University of Technology
- Ismo Mäkinen, Concello Consulting Oy

In addition several other people have contributed by providing information and editing the report text. The ELO Program wishes to thank them for their valuable contribution.

The last revision of the LTRM was prepared during 2005, utilising the Delphi method. A set of statements was collected from various sources and classified in three groups by Finnish logistics experts and researchers in workgroup meetings. The criteria for classification were the materialisation potential of each statement by year 2010. The Internet was used for the second round for updating and completing the work. The results of the Delphi work is presented in appendix 3.

6.2 Purpose and Goals of the Logistics Technology Roadmap

The first version of LTRM was published in spring 2003 (in Finnish). Its main focus is on the four key areas of the ELO Programme. In general a technology roadmap is a mapping tool prospecting business environment and forecasted changes. Roadmaps are also prepared for a particular line of business on a national level in order to point out directions for publicly funded research and technology programmes.

Constructing a Logistics Technology Roadmap was regarded useful for the following interest groups:

- The ELO technology programme (management group, programme manager, Tekes), directing the programme and prospecting the coverage of started projects using for example GAP Analysis
- Other future technology programmes of Tekes
- Companies, e.g. as a part of logistics strategy, especially important for companies offering logistics services
- Research organisations and universities to help in building education and research strategies

A general need to outline the logistical field by creating a technology roadmap was also anticipated. This would assist in focusing the most important development procedures. The ELO technology roadmap was also exploited in the evaluation of research proposals submitted for ELO Programme.

The general outline for ELO technology roadmap:

- Mainly to cover ELO´s four focus areas
- To maintain a business oriented view

The objective was to study the factors affecting logistics in the future. The LTRM examines logistics from a broad viewpoint, which includes demand and supply chains and –networks. The time span covers 2002-2010.

The e-logistics technology "roadmap – 2010 working group" as the work was first called, was based upon the "Fast-start TRM process of "Cambridge University for Manufacturing. A detailed description of LTRM working process and Technology Roadmaps in general is included in the appendices 1 and 2.

Implementation

The working group followed the selected roadmap structure and first produced the purpose layer "Why" in a brainstorming session. The content was segmented and prioritised in the following working group sessions. The brainstorming method was also found useful in developing other layers (What and How). Product and service features, which have the potential in addressing the market and business drivers, were considered in accordance with the ELO focus areas. The technology layer was developed and grouped into areas, which could deliver the desired product and service features. Finally risks and threats were considered. The completed roadmap is included in appendix 2. In Figure 31 are shown the different stages of LTRM implementation.

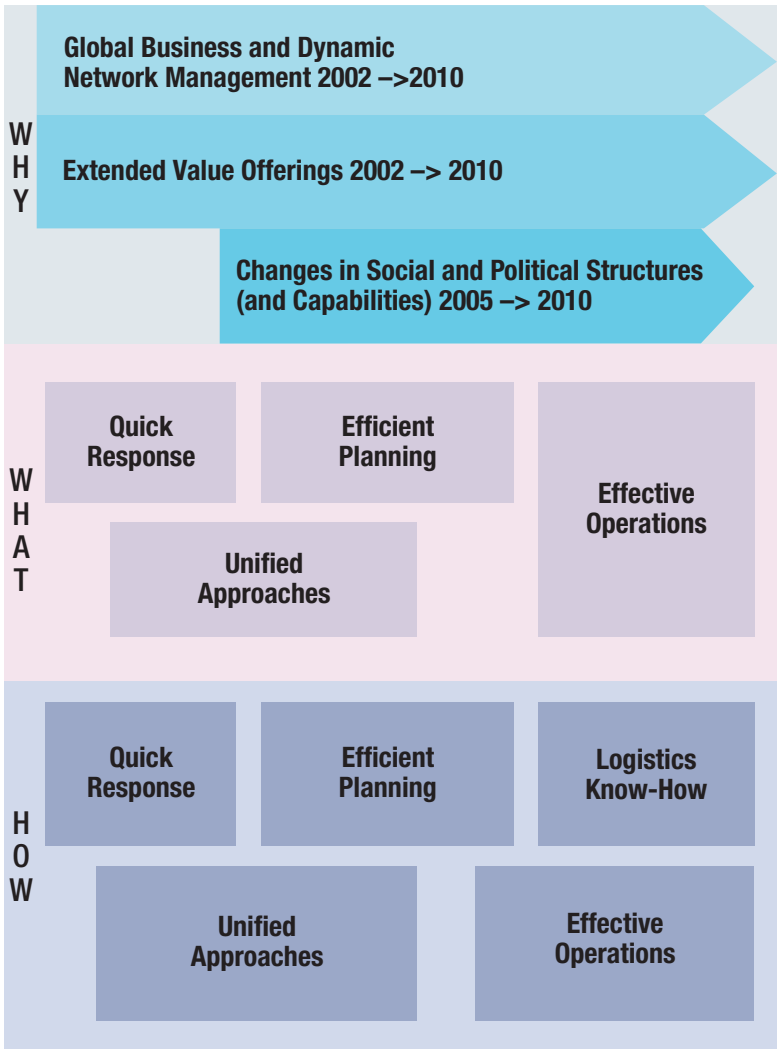


Figure 31. Technology Roadmap – levels.

6.3 Changes in Business and Market Drivers

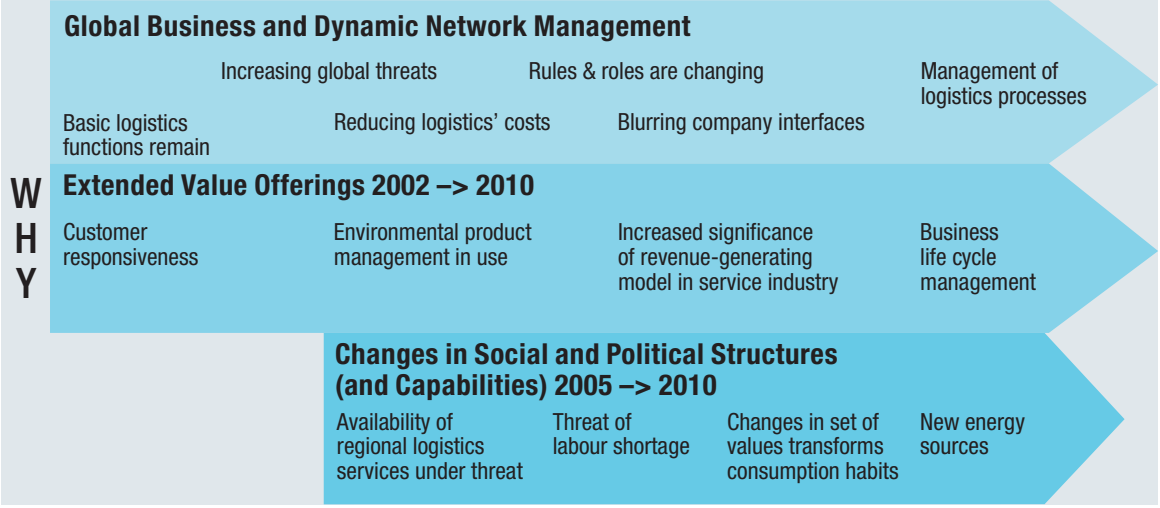
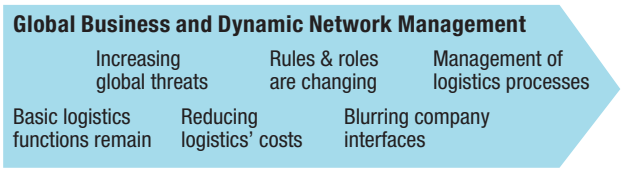


Figure 32. Changes in Business and Market Drivers grouped into three sections

6.3.1 Global Business and Dynamic Network Management



With growing globalisation, the business roles and rules of the "game" will change in enterprises during the next five years. Growing competition is also a fact to be dealt with. Labour intensive production will be located in low wage countries e.g. in China, India, Russia and Eastern Europe. This fact will have a major impact on management of supply chains and logistic costs. Business know -how will concentrate globally on the principle that every enterprise does only the things it does best itself and thus gains the most competitive advantage.

Planning and realisation of total logistics chains will become difficult and its management will be more challenging; even small deviations in a complex chain could make the whole business unprofitable. This was the case for a consumer product company who decided to outsource manufacturing to India. Before doing so, it carried out a landed cost analysis and calculated that the lower production costs would save the company $3 million a year. However after the move to India a dock strike broke out and lasted for 10 months. The company then had to transport products to the United States by air. In just one month the company spent $10 million on air transportation. Even pure logistics costs can be surprisingly high. In China logistics costs on average are 40 % of cost of goods sold (Vision, October-November 2005, Caterpillar Logistics Services). In Finland logistics costs are on average 13 percent of companies turnover (Logistics Survey 2006, Ministry of Transport and Communications), which is a relatively high figure in international comparison. In Europe according to a recent study published by ELA logistics costs were only between 5 to 6 percent.

Outsourcing of logistics services will continue. On the other hand enterprises feel that they need to manage the entire logistics process from raw materials supply to recycling logistics (from earth to earth). Service providers from abroad are showing a fresh interest in Finnish service markets. This trend is believed to be continuing due to globalisation. Logistics services are globally still very fragmented and this fact is emphasised in Europe as there is no single service provider who could cover the whole continent alone. More mergers and acquisitions are expected and this will also have an impact upon Finnish markets.

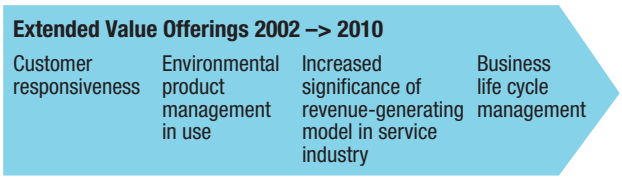
Minimising the logistic costs in order to retain competitiveness can be seen as an ongoing process in the 21st century. This is especially important for Finnish exports. The latest reports indicate that logistic costs have started to grow on both sides of Atlantic. Efforts to reduce logistics costs will continue throughout this decade even if in some industries there will be a shift in development resources from costs cutting to service improvement. A recent European logis-

tics survey indicates that logistics costs and inventory reduction are the most important challenges today for the majority of companies. Cost effectiveness can be achieved by utilising new technologies wisely and making use of existing systems better. In addition organisations have to make sure that employees' logistics know how and information systems skills are up to date. The development of improved forecasting solutions and improving warehouse management systems (WHS) could help to lower logistics and inventory costs. New advanced ICT technologies and methods have a central position in this development work. Technological changes will accelerate and the lifecycle of technologies will get shorter. The implementation of new technologies in logistics can be slow because organisations´ ability to learn and adapt them varies greatly. This means that the level of change resistance and time required to learn new methods must be taken into account in the initial planning phase. In a long supply chain the distribution of benefits (win-win-win) will be a major issue and knowing how to work it out will speed up the implementation process. Company interfaces are becoming blurred as future competition takes place between supply chains or networks. Product responsibility is emphasised in the client interface. It is understood that the company responsible is the one stated on the logo which is attached on the product. Consumers are looking for brand names they can trust especially if the retailer is unknown to them. Product trust is a key element in the decision making phase. The image of the Logistics Service Provider could also have an impact on the success of the supply chain as sometimes the truck driver is the only person who has a direct business relationship with the end user.

The basic functions of logistic operations prevail (right product, right amount, in the right place, at the right time etc.) and will become even more important when companies have started to outsource their manufacturing to low cost countries. A recent Bain & Co study showed sourcing from low cost countries offers 10–35 percent savings in product costs. However, a 20 percent reduction in purchase price could lose its appeal if the totals logistics costs and the lead time variability is taken into account.

Growing threats like war, terrorism, energy problems, pollution, changes in climate, traffic congestion etc must be taken into consideration and alternative plans should be drawn up. History has shown us that implementation of new technologies will be faster when there are threats of crises'. Investments in resilient and agile supply chains not only reduce risks but also increase competitiveness.

6.3.2 Extended Value Offerings



All parties in the supply network have an increased need to manage their overall life cycle as best they can. Enterprises wish to secure growth and improve profitability by increasing services throughout the product life cycle offerings. The product life cycle is seen from the customer's point of view – thus covering all phases from initial planning to implementation, maintenance, updates and the final discharge. The suppliers are not only producing the service but will also be taking an overall responsibility of the product's lifecycle performance.

In profit generation models the significance of services is growing and having a greater impact. Value is added to the service and not to the product. Logistics services can be seen as products with a lifecycle management of their own. Product and service lifecycle management will be common by 2010.

The environmental management of products will be in general use, following the environmental report issued in 2006. The environmental report includes information for various enterprise stakeholders and interest groups. The report can be included in the annual report or be a separate publication – either printed or published via Internet. Customer orientation is the joint theme in the entire supply network.

Strict recycling and reuse requirements will be imposed. This will create new material flows and the importance of reverse logistics and the associated management will grow. EU environmental directives will have an impact on supply chains. There are two important directives, which affect supply chain planning and monitoring. Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment and Disposal of Waste Electrical and Electronic Equipment -WEEE 2002/96/EC", They are designed to tackle the fast increasing waste stream of electrical and electronic equipment and complements European Union measures on landfill and incineration of waste. Increased recycling of electrical and electronic equipment will limit the total quantity of waste

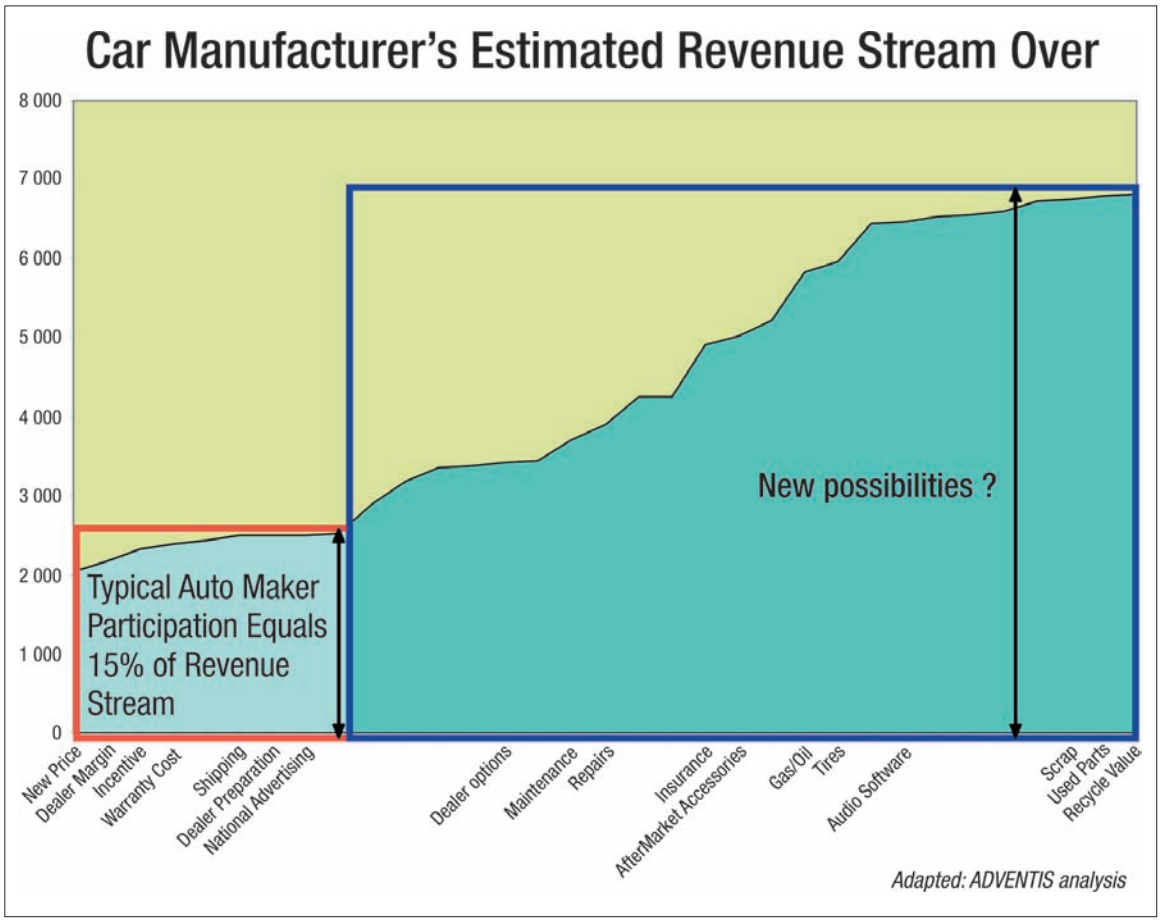


Figure 33. Companies thrive to control the whole lifecycle of the product. The Figure shows an American car manufacturer's share of a car's total lifecycle cost, which is only 15 %. The car industry has recently endeavoured to take over import and distribution chains to receive a bigger portion of lifecycle cash flow. This area has lots of new opportunities starting from insurance and fuel sales to reuse and recycling of car parts.

going to final disposal. The first one has been planned to be in force from July 1st 2006 and the last one has been in force since August 13th 2005 even though it looks like very few EU-countries have started to implement it.

Information solutions will play a major part in helping manufacturers and distributors to comply with these mandates. The EU expects to see records that four kilograms of eligible equipment collected per country resident, per year, of which at least 70 to 80 percent by weight must be recovered rather than dumped, and at least 50 to 75 percent by weight must be actively recycled. As reverse logistics and recycling are normally outside of companies' core competence they are looking to outsource these to a third party. Some European companies have created specific consortiums that will also contract the third parties to recycle and dispose of the end-of-life products. According to a report by Datamonitor, 80 percent of retail returns in the United States are outsourced to logistics companies. In Europe that figure is closer to 15 percent. This indicates that Europe's reverse logistics market is currently quite immature. Reverse and recycling logistics services is only one example on value added services logistics service providers can offer to their customers.

Figure 34. The Greening of the Supply Chain.

- Through legislation or voluntary actions.
- Possible source of competitive advantage.
- Closed loop supply chains.
- Collecting product information (product history, usage data etc.) to be able to manage the life cycle; at EOL to determine the next location, how to make use of the remainders, etc.
- Utilisation of IT-systems, web-portals, agent technology, product identification technologies e.g. RFID and sensors.
- Appointing a responsible party for every product and every lifecycle phase of a product in a supply chain.
- Changes in product development and manufacturing processes, packaging materials.
- Selling services and lease contracts instead of single products, so that products will stay in the company's property and the company can better manage and control the use of the product through the whole life cycle.
- Incentives, how to manage and guide behaviour of end users and other players in the supply chain.
- Return logistics, automated processing of returning goods

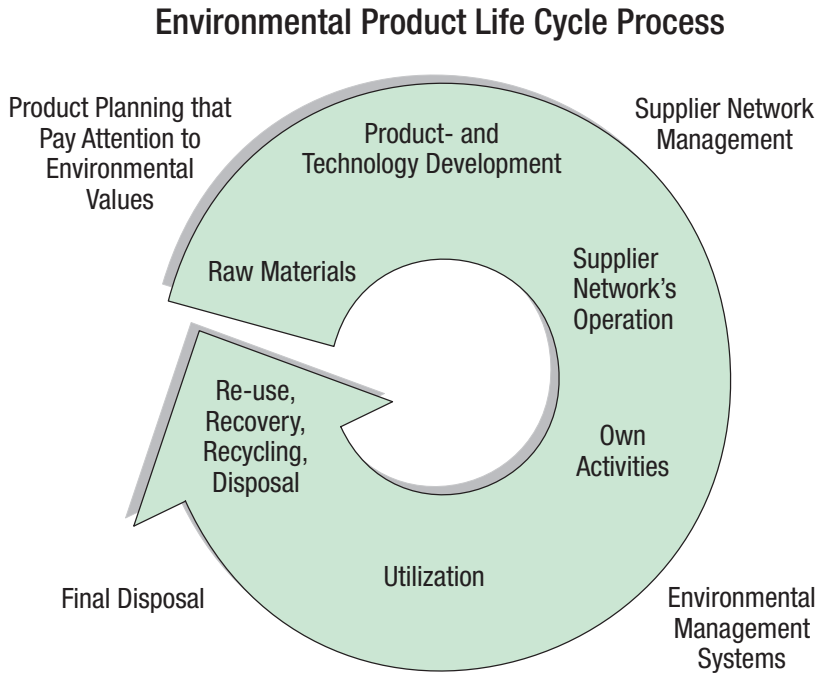


Figure 35. Product design phase takes into consideration the product's environmental effects as a part of supply chain and logistics planning.

6.3.3 Changes in Political and Social Structures

Regional reach and coverage will become a new challenge for the Finnish logistics services. It is important to find reasonably priced solutions by the end of the decade. If this does not happen there will be a real threat of regional inequality due to the sparse population. How to prevent increases in logistics costs due to the decreasing shipment sizes, which will make the material flows thinner? There will be also larger variety of product offerings, which will have a negative effect on the costs of material flows.

Finland is one of the nations where the population is aging fast and the aging population will require new services in the field of logistics as well. More money will be spent on communication and health and less on mass produced products. The trend is to more individual niche goods and services. This will create new opportunities for logistics service providers if they are innovative enough in developing and offering these services in the right form.

Finding skilled employees for logistics services will become a challenge in the future. The EU's working time directive, which regulates truck drivers' working hours has an impact on the transport industry. There is already a shortage of drivers in Western Europe and the problem will increase as transport companies have to follow the rules more closely. On the other hand labour shortage could accelerate development and demand for advanced RTLS solutions, which could help companies to utilise the trucks more effectively. Furthermore, job definitions will change. This will involve retraining and recruiting from abroad. The changing situation will create challenges for political decision-making, labour union, tax officials and immigration policy makers in Finland.

Value changes are going to affect consumer behaviour and these changes will have direct effect on logistics services. (green values, hedonism, non re-cycled products).

New forms of energy use could be available, but no commercial breakthrough is in sight despite of heavy investments. Possible threats will speed up development, mainly regarding regenerating energy sources. All signs indicate that there will be constant oil price increases in the future and this will have a very large impact on logistics and supply chain costs. There are predictions that the oil price will be soon 100 US dollars a barrel and could hit 300 US dollars within the next 15 – 20 years. Growing energy costs affect logistics as follows:

Scarceness of resources e.g. oil. What impacts will the increasing cost of fuel have on logistics and supply chain management? Increasing energy costs will have effects such as:

- Increasing use of inter-modal transportation (use of rail when economically possible),
- Combined shipments, larger delivery sizes, larger assemblies,
- Outsourcing transportation if one does not have enough volumes
- Redefinition of roles, critical activities and core competencies; make or buy decisions, outsource/in-source
- Urbanisation, regional manufacturing and distribution will become general, people buying local products, no more cost savings from producing in distant low-cost countries
- Allocation of more resources to R&D, Innovation and development; emergence of renewable, alternative energy sources and transportation solutions
- Importance of management & control in a supply chain will be emphasized
- Lower service levels in logistic services will be accepted (e.g. longer lead and delivery times)
- Allocation of more resources to develop supply chains; it will be a boom for logistics industry, logistics will be a boardroom issue

6.4 Logistics Offering

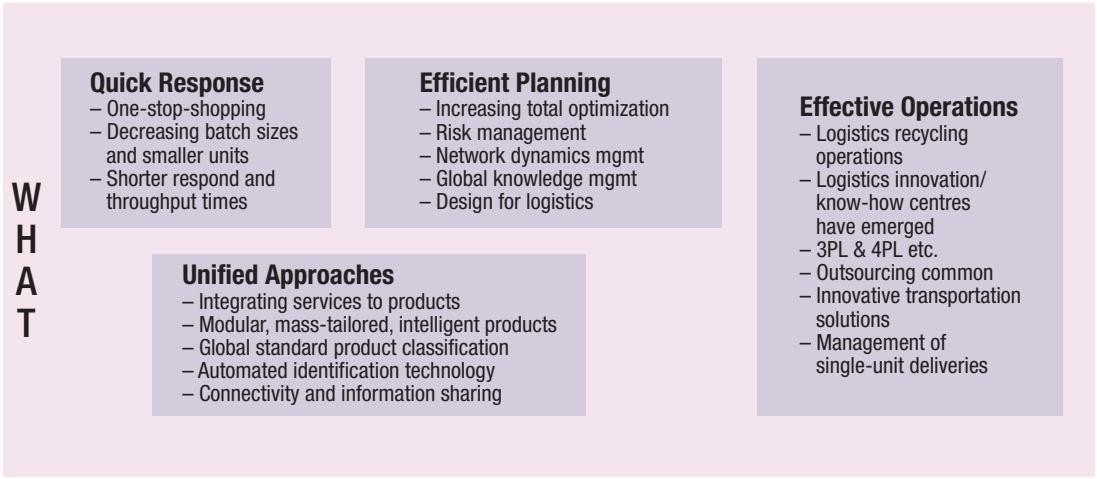


Figure 36. Estimated developments of logistic products and supply of services.

6.4.1 Quick Response

According to surveys, the most important criteria in choosing suppliers is speed, flexibility, quality and price. In addition ethical and environmental factors will play a more important role in the decision-making process.

The Quick Response concept has its origin in the consumer goods market. Suppliers have received demand and inventory level information from retailer's Point of Sale information systems (POS) and have been able to deliver replacements independently without retailer's orders.

Another concept utilised in the industry is called Vendor Managed Inventory (VMI). In VMI solution the supplier provides the customer with a service by taking charge of the replenishment planning and replenishment process. Both retailers and industrial customers have clearly benefited from this arrangement, because a more transparent supply chain has created a simple order-delivery process. Suppliers have benefited from this arrangement by being able to better secure on-shelf availability and to minimise shortages. Suppliers have a time advantage which helps them to react faster and at the same time gives them more flexibility in their "order fulfilling" operations. It will also have an effect on suppliers' and customers' inventory levels. There are also solutions were the inventory is owned by the supplier and the ownership is transferred to the customer when goods are taken from the storage.

Customers (for example retailers or production facilities) benefit from VMI systems through simplified process. Suppliers on the other hand get more accurate demand information and, more importantly, they receive the informa-

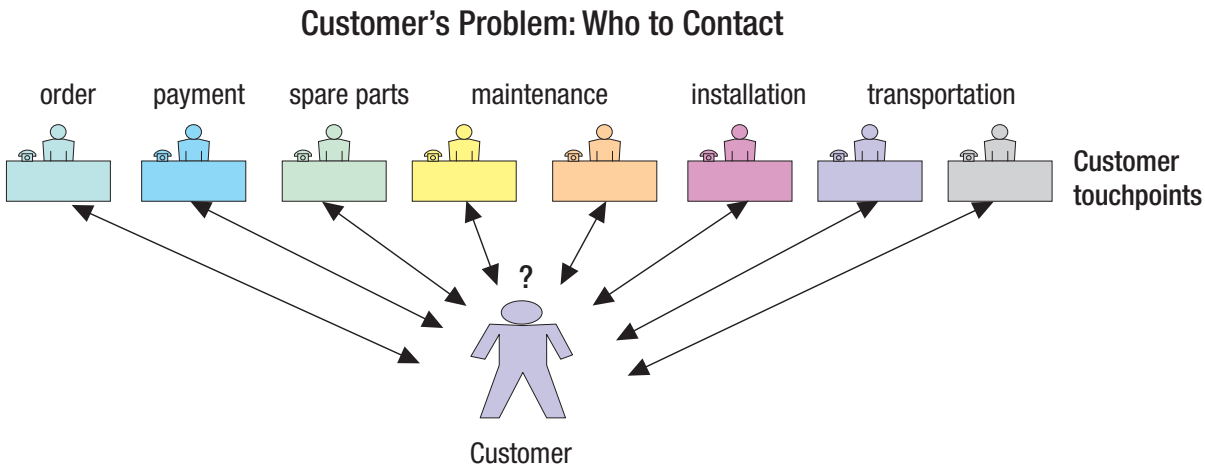


Figure 37. The goal is the so called "one stop shopping" where all required and related services can be supplied at the same time with the customer having only one contact point.

tion earlier. The suppliers´ time advantage enables more rapid reactions and more flexible processes. Some suppliers might try to bind customers by offering VMI. The benefits of VMI were clearly illustrated in the ELO Program's ELOCORE research project, which was carried out by BIT/HUT researchers.

Another example is a risk sharing agreement where supply chain risks (e.g. inventory in the pipeline) are shared between partners. The inventory is higher but the possibility of product shortage is minimized and larger sales are more than compensating the higher inventory costs.

Structural changes in business networks also affect customer management. The end customer might see the supplier network only through an agent, which can be part of an extended company only loosely linked to the network. The customer may have to deal with different parts of the network depending on the issue (warranty, spare parts, maintenance, assembly, transportation, payments, order-delivery process etc.). From the customer's viewpoint all services should be available at one place. Therefore virtual networks need their own operation models and information system supports.

Rapid reactions and fast deliveries are required especially when competition is based on freshness or novelty and the total supply chain throughput time plays a key role.Customers are also ordering smaller quantities to optimise their own order base or consumption. Delivery batches in the physical logistical chain are decreasing, which in turn creates new challenges in organising transportation, consolidating small batches and distribution.

Quick Response

- Reaction speed and simple operation (Quick Response)
- One-stop principle (network regarded as one stop)
- Customer-oriented production (Make to order)
- Diminishing patch sizes, smaller handling/shipment units
- Reaction speed increases and lead times get shorter (Quick response)
- Industry "clock speed" increases

6.4.2 Unified Approaches

- Products including services become common
- Increased modularization and mass customization
- Global standards create challenges
- Automation of product flow using remote identifiers
- Development of RFID-,W-LAN-, Bluetooth-, UWB-technologies
- Automatic data transmission within supply chain

In combining services to products, major changes are expected when new services are added to maintenance and revisions. The basic assumption is that companies buy solutions and non-core functions will be outsourced.

Modular, mass customised and intelligent products including services will emerge in 2010. Modularity increases and logistics and SCM requirements will be taken into account when designing products. Mass customisation will be more common. Mass customisation is defined as the mass production of individually customised products and services.

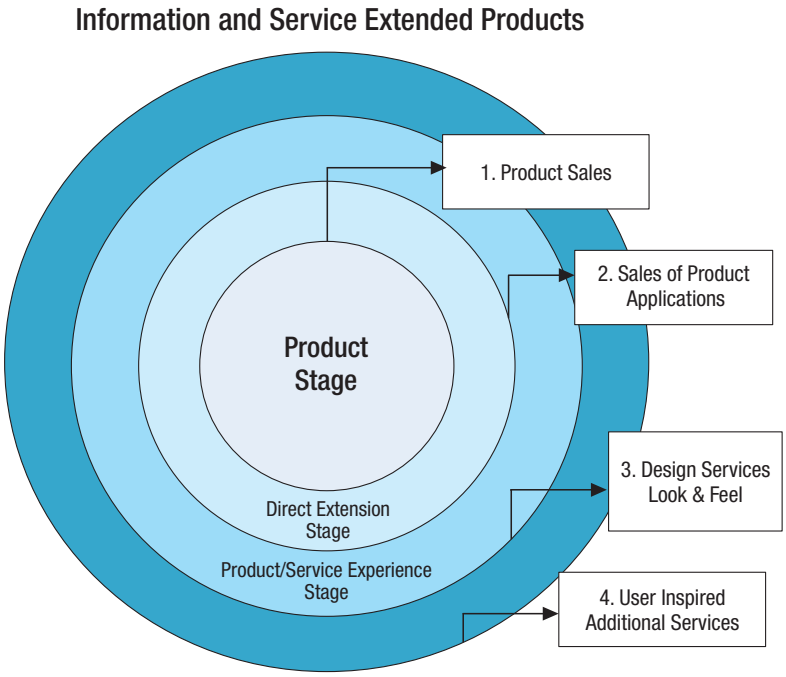


Figure 38. Products will contain more information and services. Information-centred value added services will broaden product offerings.

In a sophisticated form it means meeting each customer's individual needs exactly, but at prices comparable to those of standard mass-produced goods. Mass customisation should make companies more competitive as they become more flexible and can increase the speed of delivery. This will require development of logistic functions as reduced batch sizes tend to increase distribution costs.

Standardised global product classification system will be partly in use in 2010. There will be a stronger demand for common operational standards (e.g. UCC, RosettaNet, SCOR, CPFR) in addition to ICT-standards, like XML.

Automatic identification technology based on the use of radio frequency (RFID) will be used widely in logistics and supply chain operations in 2010 – if the technological problems (e.g. reading distance) have been solved, common standards agreed upon and the cost of passive tags will be below 5 cents each. In addition companies must discover a reasonable ROI for the RFID full scale implementation. The recent introduction of EPC and the global standardisation work on universal product coding (UPC) has encouraged more companies to adapt RFID-technology. The reading problem of tags connected to metal and liquid packages and transport units has been solved in laboratory tests and some pilots will already be completed with successful results. According to various studies RFID technology will be first employed in identification of transport units, product authentication (e.g. drugs, food, livestock, and counterfeit detection). Other areas were RFID is already used are for example libraries, security, closed loop logistic and other internal solutions. At the moment (in 2006) passive tag prices are already below ten cents. The use of other wireless devices for connectivity and information sharing e.g. Bluetooth, W-LAN will also be growing.

- Expensive tags due to small production volumes
- Reliability and cost of RFID-readers
- Lack of common global standards (country specific frequencies)
- Data Security issues
- Intellectual Property Rights
- Consumer fears
- Long payback periods (ROI issue)
- Lack of reliable information

One must remember that tag price alone is not determining whether the investment will be profitable. In addition good RFID architecture and integrators who understand the business processes are required together with reliable calculations to show that there is a reasonable return on investment (ROI) compared for example with bar code. To fully utilise new technologies over a large scale takes years or even decades. That was the case with the bar code too. The impact of mandates and government actions could speed up the implementation process. In the USA Wal-Mart's and the Department of Defence's RFID mandates issued to their biggest suppliers are examples of such cases. In Wal-Mart's case some of its biggest competitors

are following its foot steps in Europe and in the USA. In 2003 Wal-Mart asked its top 100 suppliers to start tagging pallets and cases going to a select group of distribution centres and stores. One of the anticipated benefits of RFID was a reduction in out of stocks. According to a recent Wal-Mart study published by the Information Technology Research Institute in Sam M. Walton College of Business University of Arkansas the RFID effect on out of stock varied by velocity category and, as an average products selling between 0.1 and 15 units per day, RFID reduced out of stock by 30%. This reduction came from simply using RFID data at the store level. Simply by reading RFID tags on cases that have entered the backroom, Wal-Mart was able to modify their manual reactive picking list process and to refill the store shelves from the backroom storage area more efficiently.

In Finland the major retail chains have not seen enough benefits to invest in RFID solutions. Material flow operations and management differ from the way Wal-Mart is operating. In general shelves are not refilled from the backroom even though some limited space is received for storage. Some chains refill the shelves directly from their distribution centres using special refilling teams, which move around the shops when deliveries are being made.

Accelerated employment of RFID could also have positive effects on the development of this technology. Recent government actions are directed towards improving security and in that area RFID applications could have a good market potential.

The majority of published RFID cases are in the retail business where pilots are made to test the technology's usefulness mainly in the distribution end of the supply chain using mostly incremental technology with only very slight changes in processes if required. In the future RFID is expected to be used for example on following supply chain operations:

- Manufacturing processes
- Spare parts and service maintenance
- Supply of raw materials and packaging material
- Transportation and logistics operations (RTLS)

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Positive Retail News

Wal-Mart is the leading retail company in implementing RFID technology. Their experiences are giving hope to the optimists. Wal-Mart recently reported that RFID tags have reduced their out-of-stocks merchandise by 16% at 12 pilot stores as measured against 12 non-pilot stores. They also claimed that the pilot stores were three times more effective in replenishing out-of-stock items than the non-pilot stores.

Gillette seems to have had really positive experiences in implementing RFID. At the recent EOPC Global conference, Gillette reported that they are able to show an RFID return on investment of 25 percent or more over the next ten years. This is really a startling figure, given that the bulk of the industry is still experiencing RFID as net cost to operations.

Is there something else than the depth of experience that explains the success of Wal-Mart and Gillette? When analysing the details of their public statements, a common theme emerges. The RFID initiative became a function forcing the entire organisation to get focused on supply chain efficiency. In case of Wal-Mart, the RFID project began with the objective of increasing accuracy at the store level – and the store managers and employees responded positively. How much did the "Hawthorn effect" affect the outcome?

Supply Chain Focus Boosts RFID

Exciting new advances in RFID technology, coupled with cost reduction of tags, continue to stoke optimism within the industry. A close analysis of the reported data shows, however, that the long-term potential of RFID tags to provide automated data collection has not been the key to progress thus far. Instead, cost savings have been realised by focusing the organisation on supply chain efficiency and using RFID tags as one way to support measurements where they had not been considered before. Companies that simply added RFID tagging to their existing processes will inevitably experience RFID only as pure extra cost. For Wal-Mart and Gillette the cost savings came from the process re-design. RFID's future depends, in a large part, upon an organisation's drive for supply chain efficiency and upon how it involves its processes and people.

Source: Industry Week,Nov.15.2005

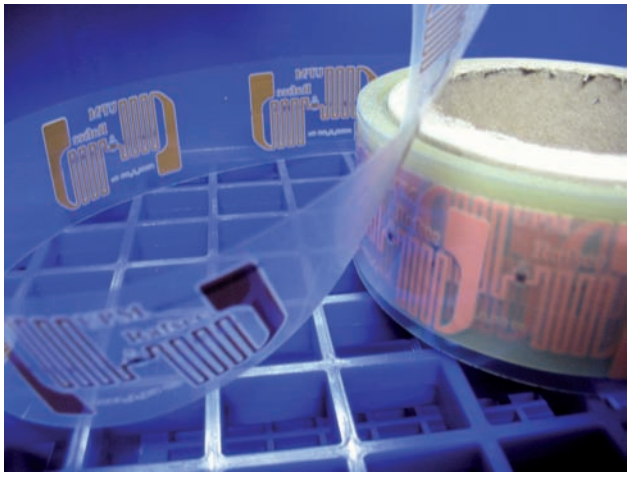


Figure 39. New manufacturing technologies will enable cheap mass production of RFID-tags and competitiveness of RFID.

Figure 40. The use of RFID will become more common in transport units. Here RFID-tags installed to pallets are read. Source: Vilant Systems Oy

RFID technology will develop fast if it can be seen that it will have commercial future e.g. ROI). New UHF-tags have improved the reading distance up to 4–6 meters. Commercialisation of UWB tags (Ultra-wide Band) has also started. The UWB -tag could be a good alternative for data collection and in addition it can communicate longer distances (30–300 meters). According to tests it will also penetrate metal and concrete walls.

There are still many companies who are only just contemplating the implementation of their first bar code system. For many companies the bar code offers a cheaper solution and depending on the business case it could be regarded as a better alternative to RFID. According to some experts RFID will not replace bar code but it will be a complimentary in solutions where a bar code is not applicable. It has also been said that in many published RFID-pilots bar codes are simply replaced by RFID tags offering no extra advantage. It has been perhaps just a quick and easy way to test the technology in the bar code environment without re-designing the existing processes.

Wireless technology like Bluetooth, WLAN and other RF-devices will become common in network connectivity and information sharing and will be used in supply chain applications. In the future multi-technology solutions will be common. One such example is RTLS (Real Time Locating System) which helps companies to monitor and manage their assets in real time. It uses RFID technology to transmit the physical location of RFID tagged objects. The system requires an RFID tag to be attached to each object that needs to be tracked and RF transmitters/receivers to determine the location (GPS) and to send information to a computerised tracking system.

RFID applications will become common as soon as the implementation problems are solved. Expensive tags as a result of small production volumes, reliability of the tags and reading devices, lack of standards (country specific frequencies), security and IP (Intellectual Property Rights) are some of the problems that must be solved. At the moment RFID applications relating to logistics are progressing from the pilot-phase to production on few lines of business in Finland and few large scale implementations have been done in a closed loop environment. A new Finnish study, which will be published in the autumn 2006, indicates that RFID will be used in year 2010 for tracking transport containers and pallet loads and the item level tagging will take place between 2010–2015.

Automatic identification technology will simplify tracking and identification. According to forecasts, RFID will become common in controlling large volumes, automating the material flow and rationalizing processes by the end of this decade. The EPC (Electronic Product Code) standard is part of the RFID solution.

The companies' goal is to synchronize business operations according to customers' demand. Management and steering of material flows in customer centric business by co-ordinating and timing planning, production, sales and distribution so that the logistics requirements are fulfilled are envisaged.

The efficient supply chain and management of the demand network will add service and product value. Value adding activities are demanding a global product classification system and efficient product information management. Product information management system will help to solve product origin and other relevant information needs for the entire product life cycle. Product life cycle management needs a functioning product classification and management of the information is one of the key elements for suc-

Semantic Web

The Supply Network can reach its full potential only if it becomes a place where information can be shared and data processed by automated tools as well as by people. In future programs must be able to share and process data even when these programs have been designed totally independently. The Semantic Web is a vision: the idea of having data on the web defined and linked in a way that it can be used by machines not just for display purposes, but for automation, integration and reuse of data across various applications.

The Semantic Web is designed to interconnect personal information management, enterprise application integration, and the global sharing of commercial, scientific and cultural data. It can offer process transparency across language and geographic boundaries to connect partners even if individual partners define or perform certain functions differently from others.

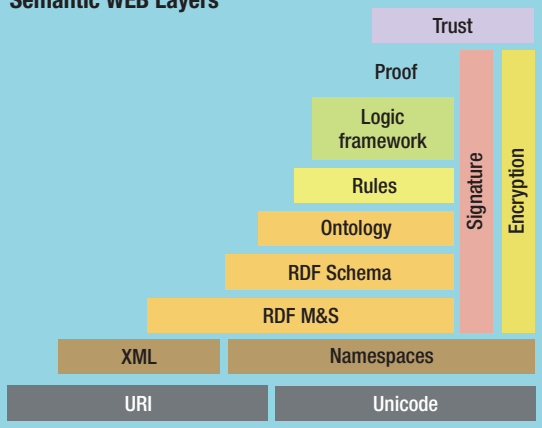
Semantics is a collection of Resource Description Framework (RDF) data (or any other semantic language) which describes the meaning of data through links to ontologies, which act as decentralized vocabularies. In philosophy, ontology is a theory about the nature of existence.

The real power of the Semantic Web will be realised when intelligent agents collect web content from diverse sources, process the information and exchange the results with other programs or data. The effectiveness of such Agents will increase exponentially as more machine-readable web content and automated information services (such as, real time-data) become available. The Semantic Web promotes the synergy between agents that were not expressly designed to work together but can now transfer data among themselves if data comes with semantics. This levels the playing field in terms of the meaning of data, such as, your purchase order is the supplier's sales order.

Semantics also makes it easier to take advantage of a service that only partially matches a request. A typical process will involve the creation of a "value chain" in which sub-assemblies of information are passed from one agent to another, each one "adding value" to construct the final product requested by the end user. To create complicated value chains, automatically, on demand, agents may increasingly exploit artificial intelligence technologies. The Semantic Web will provide the foundation and framework to make such technologies more feasible.

Source: Tim Berners-Lee and Shoumen Datta, MIT

Semantic WEB Layers



Semantic Web Layers as defined by Tim Berners-Lee

cessful business. Product classification based on global standards and a common information management system will improve dynamics and flexibility of the network. In ideal conditions a network could change in unison based on real demand requirements of customers together with suppliers and partners. The unification of processes includes blurring of company interfaces, which in turn makes the setting up of virtual networks possible. Without standard product classification and its management systems changing the networks to cope with customers' changing requirements would be very difficult and slow. The growth of e-business and e-commerce require global standard product classification.

Different industries and even industry sections and clusters are developing or have already developed their own standard business procedures. On the other hand efficient networking requires companies to develop and implement unified processes and models across the industry boundaries. Standard developers are trying to spread their particular standard widely also to other industries. Business processes based on generally accepted standards and models

will help companies to apply the best practices more easily. It will also help to measure and to compare the effectiveness of supply chain operations in a more reliable way. Often the new emerging information and communication standards are strongly connected with a particular industry. Such was the case with RosettaNet, the origin of which was in electronics and information technology. Even in this industry all companies have not agreed to use RosettaNet as a common standard but are actively developing their own standards. Industry specific information standards like RosettaNet have also started to spread to other industries like banking. It must be emphasised that because logistics is not serving one industry alone it must cope with many information standards and non-standard solutions too. This makes the operations complex and increases the service costs. The large number of standards and applications has created a demand for operators or integrators which convert messages from one standard to another. For example an operator dealing with e-invoicing receives the invoice in a form that is appropriate for the sender and converts it to a form that the receiver prefers. The same procedure applies for the information transfer in supply chains. The real efficiency and control of supply chains and networks will not come true until individual standardised information platforms and ICT-solutions meet a global standard available for everybody. Today it seems that the vision will not come true before the 2010. In 2010 industry wide standards will exist, meaning that companies belonging to a network in a certain industry can change messages automatically without a third party integrator. At the moment it looks like this vision will be achieved a long time after 2010. Some industry sectors and networks could have their own standards already by 2010 which means that they could be able to communicate and change information automatically without the help of third party integrator in a small scale. From the very beginning of the Internet era one of the visions has been to transfer data and communicate automatically between different solutions and systems. This vision is called the Semantic Web. Time will tell if this dream of Tim Berners-Lee will ever fully materialise.

The objective is to synchronise business functions with customer demand. Central issues are for example material flow control and steering in a customer oriented business by coordinating and scheduling planning, production, marketing and delivery so that objectives placed on logistics will be fulfilled.

An effective supply and network management adds value to a service or product. Value adding activities require a global product classification system and an efficient product information management. With a product information management system the product origin can be followed thorough its total lifecycle. In product lifecycle management the functional product classification and the product information control play a key role. A global standardised product classification and a product information control enable unifying processes and improve networks dynamics and flexibility. The network is able to change in accordance with customer needs (suppliers, partners etc.). Unified processes include also blurring company interfaces, which enables forming of virtual networks. Without a standard product classification and its management solutions, changing of networks according to customer's requirement would become very difficult and slow. For the increase and efficiency of e-commerce a standard product categorisation will become a prerequisite.

6.4.3 Agents in System Architecture

According to the MIT Forum for Supply Chain Innovation, supply chains will evolve to agent based adaptive networks. The Intelligent Agent is a software program that perceives its environment, acts autonomously, interacts to share objectives, constraints etc., anticipates and reacts flexibly to its environment and learns from its experience and environment. The system can include collaborative learning agents, smart agents, interface agents etc. Further alternative applications are Personal Assistant Agents, Agents as Intelligent Interface Managers, Agent-to-Agent Communication, Inter-application Communication. Agent technology is not new but its use was limited earlier. The modern ITC technology has made its use now possible in various applications. Agent technology is applied for example in ELO research project SteelNet metal industry network (See research project chapter for an abstract).

Logistics and material flow management and control are identical targets for agent technologies and automatic identification technologies. Bar codes, which slowly became common in the 80's, now have competition and supplementary logistical solutions (for example RFID, voice and Optical Character Recognition (OCR).

According to the Service oriented Architecture Benchmark Report 2005 published by Aberdeen Group, the days when companies purchase expansive and expensive technology applications may be coming to an end. This is due to more rapid development and adoption of service-oriented architecture (SOA) in supply chain operations over the next five years. Service-oriented architecture is a technology model that simplifies integration of applications, improves access to information, facilitates communication, and makes available more affordable software packages featuring a selection of services and functions.

In a recent study 300 executives were asked how well their supply chain applications support their strategies for profitable growth. Seventy-five percent said that their supply chain software limits the services they can offer customers. The SOA model allows companies to weave together people, applications, and data that support individual, unique processes. Examples of SOA-based applications include SAP's Netweaver and Oracle's Fusion.

Based on best practices in design and deployment of applications and their supporting infrastructure, SOA is expected to "revolutionize the way software is built, sold, and distributed. The way vendors develop and companies use software applications is going to change.

According to the study the application landscape will change dramatically over the next five years. During that time, we'll see fewer and fewer companies buying large applications, and instead purchasing business services offered by vendors that have broken up their big, tightly-integrated applications into smaller modules.

Source: Aberdeen Group "Service-Oriented Architecture Benchmark Report" 2005

6.4.4 Efficient Planning

- Total optimisation will be increased (e.g. life cycle management, supply chain/network)
- Risk management (e.g. security), forecasting and pro-activity will expand
- Controlling network dynamics will be a growing concern (how to control when the environment changes continuously?)
- Global knowledge management (collecting and sharing of information must be on global level due to global operating environment)
- Design for logistics (design and logistics planning functions will cooperate)
- Design for Logistics and Design for Supply Chain

Trends such as globalisation, increased customer mobility and wider goods selection as well as technology improvements are affecting the business environment and directing the companies to change their ways to operate towards a more cooperative direction. Competition between companies will be replaced by competition between networks and hence the point of view has to change: the emphasis will be on total optimisation and the role of service business will increase. The network's whole lifecycle will be under focus.

One of the aims of the total optimisation is to make decisions within a certain entity such as a specific supply chain or network. For example the delivery of a product from manufacturer to retailer is examined as a whole. The company boundaries are not necessarily the best section points to change the title of ownership or the responsibility of logistics operations. From the optimisation viewpoint it could be preferred that the distributor delivers products all the way to retailers' shelves (as e.g. the Finnish grocery distributor Ruoka-Kesko). The objective is to simplify processes and increase transparency in the supply networks. In this kind of situation the need of RFID in entirely different compared to the way Wal-Mart utilises it. This is explained in more detail in earlier section (RFID).

The dynamic business environment sets new kind of challenges for supplier network management and control. Changes are rapid and require fast reactions. (See: Quick Response). Modelling the supply network and preparation for potential risks helps to adjust to dynamic environment and to react swiftly in rapid changes. In risk management it is essential to recognise the risks. When the risks are recognised they can be controlled either by influencing the risks directly or by shaping operations. If it's possible to influence the recognised risks, companies usually strive to minimise them and in that way diminish the risk probability. These kinds of risks are for example personnel, outsourcing and financial risks. If risks cannot be influenced (for example laws, terror, war and nature catastrophes) the risk tolerance is improved e.g. by preparing activity scenar-

ios and by insuring operations in order to be ready for unexpected happenings. Logistical operation environment includes both of these risk types. In logistics the risk management will be a growing concern and more resources will be allocated for its development in the near future.

More and more companies will be competing globally - this means that knowledge and know-how also have to be on international level. Global knowledge –thinking requires international companies to collect, spread and control information globally (e.g. Nokia). We cannot build our competitive edge on know-how alone. Know-how is spreading fast and will be available globally to almost everybody. In addition we need innovations and ability to implement and utilize new emerging technologies faster than our competitors. This will make leadership's task very challenging in influencing and motivating the workforce.

Product development has traditionally been separated from logistics planning. Design for logistics means that product development and logistics planning cooperate. This enables taking essential logistical factors into account already in the planning phase and thereby decreasing unexpected incidents and changes later in the manufacturing and distribution phases. In order to be competitive globally, the design for logistics will not be enough in the future. World Class companies have already started to incorporate product development with supply chain planning. (Design for Supply Chain). The longer the supply chain is the more complex the task will be.

Supply Chain 2020

MIT´s Centre for Transportation and Logistics recently carried out a study of SCM predictions for their Supply Chain 2020 research project. The research, based on 110 relevant works on SCM, revealed some agreement on the future shape of supply chains, but the consensus raised as many questions as answers.

There seems to be a consensus that different organisations will get together to form virtual organisations that will ramp up or down to meet demand as needed. In this scenario customers take total control over the creation and delivery of services, and there is a "presumed environment of total trust and commitment" from all involved in the creation of such alliances. It was also observed that national boundaries will disappear to make way for unfettered trade, and the emergence of mature economies around the globe will "enable frictionless trade."

"This is a utopian view, at least up to the year 2020. It is difficult to imagine a supply chain that will share risks and rewards objectively among its constituents," argue Dr. Singh. Companies find it difficult enough to achieve internal alignment, let alone alignment with external trading partners. Friction between the many working parts of a supply chain will continue to inhibit the development of a Totally Enabled Supply Chain.

Also overly optimistic are the predictions of free-flowing, borderless trade. In the current political environment the trend is in the other direction – to introduce more restrictions on the movement of goods and people to counter the threat of terrorism and instability. Although tremendous advances and more efficient supply chains are anticipated the concept of total connectivity will likely be present only in spirit.

The rosy predictions also contain contradictions that strike at the heart of how businesses compete and grow today. Many visions predicted or assumed complete sharing of information or knowledge. However, sharing these resources could be problematic given that future competition is expected to rest on information-based strategies. Another apparent conflict lies in how companies will recover the rising plant and equipment costs from products that have shorter lifecycles. The definition of what constitutes an asset will have to change since investments in human capital will become more important as "knowledge bearing human beings" become more highly prized assets.

Further, the future of supply chains is shaped by macro factors such as geopolitical shifts and changing energy costs, and modelling these trends – even though the models are inaccurate – at least illuminates possible strategies for coping with what lies ahead.

This article is based on the working paper *"A Review of the Leading Opinions on the Future of Supply Chain"* by Dr. Singh. It is available on the MIT Supply Chain 2020 web site.

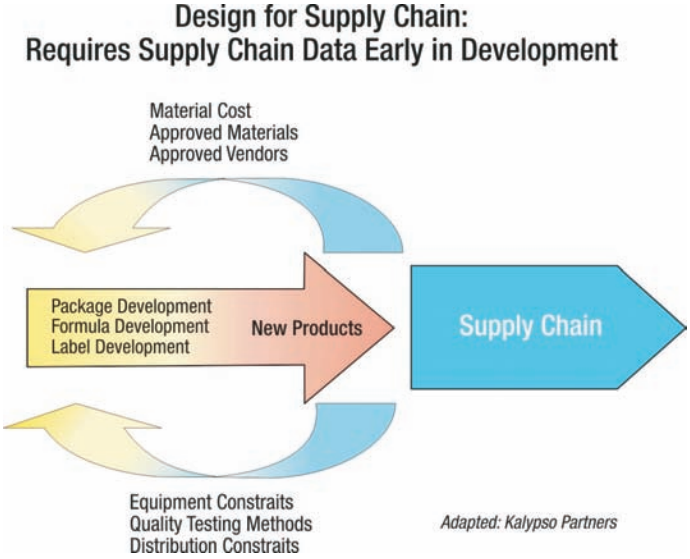


Figure 41. The product design phase must take in to account the whole supply chain.

6.4.5 Efficient Operations

- Recycling Logistics (e.g. ink cartridges, return bottles, paper, electronics)
- Logistics know-how centres and other centralised services will emerge (besides 3PL and 4PL new type of logistic solution offerings will appear.)
- Outsourcing becomes more common (it is now a growing trend but on the other hand outsourced functions are also in-sourced.) The outsourcing trend will continue if new service providers will satisfy customers' demand (3PL, 4PL etc.)
- Transportation solutions will develop further

Efficiency of logistics operations is strongly based on the right distribution of work. This means increased outsourcing of logistics services. More logistics functions and administration of those functions and even entire processes are outsourced to service providers. Outsourcing will change companies' logistics planning, information and communication systems as service providers will include these systems as part of their service offerings. Logistics services are also acquired in bigger entities. Integrators who aggregate services to meet demand are sought. Both regional and global coverage is expected from service providers. The service providers' role will also be more like consultants. They must be able to design and implement tailored solutions for their customers. The relationship between buyer and supplier of these services will be collaborative and strategic. This will be a result of the aforementioned trends. As the responsibility of the logistics provider grows, fluent cooperation will become a crucial factor for both parties.

E-Business places new requirements on logistics services. This applies especially to electronic commerce in B2C trade where completely new kind of e-Fulfilment solutions are required in order to deliver products bought from the Internet efficiently and reliably to the customer. In Europe Internet based e-commerce is mainly on national level as very few transactions go across the border. We are lagging behind the USA and some parts of Asia. The free movement of goods in the EU e-commerce trade requires lots of effort. The European based new e-Fulfilment Forum has established working groups to improve the situation and to develop recommendations for the EU. At the moment the work comprises following topics:

1. Logistics, Connectivity and Integration;
2. Payments, legislation and regulations;
3. Service standards;
4. Research and Innovation.

In B2B solutions e-business technologies bring new possibilities for collaborative process planning and integration.

According to a European-wide 3PL study, opportunity for further involvement of 3PL companies in logistics outsourcing is a matter of obtaining skills and capabilities required by the shippers. Not only in traditional operational areas, but also in areas of information and knowledge based logistics management. According to the study there are also opportunities for 3PL service providers that are capable of offering services at the high end of designing and implementing logistics systems.A global "2005 Third- Party Logistics" study from Gapgemini and Georgia Institute of Technology have similar findings. So far, customers have been disappointed by the service providers' ability to offer advanced services required by their clients. To succeed in the future Logistics service providers must work in collaboration with their clients and allocate resources for continuous improvement of services and development of innovative solutions which make their clients more competitive.

Value Creation Will Depend on the Degree of Ownership

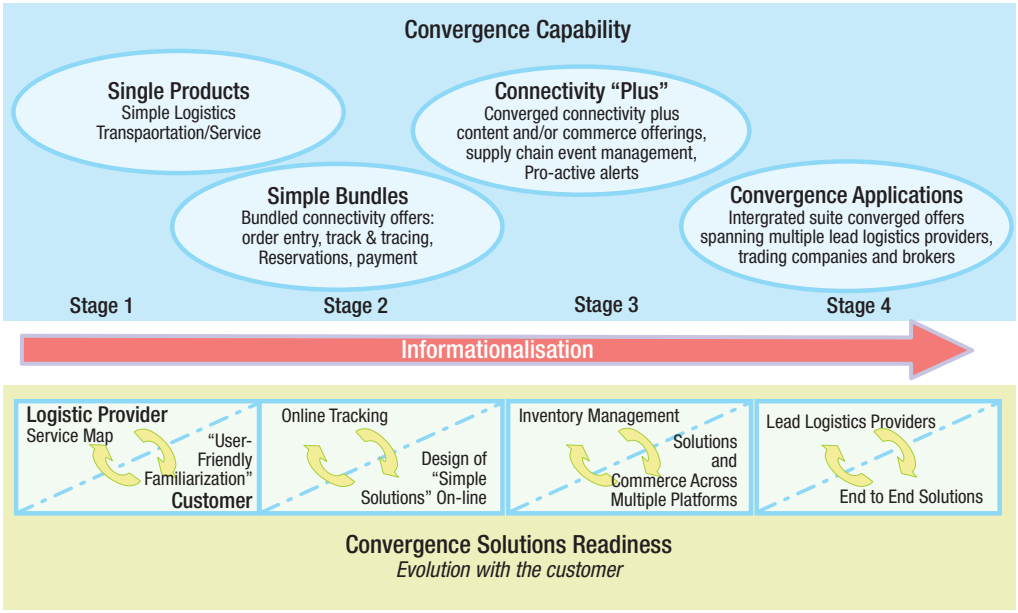


Figure 42. The picture shows a logistic service provider's technology roadmap in different development stages. These stages depend very much on the joint utilisation possibilities of information technology and how deep in to the client processes a service provider is able to get. Understanding clients' business and the status of service provider's own technology knowledge helps during the development stages.

The future trends of the 3PL Industry

According to the world wide 2005 Third Party Logistics study several industry trends were identified for the next ten years:

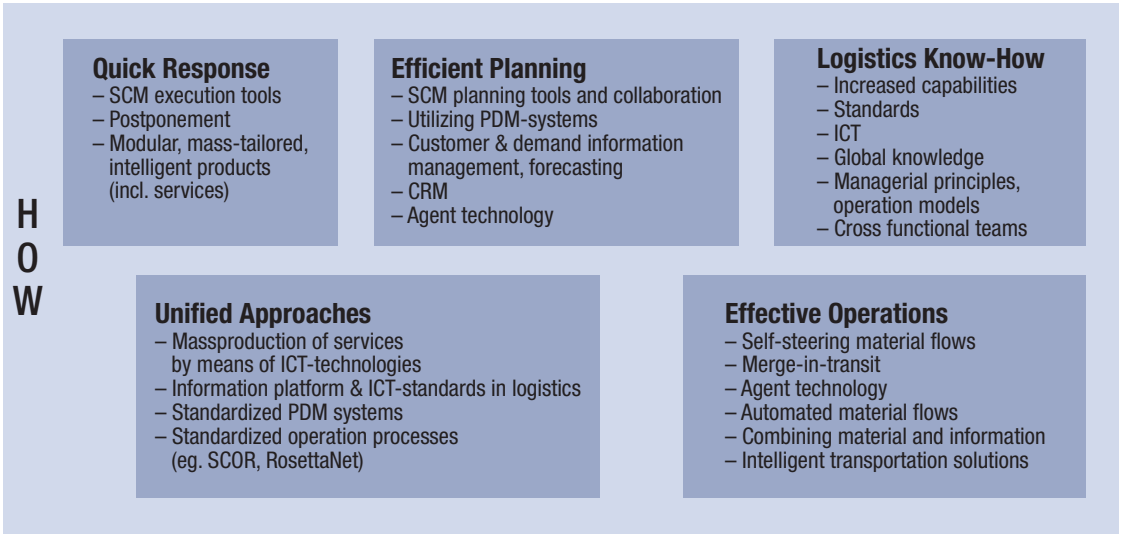
- 3PL industry will expand through mergers and acquisitions
- More developed service offerings based on customer needs (*to offer right solution, to participate in the planning of customer integration and to understand customers business*) and innovative solutions
- Simplified and advanced service definitions by making use of two level customer service relationship models (*strategic and tactic*)
- Advanced product management, flexibility in service offering, cost control, easiness of integration and improved knowledge of process orientation in 3PLs' service oriented architectures
- Continuous expansion of service offerings and capabilities in Supply Chain and outsourcing of more extensive business processes (*e.g. back office, finance, call centre, production*)
- Updating, improving, developing and expanding the relationship between a 3PL and its customer
- Expansion of global markets and the 3PLs' ability to offer required services
- Increased use of joint service networks and cooperation strategies between traditional competitors
- The utilisation of 3PLs in defining product portfolios and in management of channel strategies

While the 3PL industry continues to grow, gaps exist in several areas:

- Disappointment with the 3PL provider's abilities to develop advanced services.
- Need for relationship reinvention, mechanisms for continual improvement and solution innovation.
- Increasing importance on repeatable and leveraged solutions.
- Emerging role of supply chain integration.
- Global evolution of 3PL usage.

Source: 2005 Third Party Logistics Study, Gapgemini and Georgia Institute of Technology

6.5 Logistics Technology and Know-how



6.5.1 Quick Response

- Reaction velocity and simplicity
- SCM implementation tools (operative tools to be used in daily warehousing, transportation functions, etc.)
- Postponement, value offering point, "just for you"
- Modular, mass customized and intelligent products including services; modularity increases (how to implement, technology, knowledge?)
- Good forecasting methods
- Push-pull Supply Chain

Customer demand is changing the way logistics works. We have entered into a competitive era where the order lead time is more important than the price. In order to react fast to customers' demand and to cut the lead time different logistic solutions such as VMI will be used. Vendor managed inventory (VMI) systems originate from retail business but are also developed and used in B2B trade for example in assembly plants or in packing industry.

To accomplish customer tailored features during the last phases of the production process mass customisation and postponement are used. In this way customer specific order penetration points don't have that big an impact on the delivery process and response times can be shortened.

The use of modular mass customised products strives for faster and more reliable deliveries. Applications have been developed especially for make-to-order production for such products as cars, furniture, prefabricated houses and among consumer goods e.g. for language and country specific rules and conditions. One good example of a completely mass customised product is a tailored PC that has been assembled using finished components.

Push-pull strategy

Forecasting is used in the traditional push model to anticipate customer demand. It normally requires large safety stocks in order to satisfy demand at a reasonable high service level. During the last decade a new supply chain steering principle has emerged which has its origin in JIT. In Pull method supply chain resources are only used when there is an actual customer order in hand. The first pioneer of Pull method was Toyota in 1950´s when lean principles were introduced. As a matter of fact lean was not a pure Pull method but a Push-Pull. By defining the Push-Pull boundary in the supply chain optimally, inventories can be reduced and at the same time service level increased. In the Push portion of a Push-Pull supply chain strategy the focus is on cost minimization while in the Pull portion of the strategy the focus is on service levels. The Push part of the supply chain is applied to the portion of the supply chain where long- term forecasts have small uncertainty and variability. The Pull part is applied to the portion of the supply chain where uncertainty and variability are high and hence the focus is on matching supply and demand. Automotive and electronics industry are examples of utilisation of push-pull principle. As uncertainty grows in the global supply chains Pull methods will become more common in managing the supply chains.

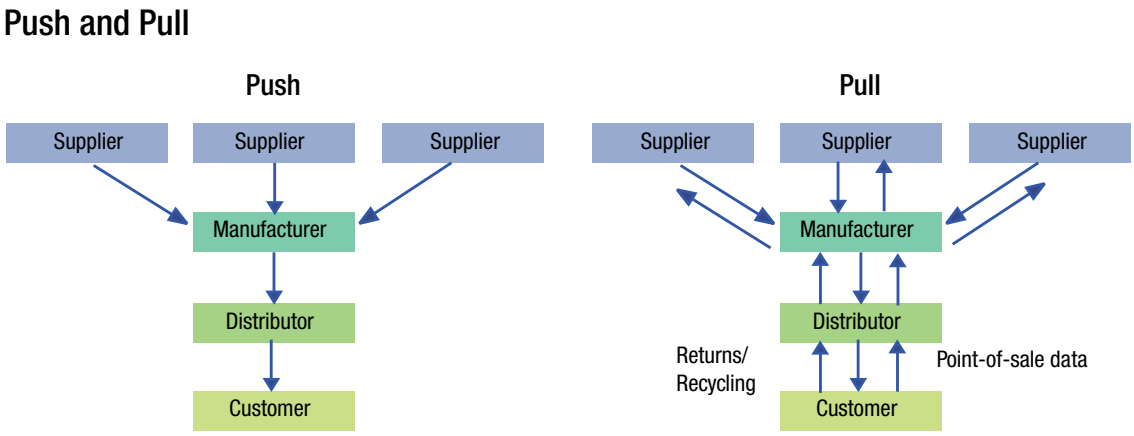


Figure 43. Companies usually benefit when moving from the Push to Pull strategy. Sometimes a full Pull strategy is not the best solution. When considering the Push-Pull strategy it is important to find out where the optimal point in the supply chain is located, where the translation from Push to Pull should be made.

Good forecasting methods have a major impact on improving responsiveness (See section: "Effective Planning") especially in the push part of the supply chain. Reacting fast contains a punctuality objective. In transportation various controlling systems, freight monitoring systems including bills of carriage, digital maps and positioning systems are used. Freight monitoring systems provide support to the physical supply chain; shipment batch identification systems make handling more effective and make monitoring a single batch possible. Batch identification may be included with the package but using modern techniques it can be included in the product itself. These intelligent product features can be utilised in the supply chain as in the product use and maintenance.

3PL and 4PL will be part of the extended company, outsourced functions as well as service providers in the customer fulfilment process. Service providers face continually greater challenges in creating efficient supply chains and adding value to their customers. Especially the integrated information systems need to develop in order to improve supply chains. To offer an integrated information system to the entire supply chain could create an interesting business potential for service providers.

6.5.2 Risks and Threats

Companies are forced to improve their operations to generate return on equity at a higher speed. Mergers and acquisitions are more common. Companies are being sold as a whole or in smaller partitions more often than in the past. Consequently, the roles in the business network also depend on the owners, and the leaders' role in the network can change fast. This has an impact not only on the customer base but also on the strategy of the network and especially on the utilities of the companies belonging to a continuously changing network. Supply chains and networks are dependent on ICT. Information systems and new technologies are expensive investments. These ICT systems often include some errors and weaknesses and the usage and up keep requires a considerable amount of knowledge and resources. Keeping a backup system becomes more difficult and expensive. In many cases nobody is responsible for the entire supply network. Who is then responsible for the operational ethics of the network? Customers are becoming more demanding. Corporate subcontracting could lead to problems as products and components acquired through this channel might not satisfy their real needs.

6.5.3 Unified Approaches

- Mass production of services using ICT technology
- Information platform and ICT standards in logistics
- Standardised PDM solutions
- Standardised operational processes (e.g. SCOR, Rosetta-Net, CPFR)
- Managing interfaces

While the service expenses are growing, companies seek to discover new ways to mass-produce services with the help of ICT technology. The objective is to create an image of personal service and as a whole a positive customer service experience. By using ICT technology for example logistics service providers (3PL or 4PL) can offer tailor made services at a fraction of the cost.

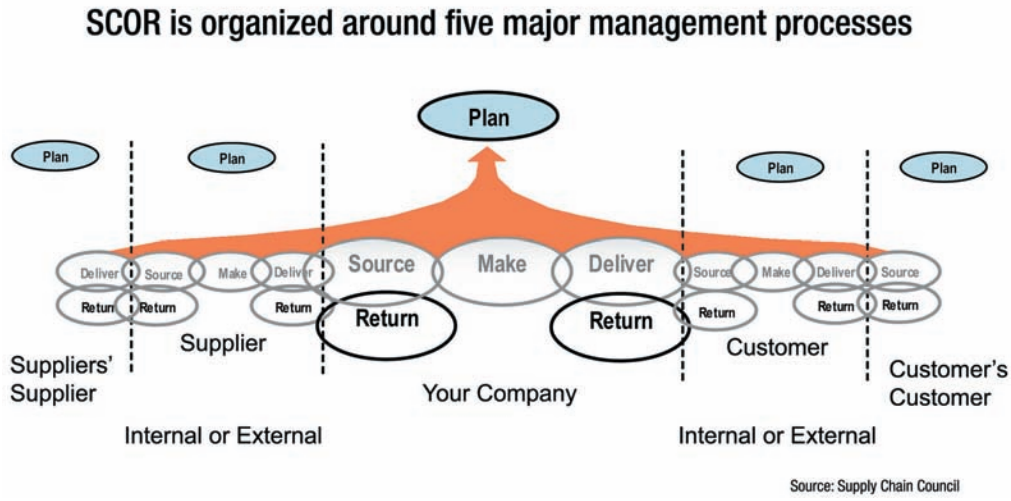


Figure 44. SCOR is a reference model created mainly to model supply chains 'material flows. It has been developed and updated by Supply Chain Council. www.scc.org.

Enterprise resource planning (ERP) system is not solely sufficient to manage supply chains. In addition to advanced planning and scheduling (APS) software, additional tools are needed to control the whole supply chain (e.g. PDM, CAD, CAE, CAM, PC-product configurator). In addition to creating product related information, controlling the information content during the whole product life cycle in the whole supply chain is becoming more and more important.

Quick response research has been carried out in many projects of the ELO programme. One example is the Smart Store project, which intends to create new and important textile and clothing business in Finland. The industry's competitiveness will be improved by developing supply chain management and production technologies as well as by creating a completely new e-business concept, which is based on mass customisation and its consequential advantages. The mass customisation concept also includes a new shopping experience with virtual mirrors and body scanning to deliver personal measurements along with the order to the clothing manufacturer. However no decision has yet been made to implement the system on a large scale in Finland.

Supply Chain Council has developed one of the most common process models, which has already become a de-facto standard. It is called SCOR (Supply Chain Operation Reference Model) – the upper level supply chain process tool. It can also be used to measure process efficiency. Further development of the SCOR-model is made by the council members in SIG (Special Industry Group) workgroups. These have been formed at several lines of business. In addition to SCOR recent new process models have been developed for product design (DCOR) and for customer relationship management (CCOR). There are also other process models covering the supply chain. Mainly APQC´s Process Classification Framework and Value Chain Group´s VCOR.

Typically industry leaders are developing industry wide standards which may also cross industry boundaries. For example in Finland among the electronics industry the leading company is Nokia, which is committed to the RosettaNet standard. RosettaNet is currently a part of the UCC, which strives for an independent global XML based ICT standard.

The SteelNet research project, which is part of the ELO programme, aims to create a flexible model for a network that exploits the potential of e-business and studies of intelligent agent architecture applications. Intelligent agents were used in the project's pilot phase to automate part of the communication between network partners. An efficient network based model requires a functional technological solution that digitalizes the network's internal data transfer. The challenge of the technological network model is how to combine the different systems used by the different companies belonging to the network. Imagine if it could have the semantic web in use. The project's objective was to use agent technology to combine different ERP systems. The agent is an autonomous software module working in the network and also capable of making separate decisions and communicating. The following requirements have been set for SteelNets technological network solution.

- The network has to be open so that participating companies have an easy access and exit from the network
- The technological solution has to be as generic as possible so that it can be easily applied to other businesses (e.g. forest and food industries)
- All companies participating in the network need to be equal – a single company cannot be a master of the network
- The solution needs to have a trouble free and safe integration to the company's own systems
- Information shared in the network could be for example bids, manufacturing process information or transportation and capacity control data

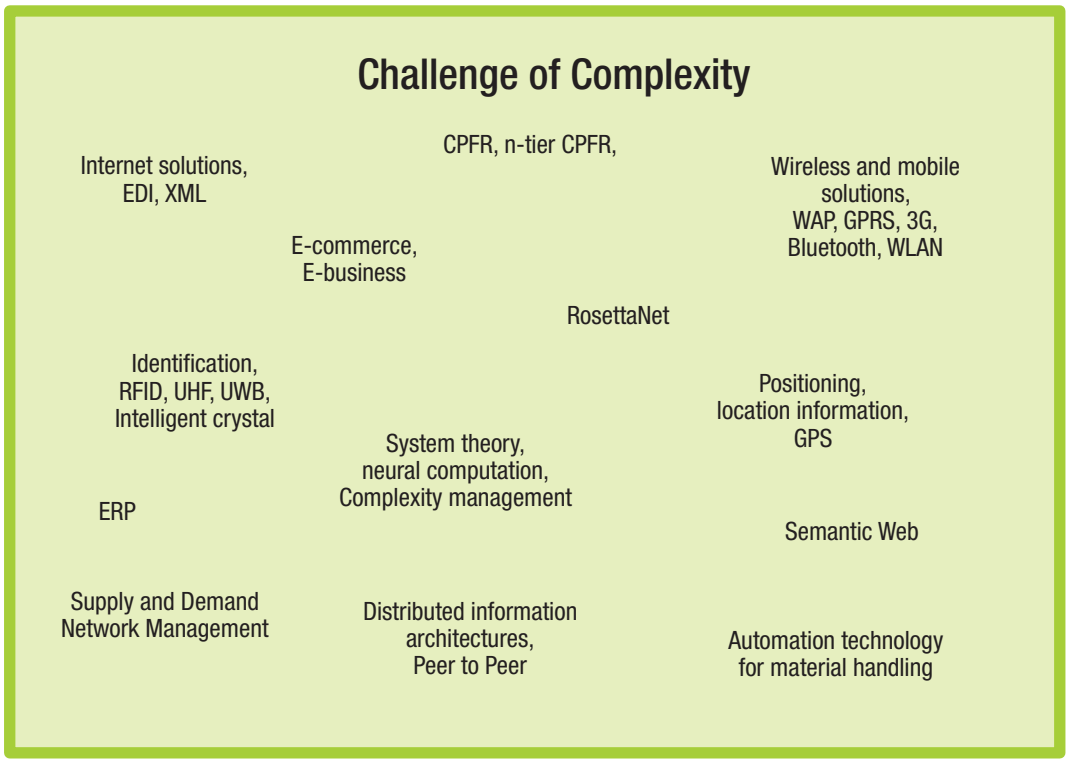


Figure 45. The role of information technology will increase and become even more complex to manage.

Examples of problems relating to the implementation.

- Development of industry-specific standards is likely to continue and even intensify. This will make the spreading and use of common standards difficult.
- New competing standards and solutions will emerge – fragmentation increases even inside industries.
- Companies' knowledge of standards is insufficient.
- Slow and expensive implementation of unified approaches, caused primarily by ICT
- Companies have difficulties to implement and to use new methods in full scale to operate and uniform processes

Coherent ways to operate as described here will be realised by 2010 only if uniformed standards, operations and processes are used generally across industry boundaries.

6.5.4 Efficient Planning

- Collaboration and SCM planning tools
- Exploiting PDM systems (requires encoding products)
- Controlling and forecasting customer and demand data
- Customer Relationship Management (CRM)
- Agent technology

Efficient planning requires effective tools. A large number of IT vendors provide collaboration and supply chain management tools that are used worldwide. These tools intend to help to manage the supply chain but also enhance collaboration, increase transparency in the chains and improve knowledge management. Several systems have functions that support risk and product lifecycle management. The employment of these supportive tools will grow if the companies can see that there is a business case that justifies its purchase and implementation costs. In many SCM planning tools the central module is called Demand Management, the core of which is a forecasting element. In a dynamic business environment the role of customer relationship management (CRM) is emphasised. This means expanding the total process management from order taking to the end of the total lifecycle including the aftercare and service business. CRM can help companies to determine the right prices quickly, to process and control orders more efficiently, plan marketing, enhance cooperation, control and analyse operations, manage contracts and real time information processing.

Product Data Management (PDM) supports efficient supply chain coordination and control by combining the information from several operators. In a network companies specialise in designing or manufacturing one specific part, which means that information regarding the end product has to move fast, flawlessly and automatically. PDM forms a common data structure for all functions and it also

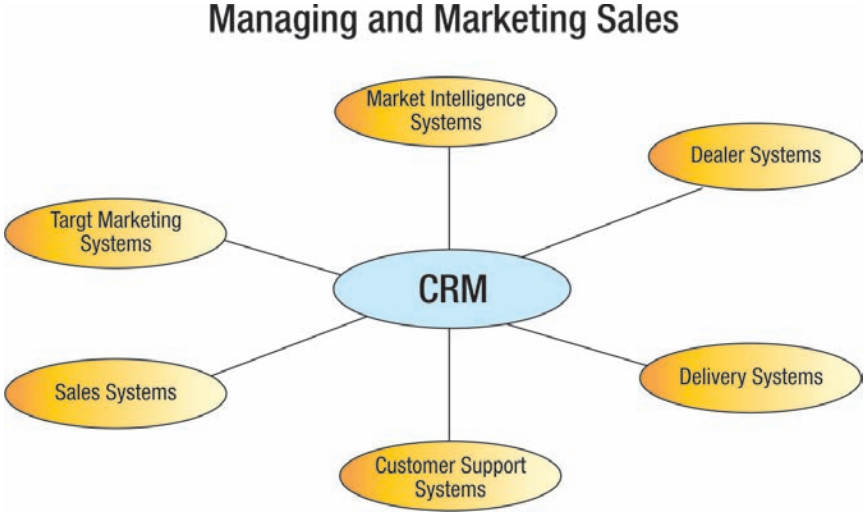


Figure 46. CRM-system interfaces with supply chain management and logistic operations.

reaches up to suppliers and customers. PDM system function as a connecting link or glue between the different functions' information systems and helps control information throughout the whole product lifecycle. Extending a PDM system to cover the entire supply chain requires the use of common, standardised product codes. In the future the role of PDM is likely to increase along with the service business that requires among others effective replacement part management. Product demand is never fully deterministic – it includes always some contingency. Hence demand forecast hardly ever meets the actual demand. This causes problems in the inventory management and in production too. Because demand uncertainty is in practise hard to influence, risks are being controlled by adapting own functions to existing risks. Optimising requires not only identifying risks but also knowing the demand and quantifying risks. Risk quantification can be done either by using existing demand data or information acquired from experts.

After defining and quantifying risks, the information is used to optimise operations. Once the costs caused by inventories, production changes and disappointed customers are known, the optimal production level based on minimum expenses can be calculated. Because estimating expenses accurately is usually difficult, it is meaningful to concentrate on guaranteeing a specific delivery assurance (for example 99%) with minimum costs. Then the costs of different production scenarios can also be examined.

The objective of collaborative planning, forecasting and replenishment (CPFR) tools is to combine the operations of the tools mentioned above. CPFR aims at changing the relationships between organisations and creating more accurate information to be transferred and exploited among cooperative companies in the supply chain. This tool has been developed and mainly used by large retail chains and their suppliers in the USA and in few European countries. In Finland there have been a few pilots but no large scale implementation. One explanation has been that the retail chains and industry operate differently here and the benefits in implementing such a heavy system are not worth the investments. However it is assumed that some of the CPFR elements or a very light version of it will be utilised in improving the transparency of the supply chain in some industries.

Basic Definition of collaborative planning, forecasting and replenishment (CPFR):

"Through CPFR, trading partners agree to share, develop, and take responsibility for what they sell and for how, when, and where goods are promoted. Manufacturers, distributors, and retailers collaborate to develop a single production and delivery forecast for specific products".

State of the Art technology is required to improve modelling and planning tools. For example agent technology offers new applications to develop logistics related solutions in modelling and in programming. The agent is a computer programme, a light sub-software or tailored procedure that performs certain task. It's supposed to be independent, be able to interact with other agents and users, observe surroundings using its sensors and react on impulses automatically, act unprompted and contribute to the surroundings through its effectors. Nowadays networks are fairly passive and the searching of specific information requires

manual actions. An agent can be used among other things to decrease manual work. It could represent the user in the network. Agent-based technologies are able to convert passive networks into active ones and the amount of manual data browsing and mining is going to diminish.

6.5.5 Efficient Operations

- Self controlled material flows (not necessarily the whole chain but some parts of it)
- Goods merge-in-transit
- Automatic material flows
- Goods and related information merge-in-transit
- Intelligent transportation solutions (cargo space, telemetrics, automatic identification technologies)

Management of material flows plays a key role in making logistic functions more efficient. Fast throughput times throughout the whole supply chain and just-in-time deliveries are the most important objectives. The trend in this area will be similar to the material flow control in production plants: steering is as decentralised as possible and everything is as automatic as possible. In practise this means that in 2010 there exists advanced solutions in which with help of technological solutions the product is able to steer itself in the supply chain, not necessarily through the whole chain but at least through some stages. Another central issue in increasing the performance of logistic functions is consolidating goods belonging to the same delivery. Traditionally consolidation has been made in a distribution centre or the customer has made it after a direct delivery. Merge in transit (MIT) uses information from PDM systems and consolidates articles belonging to a specific delivery without warehousing. In principle the idea is the same as in terminal services, but MIT also covers low volume and occasional deliveries where different parts of the delivery do not arrive at the same day.

6.5.6 Logistics Know-how

- Increased capabilities (increased knowledge of logistics functions)
- Common Standards (spreading information on advantages, lowering entry-barrier by acquiring and spreading knowledge)
- ICT capabilities
- Managerial principles, operation models, best-practises and procedures
- Cross functional teams

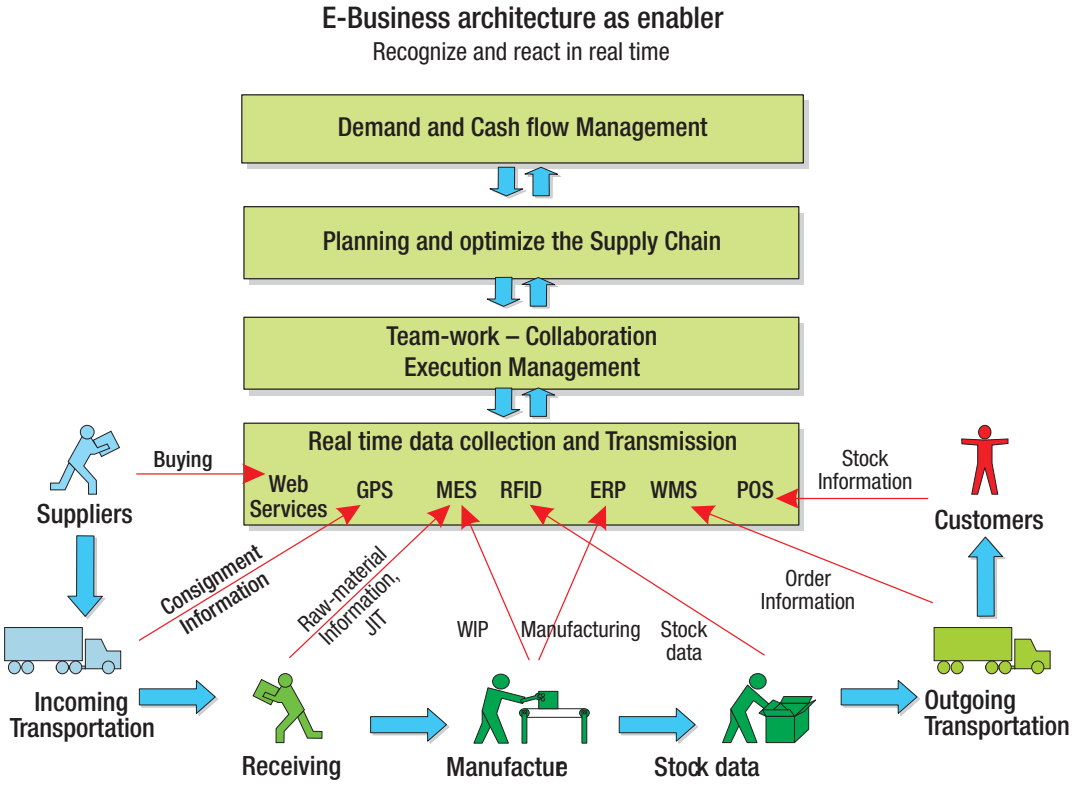


Figure 47. E-business technologies enable real-time data gathering and transparent information sharing with different members of supply chain.

Logistics is not a new concept. It has been practised under the name "logistics" for at least three decades in some form. In today's business environment it is recognised that the improved operational efficiency and sufficient knowledge of the flow of materials through the supply chain is a prerequisite of efficient business operations. E-Logistics technologies alone cannot bring the organisations to the required level of competence to survive in the highly competitive business environment. Investments in logistics education, training and research in general and especially on an individual company level will be a prerequisite for further success.

Organisations and the company leaders should be able to recognise the value of logistics, identify the major functional areas of logistics management and learn how to utilise technology wisely in supporting logistics and supply chain management. It is understood that the value of logistics in its wide meaning will grow significantly during this decade and the corporate leaders will pay more attention to the way it is used in improving business opportunities. Improvements in information processing and communications are already permitting better management of logistics than ever before. The evolution of open information networks and architectures will allow the exchange of data and improvement of processes. In order to further improve the management of information flows in supply chains the adaptation of global ICT standards are vital.

Logistics impacts and interacts with other departments and functions in the organisation. The cross-functionality needs will be even greater in supply chains and in networks. To be responsive to customers´ requirements, plans and information must be shared with internal and external team members. In addition managerial principles, operation models, best practises and procedures should be shared with them. Collaboration will increase as organisations are starting to see more benefits on closer collaboration with their partners.

6.6 SMEs´ Viewpoint in SCM and Logistics Services

In larger corporations outsourcing logistics and management of supply chains is well known. SMEs have had a tradition to operate and manage all business activities themselves especially if the operations are in a small scale. In addition the know-how of logistics and supply chain management is not in level with the large companies, with some exceptions. Below is a summary of results from an ELO technology roadmap workshop which was contemplating solutions to SMEs´ supply chain and logistics service problems.

6.6.1 Logistics Service Providers for SMEs

Vision 3PL, 4PL
- 3PL as a strong brand image creates confidence for SMEs and their clients
- The importance of customer relationship management (CRM) both B2C and B2B
- LSPs responsible for the perfect "product"
- Important for 3PL to understand the business of clients
- Outsourcing of sales activities becomes important.

Barriers
- Legal matters – e.g. commercial responsibilities
- Difficulties in integration of information systems
- Right definition of SME´s core business
- Pain of giving up and letting outsourcer handle things
- How to assure customers that our service is best.

Means
- Product data management
- Education and learning
- Service criteria well defined
- 3 PL fulfils in its own way
- Various service levels to customers
- Customers in two directions, in one end B2B and in the other end B2C.

The terms used in connection with Logistics Services Provider emphasise that logistics is and will be more than transport, warehousing or forwarding services. However abbreviations like 3PL and 4PL are making the logistics service provider an anonymous entity, whose real value to the end customer will remain unclear.

When clients are selecting a suitable logistics provider one central selection criteria will be the service provider's readiness to offer clients and to entire supply chain the technological solutions they require. Therefore it will be important that small and medium sized logistics companies are actively looking for technology partners to jointly develop and offer clients value adding services required to manage logistics and supply chains.

The brand image of the logistics service provider is very important especially in e-commerce. It is also important for assisting SMEs and niche companies in their marketing activities. The logistics service provider has to develop his service portfolio so that he can offer services to manufacturing clients in their customer interface for example product instruction and installation.

The supply chain brand, its image and its credibility could be the most important matters for a SME. Their client is trusting, when placing an electronic order, to receive prod-

ucts according to an agreement, because a strong service provider with a good brand image is taking care of the delivery.

The supply chain brand can be seen from the client's point of view as a strong product brand or/and a strong service provider's brand.The logistics service provider has typically two customer interfaces. One is the actual client, with whom he has the contractual relationship. The second is his client's contractual partner, which could be either customer or supplier. In this case the single company borders could become very vague for the end customer. See "blurring of company interfaces" which is described in earlier sections of this roadmap.

6.6.2 Supply Chain Management for SMEs

The ideal situation, what do the SMEs want?

A transparent proactive supply chain, which is influenced by the SME in such a way that he has the possibility to work and network with clients efficiently. The supply chain should have well manageable standard interfaces which are flexible and easy to change with changing business relationships.

How to get there?
- By networking in a dynamic multi-channel environment (web, EDI, XML etc.) where everybody has electronic tools with an easy access (plug and play) and close cooperation even with competitors
- Understanding customer as a driver
- Focusing and specialising on core competences and being excellent at this will provide power in the supply chain
- Being active partner and taking part in the development of information transparency, interface management and improvement of information transfer in the supply chain
- Building distinct models for different situations and for different industries will make progress and risk management easier
- Combining different logistics functions together (critical for sparsely populated areas) according to one shop principle
- Having a clear division of responsibilities and understanding of agreement practises
- Finding ways how to build virtual organisations fast
- The use and understanding of Activity Based Costing in SCM (creating cost transparency of all activities throughout the chain)
- Developing cheap and simple solutions which do not require resources from SMEs.

Barriers to win
- Understanding the role of power play in supply chains practised by large companies
- Tendency to transfer risks to suppliers
- Clients´ buying behaviour very traditional (short sighted, bidding based, adversarial relationships etc.)
- Clients are pushing their problems to logistics service providers to handle
- Organisational responsibilities hindering the partnering activities, lack of commitment inside the organisation.

SMEs' internal competition makes the collaboration and networking difficult. Even large Finnish companies are regarded as small less-important players in international markets. Therefore local networking is the only possibility for Finnish SMEs to succeed globally. Development of common standards and models, which are easy to implement and investing in affordable information technology solutions are almost a prerequisite for an efficient networking in a supply chain. Another important element is the development of SCM understanding and logistics know-how. Through research and education the basic understanding about the benefits of SCM development will increase.

Case studies involving SMEs – showing the benefits of SCM and networking development (including IT´s role).

Large enterprises should act as a driving force and take the initiative to encourage SMEs to develop their SCM and IT skills and capabilities. Distribution of information in an easily digestible way and at the time suitable in particular for small companies should help. One suggestion was to use TV channels outside the broadcasting hours for learning.

Appendix 1

Technology Roadmap – General View

1 Technology Roadmap as a Tool

Technology Roadmapping (TRM) is a planning process driven by the projected needs of future markets. It helps companies to identify, select, and develop technology options to satisfy future service, product or operational needs. Via the process, companies in a given sector can pool their resources and work together with universities and governments, to look into the future and determine what their specific markets will require. This process is led normally by industry and facilitated by government.

2 Purpose and Goals of the Logistics Technology Roadmap

2.1 Typical goals for a technology roadmap are e.g. the following

- To integrate the development resources of certain business lines or sectors
- To define the needs of a specific market
- To facilitate the integration of new technology in the planning process
- To synchronise the market, the product and the technical development in own organization and in-between organisations
- To produce expert knowledge on technology trends and their impact
- To support inter-company and intra-company communication and collaboration
- To give support in project selection, resource allocation and financing decisions

Having determined the future needs, organisations are able to examine the demand of new technologies for such future needs or the need to change operations with changing customer requirements. A forecast outlining the following factors should be made:

- Market requirements and services impacts
- Technology impacts

2.2 Technology roadmap – benefits and goals

Benefits of the LTRM

- Provides a consensus view on new market opportunities and critical technologies
- Identifies major barriers/constraints to future development
- Guides future R&D investment
- Promotes the development of leading-edge technologies
- Identifies critical skills needed
- Increases competitiveness, productivity and profitability
- Encourages the formation of new alliances, networks and partnerships
- Reduces the risks of collaboration
- Provides the direction to align government policies, programmes and regulations
- Improved skills and networking opportunities, reduced risks through collaboration
- Improved competitiveness and productivity
- Hi-tech development and implementation
- Improved capability to avail market opportunities

Furthermore LTRM gives support in widening the common knowledge base, especially into such areas where new technology, new markets, processes and products can be introduced and shared.

2.3 Method

The work of the logistics technology"roadmap"- 2010 working group" was based on the model created by the Cambridge University Institute for Manufacturing. Its common features are illustrated in figure 1. LTRM structure is based on its generic structure model shown in figure 2.

Technology Roadmaps
Common features

- Summarises technology development and technology forecasts
- Reflects possible options not just known solutions
- Time as the major dimension (on X-axis)
- Shows staged activities
- Y-axis sections
  - External influences: competitors technology info, legislation, killer technologies...
  - Major project tages of product releases
  - Skills and resources required to deliver technologies

Figure 1. Technology Roadmap – common features. Source: University of Cambridge

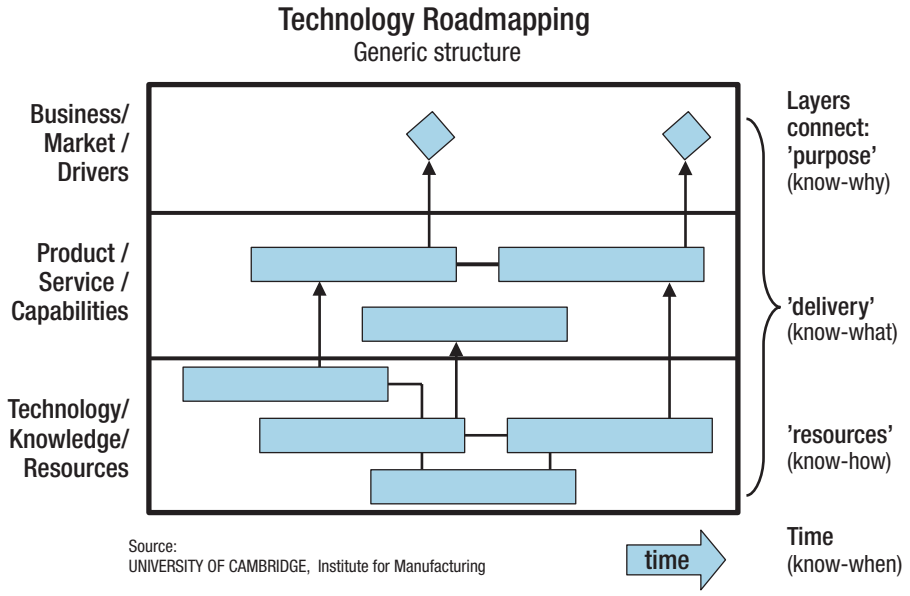


Figure 2. Technology Roadmap used in ELO Programme.

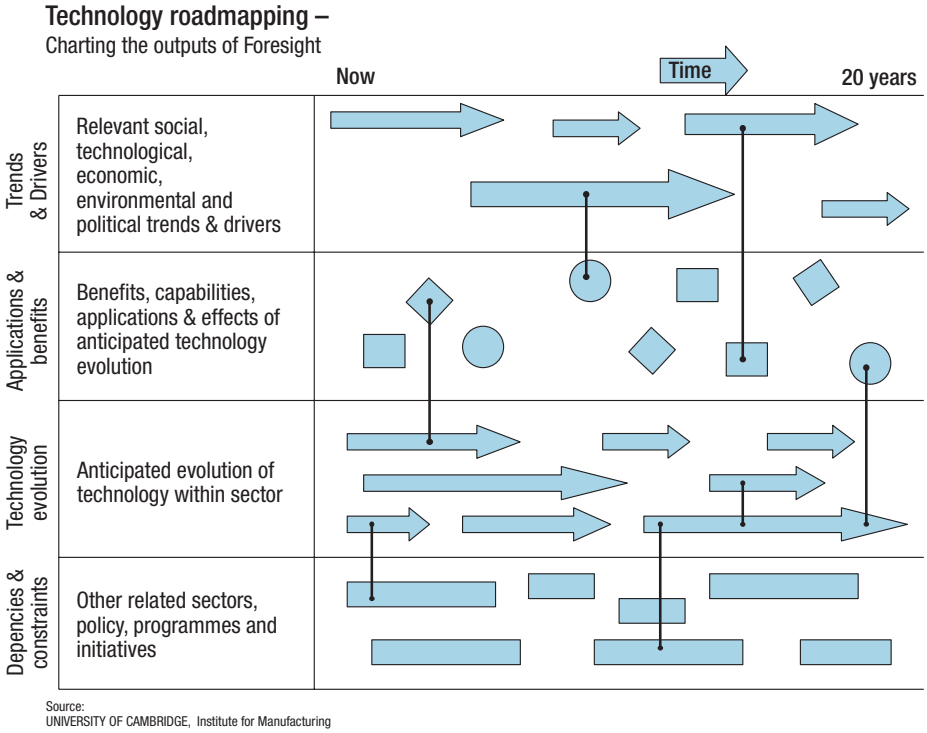


Figure 3. Technology Roadmap – structure (source: University of Cambridge)

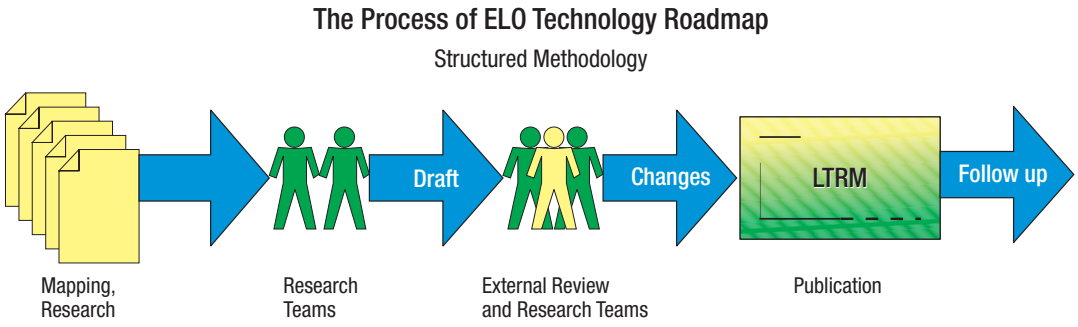


Figure 4. Technology Roadmap – implementation in ELO Programme

Appendix 2

Building a Logistics Technology Roadmap for ELO

1 Literature Research

A literature research on technology roadmaps' techniques and models was made in order to find a suitable generic model for ELO LTRM. The Internet was mainly used for this purpose. Over the past two decades, more than a hundred company specific and industry association Technology roadmaps (TRM) have been implemented and a large selection of different types of TRM reports are available over the Internet. Nevertheless, details of the actual TRM process were difficult to find. Academic literature on roadmapping was also very limited.

In general a TRM is a mapping tool prospecting business environment and forecasted changes. TRMs are usually prepared for a product or for a particular line of industry on a national level in order to point out directions for publicly funded research and technology programmes. A classical example of Industry TRM is the US-based 'National Technology Roadmap for Semiconductors' (ITRS), first developed in 1992. Motorola has been regarded as the first company which created roadmaps as early as in the 70´s. Their main purpose was to implement strategic planning worldwide in the company (Robert Calvin's (former chairman of the board of directors for Motorola) definition of Roadmapping is widely quoted in roadmapping papers: "A 'roadmap' is an extended look at the future of a chosen field of inquiry composed from the collective knowledge and imagination of the brightest drivers of change in that field. Roadmaps communicate visions, attract resources from business and government, stimulate investigations, and monitor progress. They become the inventory of possibilities for a particular field. In engineering, the roadmapping process has so positively influenced public and industry officials that their questioning of support for fundamental technology support is muted." Robert Galvin (1998). Typically technology roadmaps concentrate on a specific industry sector but may include some small section about logistics. A technology strategy guide published in Finland by Tekes, persuades even research organisations and universities to prepare roadmaps. There seems to be no clear distinction between technology roadmaps, roadmaps and foresight as organisations use these quite arbitrary. According to Schaller (1999), the roadmap applications cover a wide spectrum of uses including:

- Science and research roadmaps (e.g. science mapping)
- Cross-industry roadmaps (e.g. Industry Canada initiative)
- Industry roadmaps (e.g. SIA's Technology Roadmap for Semiconductors)
- Technology roadmaps (e.g. aerospace, aluminium, etc.)
- Product roadmaps (e.g., Motorola and others)
- Product-technology roadmaps (e.g. Lucent Technologies, Philips Electronics)
- Project and issue roadmaps (i.e. for project administration)

Schaller's classification of TRMs was based on the Office for Naval Research (ONR) workshop in 1998, where at least a dozen different technology roadmaps were presented (Kostoff, 1999).Only a few logistics technology roadmaps have been prepared so far. One example is Industry of Canada, which started lean logistics roadmapping process in 2002 (Industry Canada, 2003). The final report is a description of logistics and supply chain management best practises and does not follow the structure and presentation of a typical technology roadmap, which normally comprises graphical presentations of nodes and links in addition to text. These roadmap nodes and links can have, in the most general case, quantitative and qualitative attributes (Kostoff et al. 1999). Kostoff explains that constructing a roadmap requires identifying the nodes, specifying the note attributes, connecting the nodes with links, and specifying the link attributes. The literature research provided two publications, which presented guidance for constructing the ELO TRM. The Sandia National Laboratories report "Fundamentals of Technology Roadmapping by Garcia and Bray (1998). It divides the TRM process in three phases: preliminary activity, development of the technology roadmap, and follow-up activity. Preliminary activity includes: (1) Satisfy essential conditions. (2) Provide leadership/sponsorship. (3) Define the scope and boundaries for the technology roadmap. Development of the technology roadmap includes: (1) Identify the "product" that will be the focus of the roadmap. (2) Identify the critical system requirements and their targets. (3) Specify the major technology areas. (4) Specify the technology drivers and their targets. (5) Identify technology alternatives and their time lines. (6) Recommend the technology alternatives that should be pursued. (7) Create the technology roadmap report. Follow-up activity includes: (1) critique and validate the roadmap. (2) Develop an implementation plan. (3) Review and update. Garcia and Bray argue that Roadmapping has several potential uses and resulting benefits like providing a framework to help plan and coordinate technology developments. The main benefit of the technology Roadmapping is that it provides information to help make better investment decisions. It does this by identifying critical technologies or technology gaps that must be filled to meet the targets. The Cambridge University In-

stitute for Manufacturing, Technology Roadmap Workshop papers Farrukh et al. 2001) introduced the "Fast-start TRM process". It is a practical guide for supporting technology and product planning. Its aims are to:

- Support the start up of company specific TRM process
- Establish key links between technology resources and business drivers
- Identify important gaps in market, product and technology intelligence
- Develop a "first-cut" technology roadmap
- Support technology strategy and planning initiatives
- Support communication between technical and commercial functions

2 Construction of e-Business Logistics Technology Roadmap

The work of the e-logistics technology "roadmap – 2010 working group" as the work was first called, was based on the Cambridge University for Manufacturing "Fast-start TRM process". The LTRM structure follows its generic structure model shown in figure 2, Appendix 1. Their roadmap working papers and detailed workshop material were found very useful and helped the group in getting started. In addition, they helped for outlining the ELO LTRM so that it covered more or less the ELO focus areas. As the group work was done on voluntary basis we wished to limit the time requirement for the roadmapping and therefore simplified the process a lot.

The objective was to study factors affecting logistics in the future. It was decided to examine logistics from a broad viewpoint, which includes demand and supply chains and –networks. The time span was agreed to cover 2002-2010.

The group divided the work according to the Fast-start TRM process in four half day workshops. It was a top down approach although Meyer (1998) claims, "successful roadmapping requires both top-down and bottoms-up planning approaches rather than one or the other". The group perceived that the right point for us to start was to go through the market demand first. The first workshop dealt with business and market drivers for logistics. It was called the purpose layer "Why". Brainstorming was used to produce ideas. The ideas were segmented and prioritised in the following working group session and the content was placed under three headings: (1) Global business and dynamic supply network management, (2) Extended value offerings, (3) Changes in political and social structures. SWOT and GAP analyses were left out at this stage although regarded useful. GAP analysis was seen as a tool for the ELO Programme to use in focusing the research activities accordingly. The fourth lowest layer was called "ELO projects and initiatives" were research projects were placed in relationship with the technology and knowledge resources. This helped to identify the gaps in research and guided our efforts in influencing research organisations to do work in this particular area. The brainstorming method was found useful also in developing the "What" or "delivery" layer. It concerned those product and service features, which have the potential in addressing the market and business drivers. These were considered in accordance with the

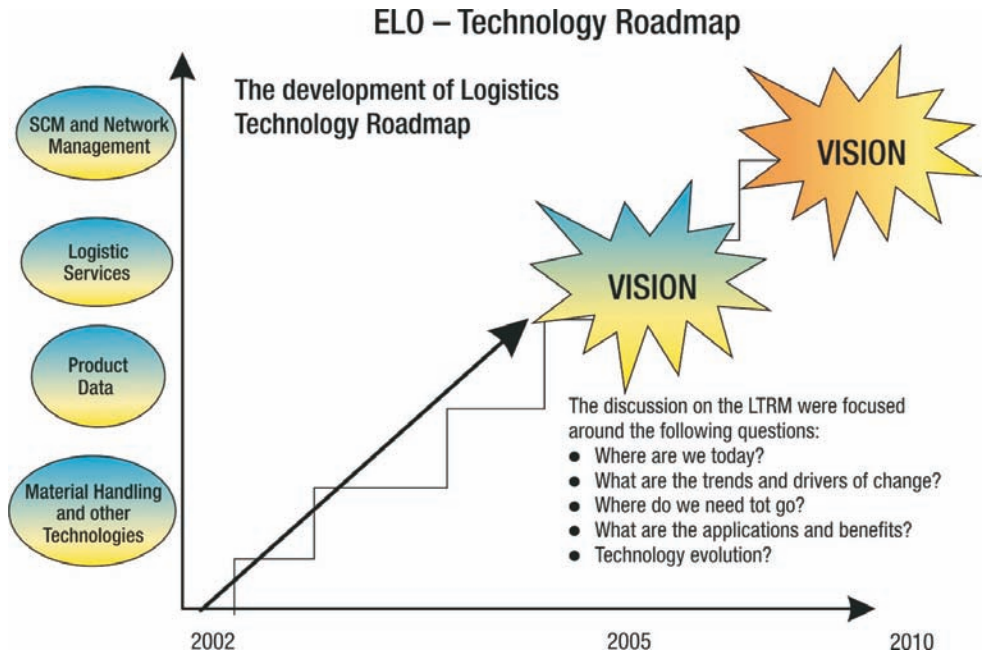


Figure 1. The development of Logistics Technology Roadmap

ELO focus areas and listed under these four headings: (1) Quick Response, (2) Unified Approaches, (3) Efficient Planning, (4) Effective Operations, and (5) Logistics Know-How. Finally risks and threats were considered for all three layers. As the group had only four meetings between June - December 2002 it managed to develop the roadmap structure, headings and sub-headings together. The rest of the work was divided among the group members to be done independently between the workshop meetings. The ELO Programme Manager co-ordinated the work and e-mails were used to exchange document material. The report writing was left to the ELO Programme Manager to do. The first draft was written in Finnish and published on ELO web pages in February 2003, prior to the follow-up phase. Since the draft was originally prepared by 10 people only, it was necessary to have it validated and critiqued by a much larger group of logistics researchers and practitioners. The first public workshop was organised in March 2003 in order to get feedback. In figure 1, appendix 1, are shown the different stages of LTRM implementation. Consecutive updates to the LTRM have also been made in yearly workshops organised for ELO researchers. One of the latest updates in March 2004 concentrated on the SMEs´ role and how they could benefit from the development of SCM practises in general and how logistics service providers could support the SMEs´ business case. This was a public workshop attracting over 40 researchers and practitioners. Since the ELO Technology Programme has an international focus it was decided at the end of 2003 to publish the LTRM report draft and its future updates only in English. The ELO LTRM is posted on a separate page at the ELO website called "Logistics vision", which will be supplemented by various information dealing with the creation of logistics technology roadmaps and roadmapping in general across the world. The distribution of logistics roadmapping know-how will be the main purpose – at the same time as organisations can benefit of the roadmap work results in their technology development projects aiming at improved their ability to be competitive.

3 Discussion

When the idea of building a technology roadmap for e-business logistics was first introduced it seemed a very challenging task. Other technology programmes in Tekes were concerned more with the traditional technology development than ELO, which was dealing with logistics services, supply chain management and product data issues. The literature search even emphasised the matter further as TRMs were (with few exceptions) all concerned with product or product group related R&D with a node and line structure and planning timeframe as common characteristics. At the other end of the spectrum were roadmaps and foresight reports describing logistics "best practices" on a fairly general level. It took some time to realise that one should not regard the word technology in its narrow meaning but include also models, methods and processes in addition to information technology, which is important for efficient logistics operations. In figure 45 are shown some of the technology enablers in ELO. In order to be successful a TRM process should be regarded as a project with proper funding and real management commitment. Our group worked on voluntary basis and it was understandable that especially practitioners´ commitment to the work was sometimes difficult to get due to the time constraints. Researchers were all involved in ELO projects and found roadmapping work complementary. The process of developing a LTRM will take time as the group must first define the right form of the roadmap, gather and sort the ideas and opinions. Building census is important and sometimes time consuming. The more work and efforts are put in, the better the outcome is. We could have improved the LTRM with more iteration rounds. The four half day workshops were not adequate, especially for our part, as the whole roadmap concept was new and the scope of ELO was quite extensive. The team leader's role in the work group is important. The leader should select the experts according to their competence and the total competence of the group should cover the entire Roadmapping area. It is a big advantage for the group, if the leader is already familiar with Roadmapping techniques and has been previously involved in roadmapping development.With regard to presentation technique we tried to connect the nodes (LTRM headings and sub-headings) in each layer with lines but the whole graphical presentation became unclear with too many lines and the whole idea was abandoned. To connect the nodes is recommended but only in case of simple roadmaps. For complex roadmaps a 4 dimensional presentation could be the answer. The ELO LTRM has proven to be useful for the Programme and we continued the work on the LTRM with follow-up workshop in 2005. We hope to attract representatives from industry, trade and from logistics and IT companies to work together with logistics researchers for updating the LTRM in the years to come.

The ELO Roadmap is posted on the ELO website on the page "Logistics vision", which will be supplemented by information dealing with the creation of logistics and technology roadmaps worldwide. The distribution of logistics roadmap know-how will be the main purpose however organisations could benefit from the roadmap results in their own technology development projects aimed at improving competitiveness.

All available feedback on the LTRM would be highly appreciated and can be sent directly to the editor by e-mail: heikki.kekalainen@logistra.fi

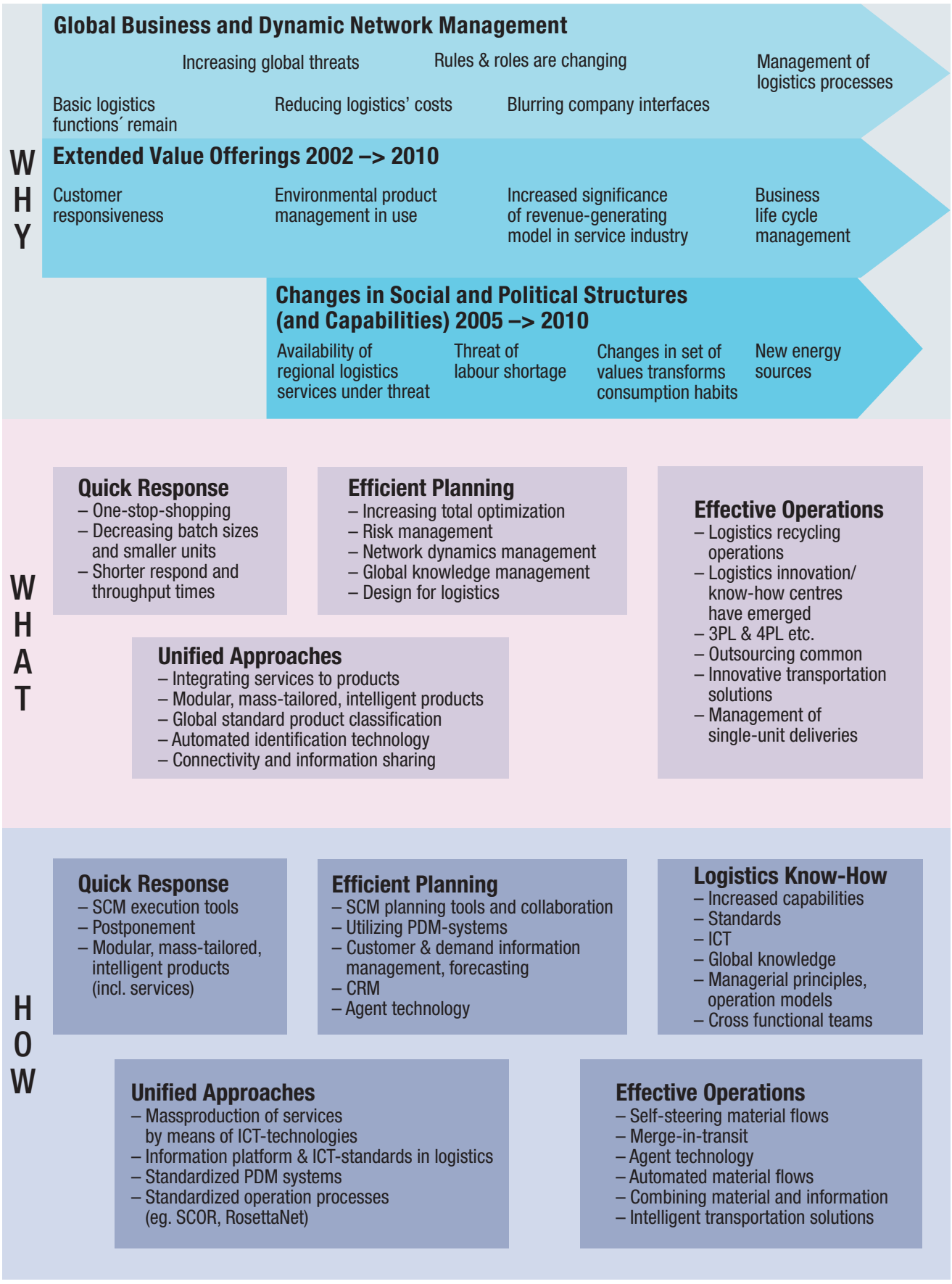


Figure 2. ELO Technology Roadmap.

Appedix 3

Logistics Macro Factors and Supply Chain Vision

The Delphi method was used in developing the e-Business Logistic Technology roadmap in 2005. A set of statements was collected from various sources and classified in three groups by Finnish logistics experts and researchers in workgroup meetings. The criteria for classification were the materialisation potential of each statement by the year 2010. The Internet was used for the second round for updating and completing the work.

The comments and explanations outside the quotation marks belong either to the workgroups or have been inserted at a later date by the writer.

1 Macro Level Foresight

1.1 Most relevant statements, which will have an impact on Logistics/SCM before 2010

1. ”Increasing globalisation of markets and increasing competition.”
   Increased competition will also mean new marketing opportunities e.g. in China. It will affect both supply and demand and will change supply chains. Planning and realisation of Supply Chains will become more difficult. In addition Supply Management and management of companies’ external resources will become more important. In Finland these areas are poorly managed at present.
2. “New marketing opportunities will arise and disappear quickly.”
   Rapid development of new technology and its usage will help companies to react and use the opportunities more easily. Supply Chains must become agile and responsive.
3. “Production resources including skilled workforce will become very competitive on a global scale.” There will be a global concentration of know-how, based on the principle that every company does the things where it can offer best value for money. The effectiveness of logistics and supply chain operations will increase in importance. The need for skills to coordinate and integrate will grow (logistics is only one area for coordination and integration). The individuals, who posses the know-how will be the major players instead of companies. This could create more business possibilities for small SMEs. For example in areas such as personalised service and Knowledge Supply Chain.
4. “Strict recycling requirements and reuse of materials will be imposed.”
   This will create new material flows and the importance of reverse logistics and its management will be emphasized. Reuse of materials will create new competitive advantages. The need to identify materials will grow and new businesses will be developed in the recognition technology area.
5. “Information and communication possibilities will increase rapidly and these new technologies will enable companies to create transparent supply chains, which make companies’ life easier.” This means that logistic chains will become more responsive and the whole business will benefit from it. The utilisation of information and knowledge creation and distribution become key issues.
6. “Technological change will accelerate and the life cycle of new technologies will be shorter.” This is true but the implementation of new technologies in logistic chains could be very slow as the organisations’ ability to adopt new technology will vary greatly.” In addition the resistance to change and to adopt new things will have to be taken in to consideration especially if the benefits are not clear to the people concerned. One major question is also how to distribute the benefits in a lengthy supply chain.
7. “There will be a constant introduction of new technologies and pressure to use them.” The adaptivity of a logistic chain for example by using RFID is one issue. To make supply chains adaptive is important. The obstacle for implementing new technologies often arises from a companies’ unwillingness to be the first to utilize it.
   There are many proven technologies to choose from. To make use of them depends very much on the organisation’s ability to understand the benefits and implement said technology.
8. “Societal demand for superior environmental obligations will increase.” New logistic solutions are required due to increasing complexity and recycling. The number of EU requirements is increasing.
9. “Ageing population.” A population which is growing older creates challenges to manufacturers and service providers. Diversification of logistic services becomes important. New package sizes will be introduced to meet the growing demand from older consumers and single households. New services in logistics are required and will be developed for ageing consumers. A common opinion was that there is already demand for such services but there are no suppliers in Finland who really understand this.

10. “There will be changing requirements of workforce and growing diversity”. Outsourcing and off shoring will increase and will become a common practise. Automation and hiring of temporary workers will increase due to shortage of labour. The skills to manage required know-how will become important and will be a valued asset.
11. ”The increased knowledge intensity of products, technology and workforce will grow due to the employment of new technological solutions”. This is true already today. Growing complexity will be a bigger problem in managing supply chains.
12. ”Companies are focusing on new lucrative markets and not interested in growing and stabilising the existing businesses.” Fear of competition makes this happen.
13. “The introduction of new product innovations will accelerate.” Inventory management especially for short life cycle products will become more important. Customer relationship management and the importance of brands will be emphasised.
14. “The threat of war and terror on a global level will affect logistics considerably” The price of oil, which is steering among other things logistical decisions like where to manufacture, will be a major issue. Electronic seals and product authentication for medicines and for preventing pirate products will become common. The threshold of making decisions and implementing new technologies is lower during crisis. Security related technologies would also have a bigger impact. Organisations should have contingency plans available to replace the current supply chains when the need arises. In addition they should plan how to reduce the vulnerability of the networks. Investments into resistant and agile supply chains do not only reduce risks but also create an advantage to compete even faster in changing market places.
15. ”Population mix will change in Finland and in the other western countries. In addition racial and cultural matters must be taken into account in market places.” All these will have an impact on logistics. In the future the order size will decrease even more as the number of product variations will increase and material flows will therefore get thinner (hyper differentiation). This will make the management of logistics difficult and the chain more expensive, if we are not able to accelerate the efforts to improve things.

1.2 Relevant statements, which will have an impact on Logistics/SCM

16. ”Financial markets will demand increased capital productivity and profitability.” Lean business thinking will spread but will not be common until 2010. Lean has two meanings: cost efficiency and customer orientation. Companies will understand that it is better to concentrate on value creation rather than only on costs. In general lean thinking is based on the following strategy: competing power is created by focusing on non value adding activities, removing them from the processes and development of customer orientation activities.
17. “Raw material substitution for products will increase and it will make the Supply Chain Management more complex.” Other factors also influence the SCM complexity in addition to above statement.
18. ”More knowledgeable customers, many in former developing countries, will demand products and services which are customised to meet their needs and requirements.” Logistics Service Providers could have new possibilities in offering tailored services if they knew how to utilize them profitably. The growth of product variations will increase complexity and costs of supply chains.
19. ”Competition will be based on creativity and innovative ability in all levels of manufacturing activities”. However this is not sufficient; in addition systematic thinking is required.
20. ”Continuous pressure to cut logistics and supply chain costs in the total chain from product planning to distribution will stay.” Innovation and implementing new technologies for redesigned processes are solutions for increasing productivity and reducing logistics costs. Logistics costs will increase in the future for example due to higher energy costs and therefore actions to lower the costs will be among the key issues. Logistics is also labour intensive (e.g. warehousing, delivery). To reduce costs new automatic solutions requiring less labour will be developed. These could be automated order receipt, order picking, conveyers, truck loading etc which are utilize new ICT technologies such as intelligent agents and RFID.
21. ”Replacing non-renewable natural resources and restrictions based on scarce resources will be implemented in manufacturing products.” The need for innovation will increase – new material substitutes will be developed. Recycling and re-use of products and components will increase. This will have an impact on R&D and product planning activities. Environmental issues will become important in the near future affecting the total life cycle of the products´ supply chain.
22. ”Global environmental regulations will be imposed”. Emissions´ trading is already working and global agreements for protecting the environment will be introduced. Requirements for environmental sustainability will present new business opportunities for those who are equipped to innovate and develop their products and services.
23. ”The utilisation of rapidly expanding technology will improve productivity and competitiveness.” It is a big challenge for companies to utilise new technological solutions wisely and to succeed at the implementation phase.

24. ”There is an instant need to use and distribute information and knowledge based on common standards in the extended supply chain without delay.” There is a problem in getting the common standards implemented and it will not be realized by 2010. There is also a need to define common standards for the whole global ICT-industry. It could help to develop new cheaper solutions for companies and end users. Easy coupling of systems (plug and play) is important in developing solutions especially for SMEs´.
25. ”There will be more demand for basic human rights (e.g. shelter, food, health) in addition for better life quality.” This will create pressure on logistic chains´ quality and service level (for example in cold chain). It could create new business opportunities for export. The entire chain will be in control (speed, quality and monitoring). One example could be fast and scheduled deliveries to consumers at the exact time they want them. There is probably already a demand for such services but unfortunately no supply.
26. ”The complexity of products and processes will increase although we strive to reduce it.” One example is modularisation. Car industry’s “Intel” – will there be a similar breakthrough in other industries? Cars are getting more complex but their assembly will become simpler.
27. ”Safety instructions will be introduced for waste handling and treatment.” This has a small impact on logistics today as waste materials are not properly managed at present. There will be changes by year 2010 which will have a wide impact on logistics, if we regard logistics as an entire physical chain from earth to earth.

1.3. Does not have an impact or has only a very modest impact on logistics

28. ”Hydrogen and other non-fossil fuels will also be the main energy sources in transport.” The impact is very small as this will not be realised by 2010. However the increase of oil price has accelerated discussion about alternative energies. In the EU a debate is going on as to how better to utilise railways and inland waterways, which are more economical and less polluting than road transport. Major international crises’ in oil producing countries could accelerate both development and utilisation of alternative fuels.
29. ”Readiness of ordinary citizens to participate in direct action will increase.” There could be a strong first reaction for a short while but normally no further actions take place. Actions and their reasons are also soon forgotten. No visible impact on logistics.
30. ”Growing disbelief in materialism, science and technology and their world rescuing impact.” No visible impact on logistics in the near future.

2 Supply Chain Vision

2.1 These statements will materialise before the year 2010

1. ”Creativity, manufacturing and distribution will become more information, knowledge and service intensive.” These are the main factors for competition if everybody offers similar products.
2. ”Business will change and offer full and complete services.” In addition, long lasting customer relationships are being created fulfilling all product related service needs. This trend, which is already a reality today, will continue and get stronger.
3. ”Trust is the key word characterising relationships of participants in anonymous market places” Buyers are looking for familiar product brands which can be trusted. Such trust will also influence purchase decisions. The image of the Logistics Service Provider will also have an impact.
4. “Value is added to service instead of physical products.” One example is the service within the car industry and the value generated thereof. With automotive solutions the service part of the offering is extremely important.
5. ”The key to successful business is the ability to diversify services relating to your products.” This does not apply only to services. Fierce competition has resulted in companies constantly developing new products in addition to services in order to maintain their market share or to gain new markets. Consumers benefit because their needs are more specifically addressed. This is a big challenge for companies, as production needs to be more flexible and the whole supply chain more agile.
6. ”Benefits of B2B commerce will reduce supply chain costs – throughput time of non value adding activities like transport and warehousing will decrease.” There is lot of development potential in the value chain. One example could be to manufacture or assemble in transit in order to reduce time.
7. ”Companies´ core competence is developing fast and changes required for utilisation of new business opportunities are improving.” On the contrary, core competence is not developing fast. However it can be varied during the product and business life cycle for example by creating wider and more complete product offerings to customers. Variation ability, cost effectiveness and risk management are important.
8. ”Capital in physical form is not the only value measure. ICT know-how, brand awareness and customer relations are all creating extra value.” This is a valid and topical argument. The ability to innovate is also valuable “capital” for companies.

9. ”Global companies are regarded as local service providers in market areas where they are present but all their activities are based on flexibility and global market positioning.” To be local creates a visible advantage, which is important for the sake of company image. This seems to be a current trend.
10. ”New business architectures and virtual companies will be established, especially through networks and teams.” This is also a current trend.
11. ”High value adding output will be the most important attribute.” The effectiveness of logistics chains will be emphasised by aiming for such standards. In addition processes and activities that increase customer value will be important.
12. ”More products will have shorter life cycles.” Adaptive logistics chains and their management will become very important. Use of forecasting tools will also be significant.
13. ”New skills are being learned faster when e-learning network tools are utilised. The communication will cross organisational boundaries.” This is important in developing supply chain transparency. The role of change management, knowledge management and information sharing will be emphasised.
14. ”A multi-talented workforce will update their skills continuously.” This will be one of the necessities in order to succeed in business in the future.
15. ”The idea of a secure lifelong relationship between employer and employee will be replaced by a lifelong possibility to obtain work.”
16. ”Individuals take more responsibility of their career development in spite of their employer. The emphasis will be on knowledge accumulation and not necessarily on salary or re-education.”
17. ”Companies are demanding instant productivity from new business opportunities.” This is true; ROI is an important metric when decisions are made.
18. ”New production architecture will be characterised by networks of autonomous, distributed, and cooperative elements that are electronically linked either directly or indirectly to all the other elements.” These elements may interact as single virtual enterprises or may grow from alliances and outsourcing of sub-functions. It is also called Next Generation Manufacturing System (NGMS) See notes below. Adaptation of production architecture will lead to “material companies” and “product companies”. It exists today. In the furniture supply chain there are for example table component manufacturers who deliver parts to product company which is only doing packing and invoicing and delivering the product to distributors like IKEA. There are other concepts to choose as well. Examples like Zara, subcontracting the materials, Nike a product company, or brand owner like RedBull. One of the characteristics of these concepts is that SCM is often outsourced to 3PL companies.

The enabling components of NGMS are:

- *Workforce Flexibility* – a set of practices, policies, processes and culture that enable employee security and ownership, while capitalizing on creativity, commitment, discretionary effort and maintaining the size and skill flexibility of the workforce
- *Rapid Product/Process Realisation* – the integration of product/process development utilizing cross-functional development teams supported with an integrated computer environment
- *Innovation Management* – comprehensive solution creation ranging from business practices to the technology used to develop and deliver products and services
- *Change Management* – the continuous application of deliberate change to the current state of the organization to achieve a more competitive future state
- *Next-Generation Manufacturing Processes and Equipment* – the development of reconfigurable, scaleable, and cost-effective manufacturing processes, equipment and systems to support an up-to-date knowledge base of product and process technology
- *Adaptive, Responsive Information Systems* – the implementation of information systems that can be dynamically reconfigured into new systems by adding new elements, replacing others, and changing how modules are connected to redirect data flows through the total system
- *Extended Enterprise Collaboration* – the seamless integration of companies and suppliers in a collaborative effort to create and support a timely and cost-effective service or product
- *Enterprise Integration* – the interconnection of personnel, processes, systems and technologies to provide the right information at the right location, with the right resources, at the right time
- *Pervasive Modeling and Simulation* – the practice of the modeling and simulation of all production decisions to replace current “build-and-test” methods
- *Knowledge Supply Chains* – the application of supply chain management to the relationships between industry, universities, schools, and associations to rapidly provide and continuously update the knowledge and talent needed to run businesses in a timely and cost-efficient manner.

Source: “Implementation of a Production Architecture For a Post-2000 Market: Demonstration of a Micro factory Concept, John Allen Neal, III, PhD dissertation, Virginia Polytechnic Institute and State University, December 10, 2001”

19. ”Long distance, national borders, differences in economies and the level of information are no longer barriers. They are key elements when companies are making outsourcing and off shoring decisions (e.g. China, Russia or India).” However there are problems in finding the right information for decision-making. One example being the logistics costs, which could be higher than estimated.

20. ”Virtual and real collaborative relationships between companies will be formed quickly to fulfil sudden market needs.” If a good breeding environment exists then a quick collaboration could succeed. Normally trust creation will take time. The realisation of win-win-win-win in a long supply chain takes enormous efforts from all parties involved and could still be impossible to achieve. In large-scale project deliveries (e.g. power plants, big construction contracts) such model is being used but it is not based on win-win-win collaborative relationship.
21. ”Time will be the most important cost factor, especially for short life cycle products.” Time is also a major cost factor in the entirely supply chain. The pay off from time reduction activities is considerable and will make companies more competitive.
22. ”The development of business operations is accelerating and requiring a faster reaction from all parties.” More adaptivity is needed in order to react faster to changing customer requirements and business needs. In addition an ability to anticipate business problems in advance should be developed.
23. ”Fast learning organisations together with a broad knowledge base and knowledge management will both be important elements for successful business.” This is important for companies acting globally as the impact on logistic chain is huge. It also affects local SMEs, which are part of the global network; even if they are not operating outside their national borders.

2.2 These statements will partly materialise in some form before 2010

24. ”Manufacturers will be held responsible for all waste flows in order to reduce environmental impact. An infrastructure will be developed for recycling, reclamation and remanufacturing.” This is the trend but it will not be fully accomplished by 2010.
25. ”Enabled Supply Chain will be common practise. It will be based upon tight cycle times and rich information flow where data and information exchange between the parties in the supply chain is well managed.” New information technology like RFID and the Internet are the enablers but that is not enough. The processes must be developed and organisations must implement and take full advantage of these new technologies.
26. ”The communication between organisations is fast, almost fully automated and operated by machines.” It will work well in physical deliveries but not as a main communication channel. There could be automatic order fulfilment systems utilising agent technology, which take into account changes in demand (Demand Chain) and flexible manufacturing supported by agent technology based supply solutions (Supply Chain).
27. ”Information is finally used in managing inventories – products are communicating with each other in real time and business partners know in real time the location of each product in the supply chain.” This is the vision and will partly materialise in 2010. Technology supporting this vision already exists.
28. ”Outsourcing is growing. Companies are transferring more operations and activities to suppliers. All operations which can be managed over the information networks are already outsourced.” Outsourcing will grow but companies should still keep the know-how in house in order to manage the suppliers.
29. ”Dynamic Capable to promise attributes are in use.” The importance of information technology is growing and these attributes are used both for make to stock and make to order products.
30. ”Virtual production systems make simulation of complete business activities possible. Expensive production tests and quality checking of products will be eliminated.” In the future simulation will cover the entire supply chain.
31. ”Flexible, revisable, autonomic FMS and other self learning intelligent systems are in use.” The total supply chain and network management will be easier in the future when this becomes a reality.
32. ”Human and machine interfaces will become more effective and productive. Agent based technology is used to develop joint creativity between human and machine.” This technology is used for example in supply chain collaboration solutions and will be developed further.
33. ”Batch production and inventories will be resigned to history, delivery chains will be compressed and capital will be freed up. We will get smaller product consignments with shorter distribution chains with shorter lead times delivered straight to the door step of consumers.” This is general trend which depends on the specific industry.
34. ”Lean thinking will expand and consumers are applying “Lean Consumption” principles.” *In an essay titled ‘’Lean Consumption" in the March 2005 issue of Harvard Business Review, researchers James P. Womack and Daniel T. lay out the next phase of the lean revolution: using technology to reduce time and hassle for customers and get them what they want when they want it.” Lean consumption requires a fundamental shift in the way retailers, service providers, manufacturers, and suppliers think about the relationship between provision and consumption, and the role their customers play in these processes. It also requires consumers to change the nature of their relationship with the companies they patronize. Consumers and providers must start collaborating to minimize total cost and wasted time and to create new value."*
35. ”Information supply chains will be planned and executed. It can be used to offer lifelong integrated education.” This will help to understand what employees already know and on the other hand, what kind of learning activities are required in the organisation and in the total supply chain.

36. ”Life long product marketing so that the updating of product expands after the product has been sold through the entire product life cycle.” This will be an expanding area that will include in the future more products than simply software. One example is housing. The relevance of services will be emphasized.
37. ”Identical offering of products, availability and costs will level retailers’ and manufacturers’ positions. Competition will ensure that the one who has the ability to innovate and market customer expectations wins.” Differentiation could be the key to success and improving and developing new services will help.
38. ”Local manufacturing and distribution will expand to satisfy customers demands more quickly and efficiently and at the same time paying regard to environmental pressures in reducing pollution and the use of energy in transportation.” This will materialise only in some niche areas like in bakeries. As a whole its importance is quite small. The fuel price has some importance but on a small scale. Quality of products and local habits, taste and customs will have a more positive impact on local business than the fuel price and environmental concerns.
39. “Product distribution and its support services will be part of the total product offering. This will lower the product life cycle costs if for example product recycling is planned in advance.” Customers normally purchase a solution to a problem, not a mere product.
40. ”It will be important that products are designed so that easy separation and sorting of materials is possible.” Legislation will have a very important impact on this matter. The share of Reverse logistics will increase, recycling logistics will develop and all this means that the whole logistics chain will become longer.
41. “Distributed order fulfilment will be widespread when the collaboration and connectivity in networks increases.” It will not work without proper coordination.

2.3 These statements will not materialise at all before 2010

42. ”Outsourcing will diminish due to a growing demand for efficiency and flexibility. There is a general need to shorten cycle times and product life cycles in addition to cutting costs and improving quality.” Outsourcing depends partly on trends and industry sectors. Supply Chain Management could be more difficult when outsourcing increases. There are examples which see companies giving up the outsourcing because the promised savings have not materialised.
43. ”Plug and Play functionality in integration between companies will be prevalent.” Plug and Play will not function alone; there is also need for closer collaboration and interface development. The share of integration will grow.
44. ”Companies’ different functions will be integrated into single unit, which will connect customers with product planners and designers.” As single unit will not be possible but there is a need to integrate customers with product planning and design in order to better understand customer requirements.
45. ”There will be perfect connections and information connectivity in the total supply chain and network.” This is the trend but for this to become perfect represents a challenge. There are doubts that the total visibility of Supply Chain will ever materialise. The SCM concept is seen as a vision worth going after although it may never fully happen..
46. ”Product planning functions will pay regard to the total life cycle support of products from “birth to death”. The manufacturer will be responsible for the product/service from “cradle to the grave”. To expand the support offering to cover the product life cycle will be improbable because customers are not ready to pay the extra costs. It will require very extensive information technologies and management efforts.

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