ABSTRACT

ERP II (ERP/2) systems is a new concept introduced by Gartner Group in 2000 in order to label the latest extensions of the ERP-systems. The purpose of this paper is to explore the next-generation of ERP systems, the Extended Enterprise Resource Planning (EERP or as we prefer to use: eERP).

The results of the paper are threefold: First a conceptual framework for eERP is established. Secondly, the business and research issues of this new framework are evaluated in the perspective of ERP and in particular the SCM developments. Third, the conceptual framework is applied in a discussion of potential impact on extended enterprise architecture.

Keywords: Enterprise Resource Planning; Supply Chain Management; Extended Enterprise; E-business

1. INTRODUCTION

The development of Enterprise Systems (ES) have progressed through almost fifty years in a constant interaction between changing business requirements, technological and organizational maturity and software vendors capabilities (Wortmann 2000).

ERP II or ERP/2 systems is a new concept introduced by Gartner Group in 2000 to label the latest extensions to the ERP-systems (Classe 2001). Gartner Groups conception of ERP II is almost similar to what AMR Research define as Enterprise Commerce Management (ECM) (Mello 2001). In this paper we use the concept of Extended Enterprise Resource Planning (eERP) as a generic concept combining ERP II, ECM as well as the state-of-the-art systems provided by the ERP vendors.

From a research point of view the new eERP concept may be discussed and some might argue that the concept is just “another one of these marketing gimmicks” designed by the software vendors and the consultants. Other may argue that the ERP II systems are “just” e-business enabled ERP and other again will claim that the new generation of extended enterprise systems will require business to rethink their approach to enterprise systems, implementation and to designing supply chain architecture – or will they?

In this paper we will set out to develop a conceptual framework for understanding the next-generation of enterprise systems. The framework will be based on an analysis of the new modules and functions supplied by the software vendors. Then we will explore and discuss the new challenges to the extended enterprise systems based on a retrospective analysis of the logistics and supply chain management concept. Then the conceptual framework applied in a discussion of potential impact on extended enterprise architecture.
With the introduction of computers to industry the first applications were automating manual tasks such as bookkeeping, invoicing and reordering. Gradually as the sophistication of computers and models increased the enterprise systems began to take a more active role as a planning and control agent. After the CIM (Computer Integrated Manufacturing) experiences in the eighties the role of the enterprise systems has been replaced by what is referred to as an “Enterprise Systems Experience” where the implementation process is confined into four distinct phases (Markus and Tanis 2000). The notion of implementation and success or failure is however more complex, and Ross and Vitale (Ross and Vitale 2001) introduce an: “ERP journey” and the idea of business transformation enabled by ERP.

However ERP systems has antecedents more than forty years back and the evolution of enterprise systems have progressed through history in a constant interaction between changing business requirements, technological and organizational maturity and software vendors capabilities (Wortmann 2000).

In Kræmmergaard & Møller (Kræmmergaard and Møller 2000) these ideas are elaborated on and ERP is combined with the Extended Enterprise leading to formulate an “Extended Enterprise System”, an an “Extended Transformation Process” and an “Extended Implementation Process”. Furthermore Kræmmergaard & Møller (Kræmmergaard and Møller 2001) presents a multi-dimensional essentially encompassing: people, business, technology and process issues.

Table 1. Enterprise Systems in retrospective.

<table>
<thead>
<tr>
<th>Decade</th>
<th>Label</th>
<th>New concept</th>
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<tbody>
<tr>
<td>60</td>
<td>Inventory Control Systems, forecasts</td>
<td>Computer in business applications</td>
</tr>
<tr>
<td>70</td>
<td>Material Requirement Planning (MRP)</td>
<td>Bill of Material (BOM) and material requirement calculations</td>
</tr>
<tr>
<td>80</td>
<td>Manufacturing Resource Planning (MRP/II)</td>
<td>Closed Loop Planning and capacity constraints</td>
</tr>
<tr>
<td>90</td>
<td>Enterprise Resource Planning (ERP)</td>
<td>Integrated database and HRM and quality management</td>
</tr>
<tr>
<td>00</td>
<td>Enterprise Resource Planning (ERP/II)</td>
<td>Inter-organizational collaboration</td>
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The prime functionalities of the eERP systems are E-commerce, Supply Chain Management (SCM), Customer Relationship Management (CRM), Business Intelligence (BI), Advance Planning and Scheduling (APS) and Internet procurement or e-procurement (Callaway 2000). Below we will elaborate on this definition in order to establish a framework for eERP functionality (see figure 1).

The traditional ERP is the main component in the eERP system. But for the purposes of the collaboration, an eERP system is opened to inflow and outflow of information. The ERP applications are now web enabled meaning that the functions are available from the internet, either on a corporate Intranet or through a corporate controlled Extranet.

E-commerce denotes the carrying out of commercial transactions be it with businesses or with individual customers over the electronic medium, commonly the Internet. This indeed requires an extensive infrastructure of which the main features are a catalogue, online ordering facilities and status checking facilities. ERP system serves as the transaction processing back end for the Internet based front end. Some of this functionality may be build on legacy EDI modules.

E-procurement or Internet Procurement improves the efficiency of the procurement process by automating and decentralizing the procurement process. The traditional methods of sending Request for Quotes (RFQ) documents and obtaining invoices etc. are carried out over the web through purchasing mechanisms such as auctions or other electronic Marketplace functions, including catalogues.

Those four items constitute the portal for the eERP system.
Figure 1. eERP conceptual framework.

**Product Lifecycle Management (PLM)** including Product Data Management (PDM) enables enterprises to bring innovative and profitable products to market more effectively, especially in the evolving e-business environment. PLM enables enterprises to harness their innovation process through effective management of the full product definition lifecycle in their extended enterprises. (cgi.appliedaeecouk.force9.co.uk/cgi-bin/group/e-Eng/pdm.php).

**Supplier Relationship Management (SRM)** is the vendor side analogy to CRM aimed at the management of the supplier base. SRM is rapidly transitioning from a competitive advantage to a competitive necessity, and is an essential element for companies to successfully compete in the evolving new world of e-business.

These new functions are provided through a combination of best-practices processes and technologies such as product data management, collaboration, visualization, enterprise applications integration, components supplier management, knowledge management, etc. However we conclude that the generic functionality of eERP systems may be conceptualised as illustrated in the framework in figure 1 above.

What we have seen so far is an evolution of the ERP systems explained from an information systems point of view. To understand the development further we need to analyse the concepts of logistics and supply chain management in order to be able to understand the driving force behind the new business models that eERP enables.

### 3. LOGISTICS AND SUPPLY CHAIN MANAGEMENT

Supply Chain Management (SCM) has gained increasingly importance to industry over the last decade. Global competition has implicated outsourcing to industry and internal improvement potentials have been exhausted and companies have thus turned their attention to their supply chain. In many cases supply chain excellence is seen as an important leverage to competitiveness and thus vital to manage.

The conception of the entire supply chain as one system embodies the core of SCM. SCM has evolved from an internal logistics management perspective, towards a slightly more strategic and an external integrated process view on the supply chain.

The concept of Supply Chain Management (SCM) has its roots in the late fifties where researchers on system dynamics explored the systemic properties of enterprises collaborating in chains.

Business dynamics (Forrester 1958) dealt with delays and information flow and addressed contemporary problems like the “Bullwhip effect” which is still an issue. The business implication of this research remained insignificant due to the maturity of the computers and also due to the fact that the inventory control systems solved problems with success (c.f. previous chapter).

The lack of tools and techniques have postponed this approach for decades, but the concepts re-emerged from the beginning of the 80’ies in production planning and logistics research, and by the 90’ies businesses were implementing major structural changes under the label of Supply Chain Management (Cooper, Lambert et al. 1997).

SCM took a systems approach to planning and controlling the material and information flow from the raw material to the final customer, and therefore SCM was defined 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 (Christopher 1998)”.

The strategic and the contractual discussions dominated the research agenda (Scott and Westbrook 1991), but the software industry responded to the business requirement by producing a new breed of software add-ons to ERP essentially extending the MRP/II planning concept to encompass the entire supply chain (Advanced Planning and Scheduling, APS). This was enabled by the refinement of mathematical programming and in particular the genetic algorithms.

Although SCM approach the entire chain, the academic discurs of SCM vary slightly between an upstream view and a downstream view. In the upstream SCM view the problems dealing the supplier network are dominating. Issues like supplier relations, partnerships, competence development and technology transfer becomes barriers for devoping the supply chain. The downstream issues are related to the demand management, order fulfillment, and Customer Relationship Management (CRM).

In practice the issues depend on the specific situation of the company. A tendency is however to promote SCM to an cross-functional organizational structure. Purchase managers, production planners and sales people team up with the suppliers and the customers in order to execute logistics in the supply chain. This creates a very complex situation new to most enterprises and hence managing information in the supply chain becomes very important.

Hau Lee defines e-business in a SCM context as: “The term “e-business”— as distinct from “e-commerce” — can be used to describe this exciting adoption of the Internet to accelerate the goal of supply chain integration. In this context, e-business specifically refers to “the planning and execution of the frontend and back-end operations in a supply chain using the Internet” (Lee & Whang, 2001). In fact they argue that e-
business already has enabled supply chain integration and that focus therefore should be redirected towards managing the demand chain.

If we look at the industrial best practice e.g. the cases collected from the ASCET projects (http://www.ascet.com) we see mainly supply chains that has a dominating enterprise – a supply captain – directing the supply chain. But we have several new theoretical concepts dealing with true networks.

4. THE EXTENDED ENTERPRISE AND BEYOND

Most industrial enterprises has been confronted with new challenges and opportunities, derived from globalization, new business dynamics and manufacturing concepts. An U.S. report from 1991 on the 21st century manufacturing enterprise strategy concluded that the transition towards agility would be an imperative to become the strongest competitor in the global marketplace (Nagel and Dove 1991). They observed that there was a common infrastructure requirement for all agile manufacturing enterprises, regardless of their industry sector. This led to a larger nation-wide research project that aimed at identifying the next-generation manufacturing enterprise, in which the extended enterprise is gaining an increasing importance.

The Extended Enterprise is a concept, which have been used to characterize the global supply chain of a single product in an environment of dynamic networks of companies engaged in many different complex relationships. The interorganizational network may be defined as a system consisting of all the relevant functions of a company, its suppliers and its customers, who together are termed the extended enterprise. The distinction between a “Company” and an “Extended Enterprise” is suggested in the Next Generation Manufacturing report (Patterson, Hardt et al. 1997):

- A Company is a conventionally defines profit-making entity with “management sovereignty” and well-established bounds of ownership and liability. It is charged with responsibility and control over its own actions.
- An Extended Enterprise is a group of institutions that develop linkages, share knowledge and resources, and collaborate to create a product and/or service. This collaboration maximizes combined capabilities and allows each institution to realize its strategic goals by providing integrated solutions to customers’ needs.

Consequently, the Extended Enterprise is a generic systems perspective of the network of companies performing the manufacturing task. O’Neill & Sackett (O’Neill and Sackett 1994) categorize the extended enterprise as being mainly characterized by engineer to order. However, the overall challenge of the “extended enterprise” is to ensure effectiveness of supply chains and production networks, at both national and global level.

A central process of the Extended Enterprise is the material flow in the supply chain. SCM has been dominating the fields of logistics and production management. All through it is discussed (Cooper, Lambert et al. 1997) whether SCM provide new perspectives on logistics or not, the supply chain has been cemented both companies and in industries. SCM addresses the managerial issues of the supply chain, i.e. the internal perspective of managing the relationships towards the suppliers (Olsen and Ellram 1997) and the external perspective of developing partnerships. This is consolidated in the network perspective of the network interaction model (Håkansson 1982).

The first wave of SCM have been preoccupied with supply chain structure. The level of outsourcing, relationships in the chain and integrations mechanism has and will be instruments for managing the supply chain. A new emerging dimension is the dynamics of the business environment in which the supply chain operates. The rate of which framework condition changes and new business opportunities arises is increasing and as a consequence the supply chain is no longer a static entity but needs to be agile. Take E-commerce as an example of a challenge most enterprises has do deal with in some way or another.

The constant adaption or configuration of the supply chain in order to meet the requirements of a volatile market consisting of individual customers is comparable to the refocusing in manufacturing from cycle times to change-over times: not only new tools were needed but also new concepts and approaches. This is the challenge of the next generation supply chains. Gartner characterize this change of SCM towards networks as adaptive supplier networks and SAP has been fast to adapt this concept.

Mass Customization is one of the new manufacturing concepts that require the enterprise to be agile. The pressure on industry to embark into the manufacturing of individually customized products is amongst others rooted in the emergence of new Internet-based business models. These new business models require companies to manage individual customer orders from upstream in the value chain through the entire supply chain to direct deliveries to the customer.

For the average industrial enterprise, the transformation towards agility is a major challenge. For years, the company may have optimized on the single function with focus on cost and capacity utilization. The price of functional focus is usually the performance of the customer-oriented processes. The transformation of the company towards process orientation must be accomplished without jeopardizing the rationale of the functional organization. This is the central design dilemma in the Extended Enterprise.

5. DISCUSSION

When we combine the network oriented Extended Enterprise concept with the evolution of the enterprise systems we find a gap between state of theory and state of practice. Theory seems to advocate loose coupled business and systems architecture where as ERP systems in practice seems to support tight coupled supply chains and integrated systems.

We have interpreted this gap as an architectural challenge to manage. This raises the important question of the structure of Enterprise Systems in the Extended Enterprise perspective?

Markus and other discusses the evolution of ERP system (Markus, Petrie & Axline 2000) and they come up with two scenarios for the future: a continuity view with monolithic systems (“Wall to wall SAP”) and a discontinuity view with componentized systems (“Best of Breed”).

This architectural dilemma extends into the Supply Chain and thus it may be replicated at the inter-organizational level, but it
is not determined by the information systems alone but also the
by the business structure in the supply chain. How can we
represent the structure of the systems?

**Figure 2. Intra-organizational systems architecture.**

At the lowest level (c.f. figure 3 above) of the architecture we
have the shop floor systems: Manufacturing Execution Systems
(MES), Warehouse Management Systems (WMS) and
Transportation Management Systems (TMS) not yet
standardized. The shop floor systems interface to the ERP
systems, which may be of different make or even a legacy
system, but essentially of same architecture. These ERP
systems are integrated along the supply chain using a Supply
Chain Planning system like i2 or SAP APO. This high level
structure is the eERP architecture (c.f. figure 3 below).

**Figure 3. Inter-organizational system architecture.**

Based on the above evaluation of half a century developments
in logistics and information systems we find that the
fundamental architecture, the dominating structure, of the
enterprise systems has been determined in a dialectic
development process between the supply chain business models
and IS application models. The available IS applications has
largely been determined by the state-of-the-art IT technology
but also by the software vendors interpretation of business
requirements. On the other hand is the business requirement
deliberately determined by the strategic business issues but also by
the available IS opportunities for supply chain collaboration.

Consequently we may explore the extended enterprise systems
architecture by using two dimensions: 1) the supply chain
dimension and 2) the enterprise system dimension.

The supply chain dimension characterize the coherency of the
business systems along the supply chain. Until the emergence of
the SCM concept and long-term relationships, logistics were
confined to the single enterprise, but with the emergence of the
Extended Enterprise concept the idea of dynamic configuration
of relations and short-term relationships were reborn. We
assume supply chains are either tight coupled or decoupled.

The enterprise systems dimension characterize the coherency of
the information systems along the supply chain. Originally the
enterprise systems in a supply chain was completely fragmented
until the developments in the DBMS made integrated ERP
systems possible. The Internet and web based technologies are
now enabling both centralized and distributed solutions. We
assume that the enterprise systems are either integrated or
modular.

Given these two dimensions we can establish a model of the
extended enterprise systems architecture c.f. figure 4. In this
model we can identify four archetypes each representing a
specific extended enterprise system configuration.

**Figure 4. eERP architecture.**

The **APS** configuration. This kind of configuration is an
extension of the MRP/ERP planning and controlling philosophy
were an aggregated and centralized state model of the static
supply chain is established in an Advanced Planing and
Scheduling (APS) system.

The **EDI** configuration. This is a classical static enterprise-to-
enterprise configuration were structured data interchange
between main actors using an agreed standard such as
EDIFACT or XML.

The **HUB** configuration. Is the marketplace or exchange
configuration were specialized intermediaries assure dynamic
supply chain relations can be established on an application-to-
application level (e-procurement).

The **P2P** configuration. Is the true network configuration where
autonomous organizations are collaborating using computer
supported processes enabled by new P2P (Peer-to-peer)
technologies like used in file-sharing services like Kazaa.

These four situations are archetype configuration and are not
likely to appear in any single or in purified form. However this
model may serve as a conceptual lens or as a framework for
understanding extended enterprise systems architecture. The
different configurations has different implications and require
different business strategies. An industrial manager may
therefore use the model for analysing the present situation and
plan for the future.
6. CONCLUSION

In this paper we have developed a conceptual framework for eERP systems and an extended enterprise systems architecture. In the model we have identified four different archetype situations, and the model may be applied in the analysis and planning of future enterprise systems strategy.

At this stage the model is mainly speculative but the models has been validated through prototype workshop sessions with ERP managers from Danish industry. The preliminary results shows that the issues raised by the models are critical to the companies but also that further development is required.

The new generation of ERP systems, the extended enterprise systems or eERP systems include the applications to support the new supply chain models. In some of the cases we can extend the concepts of ERP to extended enterprise systems but in other cases we will require business to rethink their approach to enterprise systems, implementation and to designing new supply chain strategies.

The future research challenges are obvious on the HUB situation, which include e-procurement and marketplaces. Especially we are concerned how we should redefine our ERP implementation framework to adapt to the interorganizational issues in ERP/II.

Also more basic research on interorganizational models are needed. Today we mainly have to rely on the software vendors “language”. The challenge here is to establish generic models like the SCOR model (www.supply-chain.org).

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REFERENCES


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