Product Modelling
1 Introduction

Investments in the last 10 years within shipyards world-wide led to increasing levels of automation and process integration with substantial improvements of productivity in "blue collar" areas. Most advanced shipyards developed from craft-skill-based workshop technologies towards highly robotised shipbuilding factories. Beside the consequent development of all CAD/CAM processes the shipyards also improved their organisational and logistical functions. This was necessary to serve the needs of those highly integrated production areas, but also to improve the productivity of "white collar" functions.

Most developments were oriented to improve functions and processes inside the individual companies. Whereas, new and advanced Information Society Technologies (IST), namely, Electronic Data Interchange (EDI) and Electronic Commerce by means of Internet and Multimedia technologies, open up new fields for business improvements through inter-company process integration. These technologies will sustainable change and enhance shipbuilding supply chains and co-operative engineering processes. In the future, shipyards and their co-operational partners will develop to powerful temporary networks, so called Virtual Enterprises (VE) which on the basis of integrated processes by means of information and communication technology (ICT) will behave like one large entity. Since material supplies and external engineering services count for 50-70% of the ship cost the potential for improvements in this field is comparable high.

This paper will discuss the state-of-the-art in EDI and Electronic Commerce technologies and its application in shipbuilding supply chains. On the basis of actual trends in the shipbuilding industry towards more co-operative working, outsourcing and system supplies, the potential application areas of EDI/EC technologies will be discussed including its commercial implications on the process, i.e. cost savings and lead time reductions. Results from European research projects, e.g. EDIMAR (EDI for the European Maritime Industry) and MARVEL OUS (Maritime Virtual Enterprise Linkage – Open User Syndicate) have contributed to the discussion and definition of standards. These projects have proven the functionality in different test scenarios by adapting technology ready for application, i.e. available products and services. This draws also the scenario for ongoing projects activities and on future development needs.

2 Motivation

Competition in shipbuilding is constantly increasing in the shipbuilding industry for many years. After long phases of recession in the 70ies and 80ies the markets are improving. However, through new capacities coming into the market the competitive position of many shipyards has not improved. Searching for alternative solutions to improve the competitive position the shipbuilding industry is following worldwide a trend towards further outsourcing of processes and services to benefit from a better specialisation and cost performance of smaller and self-responsible companies, i.e. marine equipment manufacturers and service companies. Compared to the total cost of a ship this trend leaves the shipyards today with a share of 50 – 70% material cost, 20 – 35% manufacturing cost
(labour and overhead), 5–10% engineering/design cost and 5-10% sales and administration cost (Figure 1).

Figure 1. Typical ship cost structure (Example)

Some of the potential advantages of outsourcing have been bought in for the price of dramatically increasing overhead and management cost. This is because many companies have not properly prepared themselves to keep control of services and processes which they so far performed by themselves. On the other hand shipyard personnel often are not used to adequate management techniques and tools to manage external resources and the purchasing process effectively. Therefore, material and services overhead cost are summing up to 5 – 8 % of the total ship cost not saying anything about the time losses through incomplete and inadequate information in the process. This substantial share of cost, which is very often not clearly visible, but hidden in other cost positions, provide a very good motivation and a large potential for cost savings.

3 Understanding the Maritime Supply Chain

3.1 Elements of the Supply Chain

Elements of the maritime supply chain can be found in almost all processes of ship newbuilding. The respective work and effects cannot be limited to the work of the purchasing department, but has to be considered as an integrated element in almost all functions throughout the shipbuilding process. It already starts with the suppliers seeking for markets and acceptance of the products and it continuous after the ship delivery through life cycle supporting functions in the area of maintenance and repair. Besides the shipyards and the suppliers maritime supply chains involve many external partners directly and indirectly (Figure 2) and requires an extensive communication process including specially applied management procedures.

More specific the different elements of the supply chain may be distinguished in the following six business processes:

Marine Equipment Type Approval

Before entering into the market marine equipment suppliers have to obtain type approvals from classification societies for their products. This is a major entrance barrier into the market and as well a time critical, lengthy and expensive process for the suppliers. It mainly involves the suppliers and the classification societies. The procedures involve laboratory tests and complex administrative procedures. For some products testing of the individual products are requested beyond type approval.
Pre-Selection of Equipment and Materials (Engineering and Design Process)

A process of vital importance for the supplier is the engineering and design process of the shipyard. The optimal situation for a supplier is to be no. 1 choice on the ship-owner's maker list, which requires after good quality and reliable products continuous marketing and sales efforts to maintain the position in the market. But even then it is necessary to be "at hand" for the designer either in form of good catalogues and fast accessible technical information, technical advisory and support services and maybe through good personal relations.

Procurement Process

Often in parallel, sometimes in a sequential order or even before the detailed design process has started, purchasing activities begin with inquiries in the market by requesting quotations from suppliers. This is not necessary for those products where the shipyards have negotiated framework contracts with the suppliers including fixed price structures. The bidding process is followed by the order process including sending the formal orders and receiving respective order responses including confirmations respectively changes to the order. Since shipbuilding is a very dynamic process with highly concurrent engineering processes order changes are frequently necessary. In some special cases the purchasing process will be handled through trading houses, which may receive better prices than single shipyards through some special framework contracts and access to different markets.

Material Delivery Process

The purchasing process itself is followed by close tracking of the order, especially with respect to the delivery date. For some supplies the timely delivery is of vital importance for the shipbuilding schedule. Therefore a continuous contact to the suppliers will be maintained and even shipping and transport are subject of close tracking. However, all the paperwork including transport data, delivery notes, despatch advices, invoices and storage intake control are subject of this process. It may also comprise the handling of certificates which may accompany the supplies. These have to be handled and administered carefully and become later an element of the overall documentation for the ship.
**On Site Assembly, Functional Testing, Approval**

Whoever is responsible for the assembly of materials and components (shipyard or supplier) will rely on good documentation for the assembly procedure. Access to remote information through direct contacts or advanced media can be important for fast and reliable mounting on site. This is followed by functional testing of systems which may involve again the classification societies. Beside the technical testing this is also a very formal procedure with excessive amounts of documentation and administrative procedure. Again the availability of all required information, certificates etc. is important for fast and reliable procedures.

**Guarantee Process, After Sales Services, Maintenance and Repair**

After the delivery of the ship normally all involved parties, i.e. the owner, the ship, the classification society and the shipyard file comprehensive sets of all documentation for the ship. For all events like potential guarantee processes, renewing the class, regular maintenance or emergency repair it is essential to have fast and reliable access to all documentation of the ship. Documentation needs to be small in size, but comprehensive and supportive in its content.

### 3.2 The Supplier Base of Shipyards

Depending on the ship-type the relative value of the manifold product groups of ship equipment may be very different. The cost-share of accommodation for a cruise ship has a totally different dimension than for a normal cargo ship. The cost-share of electrical equipment or electronic components for naval vessels are incomparable to those for tankers and so forth. Figure 3 gives an example for a typical distribution of material cost for a container-ship from a North-European shipyard. The relative value of material and other external cost against the ship total cost depend on the level of outsourcing and also on the regional employment cost of the shipyards, i.e. in regions with low employment-costs the total share for material may be relatively higher.

**Figure 3. Typical distribution of material cost (Example)**

The total number of suppliers for a large shipyard or a shipbuilding conglomerate may sum up to around 3,500 companies. For the building of a general cargo ship the shipyard may employ about 1,000 of them. To understand the structure of the suppliers, their meaning for the shipyard and to develop suitable ways to treat them in the right way, respectively to develop strategies for
improvements in the future relations the shipyards need to carry out extensive analysis. Beyond information about the products, country, reliability, owner structure, solvency etc. which need continuous updating, data about order volume, special abilities, flexibility and continuous exchange of messages is necessary. The treatment of supplier data in relational databases have facilitated this work in the last years tremendously. Targeted evaluation and interpretation of data is easily possible. Results are for instance the international level of material sourcing (Figure 4) or the identification of key suppliers by order value or of those with the highest numbers of messages to be exchanged.

**Figure 4. International Sourcing (Example)**

Examples from shipyards show that about 7% of the companies involved absorb about 70% of the ordering value (30% companies absorb 90%). Compared to that the shipyard exchanges with 15% of the companies about 70% of all messages (respectively with 40% about 90% messages). But, companies with high order values not necessarily represent those with high numbers of messages. In most cases it is the contrary (Figure 5)

**Figure 5. Extended Supplier Analysis**

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<table>
<thead>
<tr>
<th>Supplier Base</th>
<th>Typical Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 per ship</td>
<td></td>
</tr>
<tr>
<td>2500 per shipyard</td>
<td></td>
</tr>
<tr>
<td>3500 per group</td>
<td></td>
</tr>
</tbody>
</table>

Messages per Year

<table>
<thead>
<tr>
<th>Total</th>
<th>50,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orders</td>
<td>20,000</td>
</tr>
<tr>
<td>Invoices</td>
<td>26,000</td>
</tr>
<tr>
<td>Confirm</td>
<td>5,000</td>
</tr>
<tr>
<td>Others</td>
<td>5,000</td>
</tr>
</tbody>
</table>
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Understanding the different supply chain processes and working on the supplier base to derive most valuable information on the meaning of the different suppliers for the shipyard is essential to develop and evaluate new and advanced strategies. Some shipyards have developed complimentary strategies to treat different supplier groups differently. This can just be done on the basis of detailed knowledge. It must be stated that many shipyards do not have this knowledge and therefore cannot launch appropriate measures respectively cannot control the impact of their respective investments.

4 Actual Trends and Strategies

Beyond outsourcing strong tendencies towards more global sourcing of materials, more system related purchasing (reducing the supplier base!) and more collaborative engineering can be identified within the major shipbuilding groups world-wide. In spite of high potentials for cost reduction in these strategies, there are risks which may jeopardise the anticipated success. Major concerns are with the delivered quality of supplies, the timely delivery of ordered materials and components and, to come in control of the entire process, the need for new and advanced management skills in combination with a better information and communication system environment.

Benchmarking studies in the shipbuilding industry for comparable ship types show margins of 15% and more between prices for external material cost. The shipyards have started to realise those margins by putting more price-pressure on the suppliers, but also by the standardisation of technical solutions, teaming-up with other shipyards to achieve stronger buyer-power and by reducing their supplier base through more system related enquiries.

On the other hand these trends in general require also good strategic concepts from the marine equipment manufacturers for the future. Since the trend towards outsourcing in the first place effects the configuration of strategic alliances with marine equipment suppliers in geographically close regions, the building of global co-operation alliances with some material/component key-suppliers and service-providers may be more adequate. The general step-by-step process of outsourcing through shipyards is shown in Figure 6.

Figure 6. Migration towards a virtual enterprise
Beneath the effect to achieve commercial benefits through the outsourcing process itself, e.g. through higher workloads and relatively lower overhead costs, the availability of new and advanced information and communication technology allows the cost-effective realisation of those concepts. As an ultimate consequence shipyards, theirs suppliers and others integrated into the process may migrate towards a Virtual Enterprise (VE). A Virtual Enterprise by definition is a set of temporary linked individual companies clustered to fulfil a timely restricted business process and behaving for that business process as an integrated enterprise enabled by advanced technologies.

On the basis of the individual supplier analysis of a shipyard it is essential to apply the right strategy with the right partners (marine equipment suppliers) and to assign the right technology for the implementation of co-operative working solutions. An analysis of the supplier base as shown earlier (Figure 5) can be used to make appropriate decisions. From this analysis indicators and strategic decisions can be derived with which partners technical solutions towards paperless purchasing and/or collaborative engineering should be developed on high priority. Those suppliers of shipyards which provide high value components with a low amount of purchasing documents, but a high amount of technical data to be exchanged must be considered for collaborative engineering solutions. Those who supply “bulk materials” or standard products which require frequent and periodic exchange of purchasing documents, may be better considered for paperless purchasing procedures (Figure 7).

**Figure 7. Typical Supplier Analysis and Recommended Co-operation Fields**

5 New Technologies and Management Practice

New technologies, basically information and communication technologies, tremendously effect the way of working within and between companies. Since this is true for almost 40 years now, the shipbuilding industry seems still to be at the starting point for an organisational revolution caused by this. The given background of newly available technology, e.g. internet, EDI, geographically distributed client server environments etc., allow far reaching concepts for integrated supply chain management for shipbuilding applications. Principle examples for this can be found in other industries, e.g. just in time delivery solutions in automotive and aircraft industries.
The technology to be applied is very often described by the name “Virtual Enterprise Technology” (VET). VET is anticipated to play an increasing role in the support of emerging collaborative networks. Virtual enterprises are defined as a set of temporary linked individual companies clustered to fulfil a timely restricted business process and behaving for that business process as a integrated enterprise enabled by advanced information and communication technology. For example a shipyard and a set of key suppliers team-up to fulfil a ship newbuilding contract. Virtual enterprises can be build-up for different applications, e.g. supply chains, design chains, distributed manufacturing and assembly processes. Because of their temporarily nature and a heterogeneous portfolio of participating companies the mechanisms applied need to be flexible, standardised and easy to reconfigure. An open communication infrastructure, openness of software systems, agreed data exchange standards, harmonised workflow and a dynamic intra- and interorganisational reorganisation process are vital success parameters for VEs.

To achieve the expected benefits, it is further essential that the shipyards and their suppliers build up new and powerful managerial skills combined with continuous qualification programmes for their employees.

In the last ten years the European shipbuilding industry including also suppliers to some extend started to prepare the baseline for this kind of future working. Within individual projects international standards for the exchange of data have been always in focus. For example, major contributions have been made to the international discussion and development of maritime application protocols of the ISO standard STEP and to the definition of industrial specific message types according to the UN standard EDIFACT. Through the establishment of EMSA (European Maritime STEP Association) in 1994, Special Interest Groups for Networks, Electronic Data Interchange (EDI) and Product Data Management (PDM) and many bilateral international co-operations the industry achieved a better understanding for the needs and benefits of co-operative working. The industry is now at the point to show an increasing interest for putting VE-technology into operation.

Mainstreams for collaborative electronic based working is highlighted in Figure 8. Most likely a hybrid solution combining the advantages of different technologies will be implemented for individual business process needs. The major challenge is to find the right configuration by using all enabling technologies and to keep the application flexible for fast adaptation according to a fast changing technological platform.

**Figure 8. Mainstreams in EDI**

![Diagram of Mainstreams in EDI](image)

The problem is that the structure and the level of technological development may be extremely different with the co-operating partners. The portfolio ranges from fully developed and computerised
companies which also apply appropriate management abilities to the change of the processes to those companies who have hardly applied any computerised solutions for their own process handling. The shipyards have to think about the right way to build up solutions which allow most of these companies to be integrated into advanced co-operative working concepts. The way as chosen by many other industries to just put enough pressure on suppliers and force them into solutions which are favourable for the customer but complicated, inadequate and expensive for supplier cannot be applied by the shipyards. This is because the shipyards are a very heterogeneous group of companies itself which does not create enough market-power. Even co-operational agreements between bigger shipbuilding groups in Europe are not consequently used to create and us this market-power. Further, the supplier base is comparable big and consist of many small and medium sized enterprises which are by far not prepared for advanced working concepts.

New very promising technologies which have been developed for Internet applications may help to overcome the old problem of too high cost for the application of classical EDI solutions to small and medium sized enterprises. As a result it can be stated that the availability of technology for all level applications is as such that they almost offer solutions also for the incorporation of these companies. Different projects performed under the framework of European support programmes etc. have substantially contributed to some of these developments. MARVEL OUS (Maritime Virtual Enterprise Linkage - Open User Syndicate) draw a baseline to the situation of standards for Maritime Virtual Enterprises and edited a basic book on standards. EDIMAR (Electronic Data Interchange for the European Maritime Industry) developed some adapted EDIFACT messages to the need of maritime purchasing applications, contributed to the definition of STEP AP 226 and developed and adapted workflow tools and concepts to shipbuilding purchasing applications. The new project MARIFLOW (A Workflow Management System for the Maritime Industry) is now working on workflow applications to quality data chains including applications of EDI functionality for the exchange of quality certificates for steel plates. In these projects and more others functionality and potential of different technologies and standards have been proved by setting up demonstration networks and scenarios covering Computer Supported Co-operative Work (CSCW), Workflow Management Systems. Classical EDI and Extensible EDI (XDI) concepts by means of internet technology. It is now about time to continue working on these platforms and to create numerous and manifold reference applications to verify and develop commercial benefits and to create new starting points for further developments.

6 Commercial Potential

As said above the cost involved in the complex functions of supply chain management are substantial and very much worth to seriously think about an improvement. Nevertheless these cost are very often hidden in other costs and therefore, often not easily to identify or to separate. Overhead costs by nature the potential for cost reduction is difficult to prove and just be approached through consequent managerial efforts and cross-departmental thinking and re-organisation. However, a considerable overall cost-reduction for ship newbuildings can be anticipated by the application of new technologies and new ways of collaborative working if the technology is seriously taken and consequently applied.

The commercial benefits maybe generated at both ends of the collaboration, the shipyards and the suppliers. In comparison to investments in the manufacturing area the risk ratio (ratio of investment to potential earnings) is lower, but, to say this again, needs more managerial involvement and consequent reorganisation. The benefits through the application of advanced Electronic Commerce and EDI technology in the different processes of the supply chain may sum up to about 5%
of the total cost of the ship, which is a considerable share. The biggest share can be realised through decreasing material overhead cost at the shipyard and at the suppliers. However major achievements can be expected in the design area as well as in the area of Sales and Administration (Figure 9).

Figure 9. Potential for cost reduction

At the supplier side some more effects can be generated through the use of advanced multimedia marketing instruments, i.e. electronic catalogues with technical information elements either on CD-ROM and/or through suitable Internet representations. This may include product descriptions in standard formats which are ready to build in for the designer in his product model. Further the consequent building of organisational interfaces towards the shipyards including building the ability for the structured exchange of data by means of EDI can also create very positive effects for the opening of new markets and the maintenance of existing one’s.

Potential effects at the suppliers are the building of a special differential advantage in the market, possibilities for direct marketing (without regional sales agents), a faster penetration of the market with new products, a faster/cheaper change of the marketing strategy and a closer link to the customer once the new links have been positively established.

Pilot installation and demonstration cases have shown that the anticipated targets for cost reductions could be achieved easily. This is also confirmed by some comparable applications in other industries (Figure 10). However, the full benefit of the investment can just be achieved if new and EC/EDI based shipyard/supplier relations can be build up fast and consequently so that as many suppliers as possible can be linked in a short time frame. Risks can be minimised if shipyards and suppliers in the starting phase do not invest in own systems, but use commercial data clearing services (e.g. BAL.DIS the BALance Data Integration Service). As long as the number of interlinked suppliers or other co-operative partners is low or the amount of data to be transformed is limited those commercial services offer the economical solution. By developing more co-operative links one or all partners can successively migrate into an own system which can be slowly build up in parallel to an already working solution.
Other benefits have been proved through tremendous time savings during the entire purchasing process, but also in other follow-up processes. Better data accuracy, less mistakes through data coding and a better basis for decision making processes have been reported to be other major achievements which can be forecasted, but just proved through the consequent application and use of new and advanced technology and management methodologies. There is no lack in technology, even if for many special applications suitable solutions still need to be developed. But for initial earnings the technology is ready for application.

7 Conclusions

The different and manifold business processes with maritime supply chains create a substantial amount of cost in the entire shipbuilding process. Emerging advanced information and communication technology and respective developments from recently performed R&D projects allow the consequent attacking of those cost with a high potential for commercial achievements. Especially the reorganisation of the purchasing process and the logistical process between shipyards and their suppliers through the application of Electronic Data Interchange and Electronic Commerce Technology show promising potentials. Very actual new developments in the area of Internet programming languages (XML) which are allowing also the exchange of structured data on this basis are very promising to also overcome cost problems of classical EDI for small companies, which do not even run own purchasing systems. Nevertheless, all applications in this field have to consider the heterogeneous structure of the shipyard's supplier base. Therefore all solutions needs to be flexible to the outside, but streamlined to the inside. The problem to start respective applications in shipyards is not a problem of the availability of technology. A management decision has to be taken, pilot applications have to be implemented and necessary re-organisation and qualification programmes have to be started in parallel to the configuration of the technical solution. Once the technology is in place and the organisation has learned to handle it the potential to quickly earn commercial benefits is very high.
8 References


ELECTRONIC COMMERCE

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Introduction

The word “Commerce” is combined by the word *com* (together) and *merx* (merchandise). The Random House College Dictionary defines that “Commerce” is the buying and selling of goods. The world “Electronic” pertains to devices, or systems developed through electronics. Electronic Commerce is interpreted differently by different people. The first thing to understand is Electronic Commerce covers any form of computerized buying and selling, both by consumers and from company to company. It is viewed by many to be the technological revolution of the late 1990’s and early 21st century that will likely transform the operations, systems and efficiency of business, industry, and government.

Here is the other useful description:

The Automotive Industry Action Group in North America defines it as “the enablement of a business vision supported by advanced information technology to improve efficiency and effectiveness throughout the trading process.”

History

The term Electronic Commerce has really emerged in the last ten years, and can be regarded as a broadening of the term Electronic Data Interchange (EDI). However, there have been links between computers since the 1960’s, so the routes of electronic trading lie much further back even than when EDI became a buzzword during the 1980’s.

Categorization

With modern telecommunications infrastructures, we have been provided with the means to exchange data instantaneously. Electronic Commerce is about using these data-flows in the most effective way. There are commonly three phases of implementation of Electronic Commerce:

- Replace the manual and paper-based operations with electronic alternatives
- Rethinking and simplifying the information flows
- Using the information flows in the new dynamic ways

Simply replacing the existing paper-based systems will reap few real benefits. It may reduce administration costs and improve the level of accuracy in exchange data, but it does not address the questions of whether a business is operating efficiently. Electronic Commerce applications can help to reshape the ways to do business and have often acted as a catalyst for reengineering.

Reengineering is about reassessing the ways to conduct business. It is about looking at the flows of information through production processes. It is about optimizing the use of resources. Thus, it is necessary to understand the electronic commerce applications available in order to think about how they can best assist the existing system. Electronic commerce applications:

- EDI, Hybrid EDI, Interactive EDI
- Email
- Internet Applications
• Enhanced Fax
• Voice Applications
• CALS
• File Transfer
• Computer Aided Design/Manufacturing
• Multimedia
• Bulletin Boards
• Teleconferencing
• Automatic Identification

Significance of E-Commerce

Electronic commerce is important because it has the potential to advance the global economy by changing business styles. For business to survive the Information Revolution, business must take advantage of electronic commerce.

In a souvenir shop in San Francisco, there are many T-shirts of the Golden Gate Bridge, Cable Cars, Fisherman’s Wharf, etc. Most of those T-shirts are made in China at a very low cost but are sold at about five dollars or more. In an electronic commerce network were established between T-shirt factories in China and San Francisco. Chinese T-shirt makers would be able to get orders directly from tourists by simply displaying their catalog on the Internet.

With these simple ideas in mind, you may understand the impact of electronic commerce. As long as you have a good product and a competitive price, you don’t need to travel across the oceans to find retailers and to create marketing networks.

Example of Electric Commerce - Amazon.com

Amazon.com is reportedly the Internet’s largest bookstore. Customer accounts rose from 610 on June 30, 1997 to 3.1 million as of June 30, 1998. The product line was recently expanded to include music (June ’98) and has also expanded into the European market by its purchase in April of Bookpages, Ltd. Telebook Inc. and Internet Movie Database, Ltd.

Most recently in July, 1998. Amazon.com announced an agreement to participate in ModaCAD’s Virtual Shopping Mall e-business fashion solution. ModaCAD’s CEO commented that their virtual shopping experience would not be complete without the presence of an established retailer of books and music.

Amazon.com is considered a pioneer in the electronic commerce marketplace. For this news release from Amazon.com, the following comments were made regarding the agreement which identify the current considerations for e-commerce.

Factors that could actual results to differ materially include the following:
• the timely completion of the development of the company’s software products, including ModaCAD’s e-commerce and consumer software and enhanced or updated versions of the company’s electronic merchandising and CAD software products
• unforeseen technical or other obstacles in the development or production of such software
• acceptance of ModaCAD’s e-commerce and consumer software by the publisher/distributors of such software and the release and marketing plans of the publisher/distributor

• customer acceptance of ModaCAD’s e-commerce and consumer software products and updated or revised versions of the company’s electronic merchandising and CAD software products

• the company and its publisher/distributor’s ability to produce its products on a cost-effective and timely basis

• factors not directly related to the company, such as competitive pressures on pricing, market conditions in general, competition, technological progression, product obsolescence and the changing needs of potential customers as well as the software, textile, apparel, home furnishings and home design industries in general.

The announcement also contains the following statements regarding Amazon.com’s concerns for risk and uncertainties that include:

• Amazon.com’s limited operating history

• The unpredictability of its future revenues

• Risks associated with capacity constraints, management of growth and new business opportunities

Strengths of E-Commerce

E-commerce is another step closer to a goal that has started with grocery stores that stay open 24 hours 7 days a week. the quest to be able to get everything, anything and from anywhere in the world. The electronic marketplace never shuts down and the number of online available goods is ever increasing. This makes online shopping very convenient: no need to leave the house, no need to think of opening times, no need to remember you can buy what.

In addition, companies can set up personal profiles of online shoppers by tracking their moves on their web sites and create personalized offers based on previous customer preferences.

Interactively, the ability of the buyer to enter some form of dialogue (e-mail, questionnaires, etc.) with the vendor is another advantage of Internet based trading over traditional long-distance trading (e.g. mail order catalogues). This way vendors and manufacturers get valuable direct feedback from their customers.

Virtual stores can replace bricks-and-mortar stores and thereby save costs. This in return allows small companies to compete effectively with bigger corporations without the need to set up a wide system of stores and expensive logistic and distribution systems. E.g. Amazon.com completely changed the way the people can buy books. Being a new company it can effectively compete against old timers like Borders and Barnes & Noble because of the E-Commerce on Internet/WWW. The old paradigm “all business is local” does not hold true anymore. Buyers/sellers are no longer geographically confined.

Finally, E-commerce reduces costs by eliminating traditional brokers or middlemen, thereby shortening the distribution chain. The redesign of business processes forced through the new technology save money due to the greater effectiveness of the way business is done.

Weaknesses of E-Commerce

E-commerce still has a few weaknesses, too, that shouldn’t be ignored:
From a buyer's point of view, the Internet offers an overload of information that can be difficult to sort through, especially for the inexperienced user. Web browsers provide a good deal of help, but even with these the hit of 214 sites containing the searched term can be overwhelming. Therefore the problem of finding the right site, to navigate in the vast amount of information can pose a problem. Another weakness is still the unsolved security issue (see also next paragraph) that results in a low trust level when it comes to financial transactions and the exchange of credit card information, for example.

From a vendor's point of view, the Internet is a difficult place to grab and hold a customer's attention, since it is so easy for the customer to just click to the next web page. For the same reason it is difficult to build and keep up a brand loyalty as it is known from traditional retail. Also, the fact that buyers can easily find the lowest prices for a specific product forces the vendors to reduce their profit margins in order to stay competitive. Lastly, depending on the kind of business there can be rather high initial investments for hardware and software in a cyberspace business. High up-front costs combined with low profit margins can therefore pose significant hurdles for market entrance.

**Current Limitations**

- **Security**
  1. Customer to Web server security i.e. Web browser to Web server security. This is currently being addressed by various new technologies like SSL, SET and encryption but this technology is still evolving and takes some time to mature.
  2. Web Server to Merchant's Desktop security. Most small businesses don't have their own web server, they rent web space from an Internet service provider, and those who want to sell directly on Internet, rent "secure" web space (that is, equipped with SSL) so customers can communicate securely with their Web server.

- **Bandwidth and latency limitations due to various factors including technology**

  When the Internet was created 25 years ago, it was called the ARPANET and was used primarily by U.S. researchers and scholars for file transfer and E-mail. The bandwidth (measure of capacity of data transfer mediums) deployed from 9.6 Kbps to 56 Kbps, which was sufficient to support activities at that time. Today, individual and corporate users are flooding onto the Internet via the WWW in record numbers. These users demand higher bandwidth-consuming technologies (such as multimedia and voice) to perform electronic commerce. This usage is causing serious bandwidth and latency problems.

**Technical Challenges to Address**

- **Security**

  A widely held belief is that security issues continue to hinder the growth of electronic commerce over the World Wide Web. There are a number of technological and legislative efforts underway to ensure that adequate security measure exists for these Web-based transactions that include

  - Encryption
  - New communications technology like secure sockets layer (SSL), and Secure Electronics Transactions (SET)
  - Digital certificates/Authentication
• **Bandwidth and Latency**
  This problem can effectively be addressed by using various new technologies like
  * Data compression to reduce the amount of data to be transferred
  * New hardware technologies like TV cable modem, fiber optics and satellite links
  * Better packing routing technology like Resource ReSerVation Protocol (RSVP) and IP version 6 (IPv6)

• **Connectivity**
  The currently dominating media TV and Radio will eventually merge with the PC; not necessarily in the content offered (entertainment on the TV, information of the PC, a mix of both on the Radio), but at least in the point of access. One device will be used to access video, audio and text-based information and entertainment. This in return will allow for improved transmission of information and even easier access. In order to get their current applications will have to be easier to connect and “Plug ‘n Play” has to grow from a marketing slogan to reality.

**Future Trends**

• **Improved market information for sellers**
  New technology will facilitate expansion of rapidly growing database marketing trends. This expansion will also be fueled by developments like more extensive research, which will enable better understanding of consumer behavior and coordination of old and new media, which will enhance an organization’s ability to communicate with consumers. The ultimate results will be one-to-one marketing.

  With implementation of new technology future marketers can instantaneously exchange information and can assess effectiveness of marketing strategies, particularly in promotions and pricing, which is critical to maintaining a competitive edge.

  Sellers will make decisions based on individual or household demographics, responses to promotions and brand loyalty. Marketers who master this more complicated environment as a result of the enormous amount of data available, will be rewarded with customer loyalty based on increased customer satisfaction.

• **Emergence of New market Intermediaries like information warehouse**
  With the dramatic increase in information, new market intermediaries like information warehouses will emerge, which begin by providing storage capabilities and later evolve into entities which integrate massive amounts of data and sell them to organizations to enhance their marketing efforts. A parallel effort will be the emergence of intelligent hardware and software like the search engines which rely on artificial intelligence that go beyond current notation of keywords. For example, a search for the words “Casual apparel” will reveal products related to casual without the word “casual” appearing in the title, i.e., the search engines know that products associated with certain activities are considered casual.

  Market intermediaries will address the fragmentation of formerly integrated selling and buying functions. For example, electronic marketers selling at the retail level. Once the sale is made electronically, they can place an order directly with the supplier who will ship directly to the customer. This specialty technology-based service is that of a broker having no person-to-
person contacts, nor store atmosphere. This will gain importance at the retail level as selling is separated from other retail functions.

- **Expanded and more technology-based channels of physical distribution**
  Physical distribution through electronic channels will become widespread. Electronic channels will distribute any kind of product or service that can be converted to a digital format and transmitted either through fiber optic cable or satellites. These products may include movies, music, newspapers, magazines and books, money, tickets, stage plays or any other forms of entertainment or market research information. Thus products that can be digitized will be available in various formats from a variety of sources.

- **Additional technology-based consumer services**
  Time management difficulties will continue as customers seek more control over their lives, both personal and professional. This will be particularly true at the retail level as baby boomers move into their 50s and search for ways to simplify their lives. Obvious services like bill paying, time and activity organizers, callback reminders, “To Do” lists, trip schedulers and so forth will emerge first. But others, such as food purchases or recommendations on product/service purchases on the Internet will not be far behind.

- **More worldwide sourcing**
  National boundaries will fall even faster than they have in recent years. Technology will enable individuals and groups to bypass existing sources of products and services and choose those that most closely meet their needs. Competition will be facilitated not only by the Internet, but by other technologies like ISDN, HDTV and interactive voice response. Some traditional channel distribution will disappear, whereas those that provide service through the Internet will be most in tune with customer needs and desires.

- **Further price reductions on hardware side**
  The continuing decline of prices for computer hardware will further increase the availability of communication technology in the form of PCs, Laptops, Personal Assistants, and will also support the trend towards miniaturization. Smaller and cheaper devices will be used by a wider audience for a wider array of tasks and therefore, further support the rapid growth of e-commerce.

### PRACTICAL USE OF ELECTRONIC COMMERCE – CASE STUDIES

**Case One: Building a Customer Web Site**

The main objective is to redesign business processes to simplify information flow, and replace manual and paper-based operations with a cheaper and faster electronic alternative. Cost effectiveness through the reduction of personal contact based transactions can be re-directed to other business objectives. (See Appendix A presentation slides).

**Background**

The Clinical Affairs department at HBOC established a goal to provide the customer base (600+) with clinical documentation on the Web in 1998. Additionally, a large, influential client suggested that the company provide the top 100 client questions with solutions on a Website.
The Clinical Affairs department has two offices (Cambridge, MA and Malvern, PA) representing the HBOC business unit - Payor Solutions Group. The Corporate office is in Atlanta, GA. The targeted information for this initiative are MS Word documents which describe clinical logic for edits within the knowledge base/product. The documents are currently provided to clients by Internet email or PC fax.

The Process

The Clinical Affairs staff must respond within 48 hours with a solution for 70% of the questions submitted. Clients rely on the company’s ability to respond to these questions on time since reimbursement to physicians is often at stake. The remaining questions are answered within 10 working days. Meeting this response time is not related to reimbursement directly, but does affect client internal policies regarding reimbursement to physicians. Any delays experienced with this process create customer satisfaction issues.

Clients typically call the Client service organization Call Coordinators who route both product and clinical questions to Client Service Consultants. This group attempts to answer clinical questions for clients based on their knowledge of the product and available client training manuals. While some clinical questions can be answered using manuals, the majority requires further review by the Clinical Staff.

The call tracking system is the front end to this process. It serves as both a client call tracking system and a client invoicing system. It contains a database of customer information which includes questions asked about products. Clients are able to access the call tracking system to check the progress of questions. This database is centrally managed at the corporate office.

Business units do limited customization of the call tracking database. Each unit is expected to import data from the system to another database (e.g. Access), and supplement it with data and reporting relevant to business unit needs. Often, a business unit will duplicate the information from the call tracking system in order to report metrics for client and departmental activities.

Clinical Responses

Clinical questions arrive in the Clinical Affairs group once routed through the call tracking system (annual volume 2000 - 2500). In order to assure that information is captured on the client and the date a question is received and tracked through completion, the Clinical Affairs group duplicates the data entry of key customer data elements captured in the call tracking system. This information is routed to MS Excel for reporting purposes (the call tracking system does not provide reports specific to departmental processing).

The status of the question is monitored in the call tracking system which must be updated by every user assigned to the call. Clinical responses are compiled in MS Word documents, stored by client name, reviewed for quality by the clinical group, and then either faxed or emailed to the client. The call tracking system is updated to indicate the call is closed.
A historical file of clinical responses is stored in the clinical affairs directory and researched when a question is submitted. More than 40% of the calls received can be answered with history file responses which are cross-referenced in the call tracking system, but are not available to clients.

**Issues**

- Re-creating the call tracking database and clinical responses (i.e., those in the history file) is inefficient and causes delays in the overall processing of clinical responses.
- These inefficiencies cause customer dissatisfaction with respect to timely turnaround for solution.

**Infrastructure**

- The company has an Internet Web site and customers have capability to access product information (see Appendix B: HBOC Organization/Departments Home Page, HBOC Intralink Home Page Product Portfolio, EC200 Product Home Page re electronic commerce, and Customers Only Home Page).
- Remote offices are client server with communications to and through Atlanta.
- The company is moving to MS Outlook from Lotus’ CCMail, and for Intranet applications, from Lotus Notes to MS Office (see attached Monthly CIO Newsletter).
- Current technical support operations are problematic for normal email communications across remote sites (see attached IS Home Page).
- Internet communications go through Atlanta and firewalls are in place, as needed.
- Traffic on pipeline is heavy.
- Infrastructure enhancements by the Information Systems group are in the works to improve timeliness of these communications.

The company is well positioned to provide support to the Clinical Affairs group for the development of a Website to house a database of clinical responses/solutions to meet client needs.

**Departments Involved**

This initiative is spear headed by the Clinical Affairs group with representation from key departments to support the design and implementation of the Website and to define future enhancements.

- Clinical Affairs - Driving the business need based on client feedback.
- Client Services - Interface with client base.
- Corporate Information Systems - Central developers of the Website.
- Marketing - Group responsible for liaison to corporate for Website development.
- Technical Support - Group located in Malvern and Cambridge serving as liaisons to the corporate office (Atlanta).
- Product Management - Driving product direction with Clinical Affairs to meet client expectations.
- Database Tools - Support to Clinical Affairs and link to corporate regarding development of the clinical response database for the website.

**Procedural Issues**
This initiative requires a review of current processes that will be factored in to the design of the Website. The clinical Affairs directive is to provide a Website with a meaningful set of client solutions. Review and analysis needs to consider the scope of this effort so that clients will not be dissatisfied with the result, i.e. KISS.

Some procedural issues to consider include:
- Text documents - how will these documents be converted to a database for the Website? What is the company standard?
- Managing the Website and current call turnaround times
- Integrating business systems (i.e., call tracking) into the process
- Resource constraints (system and human)
- Coordination of Malvern and Cambridge offices
- Update and Maintenance of text files
- Replacement of current system or is this an adjunct to the existing process; i.e., replace only the distribution process (fax and email)
- Priority of this project over others
- Longer term objectives of Clinical Affairs and other departments

**Technology Issues**
The following issues must be considered as processes are re-engineered:
- Dynamic links
- Updates and maintenance
- ORACLE database structure and MS Word
- Store text in HTML
- Search Engine
- Object Linking and Embedding (OLE)
- Client readiness to access the Internet (i.e., dumb terminals or PC based)
- Acquisition of resources to support the initiative
- Current sluggishness of email and Internet communications
- Acquisition of hardware or new software
- Testing
- New technology with uncertainty of expert resources

**Security and Confidentiality**
The company is diligent about maintaining security for its Intranet and Internet Home Pages. Security remains one of the biggest concerns for Internet users in general. The concerns that are most pressing with the creation of the clinical Website component include:
- Company information accessible to competitors (indirectly through existing clients)
- Defining customer level of access
- Overall uncertainty of Internet security

**Strengths of the Initiative**
- The development of the clinical response system Website will reduce labor intensive processes that grow more complicated with increased client volume.
- The clients can access clinical responses by accessing the Web in lieu of making phone calls and being routed through two (2) customer service staff members.
- The clients will experience timelier processing for their needs.
- Internal resources can be re-directed to other department/company objectives.
- Current delays in faxing or emailing clinical responses caused by "pipeline" traffic will be reduced.
- Provides the foundation/experience for future technology alternatives.
- Saves human resource dollars as process improvements occur.
- Eliminates monthly mailing of client newsletters.
- All clients benefit from the initiative vs. Those who typically request more solutions (statistics show that 12 clients in the Malvern client list ask the majority of questions year after year).

**Limitations of the Initiative**

- Security and confidentiality of company information remains a concern.
- Communication issues associated with decentralized offices.
- Staff training and education.
- Availability of the technology staff.

**Case Two: Vendor Managed Inventory via EDI**

Vendor managed inventory (VMI) is when the vendor (or supplier) provides not only their products, but also performs the inventory management of those products for the customer, deciding which products need to be replenished, the quantities, and at what time. VMI focuses on the manufacturer taking responsibility for the customer's inventory levels.

Vendor managed inventory makes good business sense and presents a tremendous opportunity. A supply chain partnership between trading partners normally has two driving objectives, increase sales and reduce operating expenses in the supply chain. VMI can contribute to both of these goals. With the customer providing information, and the vendor performing the inventory planning, both parties together can increase supply reliability and reduce supply costs.

Electronic Data Interchange (EDI) is used to transmit structured data between computer applications of business partners. The mechanism for the delivery of the data depends on which method the business partners decide to use. Computers can be linked directly, via modems and phone lines, or through a private network. The most common communication method for EDI is to use a private network, or Value Added Network (VAN) to carry the data. VAN's are run by third party network operators. They provide a "store and retrieve" service for business trading partners. Each user has a mailbox on the VAN so that they can retrieve and process messages in a batch mode. VAN's offer added values such as a high level of security, a help desk when problems arise, an audit trail so that the sender knows when a message has been received and read. They also support most communication protocols and data formats.

In 1979, the American National Standards Institute (ANSI) chartered the Accredited Standards Committee (ASC) X12 to develop uniform standards for the use of EDI transactions. Committee members develop and promote EDI standards that streamline business transactions. X12 standards facilitate these transactions by establishing a common, uniform business language for computers to
communicate around the world. Currently there are more than 275 transaction sets, that are used to communicate business to business operations.

The VMI process (attachment C) uses transaction sets to transmit information to and from the customer and the vendor via EDI. The customer sends product activity (warehouse usage and withdrawals) data (852) to the vendor on a daily basis. This information contains the customer's current stock keeping unit (SKU) inventory, as well as any SKU inventory on order (currently in-transit). This product activity data is downloaded into a VMI software application such as a demand planning tool. Also transmitted to the vendor to anticipate the expected demand by product, as well as any deals or promotion the customer may be planning in the future. This product forecast information can be provided in weekly, monthly, or quarterly buckets. This is also downloaded to the VMI software application demand planning tool. This information is then used by the vendor in the demand planning tool (as time-phased DRP) to determine when it is necessary to plan and ship inventory replenishment orders to the customer's distribution centers. Once the demand planning tool determines that a replenishment order is needed, it creates a planned purchased order. A planned PO acknowledgment transaction (855) is sent from the vendor to the customer, to advise them of an expected PO. The actual planned order is sent to the vendor's order management system as an open order to ship. Once the order is picked, packed, and shipped by the vendor, another EDI transaction is sent to the customer. It is called the ship notice/manifest (856). This transaction advises the customer of the contents of the shipment, as well as product description, packaging marking, and carrier information. This information is used by the customer's receiving location. Lastly, the vendor sends the invoice transaction (810) to the customer for payment via EDI.

Electronic Commerce embraces all sorts of data, however, it does not possess the level of definition that EDI has. In fact, EDI has taken on new life within the broader framework of Electronic Commerce, and there are many benefits that can be achieved by using EDI in an organization.

Summary

Electronic Commerce as a concept is not something new, but just recently caught on fire with the emergence of World Wide Web. World Wide Web, with its easy-to-use browser interface, made interaction over electronic network (the Internet in this case) as practical and easy as a click on the mouse button.

This paper took a comprehensive approach to examine the evolution of the Electronic Commerce. We first looked at it from its definition and its history in order to understand where the concept came from and how it developed over time to become today's phenomenon. We then analyzed the significant role that Electronic Commerce was playing in today's world and how it has changed our lives and the world around us.

Secondly, we investigated several key components of Electronic Commerce, particularly in the context of the Internet and World Wide Web. This includes the technical solutions and infrastructure required, strengths and weakness comparing to conventional trading methods, and limitations of Electronic Commerce. Furthermore, we also looked into the future and gave our best shot at predicting where the Electronic Commerce was going.

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Finally, we took two real-world examples to show how the Electronic Commerce were being used in today’s organizations and how it had helped them to gain competitive advantages.
References

2. Kulwicz, R., "Vendor Managed Inventory," Modern Materials Handling, October 1997, pg. 13-14
ELECTRONIC COMMERCE FOR SHIPBUILDING SUPPLY CHAINS

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George Mason University, Fairfax, VA

Introduction

Years ago the international business community embraced the Electronic Data Interchange (EDI) as the "wave of the future." The prospect of electronically transferring large volumes of data appealed to many companies, for it would not only allow them to gain a competitive advantage by speeding up the delivery of business transactions, but also decrease IT expenditures by standardizing their information systems on the ANSI X.12 and the UN EDIFACT transaction formats. In theory, EDI was going to change the way companies interacted, data was to flow unencumbered between integrated systems and across international borders. The reality however was somewhat different.

By the 1990s, many of the early EDI proponents had to admit that the exuberance demonstrated during that earlier time was somewhat optimistic. Although EDI had made significant inroads in some large high-volume businesses, the implementation had not proven a great benefit to many small-and medium-sized enterprises (SMEs). We were aware of the problem primarily from our many interactions with SMEs through our U.S. government-sponsored electronic commerce center, but the problem was also being discussed widely in trade publications [see, for example, Mann (1996) and Smith (1996)].

The emerging opinion is that the benefits of traditional EDI (from a large supply chain perspective) are focused on large corporations at the top and the 1st and 2nd tiers of their supply chains (Table 1). These corporations command significant market share and product volume to gain a competitive advantage from EDI.

Table 1: EDI Penetration in Supply Chain Tiers

<table>
<thead>
<tr>
<th>Tiers</th>
<th>Significant Penetration</th>
<th>Slight Penetration</th>
<th>Very Low Penetration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Tier</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First Tier</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second Tier</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Third Tier</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower Tiers</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Moving further down the supply chain, EDI provided little or no competitive advantage and the EDI implementation rates at these tiers were very small. While some may be surprised by this assertion, it is not surprising to those who work extensively with SMEs. These suggestions are completely consistent with our shipbuilding supply chain project, and Shunk's (1996) supply chain

1 Electronic Data Interchange is the transmission of business transaction information in computer-readable form between organizations in a standard format.
2 Colberg, et al. (1995), provides a comprehensive review of EDI and EDI implementation practices.
3 This project is described in detail in a later section.

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research. The obvious question then follows. What caused this disparate level of EDI acceptance and what has been its effect?

This analysis is an outgrowth of our experiences obtained from working for two years in support of a large effort to integrate a major supply chain using VAN-based EDI. We reached an understanding of the extent of EDI penetration after many months of attempting to educate SMEs on the use of VAN-based EDI. This paper describes these experiences in some detail, explaining why VAN-based EDI is inappropriate for most SMEs, and also making recommendations for what is more appropriate: Internet-based Secure Transaction Processing.

The paper is organized as follows. The following section summarizes the basic concepts of EC that are relevant for our large supply chain integration project. Then, we describe the project and our experiences from the implementation effort. We also describe, with supporting references, an alternative to VAN-based EDI that is more likely to succeed with SMEs. Finally, we describe in some detail how we are focusing our implementation efforts (Phase II of this project), given our experiences that are explained in this paper.

**EDI Architectures**

We have used the following basic EDI architectures to understand EDI implementation impediments and enablers (Figure 1).

- **Standalone: Store-and-Forward** - EDI messages are delivered in a Value-Added Network (VAN) environment that offers 24-7 EDI message transaction handling services between suppliers and customers. Messages could also be received through an EDI translator module and printed. The printed orders and the message acknowledgment are often manually processed.

- **Integrated EDI: Store-and-Forward** - EDI messages are delivered in a Value-Added Network (VAN) environment that offers 24-7 EDI message transaction handling services between suppliers and customers. Messages are received through an EDI translator module and routed to a corporate information system. The transaction and the message acknowledgment are processed automatically by the corporate information system and electronically forwarded back to the trading partner.

**Alternatives to Traditional EDI: A Look at EC-based Business Transactions**

Despite the simplicity and stability offered by traditional EDI, attempts to implement these architectures were not as widely successful as had been envisioned. Many corporations implemented test case Standalone Store-and-Forward solutions. These were quickly outgrown, but security concerns and corporate policies prevented corporations from implementing the integrated EDI option. In such organizations, EDI transactions were employed only with those special customers that insisted on electronic business data; other customers were serviced in a more traditional paper-based manner. Most small companies who acquired standalone solutions, however, found that the actual transaction volume could not justify the cost of a Store-and-Forward solution.

\*24-7 allows messages to be sent and received 24 hours a day for seven days per week. The VAN stores messages until customers and suppliers are ready to receive them.
By the late 1980s, the EDI service industry was having difficulty positioning software and services that could meet the needs of many small and medium sized businesses. At the same time, many large corporations implemented proprietary Electronic Commerce solutions that were often based on private leased line (X.25 packet switched networks) and transaction standards other than X.12 or EDIFACT.

Factors that influenced this growing trend of EDI implementation reluctance include:

- Pricing and complexity of EDI software - Users found it difficult to justify the software, installation and VAN service costs, and
- Software and service interoperability - Users found that the software and VAN service implementations that were based on the X.12 and EDIFACT standards often resulted in incompatibilities between competing software products and services. Each company has its own implementation conventions, and VAN service providers do not automatically communicate with each other.

Although there are many documented cases of successful EDI implementations across the US and throughout the world, the impediments are well known. For example, Smith (1996) states directly that "despite 15 years of government and industry advocacy, EDI has been static for years because of the inflexibility of the technology and the high cost of the dedicated, proprietary value-added networks (VANs)."

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3 Electronic Commerce is the secure bi-directional flow of business data
The overall effect of these encumbrances was that many companies had given up on the EDI standardization process and began to implement their own proprietary solutions. Although this strategy proved expensive, these companies realized a significant competitive advantage after deploying trusted leased line networks. By gaining direct access to corporate data, high volume top and first tier suppliers were able to reduce their delivery cycle time significantly, while top and first tier customers reaped the cost and customer satisfaction benefits of a Just-In-Time (JIT) inventory replacement model.

Unfortunately, this trusted leased line network option was not cost-effective for smaller companies, nor was it made available to the lower tier suppliers who were forced to do business with traditional paper-based methods. It was not until 1993 that emerging Internet technologies would offer these companies an affordable and efficient EC solution. With the advent of Internet-based Secure Transaction Processing small businesses were able to take advantage of "open" World Wide Web solutions that were cheaper than proprietary leased line solutions, more economical and scaleable than traditional EDI, and provided reasonable security that could be integrated very easily into existing accounting and Enterprise Resource Planning (ERP) systems (Figure 2).

Since 1993, the influence of the Internet and the "open" nature of the TCP/IP WWW protocols have prompted many SMEs to view Electronic Commerce as a relatively low level distributed secure transaction processing activity rather than as part of a more complicated EDI solution. This transition in technologies has opened the door for SMEs to participate in EC, and it has placed tremendous pressure on suppliers of traditional EDI services and the proponents of the EDI model. Even the largest proponents have not been isolated from the pressures, as evidenced by the rejection of the federal government's acquisition network (FACNET), which mandated a van-based EDI solution through the implementation of the Federal Acquisition and Streamlining Act of 1993 [see, for example, Deller (1997) and Slabodkin (1997)].

In fact, many companies have totally abandoned EDI in favor of WWW based Extranet solutions that link customers and suppliers to secure corporate Commerce Servers (Figure 2). This is specifically the case with Mobil Oil (Mullich, 1997), and the trend in other companies is significant (Waltner, 1996). Proxy servers provide a controlled external mirror image of a portion of the actual corporate data base that allows secure transactions to be processed in real-time without giving customers (or potential "hackers") access to internal corporate data. Data on proxy servers is only posted to the corporate database once it has been analyzed and verified. This verification and posting process is in most cases automated and invoked at regularly scheduled intervals (i.e. once every 30 minutes).

Three Emerging EC/EDI Transaction Approaches

As today's business environments become increasingly competitive, firms are required to rapidly reconfigure their business processes. Traditional enterprise boundaries no longer exist. To remain competitive and realize lower costs, each enterprise seeks to establish closer relationships with its partners, customers, and suppliers. Apart from the traditional EDI mechanisms outlined in figure 1, this close relationship with external enterprises can be established through a number of new supply-chain integration mechanisms. The exponential growth of the Internet along with the well-timed

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5 Many case studies are now appearing in the popular press. For example, when Mobil Oil moved from VAN-based EDI, the savings were substantial (Mullich, 1997). "Mobil encountered many of the problems that have stymied the growth of EDI. VAN charges for using the hard-wired networks topped $100,000 a year. Maintenance was burdensome: every time Mobil changed a business rule, new software had to be sent to each dealer and installed on their desktop."

6 Turbide (1997) presents the ERP integration issue
advance of integrated Enterprise Resource Planning system software packages is causing many innovative solutions to appear in the market (Varney & McCarthy (1996) and Tucker (1997)).

![Diagram](image)

**Figure 2: Internet and Private Network Supply Chain EC Concepts**

While it is unlikely that all SMEs will adopt a fully integrated approach, there will be an increasing variety of implementation options and degrees. Rather than facing a limited choice between no EDI, stand-alone non-integrated EDI, or Integrated EDI, SMEs may have a choice of varying degrees of integration, allowing them to choose the one appropriate given their “business case.”

**The Shipbuilding Supply Chain Project**

In 1997, our project team entered into an agreement with Newport News Shipbuilding (NNS) to help them integrate their supplier base of 24,000 firms. The initial focus was on electronic procurement, with an eventual inclusion of technical data exchange. This was a dynamic period for NNS, as many internal change initiatives were underway. NNS had just separated from Tenneco (their parent company), and had once again become the largest private employer in the state of Virginia. NNS was also in the early stages of implementing major change initiatives, including company-wide client-server ERP solution, a new Product Data Management (PDM) solution, a new Component and Supplier Management (CSM), a new CAD environment, and a new Procurement Execution System (PES).

Our primary focus was not on the internal operations of NNS, but their supply chain. NNS had a plan for bringing all active8 suppliers into an electronic procurement environment using VAN-based EDI. Our task required basic understanding of NNS’s internal operations and supply chain interfaces.

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8 About 4,000 of the 24,000 suppliers were active at any point in time.
but our primary focus was on the SMEs that supply the prime contractor, and indirectly NNS's major customer: The U.S. Navy.

**Approach**

Our team worked with NNS to construct a database of characteristics for their top 1000 suppliers. The geographical location of these suppliers is presented in Figure 3.

![NNS Top 1000 Suppliers Regional Breakdown](image)

**Figure 3: Geographical Dispersion of NNS Suppliers**

We also confirmed that these 1000 top suppliers represent the bulk of the procurement transactions that are executed by NNS; i.e., our sample represented about 95% of the total purchase orders, even though it was a small portion of the total number of firms in the NNS database.

Our plan was to develop focused supplier training sessions, and invite all suppliers in targeted geographic areas to participate. The training, which was designed mainly to promote "awareness," detailed NNS's plans for requiring their suppliers to move to VAN-based EDI for procurement. Given the dispersion in Figure 3, we focused our efforts east of the Mississippi river. In the end, we personally invited\(^9\) 72% of the top 1,000 suppliers; this figure represented 82% of the purchase order volume. This coverage statistic is depicted below in Figure 4.

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\(^9\) Each company was contacted by telephone, and an effort was made to locate the responsible person for electronic procurement within the company. As will be seen later, we feel that this significantly enhanced our response rate and attendance at the training sessions.
Figure 4: Purchase Order Coverage for Selected Firms

After the training part of our approach, we planned to offer "Technical Support" to those firms requesting specific help in the implementation of EDI. That is, the target SMEs were given information about EDI in general, (and EDI with NNS in particular). Those firms with the appropriate knowledge could procure the necessary hardware, software, and services; and enter into certification testing with NNS on their own. Others could request that we help them, and this service was provided at no cost to the SME.

Of the firms invited, 25% attended the training sessions. This amount still represented 45% of all purchase orders. We attribute this high response rate to persistent telephone efforts to identify the appropriate person within the target SMEs; that is, the manager responsible for electronic procurement and/or sales to NNS.

Evaluation Criteria

To evaluate the supply chain integration engagement, we established a set of evaluation criteria. We developed the following four broad characterizations for assessing effectiveness.

- **Coverage** - Are we reaching both a broad cross section of firms as well as the most important firms?
- **Understanding of SMEs** - Do we understand the technology level of the SMEs? We constructed a survey instrument to provide a snapshot of the technological capacity of NNS suppliers.
- **Efficacy of Training** - Has the training provided sufficient information to the vendors in order for them to implement VAN-based EDI with NNS? Case Studies also are used as supporting evidence.
- **Integration to Other Objectives** - What technical support leads and follow-up consultation work resulted from the training sessions with the NNS vendors?
Supplier Coverage

The approach gives some indication of the coverage of our efforts. However, it is important to make sure that the high volume customers (with respect to purchase orders) are being reached. Figure 5 provides a picture of the NNS suppliers. Basically, there are a large number of suppliers that receive a few purchase orders. However, it should be noted that there are a significant number of suppliers at a second mode who receive a relatively large number of purchase orders. The overlay darker bar in Figure 5 indicates that these SMEs were eager to attend the sessions, as much as the "many companies/low POs" group. We were somewhat surprised by the attendance from those firms with small transactions base. After talking with them, however, it was clear that they were searching for ways to increase their business base with NNS. Some in fact made the investment in VAN-based EDI in anticipation of more business with the shipyard, only to be disappointed when the business did not materialize. This implications of this phenomenon will be discussed in more detail in a later section.

![Attendees Versus Invites Distribution by # POs per Company](image)

**Figure 5:** Attendees at Training Sessions by Purchase Order Volume

We were pleased with our coverage. We have certainly learned lessons that would alter our approach for future endeavors\(^\text{10}\), but on the whole, given the information available before the training session, we are satisfied that appropriate care was taken in constructing the sample of SMEs.

**Understanding the SMEs**

To properly assess the effectiveness of our efforts, we felt that we must attempt to quantify in a meaningful way the technological sophistication of the firms encountered. For example, if the training appeared ineffective (i.e., few firms adopted VAN-based EDI), it might be argued that lack of SME technology and IT infrastructure posed an obvious barrier to adoption. To obtain a better understanding of SME technological ability, we constructed a survey instrument that was distributed to the firms by fax after identifying the appropriate contact person. If the firm attended a training session and had not completed a survey form, they were contacted again to complete the form.

\(^\text{10}\) These lessons-learned will be presented in a later section.
The firms were asked to place themselves in one of the following categories: 1) not using EDI, 2) currently using stand-alone non-integrated EDI, or 3) currently using integrated EDI\textsuperscript{11}. The results of this survey are summarized in Figure 6.

![Figure 6: Technological Sophistication of Firms in Sample](image)

The results were surprising. Each category in Figure 6 contains a simple question: Do you have this technology capability in your company? The first bar in each category represents companies categorizing themselves as not using EDI, the second bar those involves in some basic form of EDI, while the third bar represents companies with a fully integrated EDI solution. As with any sample, there are some inconsistencies, but the striking feature is the number of firms with modems and Internet access. It is also worth noting that a large percentage also maintain corporate web pages.

This evidence points to the fact that technology is not a significant barrier in EDI adoption. These firms have access to what is currently considered high technology. If they elect not to participate through VAN-based EDI, then there must be other, more fundamental business reasons for this choice. While integrated EDI may not be fully achievable for these firms, they should be capable of at least stand-alone non-integrated EDI.

\textbf{Efficacy of Training}

The training that we performed was primarily directed toward "awareness" of EDI. In order to measure the efficacy of this training, we sent a follow-up survey to participants and queried them as to whether they have adopted EDI and if not, why? While this analysis is not yet complete, initial results seem to show that after our training nearly all participants were aware of EDI, and some had gone as far as to adopt it. Those who have chosen not to adopt EDI have overwhelmingly said that it was because they could not make a "business case" for it, and they were waiting for more cost-effective

\textsuperscript{11} The distinction is as follows: with integrated EDI, incoming and outgoing data is mapped directly from the EDI translator into the firm's database or the application logic of the ERP system. Non-integrated EDI is where the firm responds to transactions in a hands-on mode through software residing on a PC. The incoming and outgoing data require manual intervention for processing.
solutions to present themselves. Our results showed that very few SMEs who use EDI have their software integrated into their other business applications or databases, and there was little indication that they planned on doing this in the near future.

**Integration to Other Objectives**

The positive externalities created by our work with this supply chain were numerous. Benefits included gaining access to a large number of SMEs. This is paramount to us as they are often very busy organizations with few slack resources that can be devoted to conceptual planning and looking outside the organization for solutions. By working with NNS, we were able to gain meaningful access to the SMEs without incurring a large marketing expense.

We also gained a much better understanding of the needs, capabilities, and decision-making processes within SMEs. This knowledge enabled us to better understand and fine-tune our role as intermediaries in the technological advancement process.

Finally, we accumulated general knowledge on how to understand and approach a large supply chain. It is clear that particularly with a large prime like NNS, the supply chain is extremely heterogeneous. The dimensions of size and technological sophistication of individual supply chain members are obvious, but there are other subtle distinguishing attributes such as the percentage of sales that are derived from an individual company or industry, or a particular type of firm (distributor, manufacturer, etc.). A solid grasp of these important dimensions enables a better understanding of the business relationships between prime and supplier and the leverage and incentives that interplay between the two.

**Lessons Learned from the Supply Chain Integration Effort**

The average corporate picture that emerged from the self-selected sample of firms is a firm that has the necessary technology resources available, including internet, to install and run EDI, and has been educated in the uses and nature of EDI. But they still do not use EDI. The question then is why?

Our analysis of the situation concentrated on two areas:

- An thorough analysis of the product that was made available to the SMEs; i.e., VAN-based EDI, and
- The economics (i.e., the business case) for implementing and maintaining the VAN-based EDI product.

After many discussions with the firms regarding these topics, two clear conclusions could be drawn:

- The EDI product was not being used effectively in this shipbuilding environment. EDI was primarily used for trading process management; i.e., declaring a “winner” in a competitive bidding process and establishing a contractual relationship. The gains from implementing VAN-based EDI are primarily from executing routine delivery orders in an integrated environment; not the establishment of contractual relationships, which still requires hands-on intervention.\(^{12}\)

\(^{12}\) It is interesting to note that the U.S. government employs this same inefficient use of EDI. Trading process management (i.e., the awarding of a contractual relationship) provides some efficiencies, but it is the routine execution of delivery
The low volume of transactions (see figure 5), combined with the technology sophistication required to implement integrated VAN-based EDI, creates a "business case" barrier that is difficult for the firms to overcome. Economic justification is difficult, even for the non-integrated environment where the supplier is trying to preserve a business relationship with the prime.

To test the validity of the above conclusions, we searched for similar implementation experiences. Knowing that shipbuilding is a unique environment, we focused our efforts on other intra-industry attempts to implement EDI in shipbuilding.

The European Experience

The European experience with EDI in shipbuilding provides similar insight into the nature of implementation barriers discussed in the previous section. The views in this section are based on interviews with participants in a large European Union effort called EDI for the European Maritime Industry (EDIMAR). The EDIMAR project is funded by the Commission of the European Communities under the ESPRIT Program (Project No. EP 20.624). Its objective is to intensify inter-organizational cooperation within the maritime industry and to increase productivity through use of Electronic Data Interchange. Four major European shipyards are participating in the project:

- Astilleros Españoles (Spain),
- Chantiers De l'Atlantique (France),
- Fincantieri (Italy), and
- Howaldtswerke-Deutsche Werft (Germany).

The EDIMAR project is focused on the exchange of business and technical data, and it is a two-year effort that began in January 1997.

When the results of our NNS engagement were presented to the EDIMAR implementers, there were not surprised by the data. In fact, they were amazed that we had such success moving SMEs into production EDI, and in such numbers. This came as a surprise to us, since our Defense Logistics Agency sponsor had recently expressed a feeling that our NNS numbers were too low and not what they could be.

The EDIMAR implementers noted an interesting characteristic of shipbuilding industry:

A large number of firms receiving a small number of purchase orders means that the "automotive industry" model of EDI is not appropriate. For the automotive industry, the volume and frequency of orders is much higher than in shipbuilding. The automotive buyers even provide a "preview" of what they intend to order in the future, allowing the suppliers to quickly respond once the order is released - this accommodates just-in-time manufacturing. Since shipbuilding purchase patterns are very different (i.e., infrequent and small numbers of orders with no advance previews), it was clear that a strategy was needed that allowed SMEs to build the business case for participation in this market. [Personal interview (February, 1998)].

Given such an environment, the EDIMAR participants sought to modify traditional EDI to make it more palatable to SME economic tastes.

(release) orders after the establishment of a contract that yields the largest benefits to both parties. The establishment of the contractual relationship requires manual intervention by one or both parties. Release order execution requires no intervention and can be accomplished in a fully automated environment.

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For example, we have determined that the automotive industry is very different in its implementation of EDI. There is a larger volume of transactions, and the focus is on release orders to support just-in-time manufacturing.
The participant shipyards adopted an EDI clearing-house approach that makes electronic exchange easier to implement in SMEs. BALance Technology Consulting, a member of the EDIMAR project team, developed this approach, known as BAL.DIS. The idea is simple. BAL.DIS is an EDI broker service, accepting proprietary SME data, translating it into the EDIFACT standard, and forwarding the data (in any format) to another company. That is, the BAL.DIS service handles all EDI mapping and technology issues, allowing the firm to communicate directly from its legacy business systems. This is accomplished at a cost that is justifiable by the SMEs, since the SME does not have to invest in integrated EDI solutions.

While this is not the “pure” and perfect technology solution, it is appropriate in situations where the transaction volume does not support the investment in integrated EDI. Also, the solution should not be confused with the services provided by a traditional VAN service provider or an EDI service bureau. BAL.DIS provides more than the exchange and tracking of transactions. The SME organizational processes are analyzed as part of the solution, and the SME is relieved of expensive internal mapping and integration costs.

![BAL.DIS Broker Concept](image)

**Figure 7:** The Concept of an EDI Broker Service

As a final point, the EDIMAR implementers confirmed our contention that, in general, the problems of SMEs in shipbuilding supply chains, are not technology related. The EDI broker concept can overcome the technology problems. The larger problem is the inter-organizational ability to adopt to change. Shipyards in Europe have downsized, just like those in the United States. As noted in our interviews, “The newly hired and the senior employees have departed. The yards are left with the non-technologically sophisticated middle.” Unfortunately, these are the most difficult employees to adapt to the new high technology-enabled environment.

**Review of Lessons Learned**

Supply chain issues with regard to EC are increasingly important. Understanding the supply base is crucial to any successful implementation of a supply chain EC effort. To be sure, one needs to understand the technological capabilities of the suppliers and the match/mismatch of potential
technological solutions, however, even more important is sound knowledge of the nature of the business relationship between customer and supplier.

Technological solutions that allow for fine degrees of divisibility in adoption may be more suitable for the wide range of suppliers that are often encountered in a supply chain. The business case for adoption by the SMEs must be strong if there is any hope for widespread adoption. SMEs are willing to expend some effort to maintain customer satisfaction, but they are not willing to expend a large amount of money/time for solutions that that lack a clear, economic benefit.

The success of our engagement was largely due to the openness of both NNS and a large number of their suppliers. We were able to maintain this open dialogue by clearly stating that we were an independent organization that was not being paid by NNS. This helped to assure the suppliers that we were seeking to educate, not indoctrinate.

A final lesson learned was that solutions that are industry-specific would probably not be viable in the end. The technologies are rapidly changing, and any solution that is developed specifically for the shipbuilding industry will probably not advance at the same rate as general EC technologies.

**Proposed Solutions for SMEs and Lower Supply Chain Tiers**

The reality is that most SMEs at lower tiers will opt not to integrate their business transactions with their internal business databases. Any potential solution must accommodate this reality by understanding the economics of those suppliers' choices. They want a solution that has a low cost and requires little or no training and technology sophistication. These firms are interested in making money, not implementing technology. However, if there is money to be made by implementing technology, then SMEs have a much greater motivation to participate.

As new mapping technologies, such as Extensible Markup Language (XML)\(^{14}\), begin to enter the marketplace, there are expanded opportunities for viable and cost-effective solutions for SMEs. These technologies should be directed to some extent by the lessons learned from the EDI experience. Still, no technologies will be implemented unless the SME can use the technology to expand its business base.

**Conclusions**

Our successful engagement with a supply chain illuminated many of the ground level issues facing SMEs in the movement towards Inter-enterprise supply chain integration. It is clear that the drivers of EC/EDI adoption are business and cultural, not technological. In order to overcome these barriers to adoption, the business case must to be articulated by the SMEs.

Our research on a large shipbuilding supply chain indicates that the barriers are not technological. Most of the firms have access to the Internet and many maintain their own Web domain. While ease of use (or lack thereof) was a big issue, the primary concern was expanding the business base and making more money. In this supply chain, it was difficult to justify VAN-based EDI as the key to reducing costs or expanding business. Given the level of transactions in shipbuilding, the additional costs of VAN-based EDI do not exceed the benefits.

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\(^{14}\) See the article by Drummond and Spearman (1998).
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