Work-in-progress paper submitted to the 19th
Annual IMP Conference in Lugano, September 4-6th 2003

The Challenge in Supply Chain Innovation

Helén Anderson
Professor, Linköpings universitet,
581 30 Linköping, Sweden,
+ 46 13 282517 +46 13 281873
helan@eki.liu.se

Johan Lilliecreutz
PhD, CMA AB, Teknikringen 1E,
583 30 Linköping, Sweden,
+ 46 13 328584, + 46 13 212222 (fax)
johan.lilliecreutz@cma.nu

Abstract

The value 'thinking' in a supply chain is important and fruitful when to focus on the customers' need for continuous improvement and having the customer in focus enables effectiveness in providing the customer value. The lean concept in addition enforces efficiency in all activities in the production and distribution within existing supply chains. The further back in the chain you work as distributor, producer or supplier the more likely it is that you participate in several value chains in fact forming complex network-like structures. The industrial business challenge is thus to construct meaningful constructive activity responsibilities among the actors.

The defence industry is the empirical case to which the authors address their conceptual discussion. The purpose with this paper is to identify and define critical research questions in Supply Chain Innovation of particular relevance to high tech systems integrating industries. The paper relies on a literature survey in the fields of supply chain management and technology management. The formulation of the future research areas has also been inspired by the dissertation from ENDREA and IMIE.

Introduction

Parallel with the industry change, the relationships between buyers and suppliers changes and new working processes are created. The challenge for industry is to manage the logic in the traditional value chain, but at the same time benefit from the driving forces in the new business logic, with the purpose to support productivity and growth. IT is also well known that in the real business world the conceptual linear model the value chain expresses is fuzzy and hard to recognise.

In technology high complex and rapidly changing development, different business actors work highly interactively causing dynamic relationships in network-like structures. In fact, there are as many value chains as there are end-customers. The further back in the chain you work as distributor, producer or supplier the more likely it is that you participate in several value chains in fact forming complex network-like structures. The industrial business challenge is thus to construct meaningful constructive activity responsibilities among the actors. Figure 1 shows the gradual development from traditional linear thinking into more network-like borderless and dynamic organisational structures i.e. transformation from "old" approach to "emerging" lean as the structure of tomorrow.

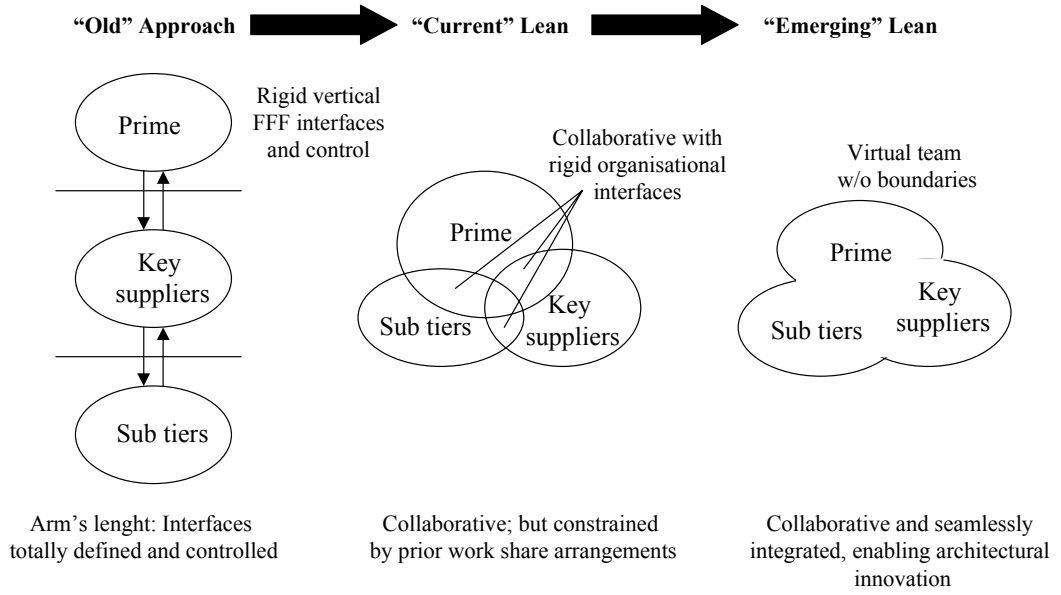

Figure 1: Early Supplier Integration into Product Development - A New Framework for Lean. Source: R&D Management, Vol 28. No 3 (July 1998), pp. 163-172

The transformation described in Figure 1 put intense and somewhat new pressure on the relationship between supply chain actors. Information technology will be an even larger part of the relationship in the future (Öhrwall Rönnbäck, 2001). The new business logic has resulted in distinct IT-tools for parts of the value chain, for example purchase (e-procurement), production (industrial IT) and sales (e-commerce). Resources and competencies are communicated and distributed between organisations. Development of new products or modification of old ones can easily happen in collaboration with others. The end-market situation can in same cases influence how the buyer acts upstream. In the telecom and automotive industry, the balance between time to market, time to technology and time to customer highlights the problem; - how to secure world class product competence with increasing outsourcing? In order to fulfil this, emphasis has to be on both lean thinking and supply chain management in on going supply chains and far-sighted in relationship issues. Both the auto and telecom industry seems to integrate their supplier base (selected suppliers) very early in the product development, called integrated product development (IPD).

This early involvement in the process indicates a move towards a way to optimise the contribution from people, processes and tools to achieve product optimality. Figure 2 visualizes the situation today (line) and the vision (doted). The challenge is to increase freedom of change (1), increase the knowledge base and product understanding (2) and at the same time decrease use of total time (3) and money spent.

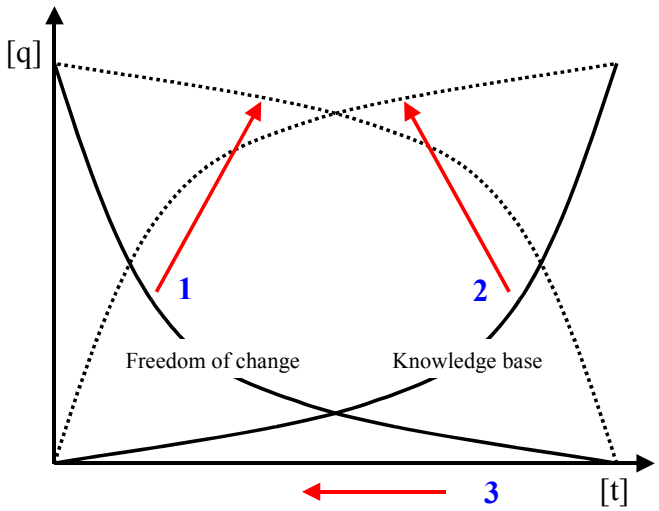

Figure 2: The challenge for IPD

Innovation is no longer an in-house activity controlled by one organisation. The innovation process comprises both customers and existing suppliers in complex interactive relationships.

In early phases of innovative work where a product application is far ahead and when the innovative challenges are great also unknown actors are potential co-operation partners. The complexity of managing complex-like interactive and dynamic structures becomes eve further complicated when the risk and uncertainty regarding technological aspects are open and not yet settled. Internal processes can even hinder creativity and the use of external innovations out-side already established communication paths and relations.

The value 'thinking' in a supply chain is important and fruitful when to focus on the customers' need for continuous improvement (Sundström 2002). Having the customer in focus enables effectiveness in providing the customer value. The concept of purchasing and supply management contains numerous perspectives on how to act as a serious buyer and supplier in the supply chain. The lean concept in addition enforces efficiency in all activities in the production and distribution within existing supply chains.

The main driver in the area of supply chain innovation has its origins in the interaction between prime and SME. Here are some examples. First, development of more complex projects and systems, often fully integrated, stresses the importance of early access to technology and innovations. Second, the procurement strategy is focusing on a small supplier base with fewer and larger suppliers, which hinders the surveillance and acquisition of new technologies, often driven by SME:s. Third, the difference in size between prime and SME:s do not support effective risk and profit sharing and transferring of knowledge in early RTD phases of large projects.

Purpose

The purpose with this paper is to identify and define critical concepts for research in supply chain innovation of particular relevance to high tech systems integrating industries such as the defence industry.

First we will give a short background on the defence industry. This is followed by a discussion on supply chain management and technology management. A section on supply chain innovation and the prior findings will finally end with some conclusions and areas for future research.

Background - A Defence Industry in Transformation

In the defence industry budgets have been subject to repeated cuts over a long time, forcing the governments and industries to act in order to ensure sufficient defence materiel supply as well as profitability for the industry. The self-supply within single countries is reduced and international collaboration becomes a pre-requisite for the development of complex systems like aircraft. Drivers are both technology supply and competitiveness. This and other factors have led to a globalisation, where international companies, partnerships and supply chains are designed and created based on a rationale ranging from cost- and risk-sharing to knowledge access, technology supply and reliability of supply in general.

One common opinion is that a focus on inventory levels in the defence industry not is necessary since most systems are only made in a few examples. That the defence industry is not a mass-producing industry and there is not enough time to build a large inventory seem to be a widespread opinion. Another common opinion is that there are far more costs involved in being late with one system than with having components and system parts in stock. Issues concerning supply chain management that do get attention is after-sales logistics and the issue of keeping old hardware and software in stock while the development in that industry is so high paced. The defence system's lifetime is often five-ten times longer than the lifetime of the hardware and software components that are built into the system.

Swedish defence industry in particular but also the European and US defence industries are faced with many changes, few actors can afford the very high costs for development of new-sophisticated products. New and advanced technology, shorter delivery times, more complex and system-integrated products necessitates co-operation within and between supply chains. Hayward (1998, p1) describes this change process: *"With elephantine pace, the European defense industry primes are beginning to rationalize. This is happening most quickly in aerospace and electronics, where companies are working to government inspired deadlines, and where mergers and acquisitions have already begun to concentrate resources. "*

Net centric defense is the term that today is used by the Swedish Armed Forces and Swedish defence industry on how to develop. The assumption is that future battles will take place on different arenas or places. The trend is towards increased coordination and communication between different forces (see Figure 2).

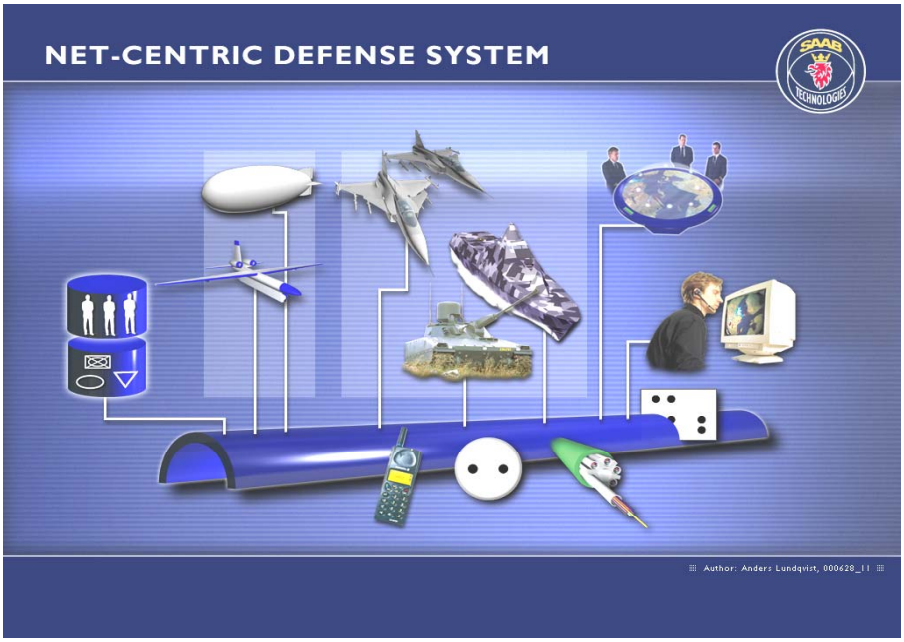

Figure 2. A transition towards net centric defence (Source: Saab Aerospace)

The development towards a net centric defense also leads to a different way of handling the development, production and use of material and products. Products will be more complex and production will focus on development of functional demonstrators.

It is unavoidable that mutual dependence is intensified in the new defence industry structure, as the number of companies will decrease. According to FMV (Swedish Defence Materiel Administration) there is nothing to do about the fact that FMV will be more dependent on a smaller number of possible suppliers in the future. Business actors in the defence industry have since long been very interdependent. The Swedish defence industry was dependent on FMV as the only customer but now, when FMV is starting to buy globally, the Swedish defence industry is forced to try and find customers in other countries.

The defence companies are also trying to come up with civil applications in order to become less dependent on the defence industry and its budget restrictions. For instance, at Saab BAe Gripen it is extremely important to choose the right supplier from the very beginning of a development process since it is almost impossible for them to switch suppliers. But they do not really see this as a problem; instead it is an issue that they have learned to live with. The reality in the defence industry: long contracts, small volume and large, global suppliers, are indicators for high dependency from the buyer's perspective. The dependency is however not equally mutual. That is, the suppliers are not dependent to the same degree as the buyers.

Supply chain and supply chain management

Supply Chain Management is prevalently understood as a distinct business management approach, or philosophy. There are many definitions of what a supply chain is and of what supply chain management involves. Cooper & Ellram (1993) describe supply chain management as an integrative philosophy to manage the total flow from the supplier to the ultimate user. However, it has been recognised that supply chain management does not necessarily deal with the whole chain in its all length. At minimum, supply chain management appears to involve three stages: a focal (or prime), its one supplier (first-tier), and a customer of the focal's product (compare with figure 1).

Most of the traditional literature about purchasing (cf. Ellram, 1991; Matthyssens & Van den Bulte, 1994; Duffy, 1999) regards the supplier as a more or less passive party in buyer/supplier relations. The problems connected with market and supplier exposure and surveillance in the early stages of a relationship is neglected. They all show supplier involvement at different stages and to a different extent.

Christopher (1998) regards supply chain management as the management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole. Efforts to integrate business processes across boundaries (e.g. organisational boundaries) have long been identified as one major approach in supply chain management (cf Cooper, Lambert and Pagh 1997). Otto & Kotzab (1999) have discerned that supply chain management manifests a clear "sequential value adding" perspective. Cox (1999) has recognised that the currently dominant paradigm for supply chain management is based on operational effectiveness and efficiency.

In the recent literature on supply chain management different paths can be identified. One is on relationship issues closely connected to contractual forms. Another path is on more operational issues and by that related to lean production and logistics. A third path is looking over the whole process focusing on value whereas identification, creation and delivering of value are the main object. The book ”Lean Enterprise Value – Insights from MIT’s Lean Aerospace Initiative” (Murman et al, 2002) is somewhat in between these paths discussing the lean concept in detail and specially the term “lean value”. They state (p. 3) *“The core challenge for industries in the 21st century involves identifying and delivering value to every stakeholder. Meeting that challenge requires lean capability at the enterprise level*”. Based on

the findings, mainly from the aerospace sector, the authors propose five guiding principles for the transition towards lean enterprise value (3).

There is also an ongoing discussion on creating lean enterprise value in product development. Though, the discussion gives little guidance on how to involve the supply base regarding innovations in early stages. Murman et al, 2002, mean that defining value is more complex the further away you are from the end users – but they also state that this is where the leverage is also greatest. This could indicate that identification of future customer value is as crucial and important as finding value sources, internal or external. An enterprise transition in the age of a new economy requires closer linkages with other organisations. The primary contribution from the LAI book is on how to define value and specially value connected to innovations.

This transformation is a big challenge for Swedish defence industry companies regarding supply chain management and sub-tier structures. There is no panacea solution for choice of strategy for the supply chain. Instead, each level in the tier-structure has to act accordingly to their position in the vertical market system. The different paths that the suppliers in the Swedish defence industry have to choose among in the future can be identified as below:

- To focus even more on the core business and become a very specialized supplier.
- To become a system supplier.
- To become a function supplier offering a wider product portfolio.

Each strategy has its own consequences both inter-organizational (vertical and horizontal) and intra-organizational (inside the company). If the path is towards a more integrated supply chain much emphasis has to be put upon relationship issues. Partnership relations are based on soft issues such as trust, confidence and mutual commitments. Even if a partnership relation is established it does not have to lead to a win-win situation. One problem seems to be the procedure to find factors on the basis of which the relationship is measured. Partnership relationship would probably benefit from mutually agreed measures or definition of performance success.

Depending on user perspective (prime or 1st-tier or 2nd-tier etc) and problem areas different views on the international state-of-the-art can be identified. In a recent article by Duffy in

World Market Series - Business Briefing: Global Purchasing and Supply Chain Management (December 1999) points out challenges to come in the field of purchasing and supply chain management, for example strong supply-side involvement, new buying methods, purchasing integrated with information technology and greater flexibility. These challenges are captured in study called "The Future of Purchasing and Supply: A Five- and Ten-Year Forecast".

The development in the Internet and e-purchasing field is hoping to make the surveillance effective. A recent survey by Purchasing Online Magazine shows that buyers believe the power of the Internet can best be deployed to obtain technical information about suppliers' products, to email suppliers, to search for parts and to check prices. Baker (1999) states that most Internet solutions remains focused on automating and payment cycles for acquisition of non-production of goods and services that have already been established on corporate contracts. In the very early phase of RTD the search is for not known issues and competencies.

The value ‘thinking’ in a supply chain is important and fruitful when to focus on the customers’ need for continuous improvement, and having the customer in focus enables effectiveness in providing the customer value. The lean concept in addition enforces efficiency in all activities in the production and distribution within existing supply chains. The further back in the chain you work as distributor, producer or supplier the more likely it is that you participate in several value chains in fact forming complex network-like structures. The industrial business challenge is thus to construct meaningful constructive activity responsibilities among the actors and in time. Identification of innovations in the early phases of a development of a product increases the possibility to create desired value for both the supplier and the buyer.

Some comments on online business tools. First of all, an online business tool must include and adapt to all participants. If not, one or more parties will not be committed to the tool and there will be a lack of trust that can show to be crucial to its success. The vital point is to create trust and reduce anxiety. Only after this is done the value added by the tool becomes visible and interesting. Collaboration, or even worse collaborative innovation, is inconceivable without trust between the participants.

Secondly, an online business tool can have many different purposes, e.g. lower prices, reduce costs, reduce time, and increase collaboration. These purposes may not all be inclusive, and some may even be hard to implement together. Suppliers submitted to hard price pressure, may not be so willing to extend the collaboration with the buyer or with other, possibly competing, suppliers. Accordingly, purposes must be identified and prioritised, and the online business tool should adapt to the desired purposes. Especially interfering purposes must be kept apart and watched, so that the prioritised one is not harmed by a lower-priority goal.

However, it seems possible, though not evident or automatic, that an Internet-based online business tool, like Covisint, could encourage product innovation in early phases of the product development process in an inter-organisational context. The design, implementation and continuous development of the tool must be managed with the innovation-encouraging purpose in mind. This includes creating trust for the business tool among all participants.

Technology Management

The Innovation literature has a strong emphasis on process characteristics. Already in the early findings of product development processes the introduction and characterisation of different phases or stages are characterised. The more empirical studies have been performed the more evident becomes the complexity of the process. The linear rational design of how the process works is very dominating in the literature from the start. Human behaviour is recognised as one or they key factor by some authors quite early but has only recently won a more overall interest in the product development field. Thus the organisational and managerial dimension has increased in importance.

The development of the field of project management expresses well the development above. In the early project management models a rational approach on problem solving is adopted and turned into helpful project management tools. In recent research on project management however empirical data convinces us about the many simplifications about human behaviour that have been assumed. The discovery of the complex nature of human behaviour has introduced doubts and questioned many of the early assumptions translated into management tools. The managerial dimension has in line with such a development changed its contents and focus and very recent influences from the knowledge management area are starting to impregnate also project management thinking and practice.

Another well-recognised and important dimension is that of interplay between the technology dimension and the market dimension. The need for technological competence and creativeness is a key concern in literature and in practice. Research findings have given us insight into how engineers work and gather knowledge and information. The focus on gathering information and new knowledge is the concern of much research. Research results show a tendency to devoting more management attention into constructing information systems on gathering and distributing new information than on reviewing and reflecting on experience and evaluation data.

A modern way of presenting such an assumption is expressed by Tidd et al (1997): *'... innovation is a process of turning opportunities into new ideas and putting these into widely used practice'*. In the efforts of managing information flows however, there seems to be a tendency towards concentrating more interest towards the technology dimension than the market dimension. In addition there is also a lack of ex ante data from the market. Most studies deal with ex post observations of how well a product has been accepted by the market.

There is a focus on product development but many innovations deal with processes. A usual development is that of a process innovation following the production of a new product. The process-innovation will enable both better and cheaper production processes, and support the qualitative development of the product.

Very often authors differ between what is called a radical innovation. Such a product or process has a great impact on the market and production structure. The innovation is likely to create quite new actors on the market, new infrastructures and changed buyer behaviour as the buyers start to demand and accept the product. In cases of innovation which are very difficult to foresee or predict it is not unusual that completely new business actors enter into the scene. Incremental innovation is the most common type of new technology and products. In these cases there are continuous interaction with customers and producers. Any improvement can be seen as the outcome of negotiations between what can be done and what will be paid for in the innovation process.

In two different theoretical schools the customer interaction have been in focus. The essence within the interaction or network approach is the exchange process between business actors such as buyer and seller. The important notion is that of continuous social construction and

reconstruction of the exchange process through interaction. In the area of Total Quality Management the concept 'customer in focus' is essential. This is dealt with mainly through sophisticated surveys among existing or potential customers.

Thus to be concluded: process, rational, degree of newness, market-technology interplay, human behaviour, information gathering and processing and interaction, are all important aspects dealt with in the technology management area.

The Challenge in Supply Chain Innovation – from Lean to Value

The redirection of the Swedish defence into a Net Centric Defence paradigm means e.g. that systems have to support a more flexible use and integration with other systems. Furthermore, the whole system of systems will be subject to continuous change, and all involved systems will need to adapt and be able to federate with a wide range of systems over time.

In a literature review of licentiate and PhD-thesis mainly from two graduate schools, which has focus on economics and engineering we tried to capture what kind of questions for future research that was highlighted.

Source	Total number of dissertations	Numbers regarded for final analysis	Upstream	Down	Up & Down
IMIE	66 (44 Lic , 22 Dr)	15 (9 Lic, 6 Dr)	5	6	4
Endrea	60 (43 Lic, 17 Dr)	9 (1 Lic, 8 Dr)	4	3	2
Other	6 (2 Lic, 4 Dr)	5 (2 Lic, 3 Dr)	3	1	1
Total:	132 (89 Lic, 43 Dr)	29 (12 Lic, 17 Dr)	12	9	7

Table 1. Licentiate and PhD-thesis from IMIE and Endrea

Our impression from a total of 126 dissertations (87 Licentiate thesis and 39 PhD-thesis) is that they primarily consider the manufacturing company as the focal point and looks at the environment from that perspective. Dissertations classified as Upstream are the group that has the most diverse content. It looks at manufacturing networks, supplier and sub-supplier networks and purchasing in general as well as in the context of projects. The Downstream group is only considering the customer or end-user in two cases in which the focus is quite narrow and connected to the specific PD process. The other cases consider logistics and sales problems close to the focal company. Again the downstream issues closer to the customer or end-user is only briefly mentioned and mostly as a future research issue to consider.

Lilliecreutz & Holmberg indicates (1) that there is a need for an expansion of the traditional lean concept. They label this constructive lean approach as the relationship of tomorrow between a systems integrator, customers and its major suppliers in the aerospace industry. The following can be read in the findings of LARP part I[1]; *"Competitiveness is no longer a result of the effectiveness and efficiency within single corporations only, but rather a result of the co-operation and co-ordination within networks in the industrial value chain"*.

The traditional lean project is still an important component of constructive lean, as the way to bring a new system to completion when it is through its architectural phase. Since a high degree of the aircraft content is developed and supplied by other sources than the system integrator, it is important to achieve interaction mechanisms which supports co-ordination, where needed.

Constructive lean focuses on up-front value creation throughout the supply chain or value network. The challenge for constructive lean is to create the right environment for the whole supply chain at early stages to generate value and achieve the right conditions for a lean project. If this fails, there is a clear risk that only the traditional down-stream lean project remains. This could become a long term threat for the company as it only allows for current systems to generate profit by continuous cost and resource reduction, but does not stimulate the achievement of new competitive systems supporting the long term development of the company, a situation we label anorectic lean.

The expansion from lean, constructive lean to value creation has its origins in prime/SME real-time situation and problem areas. Here are some examples. First, development of more complex projects and systems, often fully integrated, stresses the importance of early access to technology and innovations. Second, the procurement strategy is focusing on a small supplier base with fewer and larger suppliers, which hinders the surveillance and acquisition of new technologies, often driven by SMEs. Third, the difference in size between prime and SMEs do not support effective risk and profit sharing and transferring of knowledge in early RTD phases of large projects. The dynamic increases if the focus is on knowledge non-existing supplier base are added as a supplement to just the existing one.

[1] Lilliecreutz, J., and Holmberg, G., ed., (2000). LARP – A Research Report from Linköpings Universitet and SAAB. Findings from LARP Part I., Linköpings universitet

In figure 4, newness in product and technology is matched with level of organisational complexity. When it comes to supply chain innovation in early stages of product development process other organisations are expected to contribute with their knowledge and skills. This is a situation, which forces systems integrators to handle both different levels of newness and organisational complexity. Can this happen in the same organisation?

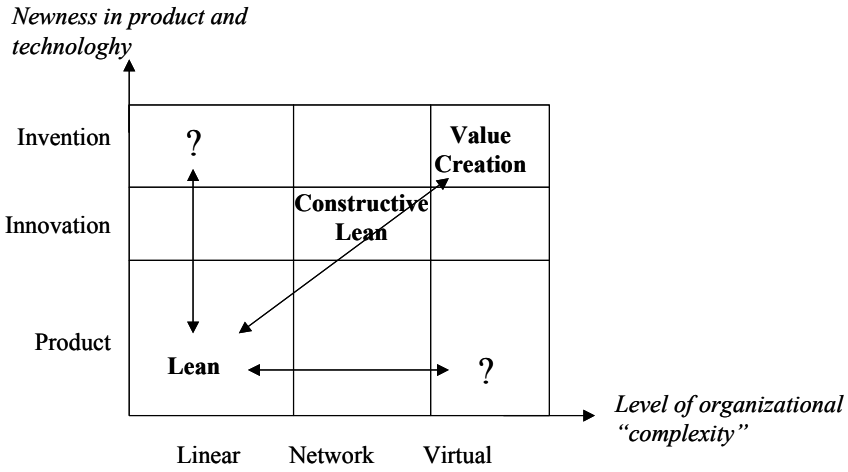

Figure 4. Evolution from lean to value creation

Conclusion - Areas of further research and critical questions

Finally we have developed the following four important concepts for continued research will be focusing on the following four drivers in order to further develop the constructive lean approach under a Supply Chain and Innovation or Product Development agenda. These are:

- Initiatives
- Incentives
- Interaction
- Interdependence

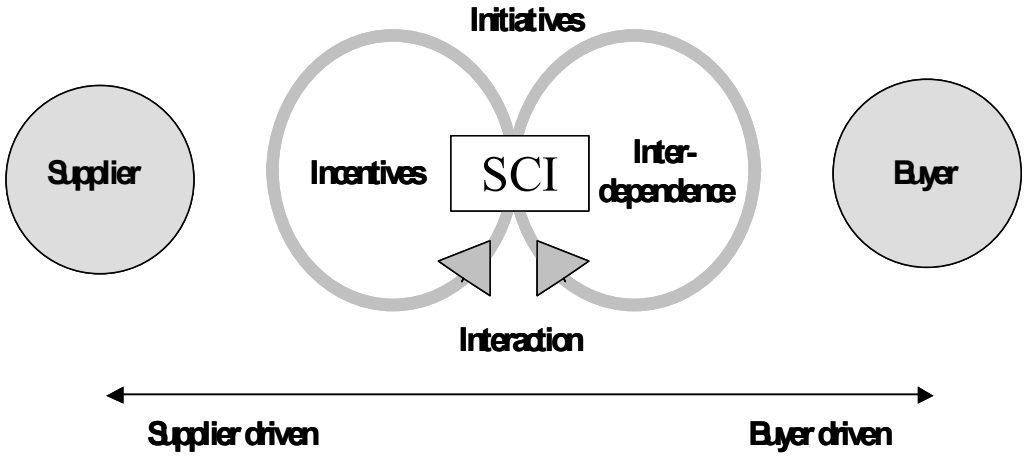

Figure 5. Four topics or drivers in a double-helix logic reaching SCI.

The first topic, initiatives, considers primarily questions such as; what are the external triggering decisions, events, happenings, information, news, - What are the internal triggering factors? How and when is the early product development phase characterised? How can the innovation driving individuals be described and characterized.

The second topic, incentives, considers primarily questions such as; what are the driving forces for both individuals and management? What are the formal goals or objective for all actors? What are the informal motives? How is a business model expressed for interacting innovation? What kind of motivating factors?

The third topic, interaction, considers primarily questions such as; – what are the working activities? How is leadership performed? How is the project organised? How are competencies and knowledge communicated and understood by all actors' ownership of common innovation?

The fourth topic, interdependence, considers primarily questions such as; what kind of common methods, databases etc are used? What kind of common knowledge is developed? How is communication between actors organised and performed? How is cost and revenue shared?

End notes

(1) Lean thinking or manufacturing is a philosophy pioneered by Toyota executive Taiichi Ohno and codified in the Toyota Production System. Employing five basic principles: specifying value from the perspective of the end customer, identifying the value stream for each product, creating continuous flow in manufacturing and assembly, making products flow only at the "pull" of the customer, and striving for perfection, lean is intended to attack waste and give customers exactly what they want.

(2) LARP is a research program conducted in close co-operation between academia and industry with the overall purpose to identify the relationships of tomorrow between systems integrators, customers and their major suppliers in the aerospace industry, building on research findings and industrial experience. In the research process two graduate schools, IMIE (International Graduate School of Management and Industrial Engineering) and ENDREA (the Swedish Engineering Design Research and Education Agenda), played an important role. NFFP (Nationellt Flygtekniskt ForskningsProgram) contributed to the funding together with the involved industries. IMIE and ENDREA were supported by the Swedish foundation for Strategic Research.

(3) The principles are: Create lean value by doing the job right and by doing the right job; Deliver value only after identifying stakeholder value and constructing robust value propositions; fully realize lean value only by adopting an enterprise perspective; Address the interdependencies across enterprise levels to increase lean value; People, not just processes, effectuate lean value.

References (not complete)

Christopher, M., (1998), *Logistics and Supply Chain Management*, Pitman, London.

Cooper, M. & Ellram, L, (1993), "Characteristics of Supply Chain Management and the implications for purchasing and logistics strategy", *International Journal of Logistics Management* 4:2, pp 13-25

Cooper, M, Lambert D., & Pagh, J., (1997), "Supply Chain Management - more than a new name for logistics", *International Journal of Logistics Management* 8:1, pp 1-14

Cox, A., (1999), "Power, value and Supply Chain Management", *Supply Chain Management* 4: 4, pp 167-175.

Fine, C., (1998), *Clockspeed : Winning Industry Control in the Age of Temporary Advantage*, MIT.

Hayward, K., (1999), Guaranteeing Second and Third Tier Relationships: the impact of prime contractor rationalisation on the supply chain, Conference paper at "Reshaping Business Strategies in the defence industry", London

Lilliecreutz, J. & Holmberg, G., ed., 2000, "*Constructive Lean - A Systems Integrators Perspective, The Relationships of Tomorrow Between Systems Integrators, Customers and Their Major Suppliers in the Aerospace Industry"*, Research Report, LARP LiTH, Linköpings universitet.

Matthyssens, P., & van den Bulte, C., (1994), "Getting closer and nicer: Partnerships in the supply chain", *Long Range Planning,* Feb, vol 27:1, pp. 72-83.

Otto A., & Kotzab, H., (1999), "How Supply Chain Management contributes to the management of Supply Chains - preliminary thoughts on an unpopular question", in: Building New Bridges in Logistics (Larsson & Paulsson, eds), 11th NOFOMA Conference, Lund University, Lund 1999, pp 213-236.

Tidd et al, 1997

Öhrwall Rönnbäck, A., 2001