

PROCUREMENT AND IMPLEMENTATION OF A SUPPLY CHAIN MANAGEMENT SYSTEM

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DECLARATION

I, Vojta Svoboda, declare that the work contained in this thesis is my original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

Date: 21/12/1998

SYNOPSIS

With the globalisation and internationalisation of markets and businesses, organisations have had to find new ways to not only view and run their own organisations to keep their existing markets but also to enable them to capture new markets.

In the past the way to gain competitive advantage in any industry was to streamline, re-engineer and revolutionise your organisation's internal operations, procedures and structures. This gave rise to initiatives such as Total Quality Management (TQM), Materials Requirement Planning (MRP), Just in Time (JIT) and numerous Business Process Re-engineering (BPR) projects. However, it has become increasingly more difficult to squeeze savings out of an operation. You cannot downsize forever and cannot gain new markets by growing continuously smaller. Activities and processes have some inherent inefficiencies built into them. These will remain no matter how the procedures improve e.g. set-up time of steel press will never be zero etc.

The key in further improvement lies in the co-ordination and co-operation between organisations that interact with each other and provide the organisation with value adding or necessary services or products. This is currently known as supply chain management. It involves a global and holistic view of the market and the realisation that other organisations up and down stream from you do not compete with you but complement each other to provide the final product - an item sold to the consumer in the right quantity, quality, at the right price and right place, not just the item that your organisation has produced and passed on to the next organisation in the supply chain.

Much of this thinking has existed for several decades but has not materialised into best practice due to a lack of technology to support and complement it. However, in the last five years technology has developed and kept pace with these principles and in fact has become

one of the major driving factors that drive supply chain strategies, optimisation initiatives and development of organisational cultures.

Spoornet has developed visions and strategies to take part and to become a leader in supply chain solutions in South Africa. It has actively participated in this area for a number of years.

The author was part of a team that realised the need and developed the ideas of such a decision support tool for supply chain management at Spoornet. This software tool was intended to assist the Channel Manager in decision making in his/her supply chain. It would add value to the decision making process revolutionising it from a manual inaccurate task to a more automated, technical, mathematical and efficient process. This would enable the Channel Managers to concentrate on communication and the relationships with partner organisations and customers. This adds considerably more business value to Spoornet.

This thesis discusses the initial development of the ideas and principles of decision support for the supply chain through to the procurement process of such technology, as well as the first pilot project and finally the complex issues that have to be considered and dealt with when these types of solutions are to be implemented and used successfully.

The author was directly responsible for the development of the ideas in this thesis as well as those deployed during numerous Spoornet supply chain projects. Shortly after this development, he received a position in the Centre for Logistics Excellence (CLE) at Spoornet. The CLE was responsible for the development of logistic and supply chain strategies and competencies in Spoornet.

Together with Dirk du Toit, he was responsible for the procurement of the supply chain management tool. Soon after the procurement of the tool, Mr. Du Toit left the organisation and the responsibility for the further development and the pilot project was passed onto the author. This involved further negotiations with the supplier, clients as well as the

development of future competencies and strategies by utilising the supply chain management tool.

The first part of the document outlines the project during which the ideas of supply chain management technology and software first came to the fore. This includes the project background, the inefficiencies of the current process and very high level specifications that would be required of the "TO-BE" software. These specifications are in terms of how the software could assist Channel Managers.

This is followed by analysis (literature survey) of techniques and methods that could be potentially capable of satisfying the high level specifications. From the analysis, it was decided that the use of deterministic programming would be the most suitable approach for this type of decision making. (Especially considering current advances in software technology).

More detailed specifications are then outlined by a set of process models and descriptions. A number of software tools are analysed for their suitability and capability to deliver the specifications.

The CAPS toolkit of supply chain applications was the most suitable for these particular needs and requirements. This tool was chosen and purchased.

The rest of the document details the customisation and development of CAPS into the tool that would be used in projects. This includes data requirements, data collection, human competencies required to use the tool and a quick overview of how the tool would be used.

An overview of the pilot project that was to be carried out is also provided. This project would be used to illustrate the benefits that could be gained from supply chain optimisation using this type of tool.

Unfortunately, the author left the organisation that had purchased the tool so the pilot project was never finished. However, a number of lessons were learnt as to the factors that need to be taken into account when implementing and utilising such a tool. The are factors such as organisational structure, organisations' role in the supply chain as well as supply chain pricing.

The final sections of this document outline the current thinking in terms of Supply Chain Management and related issues that are currently in the process of being addressed internationally by many logistically advanced and progressive corporations.

The initial aims of the initiatives discussed in this document was to procure and implement a supply chain management system. The procurement of the tool was successfully accomplished and Spoornet currently has licences for the CAPS toolkit. It is capable of designing and planning complex supply chains together with it clients/partners.

The secondary aim discussed in this document was the implementation of the tool in terms of a pilot project. This pilot project was to illustrate the benefits and the saving that can be gained from the use of the CAPS tool in a realistic supply chain situation. This was not fully accomplished. The project team working on the pilot project lost several of its key members, including the author, and was not able to complete the pilot project with the remaining members.

The parts that were accomplished were the preparatory stages of the project such as data collection and development of cost models to be used in CAPS.

OPSOMMING

Die globalisering en internationalisering van markte en besighede het organisasies genoodsaak om nuwe maniere te vind om nie net hulle eie organisasie te bestuur en bestaande mark te behou nie, maar ook om nuwe markte te teiken.

Dit word progressief meer ingewikkeld om besparing vanuit operasies te bewerk.

Die oplossing hiervoor is daarin geleë om koördinasie en samewerking tussen die organisasies, wat in interaksie met die organisasie staan en 'n waardetoevoegende of noodsaaklike diens of produk lewer, te bewerkstellig.

Tegnologie het in pas gebly met dié beginsels en het een van die primêre drywers geword van verskaffingskettingstrategie, optimiseringsprojekte, en kultuurontwikkelinginitiatiewe.

Hierdie dokument bespreek die aanvanklike ontwikkeling van die idees en beginsels van besluitneming in terme van die verskaffingsketting, deur die aankoopproses van sulke tegnologie te ondersoek. Dit bespreek die eerste lootsprojek en die komplekse faktore wat in ag geneem moet word om hierdie tipe oplossings te suksesvol te implementeer.

Die eerste gedeelte van die verslag handel oor die projek waar die idees van die verskaffingskettingtegnologie en sagteware na vore gekom het. Dit bespreek die agtergrond van die projek, die oneffektiwiteit van die bestaande prosesse en hoëvlak spesifikasies vereistes vir toekomstige sagteware. Hierdie spesifikasies word gespesifiseer in die mate waartoe dit die kanaalbestuurders kan ondersteun.

Dit word gevolg deur die analise van metodes en tegnieke wat die potensiaal besit om aan die hoëvlak spesifikasies te voldoen. Die resultaat van hierdie analise dui aan dat deterministiese programmering die mees gepaste benadering is tot hierdie tipe besluitneming. (Dit geld as gevolg van die huidige ontwikkeling in sagteware tegnologie).

Hierna word detail spesifikasies outgestip deur 'n stel prosesmodelle en prosesbeskrywings. 'n Aantal alternatiewe sagteware oplossings word geëvalueer volgens hul vermoë en kapasiteit om hieraan te voldoen. 'n Produk word gekies en aangekoop.

Die CAPS pakket vir verskaffingskettingapplikasies was die mees geskikte pakket vir hierdie spesifieke behoeftes en vereistes.

Die res van die dokument bespreek die aanpassing en ontwikkeling van CAPS vir die kliënt om sodat dit gebruik kan word in projekte. Dit beskryf die datavereistes, data insameling, vereiste personeel vermoëns vir die gebruik van die pakket en 'n vinnige oorsig oor die gebruik daarvan.

'n Oorsig oor die lootsprojek wat sou volg word ook verskaf. Hierdie projek sal gebruik word om die voordele aan te dui in die gebruik van hierdie pakket in verskaffingskettingoptimisering.

Die outeur het die organisasie verlaat voor die pakket aangeskaf is en die lootsprojek is nooit voltooi nie, maar 'n aantal lesse wat geleer is en faktore wat oorweeg moet met die implementering en gebruik van so 'n pakket word bespreek. Hierdie faktore sluit die organisasiestruktuur, die organisasie se rol in die verskaffingsketting en die verskaffingsketting prysbeginsels in.

Die laaste gedeelte van die dokument gee 'n oorsig oor die huidige denke in terme van Verskaffingskettingbestuur soos gevind by internasionale gevorderde logistieke organisasies.

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TERMS OF REFERENCE

The project arose from the Spoornet vision of delivering complete solutions to its clients. The aim was to add more value to the client than just a railhead to railhead service. This vision is called Freight Logistic Solution (FLS). This vision would revolutionise the way Spoornet does business and the way it handles relations with its clients. While visions such as Predictable Service look at the Spoornet operations internally, this vision looks outward at current and new possible Spoornet business.

It was to be accomplished by a number of supply chain projects that would involve partnerships with clients, joint planning of operations as well as various mutual re-engineering initiatives to improve efficiency and effectiveness of both the Spoornet systems as well as the clients' systems.

During a number of these projects it was observed that the complexity of today's supply chain operations was such that a human without any technical assistance could not hope to achieve the benefits that were hoped to be gained from such supply chain partnerships.

A search was started for such technical assistance, then known as decision support system (DSS). It received considerable support as it would contribute directly to the FLS vision and assist the numerous business managers in being able to offer value added service and develop long term supply chain partnerships.

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ABBREVIATIONS AND ACRONYMS

- ABC - Activity Based Costing**
- DC - Distribution Centre**
- DRP - Demand Requirement Planning**
- DSS - Decision Support System**
- EC - Electronic Commerce**
- EDI - Electronic Data Interchange**
- ERP - Enterprise Resource Planning**
- FTL - Full Truck Load**
- GIS - Geographic Information System**
- GUI - Graphical User Interface**
- JIT - Just in Time**
- KB - Knowledge Base**
- KC - Knowledge Co-ordination**
- KPI - Key Performance Area**
- LP - Linear Programming**
- LTL - Less than Truckload**
- MIS - Management Information System**
- MRP - Materials Requirements Planning**
- ODBC - Open Data Base Connectivity**
- ODBMS - Object Data Base Management System**
- RDBMS - Relational Data Base Management System**
- SCM - Supply Chain Management**
- SCMS - Supply Chain Management System**
- SCP - Supply Chain Planning**
- SOM - Spatial Object Manager (a type of database)**
- SP - Service Provider**
- SQL - Sequel**

GLOSSARY

AS-IS - the current situation or state of the discussed matter.

Channel Manager - a person that plans, schedules and organises the supply chain

TO-BE - a design, appearance or state of the discussed item in the future

1 INTRODUCTION

Traditionally organisations have a fragmented view of the supply chain. In fact their own organisations were fragmented into separate functional departments. Gaps started appearing and problems occurring when competition in all industries increased. Major organisations had to try and squeeze as much as possible out of their existing channel and resources in order to compete in their current market and to expand their business into other markets. Figure 1, Development of Supply Chain Principles, roughly illustrates the path that many organisations followed in this respect.

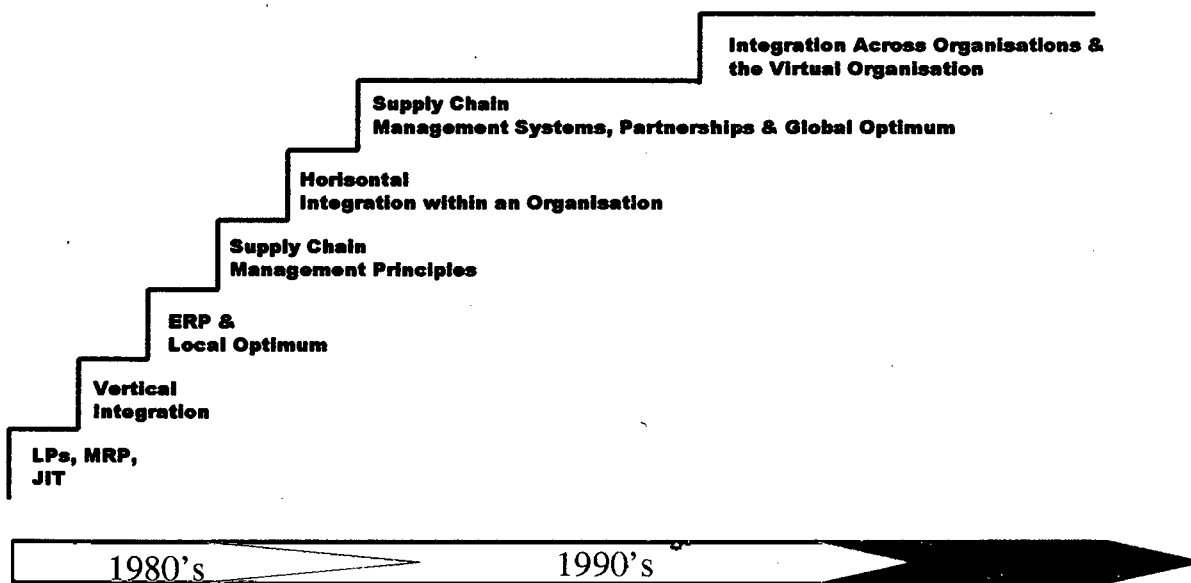


Figure 1: Development of Supply Chain Principles

In the 1980s efforts to address the problems took place mainly in the manufacturing area. Decision models started being used. New principles and methodologies such as JIT (Just in Time) and MRP (Materials Requirement Planning) came to the fore. Stochastic simulation as

well as deterministic models (Linear programming) became more widely used to assist in significant decision making.

Vertical integration started taking place. This is integration within the organisation such as marketing and sales or marketing and production. General awareness of the flow of inventory through an organisation was established.

Process engineering became utilised. This is the awareness of all the activities, resources (human, technical and information) and the time required to produce and distribute a product.

However, what was lacking in many organisations was horizontal integration, i.e. the integration of production with procurement and distribution functions.

Each company aimed to optimise its own operations. This gave rise to local optimums within the supply chains. They concentrated in competing against each other.

At this stage ERP (Enterprise Resource Planning) systems came to the fore. They attempted to plan and optimise the operations of a single organisation in a single comprehensive modular tool.

However, not many organisations were aware that their customers were not the next element/ organisation in the chain but the end consumer, the "man in the street". After extensive re-engineering and ERP initiatives organisations were no longer fragmented. But the supply chains were still fragmented.

With the increased globalisation of the 1990s, supply chains became longer. The inefficiencies that had existed before and had perhaps been hidden or were not significant started occurring and became significant even though the organisation itself was running at an optimum.

Costs such as the following appeared:

- Lowered customer service
- Rising costs
- High inventories
- Stockouts
- Production was not to demand
- Etc.

The philosophy of the "virtual organisation" appeared. This signified some of the following factors:

- End customer pull
- Global vs. local optimisation
- Partnerships
- Sharing and trust
- The "win-win" principles
- Competing of supply chains not only products
- Different roles in the supply chain for different organisations
- Total cost
- Optimal supply chain not only optimal organisation

The adoption of the global principles gave rise to very complex supply chain network combinations and decision-making requirements. Technology was needed to treat the supply chain as a single entity and not in a fragmented manner.

This type of software would be known as a supply chain management system (SCMS). It would enable the supply chain to transfer its operations from a push to a pull demand. They would operate on the principle of an integrated supply chain, considering all activities to take place and would enable the co-ordination of those activities. A major result and benefit from its use would be flexibility of the supply chain and quick reaction to change.

2 SUPPLY CHAIN MANAGEMENT CONCEPTS

This chapter discusses the principles and concepts that underpin the topic of supply chain management. It is a Literature Survey compiled from a number of books and articles written on the topic as well as the author's interpretation of these and his own concepts.

It attempts to answer questions such as:

- Is supply chain management (SCM) just another business buzzword, a faddish term destined to be replaced by yet another buzzword?
- Despite its current widespread popularity, supply chain management remains a somewhat mysterious concept. Its basic precepts are not clearly understood, its origins puzzling, its concepts amorphous, its future fuzzy. Given these concerns, is supply chain management real?

The aim of this chapter is to show that supply chain management is, in fact, an essential element in every business strategy and it is necessary for businesses to keep abreast of all the latest supply chain developments.

2.1 The principles of supply chains

Many experts and authors believe that "Supply chain management (SCM) is rocket science at its core. It uses advanced technology, information management, and operations research to plan and control an expanding complexity of factors to better produce and deliver products and services in a customer-pleasing way." [1]

This is perhaps true. Supply chain management does utilise sophisticated mixed-integer programming, relational databases and concurrent engineering [37]. However, behind all this

advanced technology is a set of relatively basic and logical principles that form the basis for utilisation of this advanced technology.

These principles are essential. They are often misunderstood, misinterpreted and occasionally go against the grain of what is considered 'normal thinking' in an organisation.

While it isn't easy to develop supply chain processes and technologies within organisations^[38], grasping of the principles is. Without the use of the principles, any use of technology and processes will falter.

These are some of the supply chain principles that must be understood and kept in mind when dealing with supply chain problems:

1. Many actions that are needed for improving lead-time, reliability, quality, response time and service do not save cost and /or increase costs in the short run.^[39]
2. Segment customers based on the service needs of distinct groups and adapt the supply chain to serve these segments profitably^[40]. These segments can be considered different products offerings.
3. Listen to market signals and align demand planning accordingly across the supply chain, ensuring consistent forecasts and optimal resource allocation.^[40]
4. Managers must try to run their companies by striving to achieve global optima, not local optima.^[39]
5. Companies have already cut all costs they know how to cut. To improve their financial position, companies must increase sales, develop new products and improve market share^[39]
6. Adopt channel-spanning performance measures to gauge collective success in reaching the end-user effectively and efficiently^[40] since current measures focus in the local optima, e.g. cost accounting measures not global optima.^[39]
7. Integrate production, inventory planning, customer service, distribution and transportation functions to improve information availability, reduce inventory and improve service.^[41]

8. Manage sources of supply strategically to reduce the total cost of owning materials and services. ^[40]
9. Develop a supply chain-wide technology strategy that supports multiple levels of decision making and gives a clear view of the flow products, services and information. ^[40]
10. Communication is central to the supply chain management process ^[42] and strategic partnerships should be developed to transform a fragmented supply chain into a virtual organisation. ^[43]

There are many more that could be added to this list of ten; they are, however, too numerous to mention. They range from strategic to tactical to operational principles.

A significant principle that perhaps guides all the others is that the customer, not the supplier determines the value of a product ^[39]. Organisations need to realise that they exist in order to serve the customer and "the initial benefits of the supply chain accrue to the customer" ^[42].

2.2 Traditional Supply Chain Thinking

Traditionally supply chains were considered something that takes place within your own organisation. The supply chain was between procurement, manufacturing, distribution and finally finance. These departments were isolated silos that operated to their own agenda, with their own measurements and often with total disregard for the end consumer and other 'partners' in the supply chain.

Such a supply chain is illustrated Figure 2: Single Stage Traditional Supply Chain ^[37], below.

The traditional supply chain management "discovered the inter-relationship between warehousing and the transport functions" ^[37]. These were the first to be integrated and considered as actually being one functional area within an organisation.

This enables benefits such as the following:

- Shorter lead-times.
- Optimisation of warehouse locations. ^[37]
- Lower distribution costs i.e. lower total cost ^[37]
- Realisation that the aim is not to lower transport costs and warehousing/inventory costs separately. It is the combination of the two that is a significant measure.

The next integration was the incorporation of the manufacturing, procurement and order management functions within the organisation. This enabled the sales forecast to be the catalyst for all planning and management within the organisation. All departments communicated and managed together to get the product to their customer. Not only were they able to do this more effectively but also more efficiently and at a lower cost.

Much of this was enabled by better data and more advanced analytical techniques as well as ever improving communications and analyses ^[37].

However, all these improvements only took place within the organisation not in the entire supply chain. Each organisation only saw as far as its supplier and its customer, not its suppliers' supplier and its customers' customer etc.

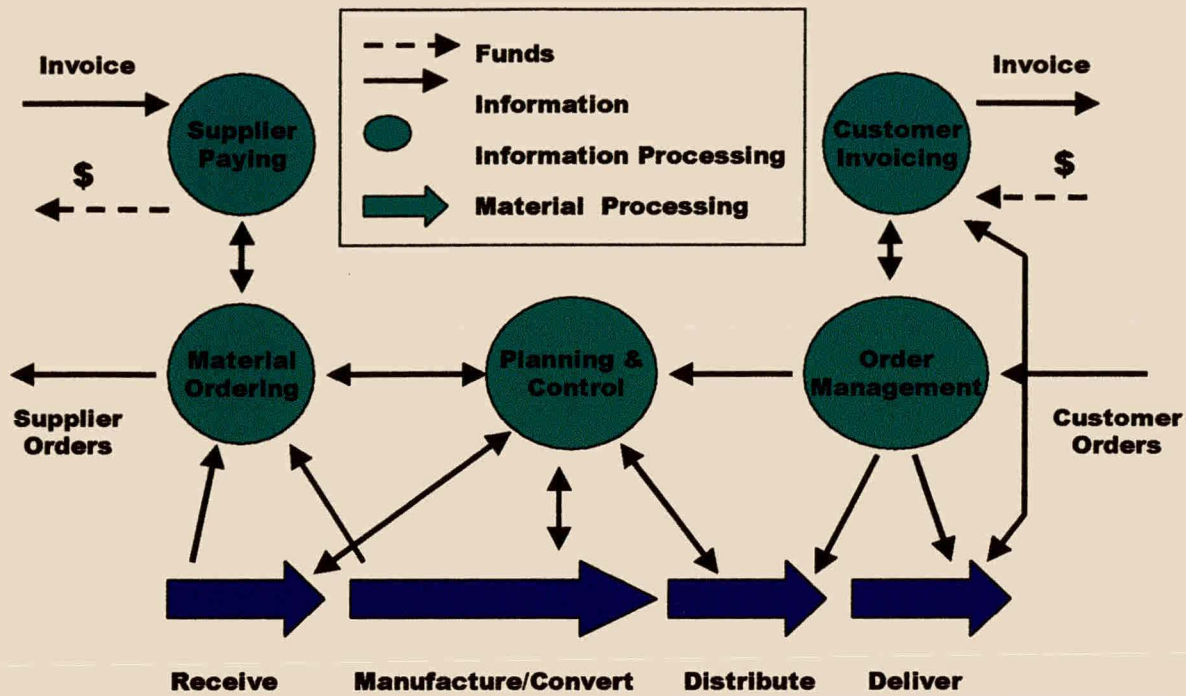


Figure 2: Single Stage Traditional Supply Chain ^[37]

This single-stage supply chain, typically found in a single company, has been the primary focus of supply chain management to date. ^[37]

It has characteristics such as:

- Management strive for local optima. ^[39]
- Use of inappropriate performance measures for global and supply chain wide operations and control.
- Lack of supply chain wide communication.
- Lack of global strategic vision.
- Lack of customer knowledge and support.
- High inventory levels, high obsolescence and low order performance ^[39] in the supply chain as a whole.

2.3 Modern Supply Chain Thinking

The following definition of supply chain management is used at MIT: Integrated Supply Chain Management (ISCM) is a process-oriented, integrated approach to procuring, producing, and delivering products and services to customers. ISCM has a broad scope that includes sub-suppliers, suppliers, internal operations, trade customers, retail customers, and end users. ISCM covers the management of material, information, and funds flows. (Note that we add the word "integrated" to underscore the objective of integrating the many functions into the total process.)^[37]

The modern supply chain thinking is more comparable to our SCM definition. It is illustrated in Figure 3: Multi-Stage Extended Supply Chain View^[37], below.

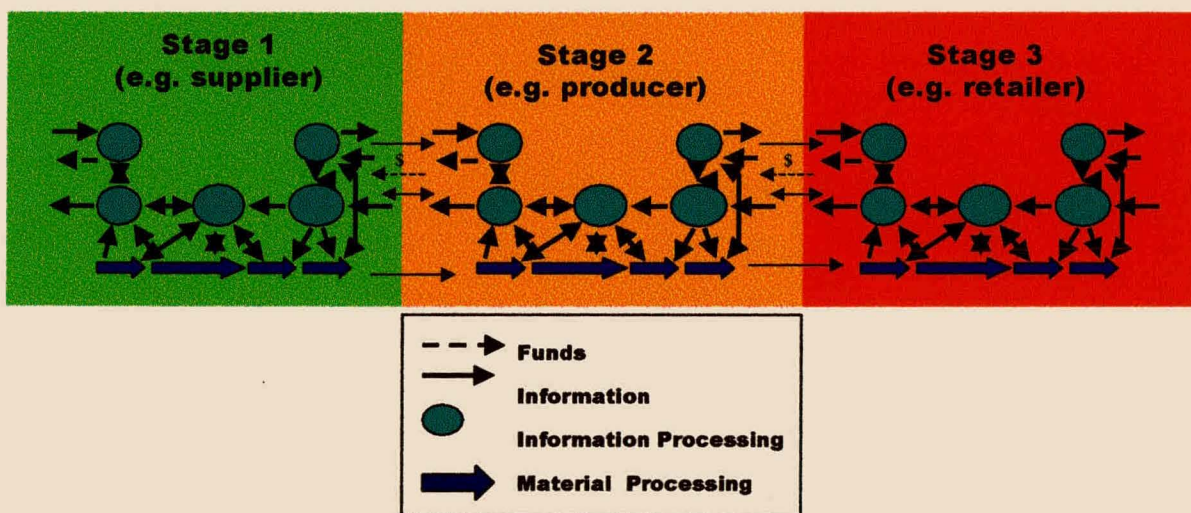


Figure 3: Multi-Stage Extended Supply Chain View^[37]

These are essentially multiple replications of the single-stage supply chain.^[37]

This integration phase has seen the development of the super supply chain^[37]. Operations and decision making of the various participants in the supply chain is communicated and used interactively for the benefit of not only a single organisation in the supply chain but of the supply chain as a whole.

This has been enabled by even more advanced communication, better and more user friendly computerised decision support systems and increased training. ^[37]

Volkswagen provides an example of a multi-stage supply chain. The automaker is working with its dealers to get advance order information and actual orders electronically and feeds the data directly into the daily automobile production planning. Volkswagen is also working with its in-house supply plants and contract suppliers to issue electronic orders for parts and sub-assemblies to be delivered in a just-in-time mode according to the daily production schedule. Volkswagen plans to use this integrated supply chain operation to reduce its present order-to-delivery cycle time from many weeks to two weeks and eventually to a matter of days. ^[37]

This new supply chain thinking embodies many of the principles that were discussed as being necessary for a successful supply chain business. The fact is that supply chains exist in manufacturing industries, in service industries, and in the home. Other terms are 'demand chains' or 'value chains.' But whatever the term used, we mean the integrated process of producing value for an end user, the ultimate customer. ^[37]

These new supply chains have some of the following characteristics:

- Attempt to obtain a global optimum.
- Utilise partnerships to achieve the ultimate goal - serving the consumer.
- Have adopted global performance measures.
- Use extensive information technology to manage the supply chain.
- Continuous improvement.

These developments, be they within the organisation or throughout the supply chain, have one factor in common. They have utilised technology, namely information technology, as a key supply chain driver ^[37].

In the past it has been the markets and industries that have driven and governed the technology developments. Currently and in the future, the technology will drive the markets and industries.

A fine example of this is the advent of E-commerce. This has driven and transformed world markets in multiple industries. ^[47] However, there are others such as ^[93]:

- **Consumer Demands-** customers will get what they want. If you do not meet their needs, someone else will.
- **Globalisation** - no part of the world is safe from your competitors' reach just as barriers to entry of your organisation into any geographical market are disappearing.
- **Competition** - tougher competition will continue to facilitate supply chain innovation.
- **Government Regulation** - governments will continue to shape supply chains e.g. European Union.
- **Environment** - eco-efficiency, re-cycling and waste minimisation are becoming more important.
- **Supply Chain Vision** - strategic visions and goals of organisations will need to improve supply chains into the future.
- **Flexible Integrated Design** - fast reaction, design and re-design are needed to suit needs of manufacturing, transport, storage and the consumer.
- **Household Replenishment** - automated fulfilment of customer demand at his/her point of consumption, i.e. the home, will become the new battlefield for competitive organisations in many industries.
- **Virtual Organisation** - such as Nike selling \$9billion worth of athletic shoes annually without owning any factories itself, will become the new *modus operandi*.

2.4 The benefits and accomplishments of Supply Chain Management

It is very difficult to list all the favourable results of successful supply chain management. There are many and in various industries. There have also been many failures when organisations have attempted to implement supply chain management without fully understanding the real underlining principles.

The following list provides real life proof that supply chain management can and will work when fully appreciated and understood. These are just examples and actual results may vary from industry to industry and company to company. Some examples are:

- Inventory reduced by 50 %. ^[37]
- Procter & Gamble saved its retail customers \$65 million through logistics gains over past 18 months. ^[43]
- Dell Computer's share price has mushroomed nearly 200 fold since 1990. 'We already have a quick-ship plan for large customers where we can deliver a machine within 48 hours of an order' Michael Dell explains (Fortune, Sept. 8, 1997). ^[43]
- Polaroid has realised significant cost, service and inventory improvements on a global basis. ^[38]
- In an industry with a five-year average annual growth rate of 8%, Micro-Age impressive 43% per year growth reflects the real potential of supply chain management ^[44] (Micro-Age is a distributor of computers and related equipment).
- Domino's Pizza Inc. sales in 1996 reached \$2.8 billion, making the fourth consecutive year of increased sales. ^[45] Domino's has over 1200 franchisees, operates more that 5700 stores in the USA and internationally. It attributes much of its success to successful supply chain management.
- Donaldson Co. manufacturers filtration systems rejected the status quo and adopted supply chain management. Donaldson Co. changed the way it distributed products in

Canada, the result was faster transit times, lower logistics costs and booming sales.

[47]

- Through its comprehensive Integrated Supply Chain Benchmarking Study, PRTM (Pittiglio Rabin Todd & McGrath) found that best-practice supply chain management companies enjoyed a 45% total supply chain cost advantage over their median competitors. [47]
- The companies studied by MIT have recorded a number of impressive supply chain accomplishments, including 50% inventory reduction, 40% increase in on-time deliveries, 27% decrease in cumulative cycle time as well as 17% revenue increases. [47]

These are all real improvements created by the better decision making made possible by integrated supply chain management.

However, there are also warning signs of what can happen if supply chain management is not implemented in an organisation. Boeing Aircraft, one of America's leading capital goods producers and top exporters, was forced to announce writedowns of \$2.6 billion in October. The reason? It is blaming 'raw material shortages, internal and supplier parts shortages and productivity inefficiencies ... (Wall Street Journal, Oct. 23, 1997) [43]

However, one of the most impressive things about supply chain management is that there's also a non-intuitive result: Supply chain management can reduce costs, improve service, and enhance revenues simultaneously! [37]

For example, the VF Corporation, which makes popular lines of clothing such as Jantzen, Vanity Fair, and Wrangler, achieved a 17% increase in revenues. [37]

The company used initial sales information for new product design through advanced computer aided design (CAD) and computer aided manufacturing (CAM). This enabled them to reduce the lead-time of product design to manufacture.

This data, combined with updated forecasts, was electronically fed to the agile CAM manufacturing plants. Also, fast air transportation quickly brought the right quantities of the right product to the retail shelves. Together, these supply chain innovations improved sales in the peak season and reduced left-over product to be sold at a discount. ^[37] As a result:

- The revenues improved.
- Customer service improved.
- Inventory and resale cost decreased.

It is clear that supply chain management provides the 'whole' solution. Organisations can no longer do without it. Currently it is a factor that differentiates the achievers from the ordinary competitors. In the future SCM will no longer be a differentiator but a business necessity for a company to simply exist in the market.

3 INITIAL DECISION SUPPORT SYSTEM REQUIREMENT DEVELOPMENT

In 1996 Spoornet was working on a large supply chain and partnership project with one of its clients, Tiger Milling.

Tiger Milling had the following characteristics:

- Large users of rail for inbound traffic.
- Consisted of a large number of mills
- Large number of suppliers to source raw materials from
- The potential to handle the outbound traffic and distribution by rail

To handle the Tiger Milling project, a team consisting of the following was assembled:

- Two industrial engineers
- A Business Analyst
- A rail freight expert

The goal of the project was to:

- Model the AS-IS supply chain for several selected mills:
 - Pietermaritzburg
 - Delmas
 - East London
- Develop process models of:
 - the decision making operation
 - the procurement and distribution operations
 - the invoicing, billing and payment functions
 - the receiving and storage allocation function
- Workshop with:
 - The procurement department

- Finance department
- Receiving department
- Spoornet operations
- IT departments

3.1 Summary of the Current Situation and Markets

Tiger Milling's situation was characterised by:

- The market that the company was in is very dynamic and highly competitive.
- Fluctuating price, quality and quantity of raw material supply and product demand.
- Large number of supplier combinations.
- Very particular demand due to an essential quality consideration.
- Complex transport network.
- Optimal individual mill operations in terms of the milling process and technology.
- Well-monitored inventory in terms of what is required and what is incoming.
- Typical situation of excellent local optimum on the mill level (intra-mill) and no optimum on the supply chain or inter-mill level.
- Lack of technical support.
- Large product mix.
- Global markets - import and export.
- Falling away of Wheat and Maize Boards.
- All planning and decisions are done manually.
- Need to look at logistical cost not only normal cost.

3.2 Existing Problem Areas

The following problem areas existed in this particular supply chain:

- High cost of procurement in terms of transport and product.

- ❑ Lack of planning. Relying on "fire fighting".
- ❑ High inventory levels.
- ❑ Frequent stockouts of required inventory.
- ❑ Fragmented organisation in terms of inter-mill operations and planning of outbound, inbound and manufacturing functions.
- ❑ No procurement strategy.
- ❑ Large number of variables to be considered in planning - quality, price, time, volume, capacity etc.
- ❑ Use of inadequate linear programmes for decision support.
- ❑ Capacity of sidings at the mills and actual arrivals of trains not compatible.
- ❑ Lack of planning on strategic and tactical levels.
- ❑ Lack of KPIs (Key Performance Indicators) and benchmarks.
- ❑ Lack of speed and flexibility in planning.
- ❑ Inability to produce an optimal plan. Plans are feasible at best.

3.3 The need for a Logistical Decision Support System

Reasons why a decision support tool was required included the following:

- ❑ To analyse network combinations and alternatives.
- ❑ Ask "what if" questions and attempt to answer them.
- ❑ Know what the cost of distribution and procurement is.
- ❑ Consider all variables simultaneously.
- ❑ Develop feasible as well as optimal designs and plans.
- ❑ Quick reaction in changing existing plans or developing new ones.
- ❑ Assisting procurement and distribution planners.
- ❑ Utilise the economies of scale of considering all mills and requirements holistically.

4 TIGER MILLING SCENARIO

The following section discusses the project that initiated the thinking with respect to decision support itself and the tools and methodologies that would be used for decision support.

4.1 The Project

The project between Tiger Milling and Spoornet was initiated in early 1996 after repeated problems with sourcing of grain from various farms, silos and co-operatives throughout the country. The distribution to the mills was also a problem.

The project team has to analyse and reengineer several processes within Tiger Milling and those linking Tiger Milling and Spoornet. These are:

- Ordering and reservation of Spoornet wagons by Tiger Milling.
- Decisions as to where to source from, when, how much and what type of product.
- Incorporation of loading, offloading and quality testing processes.
- The invoicing, reconciliation and billing processes between Tiger Milling, Spoornet, farmers and Wheat and Maize Boards.
- Operational processes determining the movement of product from sites to the mills.

The deliverables were the AS-IS processes, TO-BE improved processes, infrastructure changes and improved relationship/partnership between the two organisations for the next five years. This should result in the lowering of costs and improving of profits for both organisations.

During the progress of the project, while studying the current process and operations, the complexity of the decisions needed to be made became clear. The total inadequacy of the current data availability, decision processes, software and hardware tools and qualified personnel became obvious.

This became the author's area of expertise and area of involvement in the project. To explain the situation, a typical scenario of a distribution problem such as faced by Spoornet and Tiger Milling planners, is discussed in the rest of this chapter.

4.2 Mill Level

Every Tiger Milling mill carried out its own planning and distribution decisions. Figure 4: Procurement of Grain Network

, below, illustrates what a procurement network of the mills looks like and how they inefficiently overlap each other when there is no communication and a lack of integrated planning among them.

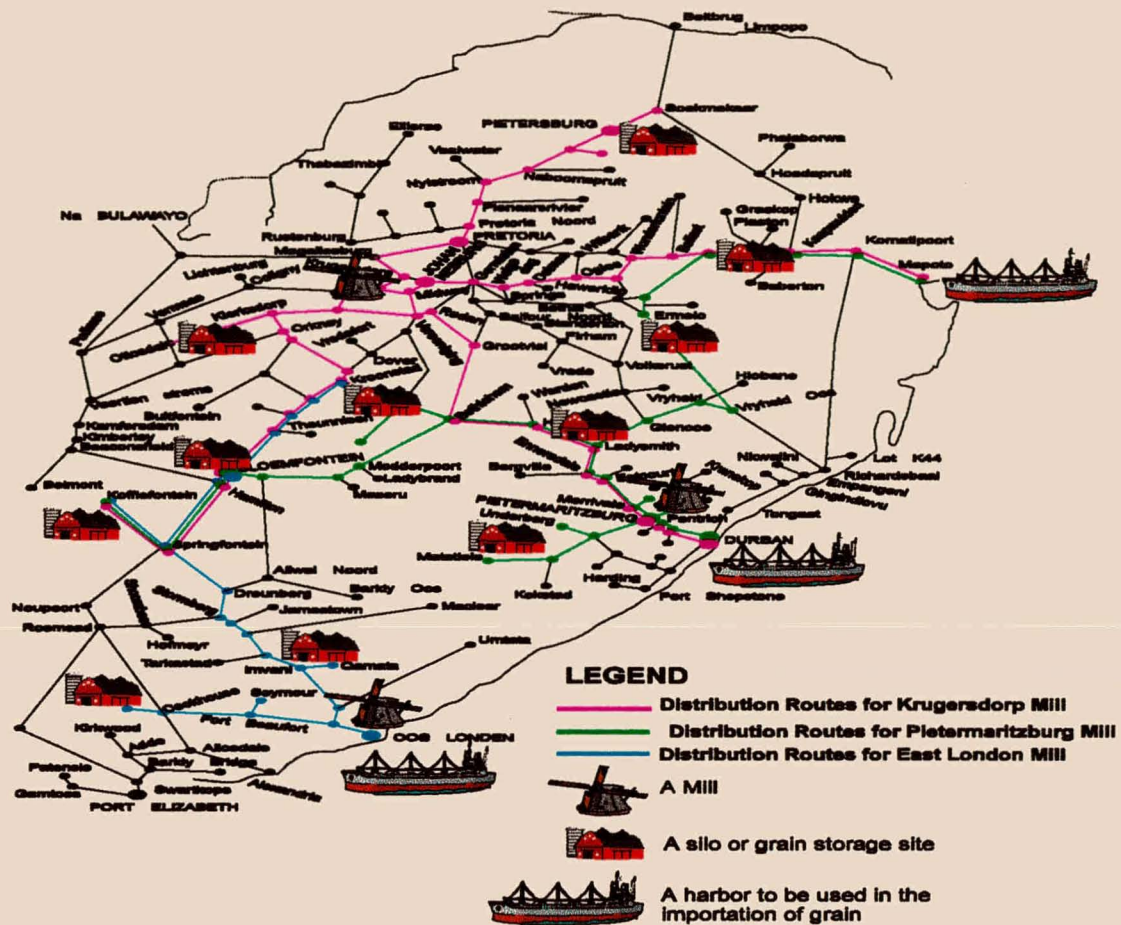


Figure 4: Procurement of Grain Network

Each mill forecasted a certain demand for itself based on historical data. This demand was initially on a yearly level. This demand would be for wheat and maize. Maize demand is relatively straightforward. However, wheat is more complex because it is available in many grades (quality types).

The end product from the mill has to be of a certain standard quality. It must be maintained for as long as possible. This quality obviously governs the mix of grades of wheat it takes to make it. As a result only certain grades are needed in specific quantities.

The supplier, be they farmers, silos or co-operatives, produce finite quantities of various grades of wheat and maize. The distribution managers, therefore, must determine what they need. Then they "go shopping" for the cheapest raw material.

Once they have secured the contracts for the raw material, they contract Spoornet to arrange for rail wagons to transport the goods.

On the operational levels, personnel must balance storage space. Silos at the mills are limited and no two different grades can be stored together in the same silo. Other variables that come into play are the loading and offloading rates, siding capacities, rail transit times, mill production rates, changes in harvest quality, quality and timing, combining wagons to make up trains, changes in any operational issues, imported wheat arrivals, etc.

4.3 Tiger Milling at Group Level

While each mill did its own selection, they were in fact often competing against each other for the same raw material and transport capacity. These types of decisions should be made centrally to utilise economies of scale.

This would, however, increase the complexity of the decisions to be taken exponentially due to the possible number of combinations of potential solutions and variables and constraints.

All that the distribution managers at Tiger Milling and Spoornet had at their disposal was paper, pen and perhaps and computer spreadsheets. This is totally insufficient to take into account all of the variables that exist. To worsen the situation, the cost of transport was excluded. A major factor in decision making.

The fact that they should have been considering total cost (i.e. raw material, transport and whatever other costs are incurred) was not realised. Therefore, not only were they not taking into account all possible variables sufficiently, but they were doing it in the wrong manner as well.

Not only was this extremely inefficient but it was costing both organisations large quantities of money.

Typical inefficiencies were:

- Time-wasting manual tasks left no room for finding an optimum.
- Not considering all factors ensured that the optimum or even cost effectiveness would not be reached.
- No mechanisms to help in the analysis of the situation.
- Could not balance costs, customer service and capacity simultaneously.
- Could not analyse or create "what if" scenarios.
- Could not react to changes in capacity or demand.
- Took a very long time to produce an inefficient plan.
- Could not include constraints and capacities of resources and role players that influence and constrain the process.
- A global holistic view of the Tiger Milling supply chain with all the mills, routes and sources could not be established and analysed.
- The real total cost of the sourcing was not known or determined.

4.4 Solution to the Problem

A solution to the problem was a modelling tool that would be able to model all the variables and play off scenarios against each other to reach optimal costs while meeting all demand. These models would have to be run very quickly to reach the results and would need to be rerun if changes in the system occurred.

It was foreseen that this type of system/tool would be used centrally and would include all the mills and possible sources of raw materials and all possible transport routes.

This tool would have to either replace the current Channel Managers or help them in their duties. This would allow significantly better plans and results to be produced both for Spoornet and Tiger Milling.

The tool would have to carry out considerable mathematical and statistical analyses based on the input data and assist in decision making that would enable both organisations to run better supply chains.

Often there is no single best approach to the problem. Neither is there a best model, representation, simulation or tool. It is a matter of choosing which one is better for the particular problem situation and your needs. Often a trade-off has to be made.

Should the tool and the software be customised or "off the shelf" packaged. The disadvantages of each are:

Custom software:

- Expensive to build
- Long lead time
- Frequent modifications required
- Difficult to maintain

Packaged software:

- Does not exactly fit the business or situation
- Difficult and cumbersome to change

It is, therefore, essential that this is realised and considered when procuring software. One of the criteria should be that some parts of the software be packaged and others customised. This can be done because many of the features are similar regardless of the industry but others need to be customised depending on the industry or the business.

4.5 Primary Criteria for the Decision Support System

- User friendly**
- Not require major qualifications or excessive training to use**
- Accurate**
- Assist the Channel Manager in decision making**
- Answer "what if" questions**
- Fast running time**
- Flexible in terms of additions to the model**
- Stable technology**
- Reasonable data requirements**

5 LITERATURE STUDY OF METHODS OF DECISION SUPPORT

This chapter is a discussion on the literature study that was carried out in order to determine the various potential methodologies that exist in the field of decision support.

This literature study consisted of a study of a large number of journals and textbooks on decision support as well as other related topics. Much of this literature was very theoretical. Considerable analysis and transformation had to be done to make it directly applicable to supply chain management and the project requirements.

The chapter that follows is a summary of the literature survey. The entire literature survey was not included as it was extremely lengthy and as mentioned not always applicable to the subject matter.

This summarised version is not as theoretical as the majority of the published literature. It is more suited to the exact topic, supply chain decision support, that Spornet as well as the author was interested in.

At the time of the Tiger Milling project, a number of simulation and decision support models were in use in South Africa. They were:

- Simulation models used in manufacturing
- Linear/integer optimisation models
- Expert systems used for process control

Each of these was investigated thoroughly as to their decision making capability, ease of use, speed of modelling, functionality, reusability, optimisation capability, accuracy, support and reliability, etc.

5.1 Stochastic Simulation

This is the type of simulation that is used commonly in manufacturing and other related industries. A model of the plant or warehouse is built in the software. It provides for all the machines, operators, storage areas and other elements that exist in the plant ^[3].

Running the model involves pushing raw materials into the process and seeing how much work in progress (WIP) and final product is produced. Data indicating the performance of each resource and element is collected. This includes utilisation, costs, blockages and overloads.

Constraints such as maintenance of machines, failure of machines and percentage quality rejection, etc. can be built into the model.

Based on the results of the model, the user will make a change to the model, e.g. add an extra machine or resource where it seems a bottleneck is occurring. The user will then rerun the model, collect the data, interpret the results and compare them to the previous scenario.

Figure 5: Stochastic Shipyard Model, below, illustrates a screen print of a stochastic simulator designed to simulate the arrivals of ships in a harbour, the offloading of the ships and the storage of the goods.



Figure 5: Stochastic Shipyard Model

This type of simulation has both advantages and disadvantages that have to be considered in choosing this as the modelling approach.

5.1.1 Advantages

It is extremely accurate in the way it represents reality when modelled accurately and capably ^[1].

It is event driven and makes considerable use of statistical data and calculations. Since it uses a distribution to indicate duration and other resource characteristics, it enables the model to take into account that these times may vary due to the random nature of events. As a result, events vary in length and take place randomly as they would in reality. A random number stream is used. Each time increment has a different number which, in turn, gives rise to a different set of variable values and event occurrences.

The characteristics discussed above ensure that currently stochastic modelling is one of the most accurate modelling techniques in terms of statistical reliability of reality. It can be assured that the behaviour of the model approximates reality to an extremely high percentage of over 90%. ^[1]

The following assumptions were made in the statements above:

- The model is well and accurately built
- Accurate data is available
- Sufficient analysis is done of the raw input data as well as model output data

5.1.2 Disadvantages

There are fundamental disadvantages to this modelling technique for the Tiger Milling scenario. They are numerous:

- Due to the statistical nature of the method, large quantities of accurate data are required. It is often time consuming to collect and analyse ^[2]. Time and resources that Channel Managers do not have.
- A large number of replications needs to be run to get the desired statistical accuracy of the output^[3]. This can take considerable time that is not available in the environment that the Channel Manager must make decisions in.
- The model only indicates the behaviour of the system. It does not provide solutions or drive the model and variables towards optimality. All analysis is left to the user. It is the user that must drive the model to an optimum. He/she must analyse the model outputs, make the correct decisions as to which direction the optimum lies, model it again and analyse the results. This can carry on until the user is satisfied that optimality has been reached.

- This method requires high skill and is time consuming ^[3]. One of the requirements was that the decision support system should help the Channel Manager to make decisions. This method would add to the workload and is not feasible.

Therefore, while this modelling technique is extremely accurate, it is time consuming, requires high skill and requires the user to make the majority of the decisions. It is not suitable for the needs outlined.

5.2 Expert Systems

These are systems that are used to simulate the decisions made by the human mind in a particular environment. Their aim is to replace the operator or part of the operator's function.

It is done by the programming of various rules and procedures, which will be carried out when decisions need to be made, into a computer language. The code can be written in various languages such as Visual Basic, C++ as well as specific expert system languages ^[4]. The figure below illustrates an example of architecture of an expert system.

The user sees the user interface and utilises various strategies as well as rules and facts (stored in the knowledge base) to make decisions. The knowledge engineer is the one who maintains the expert system by keeping the knowledge base reliable and up-to-date. He/she is also responsible for the stability and accuracy of the inference engine ^[4].

The expert systems have often been used in control or filtering environments. E.g. A fault-reporting centre at a telecommunications company will use an expert system as the first point of entry for incoming queries. The expert system will use its capability to filter the incoming faults and solve some of them itself. The more complex fault will be passed over to

the technical staff manning the centre. This enables the technical staff to handle fewer problems and problems more challenging in nature.

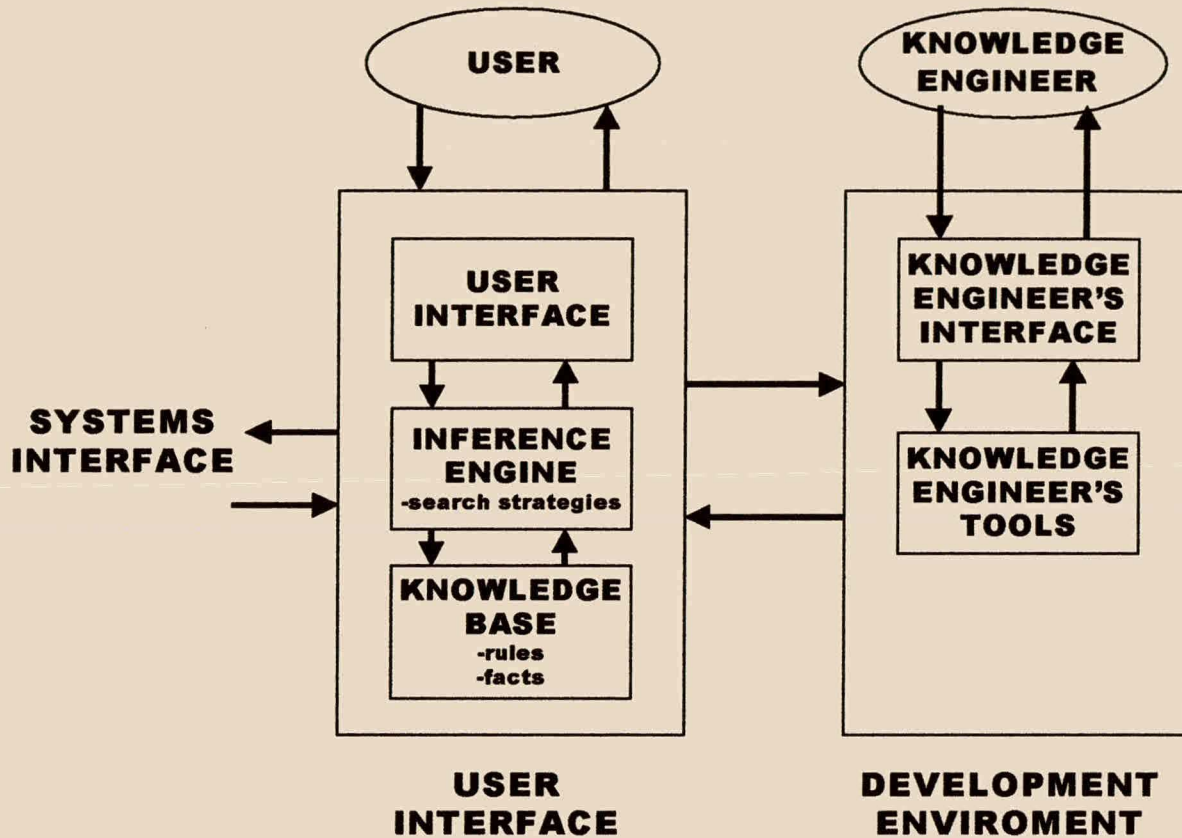


Figure 6: Basic Architecture of an Expert System ^[4]

It is also often used to control furnaces at steel factories, where a change in certain variables will cause the system to react and take action to stabilise the furnace by altering other variables.

This type of system would be ideal in taking over many of the more basic functions performed by the Channel Manager. But, they would not be able to take over all the work. At this stage these systems are not yet as advanced and reliable to perform the full function of a Channel Manager. This means that still much of the work that the Channel Manager has to do will still have to be done by him/her. This includes all the decisions that are too complex and practically impossible to take into account other than by the human brain.

The expert system is not suited to this type of decision making where scenarios must be created and an optimal distribution found by means of iterations and mathematical calculations.

This type of decision making takes the expert system into the realms of artificial intelligence. These are only in their experimental stages and can by no means provide the solution.

While it is something that should be considered in future, it currently is not the solution to the project requirements.

5.3 Gensym's G2

Although here we have mentioned a specific tool as opposed to a method, this tool is unique and powerful enough to warrant its being mentioned specifically. Many misconceptions exist as to what this tool's true application and capability is.

This tool is used to control refineries, furnaces and power station operations. It offers a graphical, object orientated environment to create intelligent applications that monitor, diagnose and control dynamic events in on-line as well as simulated environments ^[5]. Figure 7: G2 Screen Print, below, illustrates a screen print of a G2 system monitoring and controlling flow of fluid in and out of storage tanks and into transport vehicles.

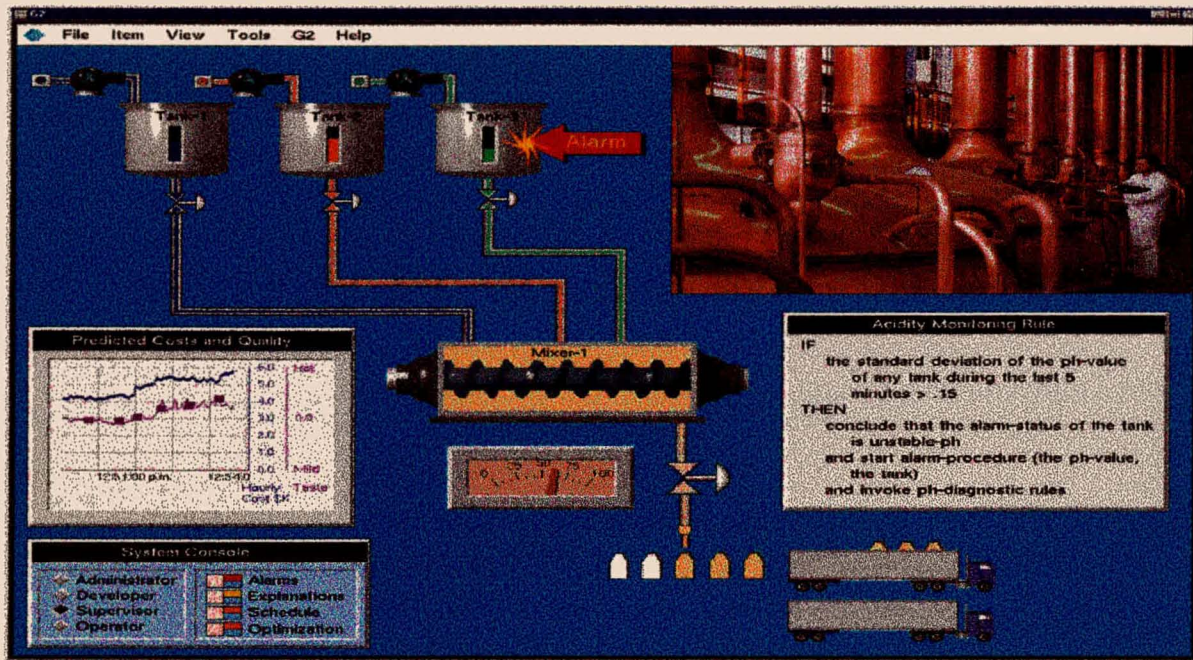


Figure 7: G2 Screen Print [5]

In many cases it can be considered an advanced expert system [5]. The use and the shortcomings of an expert system have already been discussed. However, G2 has the potential to be a simulator tool.

It utilises an extremely powerful language in which it is possible to create for example, a stochastic simulator. This would mean that there would be a decision-making expert system on top of a stochastic simulator. However, in reality this has many flaws:

- Expert systems currently do not have the required functionality (See previous section)
- Building a stochastic simulator in G2 is time consuming, resource consuming as well as very expensive. It would mean "redesigning the wheel". Building a stochastic simulator from zero base, when many can be purchased, is a futile exercise. The questions are whether Spoornet is in the business of designing software or in the provision of logistical and transport services?
- The cost of G2 and the use of G2 in terms of programming and hardware requirements make it unsuitable.

- The suitability of stochastic models is not good, at this stage of technological advancement.
- The real application for G2 is to monitor and control closed systems such as power stations and refineries, not to model supply chains ^[5].
- The use of the tool for this purpose would result in something that is cumbersome, expensive, of questionable reliability and it would not perform the task as well as some of the tools available on the market.
- Running a G2 model is very time consuming. This time is not available.
- It takes tremendous skill to programme and use G2. This is something that the Channel Managers do not have and should not need to have.

The final assessment is that G2 is not suitable for the required application.

5.4 Expert System and Stochastic Simulator Combination

This is something that could use the best of breed solutions. Expert systems to make decisions for the Channel Manager and drive the model to an optimum. The stochastic model would run the scenarios.

Currently this is something that is not entirely realistic since:

- Expert systems are not advanced enough.
- It would mean combining technologies that are very different and reside on different tools that are not very compatible. To enable the two to talk to each other would involve time, money and expertise that is not available.
- This type of system integration can be considered to be leading edge. It would involve very long development and testing time. One of the requirements was that this system needs to be implemented and used as soon as possible.
- Spoornet should not be developing and testing software. It should be using well-tested and proven applications to improve its business.

5.5 Deterministic Programming

This modelling involves the use of variables, constraints and mathematical methods to reach a desired objective function or several objective functions.

This objective function is the mathematical representation of the optimising requirements for the particular situation. The procedure generally involves the use of variables and constraints to identify a feasible region i.e. the region within which a solution will be found but which will not necessarily be the best. The objective function will help to identify the solution that is best.

Figure 8: Simple Deterministic Model, below, illustrates a very simple example of a deterministic solution to a problem. The two axes x_1 and x_2 illustrate the type of products that are produced by a wooden furniture factory. x_1 could be a table and x_2 a chair. The numbers on the respective axes indicate the number of those units - chairs or tables that can be produced. The other lines labelled carpentry and finishing constraints indicate the effort that is required in terms of building the product and in terms of putting the finishing touches on the product. E.g. both the products require 80 on the carpentry constraint but x_2 requires 100 to finish it while x_1 only 50.

The demand constraint indicates that maximum of 40 units of x_1 may be sold. These three constraints provide the red shaded region.

The red shaded region is the feasible region - configured by a combination of constraint equations.

The profit line will indicate the optimum, i.e. how much the factory should manufacture of each item to give the maximum profit.

The optimum will then be found by the dotted line (the objective function), by moving the dotted line over the feasible region and finding the optimal intercept between it and the feasible region border points (A, B or C). In this example, Point B is the optimal solution.

Methods such as linear programming, integer programming, network modelling and transportation methods are all deterministic methods. Each has its own application within which it will excel.

This type of modelling has been available for many decades and has proved very useful in providing solutions for decision-makers. Due to the mathematical nature of the method and the increased complexity and size of the equations when dealing with real life problems, this method was difficult to use and reuse by the average user ^[7].

The formulation of the equations and constraints is also complex. The earlier computer programmes did not do much to help the user in terms of ease of use and simplifications of his/her tasks.

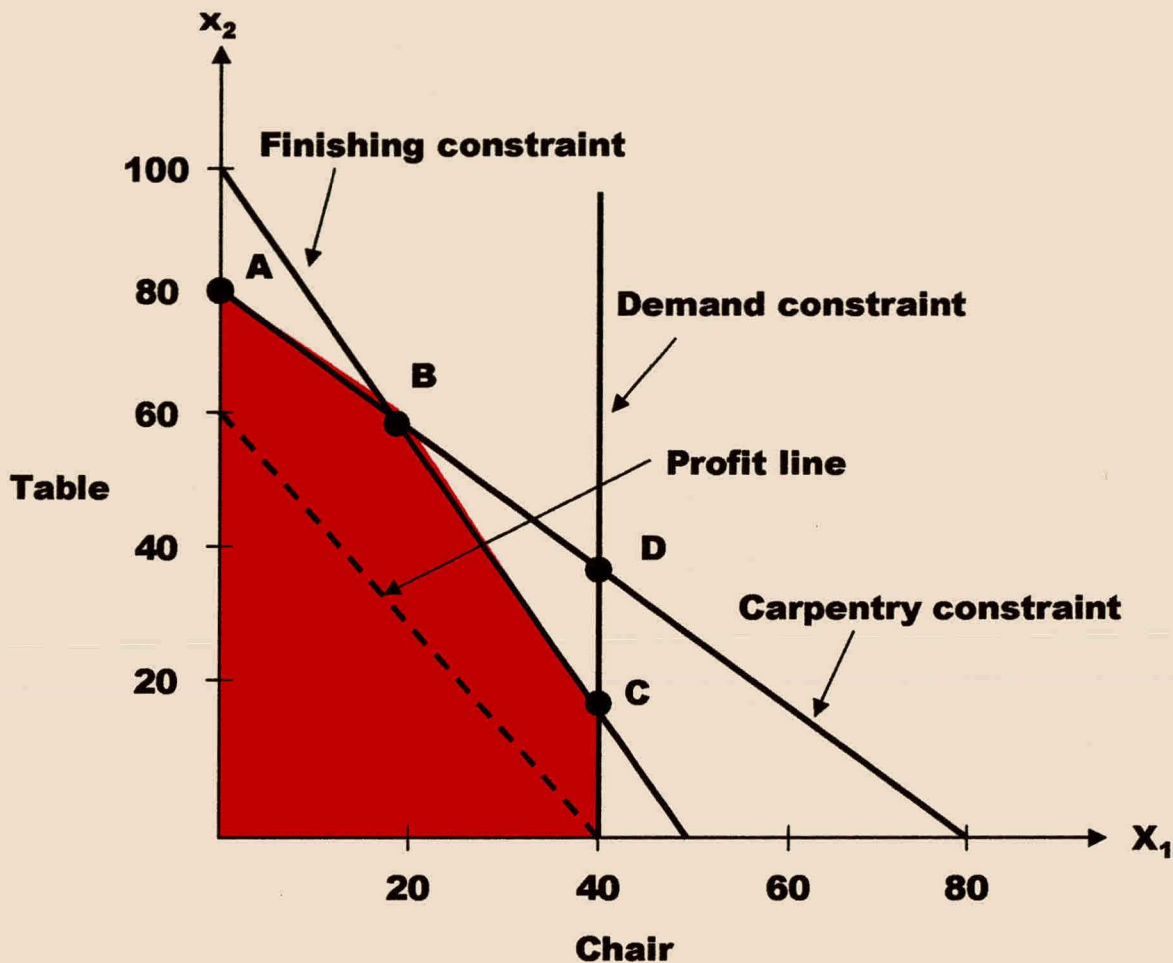


Figure 8: Simple Deterministic Model ^[27]

With the advent of more powerful computers and graphical user interfaces, deterministic programmes became much easier to formulate, use and observe the results. This improvement saw a major rise in the use of this application for commercial modelling ^[6].

A major advantage of deterministic modelling is that it finds the optimal solution (if one exists). It analyses data, makes decisions from choice and steers the solutions towards the optimum defined and desired by the user. In this role it can perform many of the functions and take many of the decisions that the Channel manager should be performing.

Because of the ability to build in as many variables and constraints as required (the only limit being the computing power of your machine), it is possible to analyse and find solutions for

the complex problems ^[6] that the Channel Manager needs to solve but is not capable of doing on his own.

The method relies on averages of the data collected. While considerable quantities of accurate data still need to be collected, it is less than needs to be collected for stochastic models. These rely on averages, standard deviations and statistical samples.

A further advantage is that with the current technology, the models will run fast and solutions will be reached quickly.

A disadvantage of this method is that it is not as accurate in representing reality as a stochastic model.

Its use of averages does not indicate or cater for variance of data. This variance does have considerable impact on activities in reality. It also does not take into account time and random occurrence of events due to time. This does happen in reality and is simulated in stochastic modelling.

However, deterministic modelling has been developed over a number of years into a complex art and science. Its wide spread use has illustrated that it has sufficient accuracy, stability and reliability in a large number of fields and industries ^[7].

6 CHOICE OF METHOD

From the methods analysed, it is believed that currently, based on the criteria set for a suitable choice of decision support system, the deterministic modelling method is the most suitable. The decision can be summarised in Table 2: Final Score of Modelling Methods and in Table 3: Ratings of Modelling Methods.

The table rates the various characteristics of the modelling methods out of 10 points. The higher the score out of 10 the better.

Each characteristic also has a weight attached to it. Table 1: Weights of Modelling Characteristics indicate the particular weight of a characteristic.

This weight indicates the importance of that category in the total decision ^[15]. To calculate its contribution to the total, the rating will be multiplied by the weight. All weights sum to 1 i.e. 100%.

These weights were established by the project team based on assumptions of what characteristics would be of more importance in the choice of a supply chain decision support method ^[15].

Table 1: Weights of Modelling Characteristics

Characteristic	Weight
Ease of Use	0.1
Stable Technology	0.2
Programming Time	0.2
Decision Making Power	0.2
Data Requirements	0.1
Accuracy	0.1
"What If" Capability	0.05
Cost of Model	0.05

Table 2: Final Score of Modelling Methods

METHOD	FINAL WEIGHED SCORE
Stochastic Simulation	5.75
Deterministic Modelling	8.25
Expert System	6.05
Expert System & Stochastic Modelling Combination	4.3
Gensym G2	4.6

Table 3: Ratings of Modelling Methods

CHARACTERISTICS								
METHOD	Ease Of Use	Stable Technology	Programming Time	Decision making Power	Data Requirements	Accuracy	"What If" Capability	Cost of Model
Stochastic Simulation	5	9	3	5	2	10	8	5
Deterministic Modelling	9	9	7	9	7	8	8	9
Expert System	8	6	6	6	7	5	3	6
Expert System & Stochastic Modelling Combination	7	1	4	7	2	5	8	2
Gensym G2	3	7	1	7	4	5	6	2

7 HIGH LEVEL SPECIFICATION FOR A DSS

After the selection of deterministic modelling as the preferable method for a decision support system (DSS), high level specifications for the required DSS were constructed.

These specifications are considerably more detailed than the specifications discussed in Initial Decision Support System Requirement development. These specifications provided a checklist that was used to search for suitable software available on the market.

Further, more detailed, differentiation between software tools will be done once the finalists (the tools that conform to these specifications) have been chosen.

The specifications are explained by means of a process diagram for each level and a discussion of the inputs into the process, the mechanism, resources or methods used and the outputs of the process.

7.1 DSS Level 1

At this level of the decision support system, the yearly or seasonal mill requirements and the seasonal harvest forecasts are split and processed into monthly allocations of raw materials from silos to mills for the entire year.

7.1.1 Inputs

Mill requirements i.e. tons and grade per raw material type for the next year.

Potential sources - tons available, grade, price and when during the season they will become available (harvesting).

Transport routes - capacity and the cost of the routes.

7.1.2 Method

This level could be solved using linear programming style of methodology. There would be an objective function that would aim to optimise the total cost of distribution. This is the raw material cost as well as the transport cost.

The other part of the programme would be the constraints of the system in mathematical format of equations and inequalities. They would represent the quality, quantity, rail capacity, budget limits and any other factors that effect and limit the system.

The programme would initially determine the feasible region from these constraining equations. In this region, all possible solutions are feasible but not necessarily optimal. The objective function would then be used to determine the optimal solution for the particular situation, in this case the lowest possible cost distribution of raw materials.

7.1.3 Outputs

The output of this programme would be a list for each mill stating:

- The supplying silos
- The raw material, tons and grade they will supply
- This will be broken down into monthly figures

Thereafter, the total cost for the distribution will be calculated and presented along with the above.

7.1.4 Process

The process in Figure 9: Level 1 High Level Process, below, illustrates the procedure as it will be carried out by the user during solution of the planning problem.

The Level 1 has a database that contains data used as a foundation for the operation of the linear or integer programme. It is data such as the possible sources of raw material, the routes from the mills to the silos, cost of raw material as well as of transport on those routes, etc.

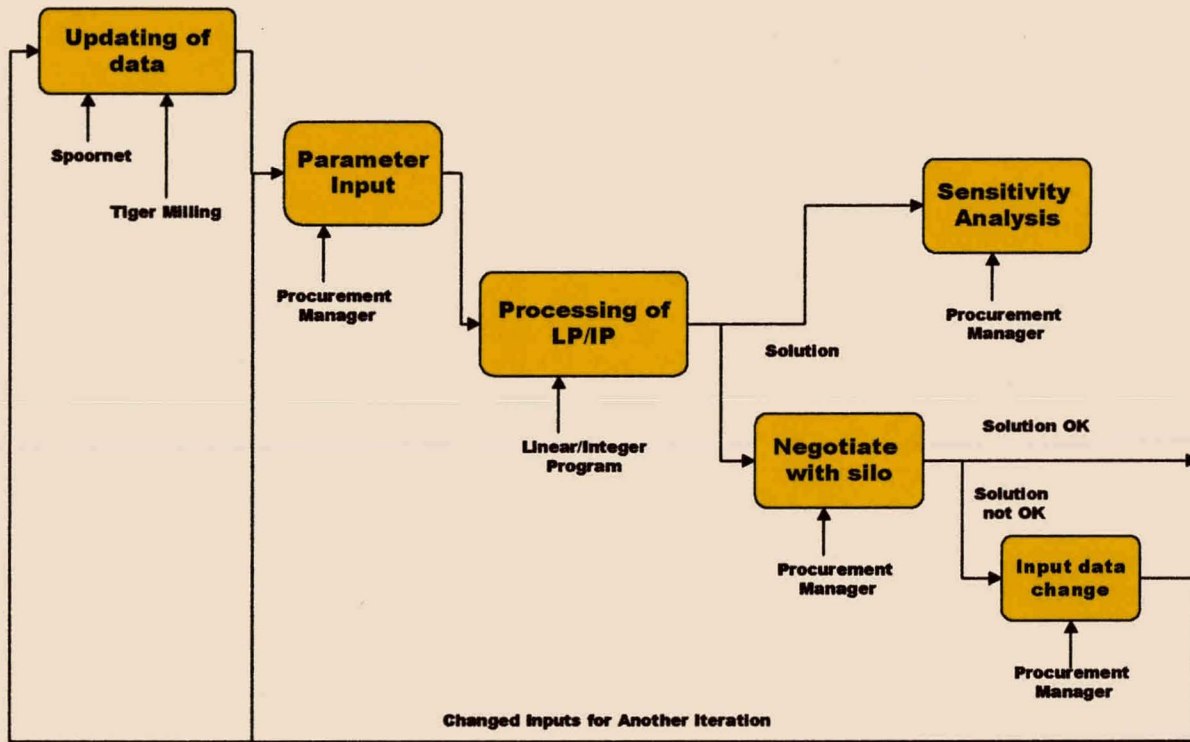


Figure 9: Level 1 High Level Process (Yearly to Monthly Basis)

This data will be updated by Spoornet and Tiger Milling personnel, each being responsible for their own particular data. Some of the data may even be entered by the silos, especially data concerned with the harvest forecasts and prices of raw materials.

Other data required by the process will be the parameters with which the programme will function for that particular distribution situation. This will be the demand of a mill for the next year, budget/financial limitation, sourcing limitation, etc. These will govern the functioning of the programme as it attempts to find a low cost solution.

After the programme is run, it produces a solution that is optimal under the circumstances discussed above. This solution will tell the user how many tons of each raw material should be sourced from silos for each mill per month for the next year.

The procurement manager will then go and negotiate with the silos to see if he/she can secure contracts as per the lowest cost plan. If this is possible and is carried out, the Level 1 plan will be made available to the lower levels for more detailed planning.

If it is not possible - harvests did not go according to plan, silos have already sold their products to the competitors, etc. - the procurement manager will have to change the inputs to the programme, update the database to reflect the changes and run the programme again. This will provide another lowest cost proposal. This procedure will be carried out until the proposed solution is possible.

7.2 DSS Level 2

The Level 2 considers the monthly allocations as calculated by Level 1. It decomposes them into weekly allocations for that particular month. It will have to consider any overflow from the previous week such as demand not satisfied, changes in harvest etc.

If any changes or re-planning cannot be handled at this level (weekly), they will have to be considered at Level 1 and fed back down to this level in terms of a changed Level 1 plan.

7.2.1 Inputs

The inputs at this level will be considerably more complex than Level 1 inputs. They will consist of:

- The Level 1 plan as per the output from Level 1.
- The situation/status at the start of the period. This would be obtained from the discrepancies between the previous Level 2 and 3 plans and reality.

- From the mills - the stock levels and production rate as well as inventory along the way. This information would be available from the mills themselves or a monitoring system.
- From the silos, their stock levels would be essential and would also be obtained from the silos or from the monitoring system.
- From Spoornet, capacity constraints would be essential (trucks, locomotives, train slots and shunts etc.)

7.2.2 Method

To solve this level, a type of simulation would have to be used. Preferably a deterministic method.

7.2.3 Outputs

While the Level 1 broke a year down into months, the Level 2 will break the months down into weeks. It will calculate the weekly tons from silos to the mills.

7.2.4 Process

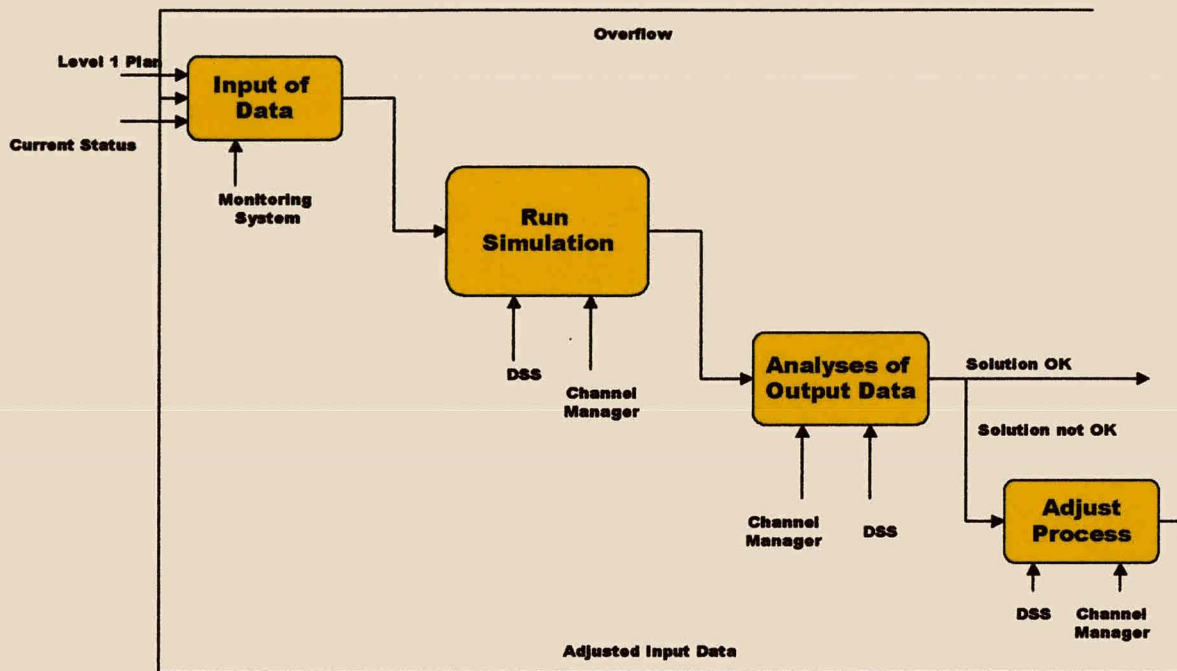


Figure 10: Level 2 Process (Monthly to Weekly Basis)

In Figure 10: Level 2 Process, above, a simulation will be used. It has some foundation data that will be resident in the simulation model database and will not change at all or not often.

Input is necessary to initialise the simulation run. This input will consist of the plan produced in Level 1 as well as any overflow that occurred in the previous months if the events did not run according to plan i.e. not all that was supposed to be delivered to the mills was delivered.

Further inputs needed for the simulation may be typed in by the user or fed in by GLS. These are factors such as mill production rate, mill and silo stock levels, and inventory on the way.

After this the simulation will be run and the outputs obtained. These could be results such as flow of inventory, stock outs and blockages. The user, with the assistance of the DSS will analyse the data and decide whether the proposed plan is satisfactory or not.

If it is not satisfactory, the user and the DSS will have to adjust some of the parameters of the process that will enable the plan to be optimised further. This is an iterative loop and will carry on until the user is satisfied with the performance of the plan under the simulated circumstances.

7.3 DSS Level 3

This level is the most detailed of all the levels. It will take the weekly Level 2 plan and decompose it to daily operational details. Again, any overflow from the previous week must be considered. If it cannot be contained within the weekly planning horizon/s, it will be fed up to the higher levels where re-planning will take place. The reworked plan will be fed back to this level.

The goal is to attempt to contain any disruption or discrepancies to within the shortest planning horizons so as to limit the ripple effect. Sometimes this will be impossible and the re-planning will have to take place at the higher levels.

7.3.1 Inputs

The inputs at this level are similar to those in Level 2 but more detailed in terms of low level operational data. The inputs would be:

- Level 2 plan of tons from silo to mill per week
- Mill constraints - suitable off loading times, working hours, maintenance windows, off loading rate, siding size etc.
- Silo constraints. These are very similar to the data from the mills.
- Spoornet constraints such as shunts, train and train slots/schedules, wagons, crew, travel time and route.

- The monitoring system - information as to the current status of the service will be received. This will initiate re-planning due to operational discrepancies that occurred in the previous week or may occur anytime during the week for which the plan was produced.

7.3.2 Method

For this level, the same deterministic method as used in Level 2 should be used. The Channel Manager will utilise this programme to find the optimal plan and analyse the outputs.

7.3.3 Outputs

The Level 3 produces daily operational details of what should happen on the ground. Three plans or schedules will be produced - for the silos, the mills and Spoornet operations. The plans will tell the mill:

- The trains arriving each day
- How many wagons, what commodities and tons
- When they arrive
- When the pick up train for empty wagons will arrive.

The plan for the silo will be very similar. For Spoornet, it will specify details of train slots, shunts, reservations and all the necessary service details that must be specified for the service to operate.

7.3.4 Process

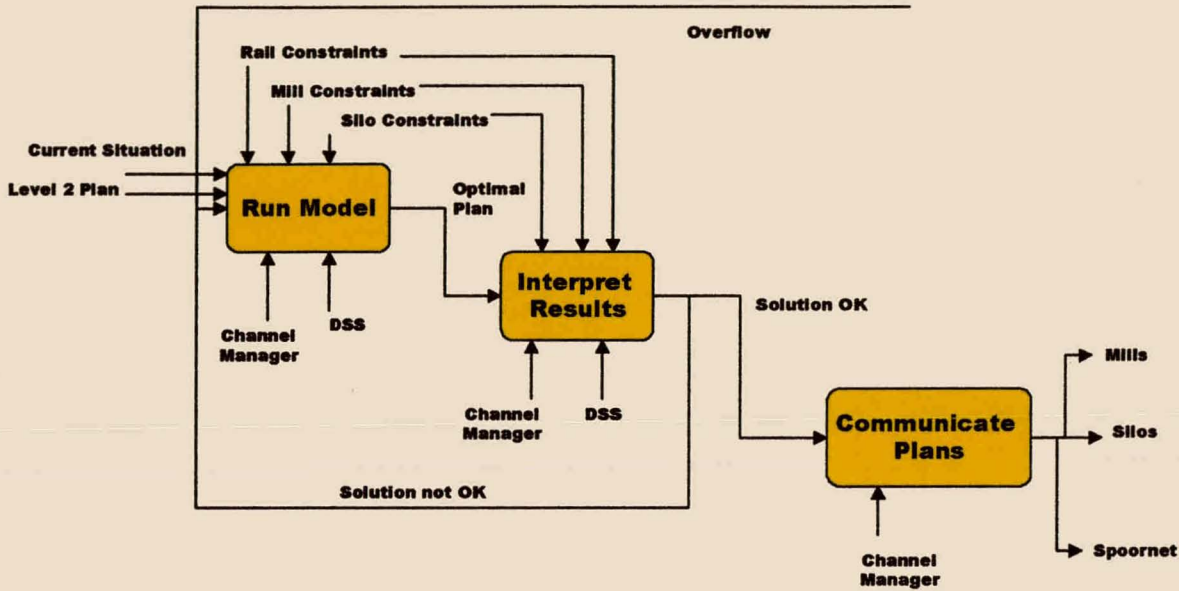


Figure 11: Level 3 Process (Weekly to Daily)

This process in Figure 11: Level 3 Process, above, is similar to that of Level 2 but is more complex. The plan from Level 2 will be one of the inputs as will be any discrepancies and overflow occurring in the previous week. Together with other inputs such as the train schedule and constraints of rail, mills and the silos, the user and the DSS will select trains that the Channel Manager thinks will be able to provide the necessary service during the next week.

These results will outline what trains will be used, when they will arrive at the mills, silos or stations and how much inventory in terms of orders will be moved.

If it is not satisfactory and changes need to be made, the Channel Manager will rerun the plan and analyse the results.

These optimal plans will be communicated to the various role players or service providers.

8 SEARCHING FOR A DSS

After the high level specifications were developed, a search began for suitable software that would perform the job. The specifications were used as a benchmark to measure the software capabilities against.

The search for packages was done on the Internet and with the help of the Gartner Group^[9]. Numerous sites of software developers were accessed. Sites like:

- Red Pepper Software
- SAP (reference 22)
- Baan (reference 23)
- I2 (reference 11)
- Numetrix (reference 16)
- Manugistics (reference 13)
- G2 (reference 5)
- CAPS (reference 18)
- People Soft (reference 24)
- ILOG (reference 12)
- Etc.

These are some of the many companies that are involved in the manufacturing and supply chain simulation, decision support and optimisation market.

However, only limited information can be gained from the Internet. The majority of the sites are used as marketing tools and often promise functionality and software capability beyond its actual capability.

Further information and evaluations were carried out by teleconferencing with the software vendors as well as communication and conferences with independent technology consultants such as the Gartner Group.

To make distinction between the software for Spoornet's use and software that is not suitable, more detailed information about the basic assumptions made in developing the software, the constraints taken into account as well as the data types and complexities is needed. The type of information that is available is illustrated in Appendix A.

Of the software and companies that were initially investigated, many were basic Enterprise Resource Planning (ERP) packages that have been designed to perform enterprise functions such as payroll, general ledger and inventory control. Their scope is, however, only within the particular organisation ^[10]. One of the specifications was that the tools should span several organisations and that the tool is a supply chain wide tool.

These software packages do claim to have supply chain capabilities, purchasing, sale and distribution. These are very basic functions that do not satisfy most of the technical specifications required of these tools ^[8].

The core problem with the ERP packages is that they assume a "best practice process" or methodology that they have built into them. They claim to have all the solutions for the enterprise. The truth is that they impose their methodology and processes onto the client organisation i.e. adapt the company and processes to suit the tool ^[8].

The companies also claim that their particular ERP package can be used in any industry or market.

This poses several problems:

- By adapting the problem to the tool, the problem is not solved at all, at most partially. If the core assumptions and methodologies do not fit the organisation or the market, the tool is not suitable. It will cause the organisation to die.

- The tool is too generic to be used in many industries. The only way it can perform the functions are for them to be basic and not very detailed. What is needed is a highly customisable tool that either involves a fair amount of work to customise or is only applicable to a few industries.

- The fact that they are so easily customisable to all industries, tells us that they do not perform many functions that are specific and detailed to a specific industry.

Therefore, for functions such as financials, human resources etc., the ERP is very suitable. These are relatively straightforward procedures that are very similar in most organisations [10].

For more complex processes and requirements such as distribution planning, logistics and various optimisations functions they are not suitable [36].

The Figure 12: Supply Chain Planning Market Quadrant, below, illustrates the hierarchy with which software as well as its functionality could exist to effectively manage a supply chain.

This quadrant was produced by the Gartner Group [37] in 1997. The capability of some of the vendors may have changed since then. However, at the time when the choice of the most suitable choice for a tool was made this was the situation of the leading edge supply chain applications.

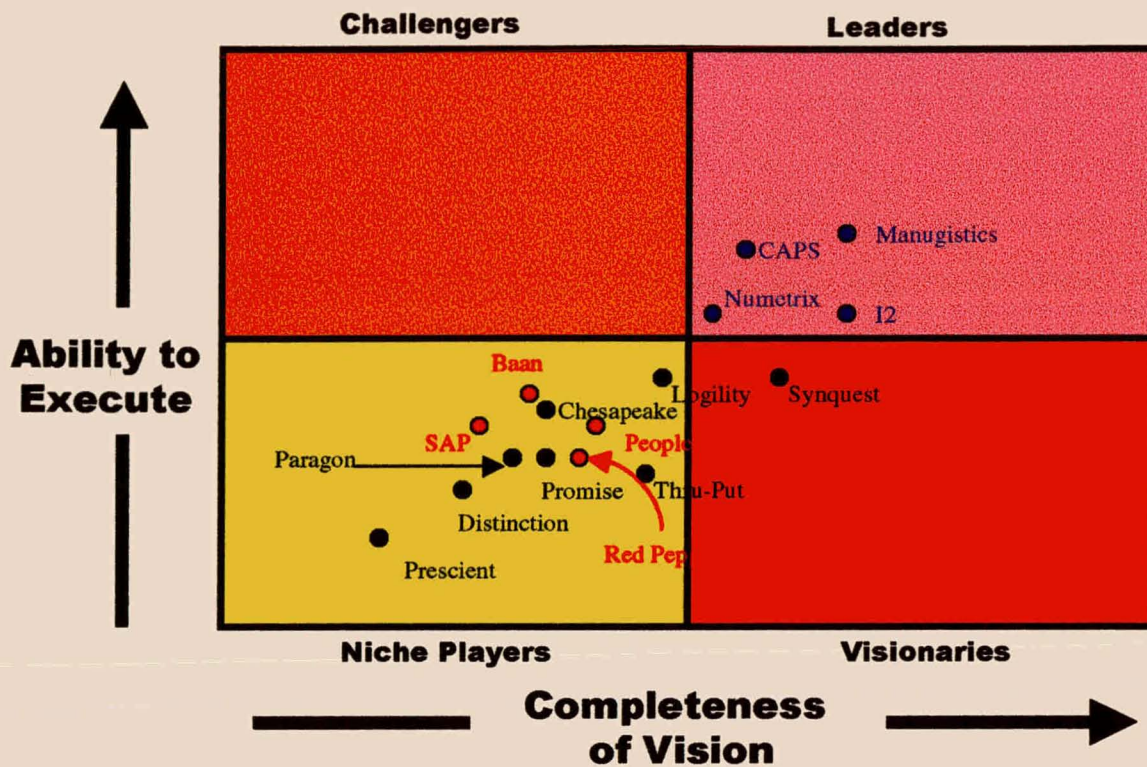


Figure 12: Supply Chain Planning Market Quadrant ^[9]

The ERP software that was considered in this evaluation is written in red. The more supply chain specific software as will be discussed later in the chapter is in blue. The four quadrants that are shown represent the abilities of the various role players.

It can be said that ^[9]:

- The Leaders: Manugistics, CAPS, Numetrix and I2 have broken from the pack and appear in the leader quadrant. The rules for the market leadership include:
 1. Highly effective sales channel
 2. A well-executed capitalisation strategy
 3. A proven ability to obtain and retain people with domain expertise in solving complex supply chain problems
 4. A large, loyal and growing customer base
 5. Strong systems integrator relationships

6. A highly believable vision for a concurrent supply chain planning (SCP) suite with both breadth and depth of functionality.

To maintain their leadership position, these vendors must continue executing their functional and business plans to meet rising customer expectations and prove that they can maintain growth as the ERP enters the market space.

- Bottom Line: Only a few vendors have been able to differentiate themselves from the SCP pack in their vision or ability to execute. The majority of vendors are clustered in the niche quadrant, among them SAP, Baan, People Soft and Red Pepper.

It can be seen that ERP software has a place in the market but by no means does it fulfil the supply chain needs. Considerably more functionality is required from them.

This disqualifies the following from the race:

- SAP
- Baan
- Red Pepper
- People Soft

Bearing in mind what was said about the customisation need, it is also essential that the tool does not require too much customisation and programming. A Channel Manager must use the tool, not a computer programmer.

A further specification was reaction time, running time of the scenarios etc. This requirement does away with tools like G2. G2 requires extensive customisation each time a new service or a new model is built.

This leaves software such as:

- I2
- Manugistics
- Numetrix
- CAPS

These four can be considered as true supply chain management (SCM) software products ^[36].

Brief literature that discusses the capability of each can be found in Appendix B.

Information for these tools was obtained not only from the sales brochures that are available on the Internet. Extensive telephone conferences and mail communication was carried out between the vendors of the software and the project team involved in the tool selection.

The author set up questionnaires. These ensured that all aspects of supply chain planning applicable to Spoornet were addressed. The questions and examples in the questionnaires provided the bulk of the discussion material during the telephone conferences.

The conferences were minuted and the replies from the various vendors compared to each other.

Gartner Group was often consulted to obtain an objective view and critique concerning the application and superiority on the tools in various functional areas. The questionnaire composed for the conferences was also used as a base for queries for the Gartner Group.

The following sections are summaries of all the gathered and communicated information. This data was available in an unstructured and unsorted manner. This summary aims to place it into perspective and user friendly format.

8.1 I2

This software is available from Intertrans Logistics Solutions. It comes in several modules ranging from the supply chain strategies to Global Logistics System (GLS) that actually monitors the operations on the ground ^[21].

On the highest level it will analyse the network that is to be used in the supply chain. The loading of facilities and transport routes etc. can be analysed and the optimal settings can be calculated.

The other modules such as Trans Modeller, Optimiser, Manager etc. look at the transport function on a tactical as well as operational level. They take into account amongst others pooling of transport, multi-stop and less than truckload (LTL).

The GLM function monitors the schedules that are produced by the transport modules. Deviations from the plan can be observed and catered for. This GLM has been purchased by Spoornet but before GLM became part of I2 software.

Figure 13: Representation of the Hierarchy of I2 Suite of Supply Chain Applications, below, illustrates where the various I2 modules fit in and the planning time window each is involved in. It also represents I2's vision of what is required to effectively and efficiently plan a multi-organisational supply chain ^[11].

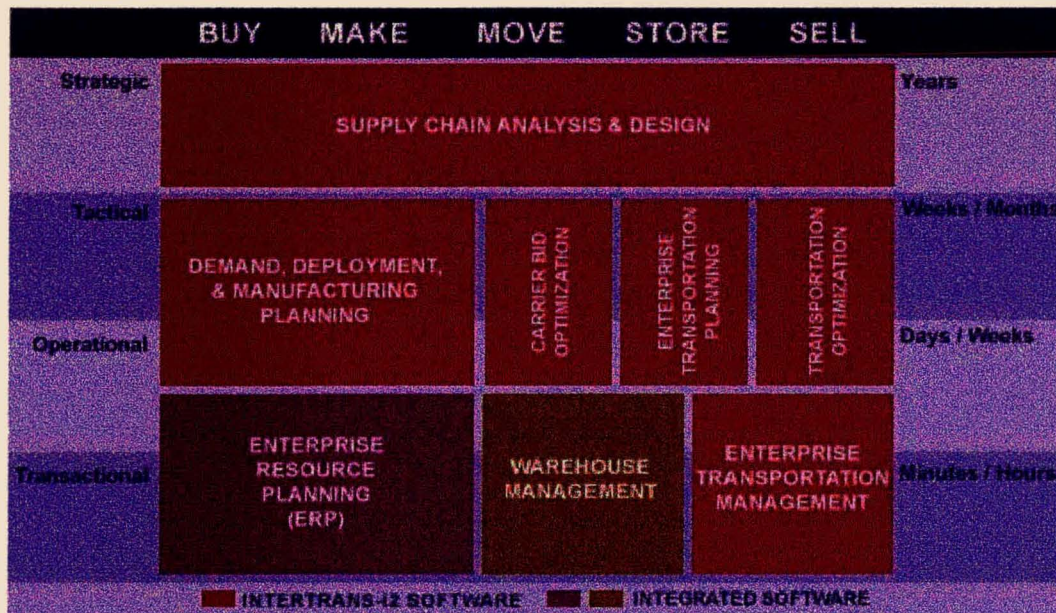


Figure 13: Representation of the Hierarchy of I2 Suite of Supply Chain Applications ^[11]

The software is windows-based and user friendly. It is currently also integrated with the SAP software suite. This was not the case when the software was analysed.

It is capable of data links to many databases such as Access, Oracle and Sybase. Its use of SQL (Sequel) and ODBC (Open Data Base Connectivity) enables it to relatively easily connect with other software.

I2's core principles and algorithms seem to be very sound. The CPLEX suite of linear and integer programming tools from ILOG is used. CPLEX is considered to be one of the most stable and accurate suites of optimisation components available. This will ensure that the decisions that are made will be accurate and reliable. For details on ILOG and CPLEX (reference 12) see Appendix C.

8.2 Manugistics

This software is available from Manugistics in the USA. It is available in several modules, each of which performs a different function in the supply chain. The overview of the thinking behind Manugistics and where its modules fit in is depicted in Figure 14: Representation of Manugistics Set of Modular Applications, below.

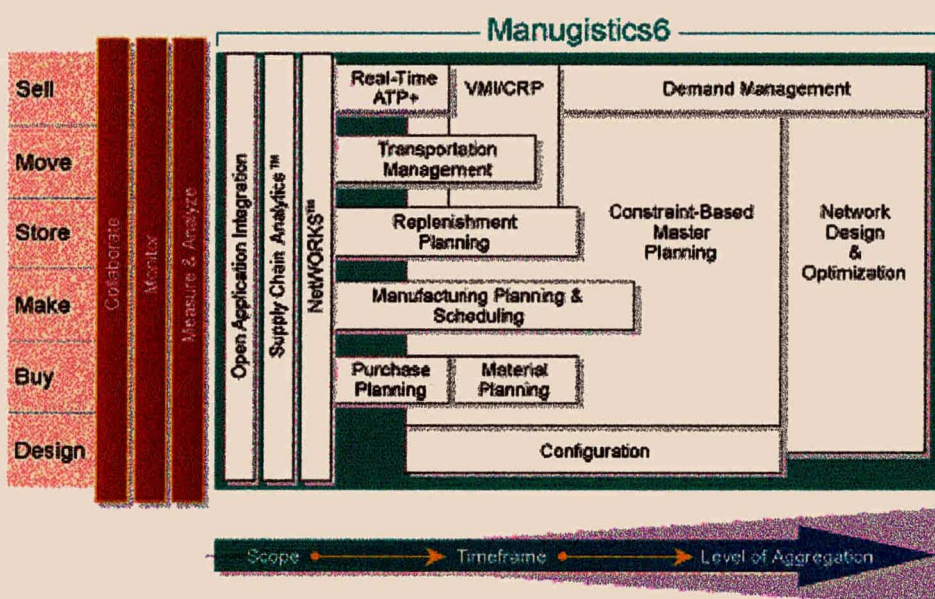


Figure 14: Representation of Manugistics Set of Modular Applications ^[13]

More detailed literature on the application of Manugistics is available in Appendix B.

Its principles do lie along the lines of ILOG, from Network Design and Optimisation that assesses the network configuration on the highest level to Monitoring on the lowest level ^[14]. This monitoring is similar to that of GLM in I2.

The other modules address the various areas within the supply chain - manufacturing, transportation, materials planning etc.

While the general way of thinking is similar to I2 and is along the lines outlined by the high level specifications, this software places considerably more emphasis on manufacturing than transport and distribution. Since Spoornet is a transport company, it would wish the emphasis of its supply chain software to be on transport-related areas.

This application is also windows-based and therefore it will have the connectivity benefits and integration benefits discussed with I2.

Currently it is not coupled to an ERP system. This, however, is not a major issue.

Manugistics seems to be more suited to the manufacturing industry to be used by a manufacturer to address its supply chain issues. Even its list of current users and clients indicates this. They include ^[13]:

- Lockheed
- Firestone
- Gillette

8.3 Numetrix

This supply chain software is called Numetrix/3. It consists of modules such as Enterprise Planning, Production Scheduling, Distribution Planning and Deployment Scheduling. There are also such levels as strategic and tactical that configure the network to the demands of the specific situation.

The general structure is similar to I2 and Manugistics, but even though it has transport functionality, it is very production/manufacturing orientated.

This tool itself had originated in the manufacturing environment with MRP (Material Requirement Planning) and DRP (Demand Requirement Planning) being its core principles ^[17].

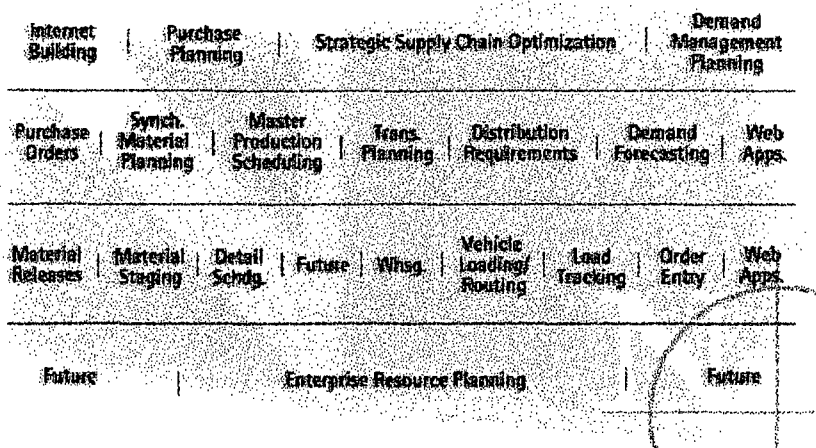


Figure 15: Representation of Numetrix Suite of Applications [16]

Figure 15: Representation of Numetrix Suite of Applications, above, illustrates the modules that are available from Numetrix.

The strategic and tactical levels as well as the transport aspects are not given the same attention as production. This is what Spornet needs to focus on. Due to its background in MRP and DRP, its use of mathematical algorithms is not as advanced as the other solutions. More detailed literature on this topic is available in Appendix B.

The software does have an entire integrating module that helps it to integrate with other software packages and components [16].

The userfriendliness and GUI (Graphical User Interface) is not on the same level as I2, Manugistics or CAPS.

8.4 CAPS

This software is used for logistical planning and scheduling. Its prime function is in optimisation of transportation planning, routing and scheduling. This is the area of focus for Spoornet.

It is available in modules such as Supply Chain Designer, Co-ordinator and Route Designer and Dispatcher. A more detailed description of the modules is available in Appendix B.

On the highest level the network is configured in terms of site location, routes and possible transport modes etc. On the tactical level, pooling of carriers can take place, selection of carriers as well as inbound sourcing etc. On the operational level, trucks can be routed to serve specific clients during runs from specific distribution centres etc.

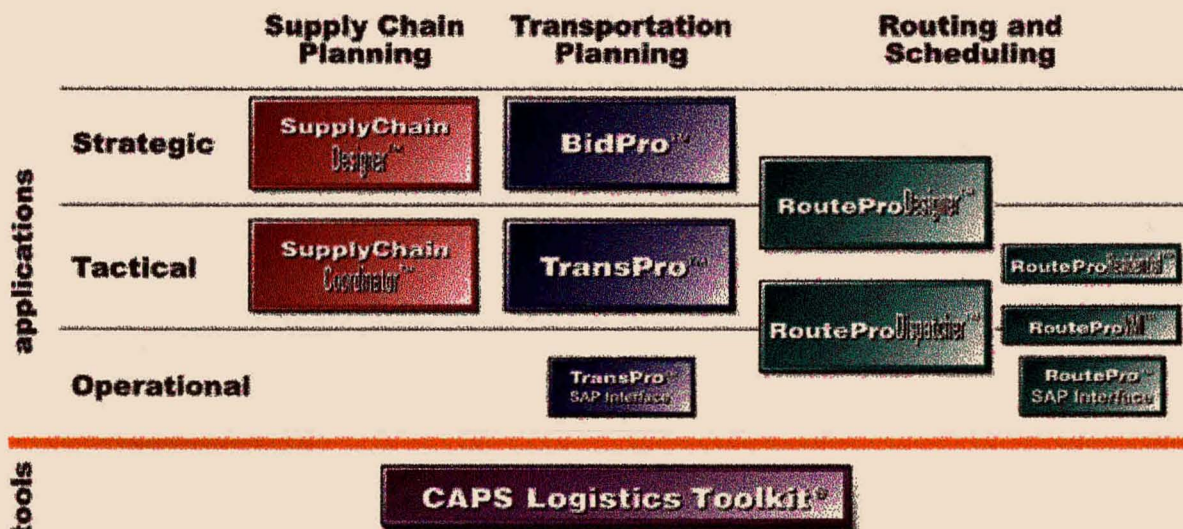


Figure 16: CAPS Suite of Modules and Supply Chain Planning Applications ^[18]

Figure 16: CAPS Suite of Modules and Supply Chain Planning Applications, above, illustrates the design and planning sectors and time windows that are covered by the CAPS toolkit. The major modules and applications of interest for the specifications outlined by Spoornet are the SC Designer and Co-ordinator, TransPro and the RoutePro Designer and Dispatcher.

CAPS maintains a global view of the supply chain while focusing on transport and distribution, inbound as well as outbound. It does not ignore the production and warehousing functions. Just as other tools discussed focus on production, CAPS focuses on transportation with manufacturing playing a minor role.

It is ideal for a third party logistical company or a transport company where a manufacturer is just a service provider. This is the role that Spoornet plays.

Currently, alliances have been made with SAP and People Soft and CAPS to integrate the CAPS platforms to these software tools. This capability makes the tool more powerful and increases its impact on the supply chain ^[18].

The tool itself has an excellent GUI that will display the location of the sites as well as the routes. For its optimisation capability, it uses the CPLEX optimisation suite. This is a very stable and accurate suite of operations research components.

CAPS also utilises GIS (Geographic Information System) technology in its calculations, displays and decision support. This means that distances and geographic locations used are totally precise.

Large portions of its client list indicate its suitability to a transport logistics environment.

Some of the clients are ^[18]:

- Calibre Logistics
- Roadway Express
- Logistics Consulting Group
- Andersen Consulting

9 CHOICE OF A DSS

From the four supply chain management tools, CAPS was chosen, for the following reasons:

- **Ease of Use:** While many of the tools were easy to use, CAPS features the most visualisation and had the best interactive graphics with colour maps allowing for editing via drag and drop.
- **Flexibility:** CAPS is not a rigid tool. It allows form objects, tools and macros to be used to customise any part of its appearance or functionality.
- **Optimisation Technology:** It uses CPLEX technology. CAPS won an optimisation competition held by Calibre Logistics.
- **Multi Stop Routing & Scheduler Tools:** This is a very detailed and comprehensive module. The other vendors are very shallow in this area. Schneider Logistics recently held a shootout in this area. CAPS won [19].
- **Strategy and Analysis:** Schneider, Excel and Calibre all recommend CAPS in terms of the use of these modules above all the other vendors.

These are just some of the points that make CAPS preferable to Spoornet. It is perhaps not the best known software but for Spoornet it is the most suitable and will directly address the problems that are faced by Spoornet.

The other vendors focus on other areas of the industry and while their software would also address many of the areas that Spoornet is interested in, their solution is not as deeply analysed and optimised as is done by CAPS.

Another factor is the price of the software. CAPS was cheaper than many of its better known competitors.

Hardware requirements did not play any role, as all the software packages were relatively similar.

Integration was also not an issue. Many tools have alliances with ERP vendors. In this area, CAPS was also better than many of its competitors.

CAPS does not have a monitoring function. However, Spoornet had already purchased GLM and was in the process of utilising it. It was, therefore, not necessary for CAPS to have this module for the Spoornet environment. Interfacing between CAPS and GLM would have to be done, but it is not a major barrier. Both tools use ODBC and SQL and interfacing can be done in a relatively straightforward manner by these means.

10 CAPS

10.1 How It Works

10.1.1 Caps Toolkit And Platforms

The CAPS Toolkit is composed of three basic platforms. The platforms each has a different application and can work independently. They are as follows:

- Supply Chain Modelling (SCM)
- Shipment Planning (SP)
- Route Planning (RP)

Table 4 : Overview of CAPS Platforms and Functions ^[25]

	<i>supply chain planning</i>	<i>transportation planning</i>	<i>shipment planning</i>	<i>vehicle routing</i>
<i>strategic</i>	site location capacity sizing sourcing	site location fleet sizing	outsourcing bid analysis fleet sizing	fleet sizing
<i>tactical</i>	production planning sourcing	routing strategy network alignment	consolidation strategy mode strategy	routing strategy zone alignment
<i>operational</i>		load matching	shipment dispatching	vehicle dispatching

The table above, Table 4 : Overview of CAPS Platforms and Functions, provides an overview of the various levels and what their capabilities are. These capabilities govern what type of data and detail will be required at each level. The shipment and transportation planning is discussed together in this document as Shipment Planning.

In the following section a description follows of each level in detail. Thereafter, an explanation follows of how these three levels can work together and complement each other in the provision of a logistical solution.

The CAPS Toolkit analyses the routes, lanes and flows between facilities at each level of detail ^[26].

The warehouses, factories, silos, mills etc. that are connected by these flows are not analysed internally. The values for their capacity, input/output rates, costs etc. are accepted as given during this tool's analysis. If these values cause major problems in the supply chain, it will be visible in the analysis of the results from this tool. This tool will, however, do nothing about it. To analyse and solve those problems a stochastic tool for intrafacility analysis should be used.

The CAPS Toolkit is suitable for the design and analysis of interfacility style operations.

10.1.1.1 Supply Chain Modelling

This planning takes place at the high strategic level of an open system. It designs what the supply chain will look like for the planned period of time. It attempts to match supply/demand in the best possible manner while minimising the total cost for the service.

The input data values that are used are averaged values, forecasted values or even good approximations. The supply chain is modelled in terms of suppliers, production sites, warehouses, customers and the routes connecting them; see Figure 4: Procurement of Grain Network

Because we are looking at the supply chain at a high level, all the above have averaged operating rates, capacities, costs and demands etc. For example a factory will produce five different items, each at a certain rate per day/week/month. It will operate at a certain fixed cost plus a cost per item produced.

A route will connect sites and will have a certain capacity and a throughput. It will have an approximate distance or time associated with the travel along the route. These can be used to determine the cost for the route ^[25].

A great variety of other cost models can be incorporated in the model, such as inventory costs.

An entire network for a client will be created with every possible sourcing, customer and production site option.

Customers have a demand that must be satisfied. The system is a pull system governed by customer requirements. Other criteria such as this can be set. These criteria will have to be satisfied in the model run. There are objectives that must be set-up that the model will try to reach during its run e.g. lowest cost.

The user can add or take away a warehouse, change routes or production sites. The model will run and find the most suitable combination. This level of planning will decide what the infrastructure of the supply chain will look like and roughly what the flows through it will be.

If irregularities such as high costs and/or unsatisfied customer demand occur, a post run analysis can be carried out to find reasons for them. The post run analysis can also take place to find the elasticity and sensitivity of the result/s.

Figure 34: Personnel supporting the immediate use of CAPS, above, illustrates the immediate employee roles that will support the design and use of CAPS.

If the project does not have the support of top management and high status, it will pale into insignificance and will not have the impact it can potentially have.

15.4 Role in the Supply Chain

All partners should know how they wish to use CAPS and what it can do for them, now and in the future. Much of this will depend on the role they have chosen to play in the supply chain and their role in the supply chain ^[14].

Part of the CAPS offering is to have the companies outsource part of their decision making ^[31] to CAPS and Spoornet. Many companies are willing to do this if there is trust and if they see the benefit in it for themselves.

Others may not want to do this. They may wish to keep control over the decision making process.

Figure 17: Supply Chain Modelling, below, illustrates a screen output of a Supply Chain Modelling run.

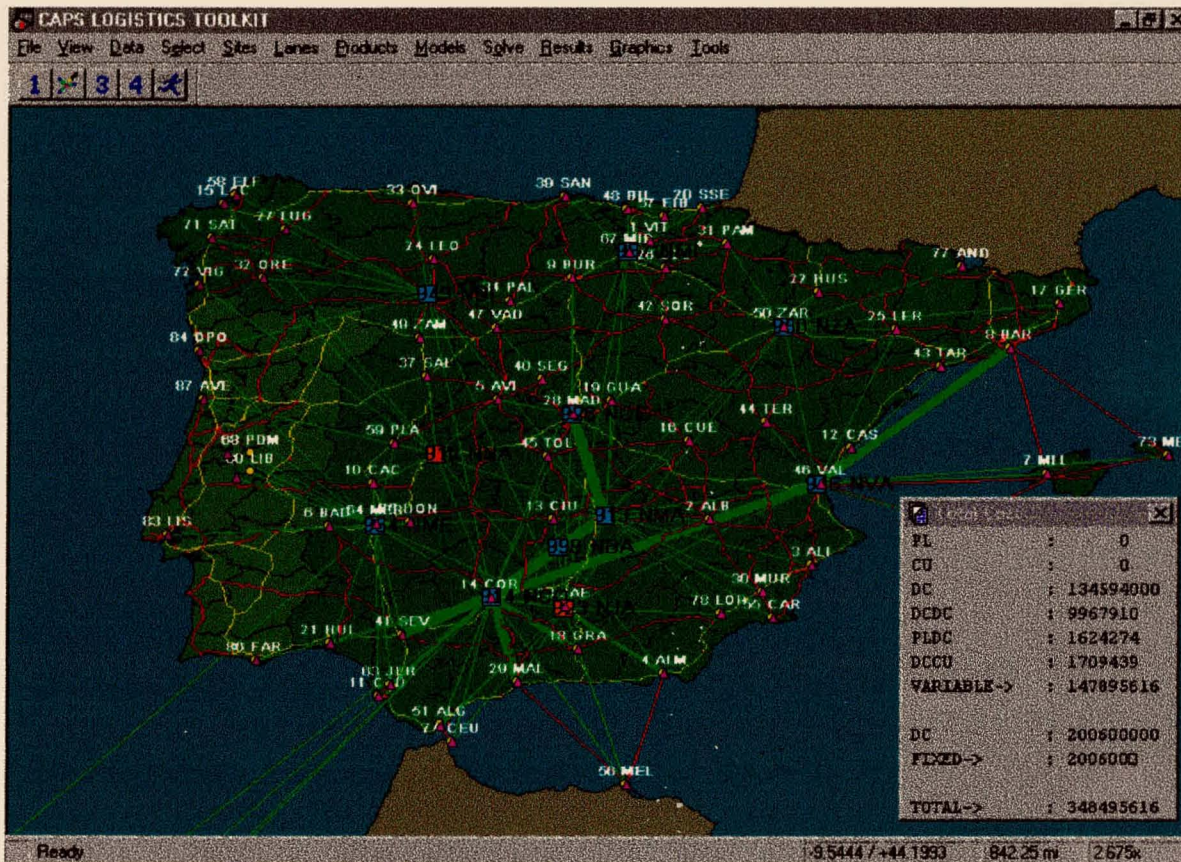


Figure 17: Supply Chain Modelling ^[18]

The red and yellow lines are all possible routes connecting customers, suppliers and warehouses. The green routes are the actual routes used. Their thickness indicates the quantity of flow through them. The blue boxes are suppliers, the circles are customers and the triangles are storage facilities. The dialogue box displays the individual and total costs for this particular solution.

10.1.1.2 Shipment Planning Platform

This level takes the solution from the Supply Chain Modelling and performs more detailed manipulation. The Supply Chain Modelling level will provide information such as - what plants will send what products to whom, what warehouse will serve what customers, along with the volumes that are handled.

The planning of the actual shipments will take place at this level. The cost structure will be more detailed to enable users to decide what mode of transport to use.

The quantities transported will be more detailed for each route for the calculation of number of trucks, wagons and trips that will be made.

Throughout the model more detail is required. More detail of how much will be produced and when, how much demand and when. More detailed indications of distances and other infrastructure data are necessary.

Vehicles will be given capacity as well as availability. This will enable the model to schedule operations in more detail.

Along with mode selection, shipment choices are offered. A shipment can be ^[25]:

- A consolidated shipment
- A direct shipment
- A multi-stop shipment

Each of these has different impacts on costs and customer service. They will be beneficial in some occasions but not in others.

In Shipment Planning time windows can be added for departures and deliveries. This will force trains and trucks to leave at specified times in order to satisfy the delivery requirements. This is a big jump in the detail of the model from the Supply Chain Platform. The time factor is introduced into the model at this level.

The results of using the model will provide the user with a more accurate look into how much and what type of transport (in terms of mode and shipment) should be used.

Figure 18: Shipment Planning, below, displays the various types of shipments from supplier to storage to customer in different colour. It is very obvious from this what customers are supplied with what type of shipment and from which storage facility.

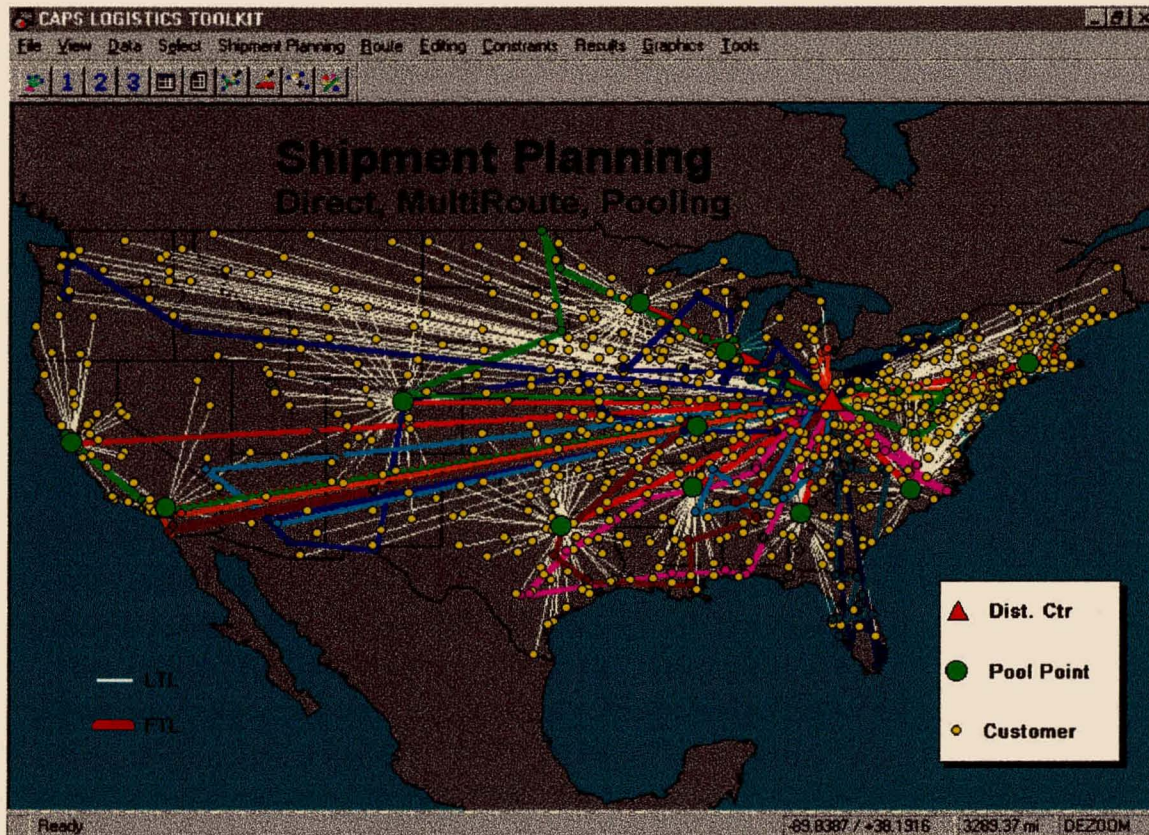


Figure 18: Shipment Planning ^[18]

10.1.1.3 Route Planning Platform

Route planning is an operational application where very detailed data is required. It uses the information from the two previous levels. More detailed data must be provided to this level.

Data such as:

- Exact distances
- Operating hours
- Off load and load times
- Carrying capacity of trucks and wagons

Specific deadlines, delivery/pickup dates and times are set and must be met. Detailed constraints such as driver working hours, traffic density and available train slots in the train plan can be incorporated.

The cost structures are more detailed. The costs of using every wagon, each activity etc. are needed. The inventory costs are also more detailed and complex. They will deal with individual items as opposed to general flow over routes.

The routing platform can be separated into two parts:

- The dispatch planning
- Longer term operational planning

Together they will look at factors such as:

1. **Customer base.** Establishing master customers whose routes and loads may be fixed for an extended period of time i.e. they do not have to be continuously scheduled and rescheduled. For this situation there are fixed loads and routes. Any extra demand above the fixed figures agreed on will be scheduled as required.
2. **The balancing of workloads over routes and vehicles to obtain even utilisation and capacity requirement.** This also attempts to smooth out peaks in demand.
3. **Empty leg delivery and pickup takes place.** This is the utilisation of the empty leg of the trip. If a truck or a train delivers something, an attempt is made to provide work for it such as picking up of something for the return leg to the source.
4. **Matches the correct wagons/trucks to the cargo requirement.** It determines the number of vehicles required over the client base.

5. Availability of wagons/trucks, weight and capacity restrictions are considered. The exact vehicle route, the stop *en route* and loading and off-loading are calculated.
6. Again time windows for order pickup/delivery are defined and have to be obeyed.
7. Time windows for trucks/trains are identified to serve as an indication for train slots.
8. Choosing the best route to take from a set of choices for a particular shipment or delivery or for a group of shipments. Several criteria can be considered e.g. traffic density and blockages at certain times of day, road conditions, time and distance to travel.

The model, after a successful run, will yield a solution in terms of:

- The exact route to be taken by the transporter
- What customers are visited and when
- Exact quantities delivered
- Minimising empty run of trucks/wagons
- What train slots are used and number of trains
- How long the trains are
- Cost of the total solution, cost of each trip, cost of each facility in the supply chain etc.
- Meeting time windows for pickup/delivery and vehicles

Figure 19: Route Planning and Dispatching, below, is an output of the routing platform. The actual route taken by each vehicle from the storage area to the customer/s is show, as are the stops along the way, the direction of travel and the utilisation of the empty leg of the trip.

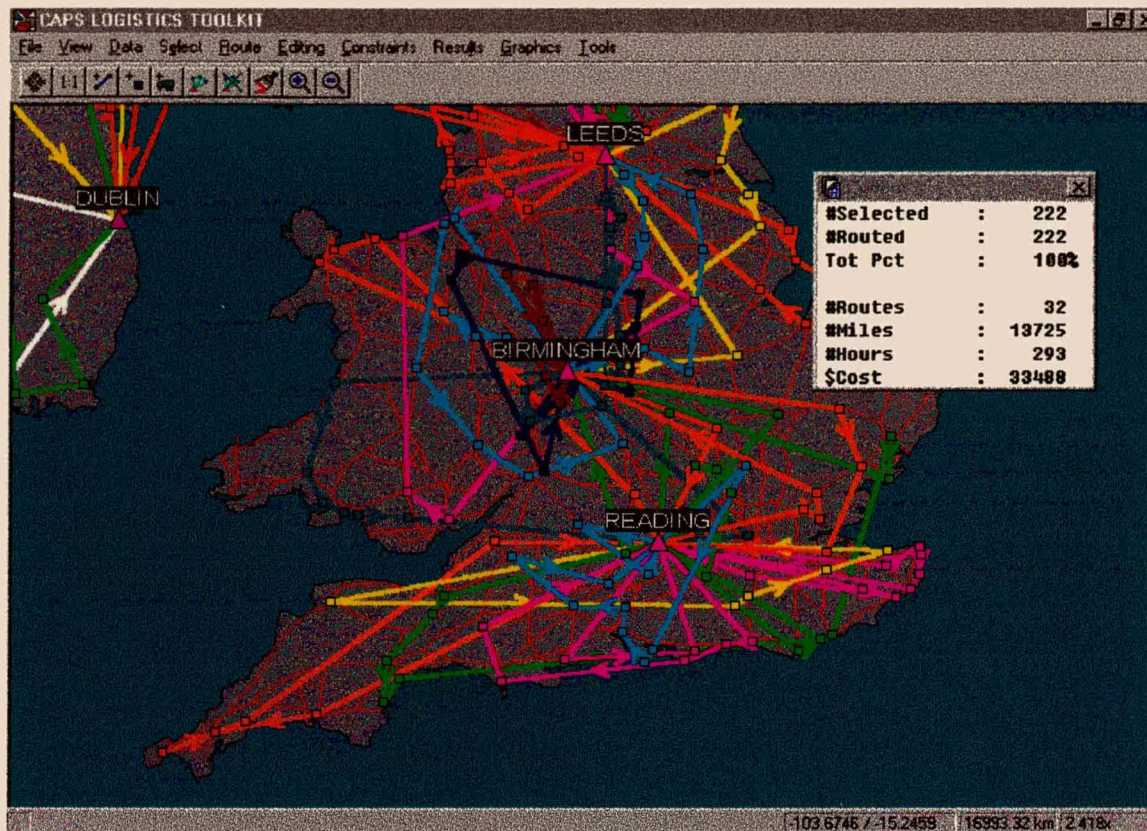


Figure 19: Route Planning and Dispatching ^[18]

10.1.1.4 Interaction Between CAPS Platforms

The CAPS toolkit can be used both in a top-down manner as well as in a bottom-up approach. Initially, one should produce a supply chain, thereafter shipments can be planned and then routed in detail to provide a work plan which should be adhered to as far as possible when operations take place.

However, unforeseen events and incidents can and do occur. This will create a need for re-planning to be done. If the supply chain is monitored efficiently and effectively, CAPS can be used to re-plan. This feedback process is illustrated in Figure 20: Interaction between CAPS Platforms.

The first level of re-planning will be the lowest CAPS level, the routing. If any changes must be made, the user will try and cater for them in this level of planning i.e. change routes, train lengths, departure/delivery times etc.

However, if this is not possible he will go up one level and cater for the changes in shipment planning. Here he can alter modes of transport, shipment types as well as time frames.

If the changes still cannot be contained here he will have to go to supply chain modelling and re-plan on a strategic level to cater for the changes but still satisfying the customer at the lowest cost.

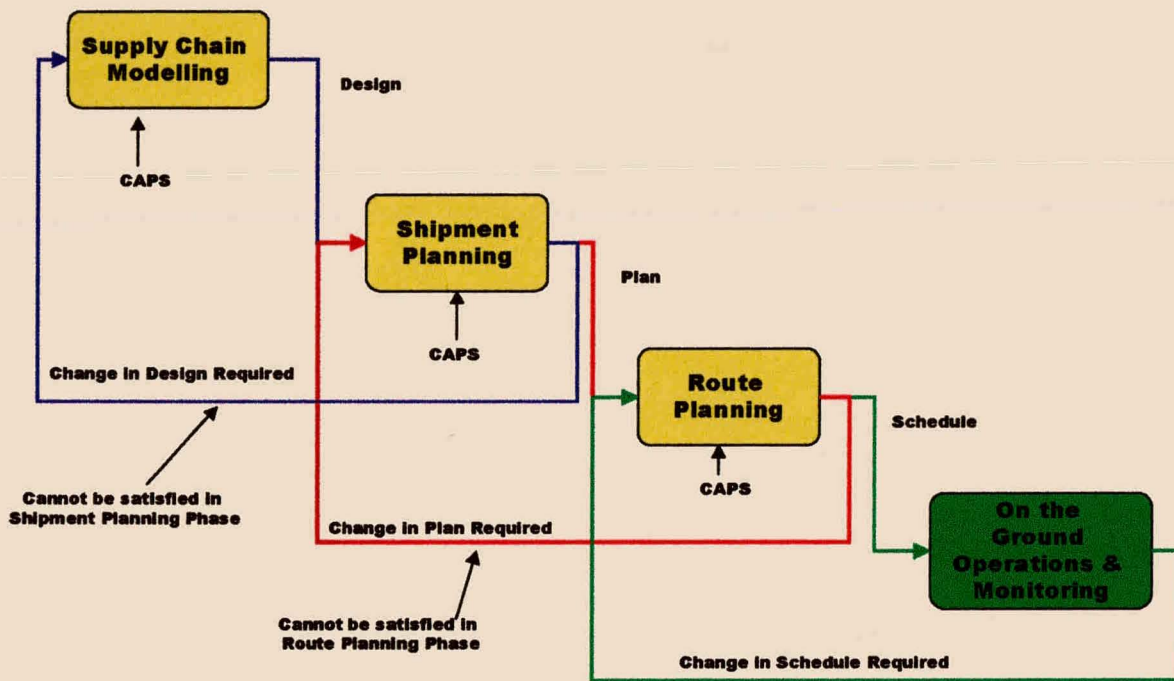


Figure 20: Interaction between CAPS Platforms

10.1.2 Areas of design in which the CAPS Toolkit features

The Toolkit provides an optimal business solution in a problem with numerous choices, possibilities and trade-off. The Toolkit is a Decision Support System with application in the field of Inter Facility Supply Chain design and analysis. The Toolkit can be used for a number of Supply Chain design applications in which some decision must be taken whether the decisions are of a strategic, tactical or an operational nature. Therefore a number of conditions must feature:

- There must be a transportation network. It is not applicable if commodities are only transported from one part of the country to another, as depicted in the top half of Figure 2.
- There must be choices in the transportation network. What route, at what cost using different modes of transport etc.
- There must be decisions to be made between potential trade-offs. For example close the warehouse and transport directly with smaller lot sizes more regularly etc. because the client is prepared to pay more for a pull system instead of a push system.

What the Toolkit is not:

- The Toolkit should not be used to improve services to clients with none of the above conditions in the system. The Toolkit is not an operations improvement application. It is rather a marketing tool that allows conversations with clients beyond the topic of price.
- The Toolkit is not a simulation product. It will not give a "What if" answer to capacity throughput problems. It will not determine bottle necks in the system
- The Toolkit is a finite capacity scheduling product. It will schedule a particular consignment to be at a certain warehouse, at a certain time. The capacity will be available for the particular consignment.

- **The Toolkit is not a monitoring system such as GLM.**

10.2 CAPS Capabilities

10.2.1 The capabilities CAPS can give to Spoornet

Currently most of Spoornet's business is generated on the inbound logistics side of a client. The majority of the material transported by Spoornet is raw or non-manufactured commodities. Spoornet is fairly successful in providing inbound logistics largely due to the considerable re-engineering efforts.

However, in very few instances is Spoornet involved in the outbound part of the supply chain. In order to achieve the vision of achieving Freight Logistic Solutions, Spoornet will have to reposition itself to provide services in outbound distribution.

Below is a diagram, Figure 21: Example of Distribution Patterns, of a typical distribution network of a Spoornet client.

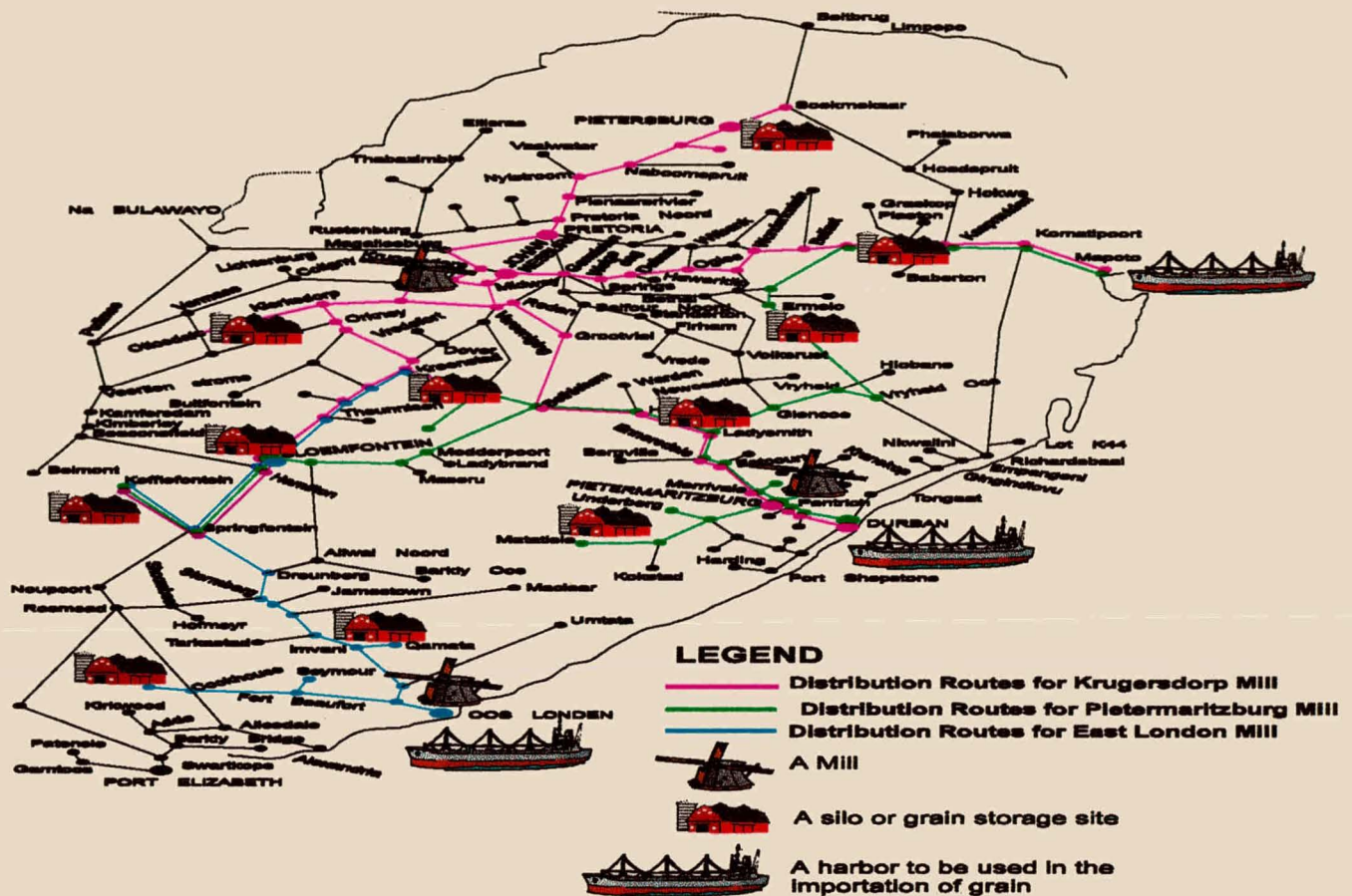


Figure 21: Example of Distribution Patterns

The major rail links are shown. From the map it is important to note the number of choices to route a train. The client also receives stock by means of road deliveries. The road network is not shown on the map. There are more road links than rail links and therefore the complexity more than doubles with the addition of road links.

In addition this picture only portrays the inbound logistics of the client. The outbound part is much more complex. Outbound logistics tend to handle smaller sized units with more time sensitive schedules that have to be adhered to.

Providing services for both in and outbound logistics is more complex than Spoornet is accustomed to handling. Both the complexity and effectiveness of the service needed by the client is much higher. Just to be able to enter this market it is imperative to gear up to be able to design the required service as for a product.

The CAPS Logistics Toolkit and Platforms will provide the organisation with the ability to design the distribution patterns of a client's supply chain. Both the inbound and outbound distribution patterns can be designed using this technology.

The biggest benefit will be derived from the outbound side. The technology can, however, be used to add value to inbound logistics as well.

While the capabilities of the technology could provided Spoornet with the ability to expand its services and therefore develop new products it also carries implications that should be understood.

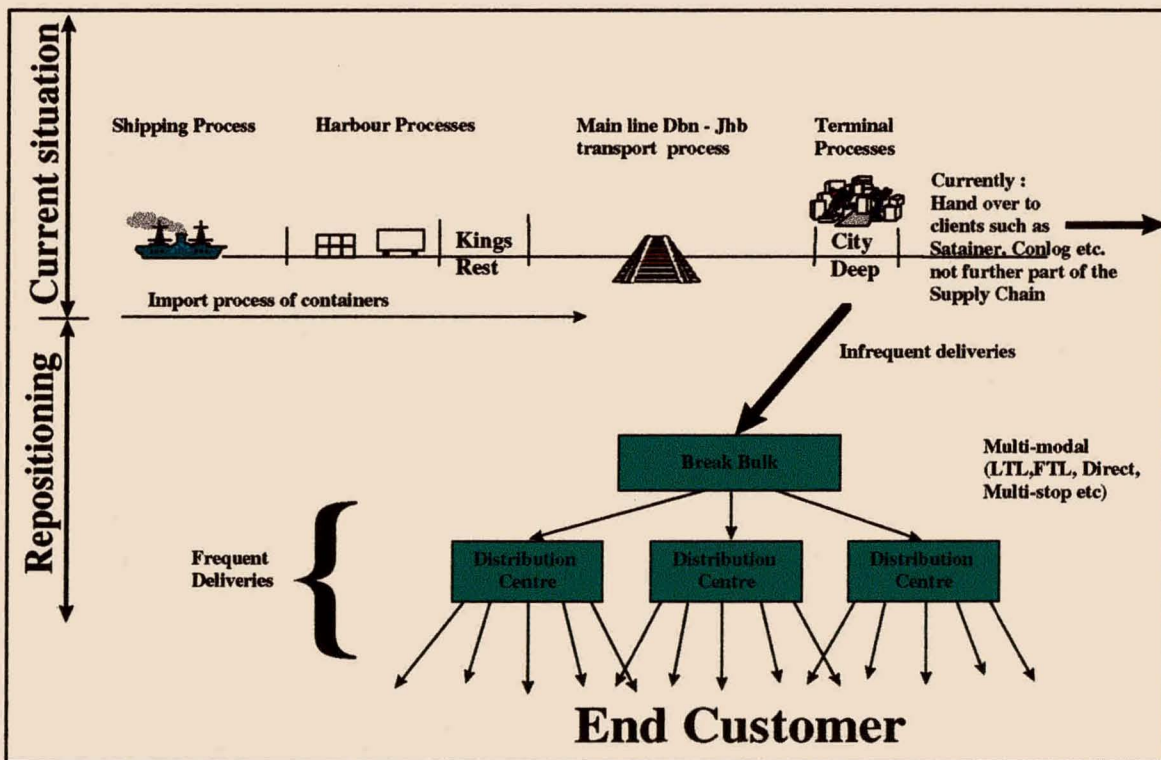


Figure 22: Positioning

As depicted above in Figure 22: Positioning, the repositioning due to Spoornet's entering the market can cause negative reactions in the market. In this example, the container service

between Durban and Johannesburg, the repositioning part of the drawing will cause severe reaction.

If Spoornet were to enter the market to distribute containers and the contents of the containers to the end clients, Spoornet would have to compete with some of its own present clients. It will probably lose some of its existing clients.

However, if Spoornet analyses what other companies in Europe and the U.S.A are doing, Spoornet will have to enter the outbound part of the Supply Chain and the distribution market.

10.2.2 Why the Toolkit is used?

CAPS Logistics have very solid expertise in this area and their product has been on the market since 1988. The approach behind the application is based on sound scientific principles.

Deterministic modelling provides an optimal answer in a very open system where other modelling approaches might not provide any answer.

Except for very solid engineering expertise behind the product there are several soft reasons for the success of this product. Spoornet believes that these are some of them:

- Interaction and Graphics
- Beyond Price
- Information

10.2.2.1 Interaction & Graphics

The CAPS Toolkit can be a powerful application in aiding Spoornet to communicate with clients. The Toolkit analyses the supply chain and is then able to present various alternative scenarios to the customer.

As the customer visualises the multitudinous alternatives provided, an optimal solution can be concluded based on the unique criteria of the customer.

Furthermore, customers are normally quite easily blown over by the dynamism and flexibility of the Toolkit as it graphically displays the entire supply chain of the customer.

10.2.2.2 Beyond price

The Toolkit provides business answers to a client based on his business and Logistics paradigm.

The power of the Toolkit lies in its ability of offering numerous business possibilities for both Spoornet and its customers. Spoornet is able to offer an optimal solution to its customers based not only on price but based on a broad range of business criteria, which might be important to the client. These criteria could include pull systems vs. push systems characteristics, multi-stop, LTL (Less than Truckload) vs. FTL (Full truckload), sequencing of stops, etc. This effectively broadens Spoornet's scope of parameters in its negotiation with customers.

If the application is used in a network environment, with multitudes of choices, the opportunities, which can be calculated and presented to the client, are comprehensive. The onus is thus on the customer to choose the solution they deem optimal.

This two-pronged approach of the Toolkit acts as a remarkably effective marketing tool for building a sound and healthy working relationship between customers and Spoornet.

10.2.2.3 Information

Clients generally do not possess the skills or tools to design an optimal solution for their supply chains. The reasons for this are multitude, one of them being that it is not their core business.

Therefore it is a golden opportunity to have their channel modelled to their requirements to give a business answer, in an easily understandable format.

By jumping at this chance they are willing to provide information about their supply chain. These will typically include cost models, throughput, inventory, distribution patterns, timing of distribution etc. This is the type of information that Spoornet usually cannot get at, owing to its confidential nature.

This in itself is a major advantage because Spoornet can avoid the problematic situation of information retentiveness. Thereby Spoornet can avoid one of the biggest stumbling blocks in the negotiation process of designing a client supply chain and later managing the supply chain.

10.3 What is Required to Make CAPS Work Effectively

10.3.1 Data and Data Bases

There is considerable need for background data support for the CAPS platforms. Each model has a relational database that stores the data that is used in that specific model. However, there should be a core database that will store all information possible that can be used in any model.

Each model will use only some of the data in this core database in terms of the files as well as any attributes that are available. The data that should be stored will be such as:

- Warehouses
- Production plants
- Silos
- Mill, etc.

Each of these resources will have characteristics (attributes) that will be stored in this database ^[25]:

- Capacities
- Throughputs
- Products
- Size
- Location
- Type
- Cost models, etc.

A Spatial Object Manager (SOM) is a database that is suited for the function of the core database. This product enables you to store spatial data to many dimensions. It enables the

user to query it in order to locate data objects overlapping, outside of, or contained within a region or definition.

E.g. during a certain project all warehouses that have automated storage in the Gauteng area are required to be known. SOM will be queried for them and will return a list of all the appropriate warehouses complying with the requirements.

The SOM is ideal for storing and visualising spatial data. The CAPS toolkit continuously utilises spatial data. The SOM will provide CAPS with a stable reusable source of data that is necessary for the design of supply chains.

The ideal would be to populate the database with a massive data collection initiative. Initially, it will probably be done on a project basis, where data that is required for a project will be gathered and stored. A fully comprehensive SOM can then be built up over a period of time.

The basis of the operation of the Toolkit is a geographic map. The ideal would be detailed GIS maps of South Africa including the rail and road network. This data will be stored in the Toolkit. All the other data required (factories, Distribution Centres etc.) would then be superimposed over the map using the location attributes of the resources stored in the SOM.

However, the GIS map is not a necessity for CAPS, but the more detailed the planning gets, the more necessary it is to have such a map. On the higher levels it is sufficient if the locations are created manually in the Toolkit.

Another data requirement would be the less than truck load (LTL) tables. These tables contain prices and distances etc. associated with transporting commodities ^[25]. This is not the initial requirement but if Spoornet wishes to expand its logistics service it will become imperative to acquire such information.

Spoornet owns several copies of the Object Store ODBMS. An interface will have to be developed for the usage of the Object Store Database.

Given the possible complications of developing the interface to the ODBMS it is not viable to develop an interface before a pilot project or hand holding exercise has been conducted. In the interim Spoornet will sacrifice somewhat in terms of the best solution and settle for a Microsoft Access Database.

After the pilot project Spoornet will be surer about the exact requirements for the ODBMS interface. Spoornet will then acquire or develop the appropriate solution to use an Object Database Management System.

10.3.2 Personnel and Teams

Ultimately several teams of people are needed to enable the Toolkit. These teams can be developed over time as the volume of work justifies it. The following is needed:

1. Permanent personnel who will use the Toolkit to develop solutions for Spoornet and clients. Their skills will have to be heavily based in Operations Research and Industrial Engineering, with some background in GIS (Graphical Information Systems), ODBMS (Object Database Management Systems) and RDBMS (Relational Database Management Systems). For the actual CAPS operation, a team of operatives will be needed to utilise the data and design logistic solutions. They will have to define their data requirements for the CAPS tool as well as for specific projects and initialise data gathering if such data is not in the SOM.
2. With the large quantities of accurate and often high technology data required a team is needed to co-ordinate and control this data. Knowledge co-ordination (KC) would be required to keep the database up to date with experience in ODBMS (Object Database Management Systems) and RDBMS (Relational Database Management Systems) will be

necessary. They will co-ordinate the structure of the database and ensure data integrity. In time it might become necessary to appoint a permanent person to handle this issue.

3. Business Architecture & Technical Architecture input.

4. Assistance is needed to handle GIS (Graphical Information Systems) issues. These will include the placing of rail tracks and road lanes on a digital map as needed per project.

5. In time an information gathering team will be required. This team would collect all the relevant data to populate the ODBMS structures necessary to flatten the development curve with the Toolkit. They will have to collect information of all warehouses, distribution centres, road transport fleets etc.

Currently, much of the data that is required will be available from the business managers and their personnel. This data can be obtained easily and entered into the SOM with ease and only a few additions and alterations. Some data will not be available anyway (e.g. cost models) unless Spoornet is very involved with the client logistically.

In future, information gathering will need to take place if Spoornet is to expand its logistical capability and variety.

10.3.3 Architectural Fit

An extensive analysis exercise was completed to indicate the fit of the CAPS architecture to the Spoornet architecture.

The majority of this information is confidential, however, enclosed in Appendix C is a CAPS White Paper of the Caps Toolkit Architecture.

10.4 How CAPS should be used

10.4.1 Prerequisites for the use of CAPS.

CAPS is a data hungry tool. Large quantities of accurate data are required for its use. Along with the procurement of CAPS, large quantities of digital geographic data had to be obtained. This is data in terms of rail network, road network as well as a general map of the country.

The road maps were obtained from an organisation that develops digital as well as ordinary maps commercially. These maps were accurate enough as well as detailed enough to be used by CAPS.

All the main roads and highways were included as well as minor and secondary roads in the more built up areas such as Johannesburg, Cape Town and Durban.

The rail network was also a necessity. This information was not commercially available. However, a division of Transnet, Propnet, is in the process of mapping all Transnet and Spoornet property. As a result, all stations, sidings and rail lines as well as storage areas used by Transnet would be available.

The accuracy of this data is not as good as the commercially available road data but it was sufficient.

The gathering of this data is a once off exercise. Once it is available it can be used by any project done on CAPS and utilised by other projects. Without it CAPS cannot be used at all.

Several formats and protocols of GIS data exist depending on the tools and methods used. These need to be converted to the CAPS format. This is done by storing and sending them to CAPS Technical Headquarters. There it will be converted and sent back for use.

10.4.2 The Staff

The use and design of CAPS requires several competencies. The user should have:

1. Statistical knowledge to determine data requirements, accuracy and use of that data.
2. Supply chain knowledge to understand inventory movements, distribution, cross docking, load consolidations and how various transport modes work.
3. Financial knowledge to determine cost data required, how it should be used, its accuracy and significance. The development of cost models is also essential.
4. Programming Knowledge. Even though CAPS is very user friendly and has an excellent GUI, customisation may still be required. If it cannot be customised by settings, macros need to be written to customise the tool, settings or simulation runs.
5. Data gathering capabilities to collect and enter large quantities of raw data to be used in simulations.
6. The capability to use and analyse the results from the toolkit. The capability to use a certain design framework to plan and schedule supply chain operations.
7. Knowledge and training in the CAPS modules.

10.4.3 Its Use

The initial supply chain should be analysed and designed by the supply chain designer. He/she will utilise the DesignPro as well as the TransPro modules. They will make the decisions required in these modules (see Section 8.1: How It Works).

It is the designer's responsibility to ensure that the model created is stable, accurate, reliable and performs what is required of it.

After this, the designer will hand over the model to the Channel Manager. The Channel Manager will use mainly the RoutePro module and occasionally part of the TransPro module.

This is possible by the use of a password security system. This prevents the Channel Manager from using certain functions, seeing certain screens and altering certain data.

The Channel Manager will use the design to run monthly, weekly and daily demand patterns and to determine the distribution plan or schedule. This will then be communicated to the operational levels and service providers for them to execute.

If there is a change in the supply chain in terms of routes or sites due to incident or a change in preference, the model will have to be handed back to the supply chain designer. He/she will alter it and return it to the Channel Manager for further use.

The supply chain designer will have competencies listed in the previous section in numbers 1, 2, 3, 4, 5 7. Figure 23: Supply Chain Designer Competencies, below, illustrates what the designers should know and be able to carry out. The Channel Manager will have numbers 6 and 7.

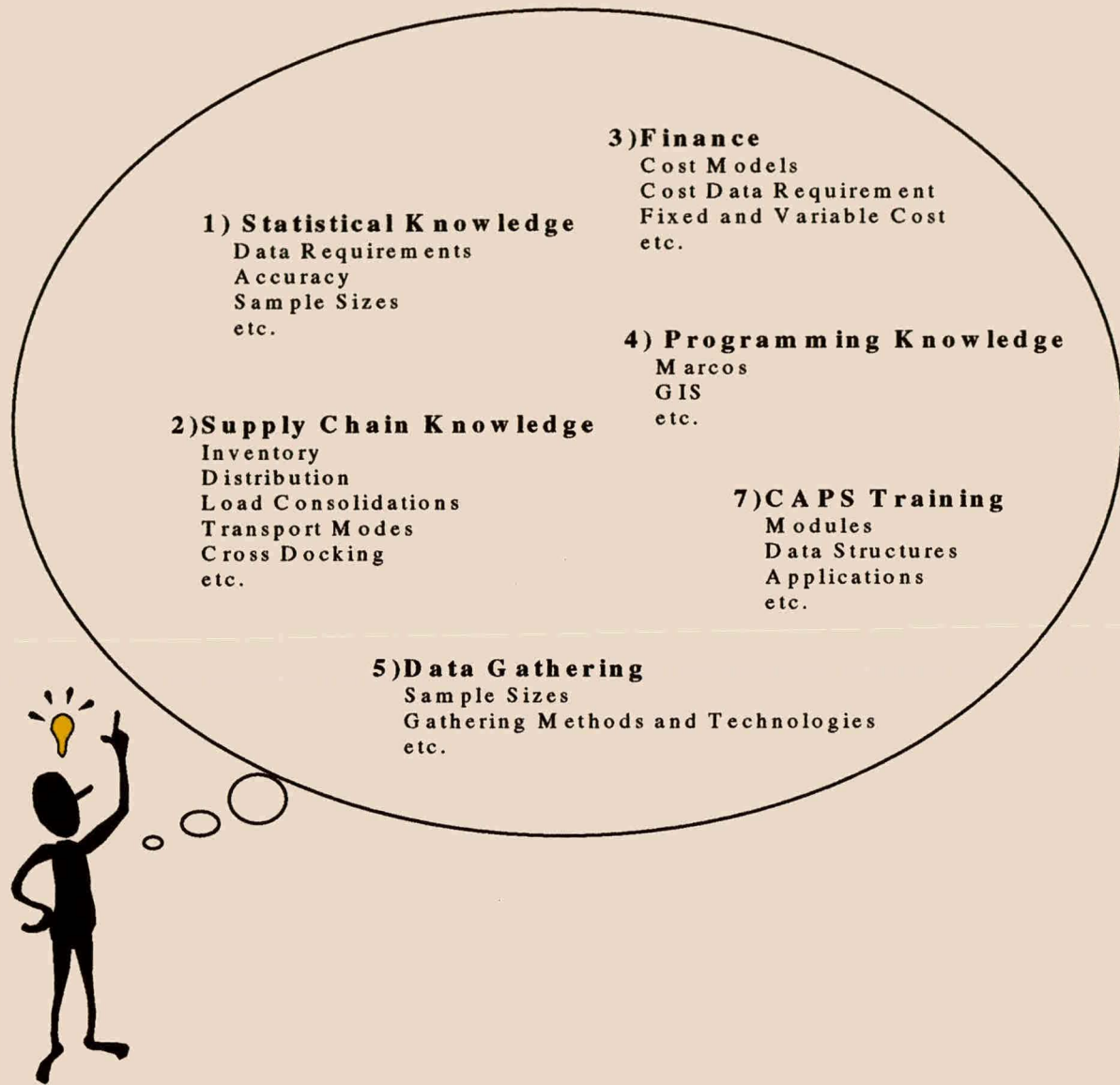


Figure 23: Supply Chain Designer Competencies

11 PILOT PROJECT

11.1 Background

Before establishing the wide spread use of CAPS in Spoornet, it had to be proved to the business sectors that benefits could be gained from the use of CAPS (see page 102), what the cost of using it would be and what skills and competencies they would need to obtain to continue using the tool.

A pilot project was chosen. The business manager in that business sector was willing to use the CAPS toolkit and the client organisation was of such a nature as to be able to recognise the potential benefits of CAPS and to be willing to experiment with it in one of its sectors.

The company was in the timber industry. For purposes of confidentiality the Spoornet customer that the pilot project was done with will remain anonymous and will be known as Customer A.

It not only harvested timber in the forest and made pulp, but also produced paper and several wood products.

It made extensive use of rail on the part of the transport leg between the forests and the pulp mills. Road carriers did the bulk of the distribution from the pulp mills onward ^[28].

The scope of the pilot project was the portion of the supply chain from the forests to the pulp mills i.e. where rail is predominantly used. These sectors can be considered outbound distribution from Customer A's point of view.

A carrot was offered to the project team: if this project showed major benefits and a definite cost saving, other parts in the supply chain will be available to be modelled on CAPS. This latter part would be mainly the outbound distribution from the pulp mills.

The project team consisted of employees from both organisations. From Spoornet two industrial engineers and other logisticians were assigned to work on the project. The business manager was involved in a management, delegation and liaison role.

The client company had several persons, from the Logistics Manager of that region to distribution managers and operational personnel. These people would be concerned mainly with making data available to the CAPS modellers.

11.2 Project Details

The geographic areas concerned by the project are Mpamalunga and Eastern and Southern Kwazulu-Natal.

The sources of raw material, the forests, are situated in Mpamalunga and Eastern Kwazulu-Natal. The pulp mills are in Richards Bay and in Durban. In the Figure 24: Region of South Africa Affected in this Project, below, the area concerned is shaded in green diagonal stripes.

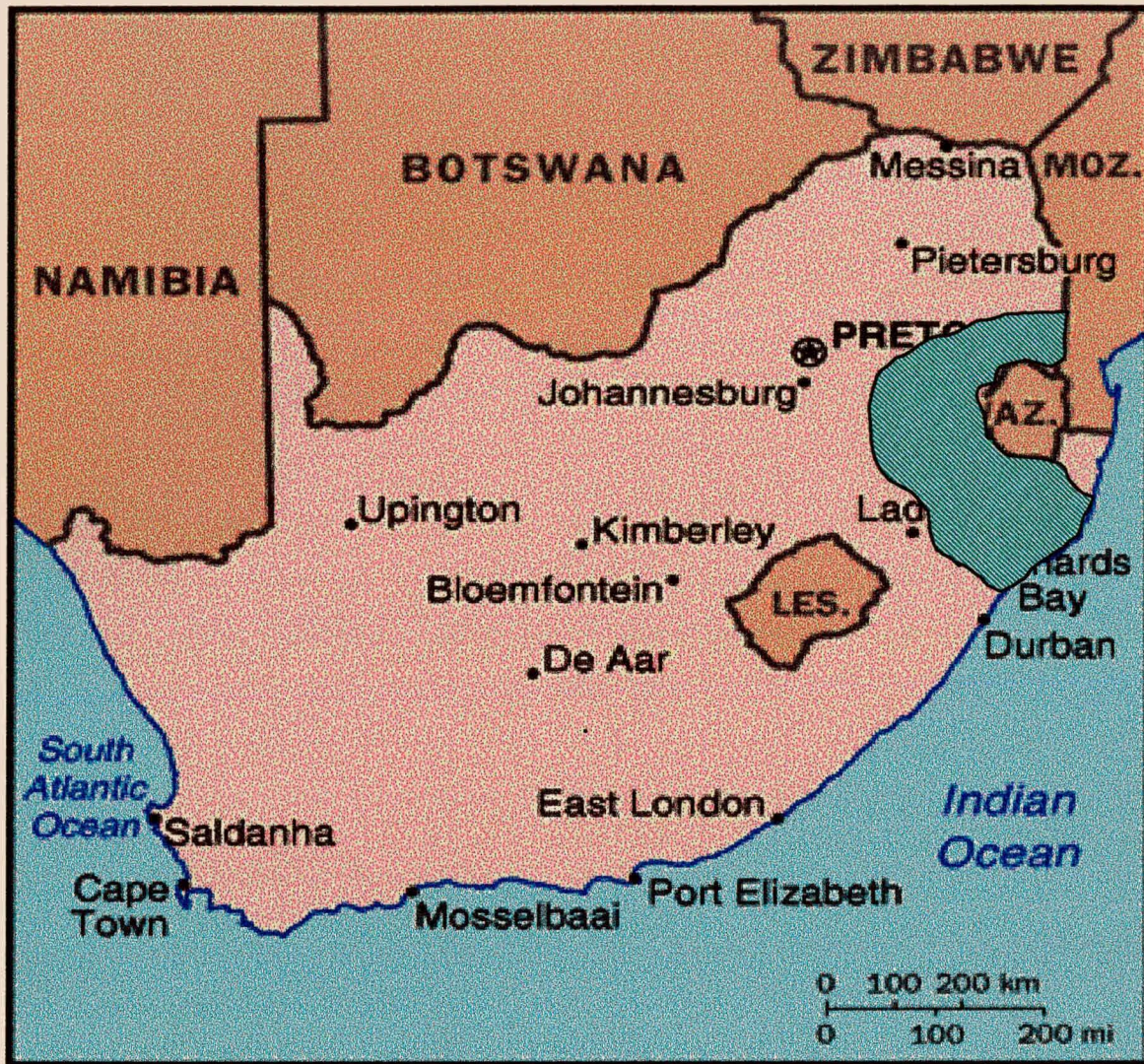


Figure 24: Region of South Africa Affected in this Project

11.2.1 Raw Materials

The forests are divided into regions, units and farms. Each farm may have a different type of tree planted on it due to different exposure to sun, soil and access to water.

The three main product types are:

- Wattle
- Gum
- Pine

Examples of the wood used for raw materials are illustrated in Figure 25: Types of Wood Used.



Pine



Gum



Wattle

Figure 25: Types of Wood Used

Within these there are further differentiation into grades. It is important not to mix them as each of the mills requires a different percentage mix of the products and grades.

It is important to get the wood to the mills as quickly as possible after harvesting. Exposure to the elements will decrease the quality of the wood and lower the grade of the wood.

The time the tree spends growing is also important. The grade of the wood is decided by the maturity of the wood i.e. the amount of the time spent growing. As a result, the timetables have been developed that indicate when what trees will be harvested.

11.2.2 Distribution Routes and Transport Modes

The routes consist of rail and road.

A farm or a forest road links the forest and a consolidation/pooling site at the railhead. From here secondary rail lines transport the wood to a consolidation point at a major station. Here wagons are made up into trains. From here the train will move to the mills.

The initial distribution is done by independent contractors that utilise trucks and tractors to take the wood from the forest to the railhead. The wood is then either transferred directly onto rail wagons or placed in storage to wait for wagons.

The independent contractors make up their own transport schedules based on what will be harvested.

The rail planners attempt to schedule the wagons arriving at the pooling sites according to how many wagons Customer A has ordered and what the independent contractors have scheduled to bring from the forests to the rail heads.

The wagons are placed at the sidings by shunting movements at certain times of the day. These shunts will also remove full wagons from the pooling points. These full wagons will be taken to the mainline stations and pooled into trains.

In Figure 26: Modal Choices in the Project, below, is a graphical representation of the modes that will be used in the CAPS project to transport the wood from source to sink.

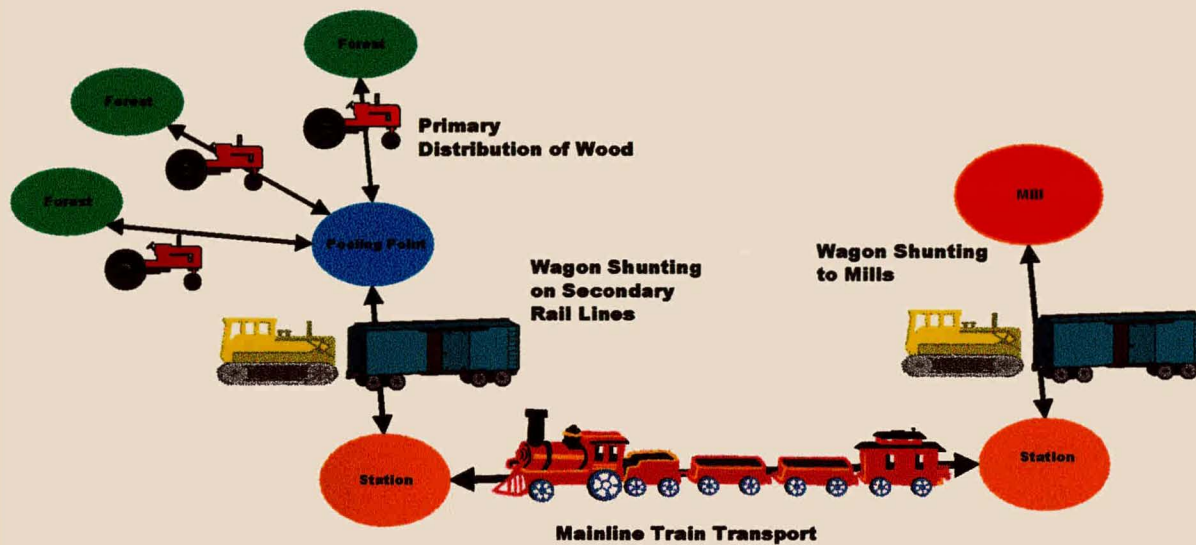


Figure 26: Modal Choices in the Project

Certain mainline trains have been scheduled in specific available train slots. These train slots are chosen in order:

- Not to conflict with other trains travelling on the same line.
- To ensure that there is crew and locomotive capacity available to serve the train.
- To match with the forecasted demand of when probable harvesting of the forest will take place.
- To match the estimated loading times from road onto rail.
- To ensure that the trains are optimally loaded in terms of their mechanical capacity i.e. maximum number of wagons for the traction power of the locomotives pulling them.

Balancing of the above variables requires that the loaded wagons have to wait at the stations for a mainline train.

The mainline trains will transport the wood to the mills. At a station close to the mills the train will be broken up and the wagons bound for the particular mills will be shunted to those mills as per the shunting schedule.

If the entire train is bound for that particular mill, it will not be broken up but will be taken whole to the mill. Much of this will depend on the capacity of the siding/s at the mills.

After offloading at the mills, the wagons will be shunted to the mainline station where a mainline train will be made up to take them back to the forest area loading points.

11.2.3 Sites

Several sites are defined in this supply chain:

- Pooling points
- Stations
- Mills
- Harvesting/Forest areas

In Figure 27: *Graphical Representation of Sites*, below, all the sites that will have to be represented in the CAPS model as well as their symbolic relationship with each other are represented.

11.2.3.1 Pooling Points

The pooling points are railheads and sidings where wood is transferred from the road vehicles to rail wagons. The wood may also firstly be placed on the ground for storage and then loaded onto rail wagons.

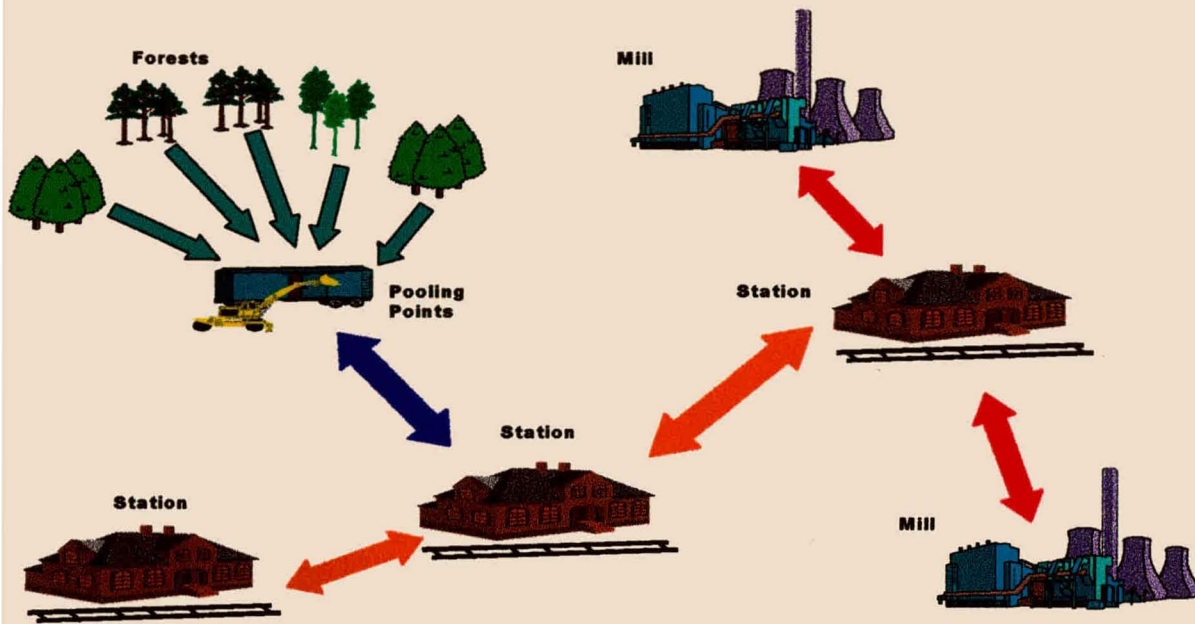


Figure 27: Graphical Representation of Sites

These pooling points consist of loading equipment and possibly a fenced storage area. There are many potential pooling areas that may be used, however only a few of them need to be used. It is possible to change the pooling areas by moving the loading equipment from the used to the unused areas.

11.2.3.2 Stations

The stations are major rail nodes where wagons can be stored and consolidated and either added to a train or a new train can be made up. Whether a particular node will be a station will be determined by the global rail simulation model that determines which location will be able to perform these activities feasibly in terms of all the Spoornet train movements taking place.

11.2.3.3 Mills

The mills are the destination points for the wagons. They have a certain demand for a finite quantity of a particular grade of wood. Associated with them is also a capacity of the mill's

sidings. This means that only a finite number of wagons can be shunted to the mills at one time.

11.2.3.4 Harvesting/Forest Areas

These are the supply points for this supply chain. A forest area is made up of several smaller units. Each unit has a certain product type (type of tree) and a grade of product that is planted in it. Forest management technology has advanced so far that it is possible to schedule to the specific day when a tree should be harvested to ensure the grade required.

11.3 Push System

This part of the supply chain that has been discussed up to now works on the "push" principle. The harvesting schedules define what will be harvested. Thereafter, all the wood is transported to the mills. This is done regardless of the actual demand at the mills or end customer demand. This causes either shortages of raw materials or a surplus of raw materials at the mills.

Harvesting is also done regionally, i.e. each Customer A region harvests and transports independently of all the other regions and obviously independently of actual market demand.

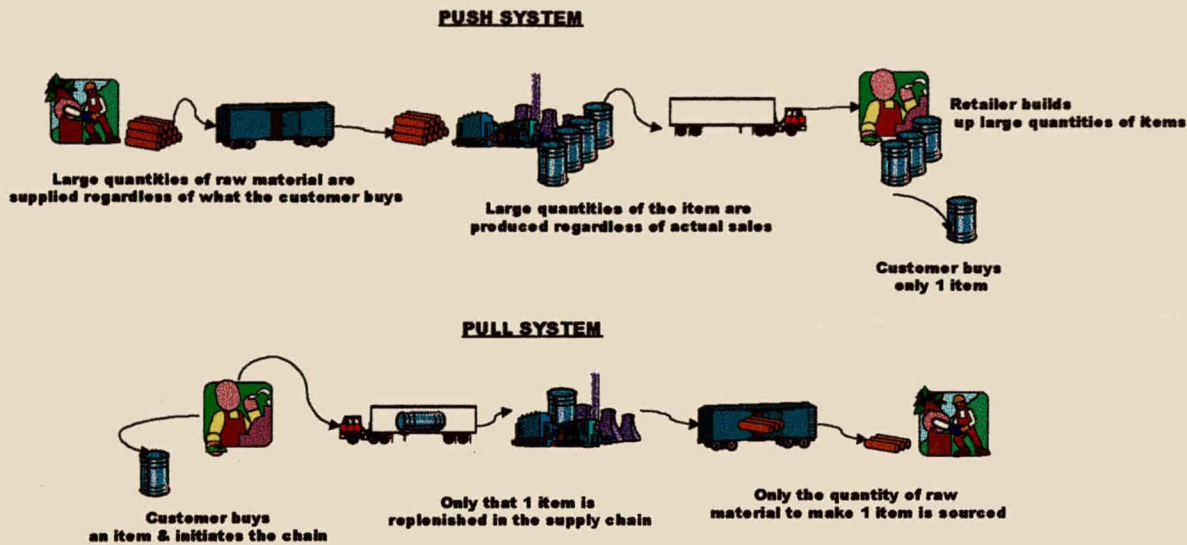


Figure 28: Push vs. Pull System

The concepts of the push system is illustrated above in Figure 28: Push vs. Pull System. It creates large quantities of inventory throughout the supply chain. Compared to this, the pull system is initiated when a sale is made and the quantity of product that is sold is replenished, manufactured and only the quantity to make the specific quantity of raw material is sourced from the suppliers. In this system there is considerably less inventory build-up at each stage of the supply chain.

The planning of these activities is also done in an uncoordinated manner.

This type of system creates inefficiencies throughout the supply chain.

11.4 Supply Chain Inefficiencies

- ❑ Wood is not supplied to demand. Shortages or blockages and oversupplies result at the mills.
- ❑ Too many wagons move around in the supply chain. This causes the utilisation of the wagons to be very low.

- Train arrivals at the mills are not co-ordinated with demand and production rate at the mills. This causes blockages at the mills when wagons must wait for excessive periods of time before they are unloaded. Shortages can result when there is no raw material. As a result, excessive inventory buffers are kept to prevent the mills from running dry.
- The scheduling of transport from the forest to the siding is not co-ordinated with train arrivals and demand. This causes either blockages or a lack of wagons at the sidings.
- Lack of co-ordination between all parties. Wagons are not supplied to areas where they are needed. Inventory buffers build up at every break in the supply chain to cater for these inefficiencies.
- Lack of planning on a tactical and strategic level. As a result the supply chain is very inflexible and unable to adapt to changes in demand or changes due to natural causes.
- Pooling points are not optimally located. This causes unnecessary cost to be incurred due to non-optimal delivery from forest to railhead and non-optimal shunts from sidings to mainline stations.
- Harvesting is not co-ordinated with demand. This creates inefficiencies throughout the supply chain in all sectors.

12 CAPS MODULES TO BE USED

The TransPro module was selected for this pilot project. During the initial AS-IS project analysis several constraints to the project scope appeared. These narrowed the project scope considerably. They were the following:

- The harvesting schedule is set i.e. determining the harvesting schedule based on final demand as well as all the activities that take place before harvesting is not in the scope.
- CAPS was not allowed schedule the distribution from the forests to the railheads at this stage. Independent contractors do this. They will plan their own distribution.

As a result, the system cannot become a true "pull" system based on customer demand and the total cost of distribution cannot be influenced, as the project team will not have full influence over all the elements.

No new routes and sites etc. will be added. The project will have to attempt to optimise within these constraints.

It is therefore not useful to use the Supply Chain Design module. Since the detailed distribution between forest and the railheads is also excluded, the use of RoutePro is not warranted.

The use of TransPro will provide the following results:

- Selection of the optimal pooling locations based on the costs of the operations, cost of transfer of equipment to a new site, locations of stations and the quantity of supply in the area.

- Scheduling of the shunts from the pooling locations to the stations. This will depend on cost, time, supply as well as the mainline train schedules.
- Selection of the optimal mainline train slot from a menu of feasible and available train slots. This will be done by balancing the cost of running the trains, the shunting times and volumes, and the times and volumes at the mills.

Theoretically, after running the CAPS models, the Channel Manager will have plans that will schedule the movement of full wagons to the mills and determine the best distribution of the empty wagons arriving from the mills at the forests.

The three points mentioned previously will be areas where CAPS will attempt to optimise the supply chain operations. They will be assessed in terms of:

- Time
- Cost
- Volume of product

This is to ensure that as few blockages as possible, missed train connections, waiting time and any other conflicts occur during its operation. During this process the cost of the supply chain will be optimised as far as possible.

These plans will then be produced on a monthly basis.

13 PRE-MODELLING EFFORTS

Much work had to be carried out prior to actually running the scenarios and getting results.

13.1 Establishing Data Requirements

In order to run the scenarios, the CAPS data requirements have to be satisfied. These data requirements are available in a generic form in Appendix F.

The following were the requirements for this specific project:

13.1.1 Geographic Data

Because CAPS is GIS based, the longitude and latitude co-ordinates of all sites and the network were required ^[25]. This meant:

- An accurate map of South Africa
- An accurate map of the rail network
- Co-ordinates of all stations, mills as well as pooling points

The road network was not required for this phase of the project as no road transport was in scope.

13.1.2 Demand Data

This should be in terms of daily or weekly demand for each mill. It should be per product type.

Initially it should be historical data. The results of that model will be compared to actual events to indicate saving and improvements.

13.1.3 Supply Data

A list of what product will be harvested, when, the quality of the wood and the locations of the harvest.

13.1.4 Mainline Schedules

This will indicate the times and the train slots that are open for reservation. Other variables such as the space on the train and the stations it passes through are also important.

13.1.5 Shunting Schedule

The data here will be when shunts are carried out, how long they take, how many locomotives are available, how many wagons/tons can be pulled etc.

13.1.6 Pooling Locations

Their capacity in terms of how many wagons can be placed there, how many can be loaded at one time, and loading rate in tons per time period, as well as operating times are all essential information.

13.1.7 Stations

Operating times, loading rates of tons per time period, siding size in wagons and capacity of storage areas.

13.1.8 Costs

The following cost data will be required:

- Shunting costs
- Mainline train costs
- Pooling location operational costs
- Pooling location transfer costs
- Cost of empty wagons
- Cost of product
- Any waiting costs such as empty wagons or full wagons waiting for trains.
- Etc.

13.2 Data Collection

13.2.1 Geographic Data

Since much of the scope of the project was reduced to rail-based calculations and decisions, the GIS data of the road and street network is not of high priority. It was obtained with relative ease from a commercial organisation specialising in maps.

The bottleneck in this process was sufficient quality and quantity of the rail-based information. As mentioned before, Propnet was currently busy with initiatives of mapping and geocoding data on Transnet and Spoornet property.

Unfortunately, much of it did not exist in digital format and it was not sufficiently accurate. After extensive negotiations, Spoornet had to settle for only a segment of the rail data that was accurate enough to be used.

Fortunately this was the Mpumalanga and Kwazulu-Natal rail lines and siding. These are the ones used in the project.

There was also a large offset error in the data that would make it unsuitable for mathematical calculations. This error was calculated and the entire network was manually

adjusted by the estimated error. The result was, at least initially, data suitable for use by CAPS.

Once this data was available, it was sent to CAPS offices in the USA for conversion into the format that was used by CAPS.

The data was returned and loaded into CAPS. At this stage a further error in the data was discovered. The rail network was offset from the correct road network and the correct South African map data. Further investigation revealed that the estimated error that was adjusted in the original Propnet data had been incorrectly incorporated. The procedure had to be repeated again and the data again converted to CAPS format.

This data consisted of mainlines and secondary lines. It did not have sidings at this stage. Propnet also did not intend to collect information on sidings for some time to come.

The siding information was essential to the project. The sidings are pooling points for wood and places where wood would be transferred from road to rail.

After negotiations with Customer A, it was decided that they would collect all siding data. They already had the equipment and personnel necessary for finding the exact X and Y co-ordinates of the sidings. In fact Customer A used this type of data extensively for map locations of farms and plantations.

Customer A sent the project team a list of all currently used and potential sidings that could be used along with their X and Y co-ordinates. The co-ordinates of the mills were also included.

These co-ordinates were superimposed on the rail data. This total process was time consuming and took about two months.

13.2.2 Demand Data

This information was obtained from Customer A. This was the demand that they use to plan their operations. It was not the final demand but the mill demand for raw materials.

Figure 29: Example of Mill Demand Format, below, illustrates what the monthly demand from each mill could look like.

November 1997 Demand (Tons)									
Destination Mill	Week 1			Week 2			Week 3		
	Pine	Gum	Wattle	Pine	Gum	Wattle	Pine	Gum	Wattle
Richards Bay	3	2	8	1	2	4	5	2	1
Durban	6	7	0	3	4	0	3	5	0

Figure 29: Example of Mill Demand Format

Initially two sets of data were needed - historical and current data. The historical data would be used to test and validate the model. The current data would then be used to actually run CAPS and implement the plan.

The information was available on a weekly basis. This was then divided into daily demands.

13.2.3 Supply Data

This was only available from the forestry departments at Customer A. Each district had its own information. Customer A was reluctant to make this available, but finally it was decided that it could be used for the project.

At the stage when the author left the organisation the information was not yet available. The plan was to integrate all the various schedules from the various forest districts into one unified schedule.

13.2.4 Mainline Schedules

Many of the scenarios that would be run on CAPS were about the selection of the optimal trains - all the trains that passed through any of the stations in the areas were discussed and the trains identified that could potentially be used in the project were required.

All this data was already stored in a large data warehouse at SpoorNet. Permission was obtained to use this data and a very large quantity was downloaded onto an MS Access data base.

Due to the large quantities of data, it was necessary to improve the utilisation of storage space and the data was stored in several interlinked tables. Because this type of request was one of the first in SpoorNet, the information technology infrastructure was not geared towards providing it. Therefore, it was not just a matter of printing out standard train schedules.

TrainNo	Train Type	Length	Origin	Dep. Date	Dep. Time	Destination	Arr. Date	Arr. Time	Node1	Node1 Arr. Date	Node1 Arr. Time	Node1 Dept. Date	Node1 Dept. Time
5252784351109	2	35	BEL	25/05/96	9:00	FOD	28/05/96	12:00	EML	27/05/96	22:00	27/05/96	22:25
2357888540867	1	40	JNB	6/11/96	2:00	CTQ	8/11/96	6:30	EML	06/11/96	13:50	6/11/96	14:25

Figure 30: Example of a Mainline Train Schedule

After lengthy and complex searches, a finite number of trains and their details were obtained.

These were taken to the scheduling department for confirmation as to whether they do exist (the data warehouse was notorious for keeping out-of-date and non-existing train data) and the details (departure times etc.) were correct.

Many of the trains had to be ignored because they were special block trains used to transport coal to Richards Bay and were not allowed to transport anything else or to stop along the way.

After this process a list of train slots that would be able to transport wood was compiled.

A final table of trains (see Figure 30: Example of a Mainline Train Schedule, above, for example) was composed, indicating:

- The route
- The times
- The duration
- Space on the train

This data table could then be used directly by CAPS.

13.2.5 Shunting Schedule

This schedule was considerably simpler than the main line schedule. There is actually no real fixed schedule but rather a list of time windows indicating when shunts take place from a certain station to a specific area.

A particular wagon could be placed or taken away by a shunt anytime during the time window (usually three hours).

Information was gathered from the scheduling department and the regional personnel to establish how many shunting locomotives were available at the various stations in the areas concerned with the project. These stations would serve a number of sidings and pooling locations in their immediate vicinity.

Spoornet has a Global Rail Simulation Model. This model is used to calculate which stations should have the capability to make up trains or where wagons can be added to main line trains. This model uses the entire global Spoornet network to make its decisions from a total cost point of view.

As a result, a train will not be able to stop at all the stations along the rail lines passing through the forest areas. Similarly, shunts will not take place from all the stations. Before deciding what nodes should be stations from which shunts can take place, they must be passed through the simulator to indicate whether it is optimal for Spoornet to do this.

This is a further constraint to the project. Once CAPS calculated the shunts that would be optimal for its supply chain, they would have to be taken to the Global Simulator and tested for their holistic feasibility.

The result of this would have to be fed back to CAPS. If there are changes to be made, they must be remodelled in CAPS and the process repeated.

13.2.6 Pooling Locations

This data was available from the Spoornet data warehouse. It was, however, not totally accurate and up-to-date. A list of potential sidings that could be used had to be obtained manually in discussions with operational and regional business personnel.

The details would include variables such as:

- Wagon capacity
- Storage facilities (if any)
- Capacity of storage facilities

Not all of this data had been collected by the time the author left the organisation.

13.2.7 Stations

Details of each potential station had to be known, such as:

- Wagon storage capacity
- Operating hours
- Number of shunting locomotives

- Number of rail lines

13.2.8 Mills

Customer A would make this data available. It would be in paper format and would have to be entered into a format usable by CAPS.

Data such as the following is important:

- Production rate
- Wood storage capacity
- Wagon storage capacity

13.2.9 Costs

The majority of the cost data would be rail-related costs and would have to be obtained from the Spoornet finance department. Special permission had to be obtained in order for the project team to be able to have assessed and used the data.

Spoornet was in the process of implementing ABC (Activity Based Costing). However, many of the costs required were not available. They had never been calculated in the manner required.

The only way to obtain them would be by estimates made by relevant personnel. Financial, business and operational personnel had to be consulted to provide accurate estimates that could be used in CAPS calculations. These were costs such as:

- Empty wagon costs
- Waiting costs
- Shunting costs
- Station costs
- Etc.

The costs of mainline trains had to be obtained from the finance department. The requirement was the cost of transporting a wagon from a station to a mill.

Unfortunately this was a unique request. Previously, the requests were for cost of entire trains with a specific number of wagons and a specific origin and destination. This was very different to what the project team had requested.

We had several potential origins (stations) and several potential destinations (mills). CAPS would calculate the lengths of the trains so that they are optimal for the supply chain, so at this stage the number of wagons was unknown.

As a result there would be a large number of combinations of origin and destinations mixes as well as a large number of combinations of the number of wagons on a train. These could vary from one to 40 wagons (maximum number of wagons for an average airbrake train).

The costs for each wagon would be different, as the costs are not linear. If the cost equation was represented graphically, it would look similar to Figure 31: Cost per Wagon Graph, below.



Figure 31: Cost per Wagon Graph

This is due to the fact that a locomotive must be available to pull even one wagon. Therefore, the cost of an additional wagon or third wagon is marginal and does not represent a major increase. The fixed cost of having to use the locomotive must be incurred, the variable cost of e.g. fuel will also be incurred with only one wagon. The cost increase will come in as the locomotive might use more fuel pulling three wagons than one wagon.

This will be the case until the number of wagons reaches and exceeds the maximum number that can be pulled by one locomotive. A second locomotive will have to be added. The cost will increase dramatically and the same process will follow until a third locomotive must be added (see Figure 31: Cost per Wagon Graph)

This means that in order to get the cost data a large number of queries must be run on the system. Since this was unique request, the queries had to be written and completed manually.

A special Pascal programme was written that enabled the team members to run all the combinations of scenarios and calculate fixed and variable costs for each. The results of each scenario were stored in a database.

After all the scenarios were run and the data was summarised, trends and patterns were identified. The best possible way to summarise and make this data available to CAPS was by means of a graph. A table would have been too large and ungainly to use.

The graph would have a shape similar to that of Figure 31: Cost per Wagon Graph and would be per kilometre. Previously the cost had been between origin and destinations.

Other cost data, such as loading/offloading cost and the transfer of loading equipment between pooling points would be obtained from Customer A.

The data collection proved to be a major bottleneck in the progress of the project. It took an estimated three months to collect the majority of the data. Even after this time some of the data was still not available and some of it was of questionable accuracy.

14 SCENARIO MODELLING

This was possibly the most exiting part of the project and probably the one that took the least amount of time. It was to include a comparative study to display the actual benefits of using CAPS (as compared to the expected benefits, see page 102). Much of the project time was spent on the preparation for modelling and on developing scenarios that would be modelled.

Before modelling, the data collected had to be entered into a format suitable for use by CAPS. Much of the data was placed into databases with the format such as illustrated in Appendix F.

Other data was placed directly into the tool. During this part of the project, the author left the organisation and his involvement on then project stopped. This section will, therefore, be a discussion on the work that was planned in terms of modelling scenarios, the potential problems and work to be done in the short, medium and long term to complete the project.

14.1 New Problem Areas

At this stage, two major problem areas were anticipated:

- The Global Rail Model would constrain the rail portion of the modelling process. Since the scope of the project was already reduced to rail only, it would be a major blow to the project.

- At this stage of development, CAPS does not take into account the size of the rail siding. As a result, the rail sidings have to be considered to have infinite capacity. This is obviously not the case.

From experience it has been shown that this capacity can exercise a considerably limiting influence as an operational and planning factor. It may be possible to write a macro to include this variable. However, in order for it to be considered in the optimisation algorithm of CAPS, CAPS will become far more complex.

The most feasible solution is to exclude it at this stage and wait until the rail module in CAPS is released. At this stage, CAPS Logistics is working on a rail module.

14.2 Scenarios

Initially three scenarios will be run on CAPS. The order in which they will progress and the conditions that have to be satisfied in order for the model to be used for the following scenario are illustrated in Figure 32: The Scenario Development Process.

The initial scenario would use the historical demand data. It would consist of:

- Running CAPS in the same way as the operations were run in the past i.e. the same number of trains, wagons, demand, leading time etc. and without performance optimisation.
- The results of the CAPS model would be compared to the actual events that occurred during that month and the statistics collected. This is done in order to prove that the model does represent reality as accurately as was required.
- This stage can be considered the validation and verification of the model and the tool. It would be signed off by all relevant parties, signifying that they are satisfied with the results.

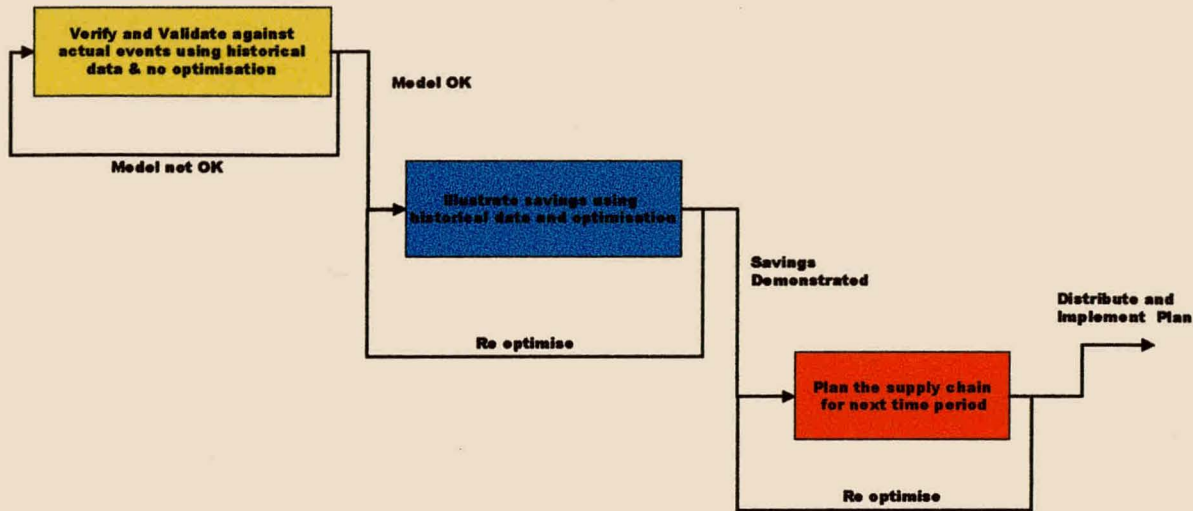


Figure 32: The Scenario Development Process

The second scenario would be to illustrate the potential benefits that can be obtained from the use of CAPS.

- The historical demand would be used but the operations of the supply chain would be optimised as far as possible.
- The comparison of the verified results of the first scenario with the results of this stage will illustrate the potential tangible and quantifiable benefits, improvements and savings that could be gained from the use of CAPS.
- The saving could be gained from the following:
 1. Improved utilisation of wagons i.e. fewer wagons is used.
 2. Optimisation of shunting operations.
 3. Timeous delivery of the correct products i.e. less wastage and blockages at the mills.
 4. Optimal use of the train schedule and therefore lower train cost.

Once these benefits have been agreed to and proved to the role players, the third scenario will be run. This will include:

- A forecasted demand for the following month. An optimal plan and schedule will be produced for the next month's supply chain operations.
- The plan will then be implemented at Spoornet and Customer A to become operational the following month.
- The potential savings and benefits will be calculated based on the results and pattern in scenario two.

Hereafter, the CAPS toolkit will be ready to be used on a monthly and daily basis by the Channel Managers for this business sector and for his client.

There are many things that need to be done to make this a comprehensive supply chain solution. It is also trusted that, based on the success of this stage of the project, the scope will increase to include other areas of the forestry business.

The following section outlines the procedure that a Channel manager will have to go through during his/her use of the CAPS tool in order to arrive at an optimal model.

14.3 What the Channel Manager will have to Take into Account

The demand/ orders drive the entire system. A quantity of products will have to be loaded, shunted, put on a train and transported to the mill/s and the off-loaded. CAPS will try to choose the lowest cost combination that meets the requirement of the orders from the client.

This is how the CAPS system should work in the hands of the Channel Manger:

- Calculate time it will take to load the order into rail wagons at the siding.

- This will be matched with the shunting time between the siding and the controlling station.
- The above will be matched with the time windows at the controlling station (the train schedule time windows).
- The arrival of the train at the mill will be matched with the time windows at the mill.
- The matching that takes place considers both time and cost.
- These are the cost factors that need to be considered:
 1. Loading
 2. Wagons shunted empty
 3. Wagons shunted full
 4. Shunting costs
 5. Mainline train costs

In order to achieve close-on optimality, one must balance the different parameters like amongst others train lengths, number of shunting moves, whether wagons are standing full or empty or doing nothing.

Other Considerations that the Channel Manager will have to take into account:

- The pooling of orders at a controlling station has cost implications. For example, certain activities take place to attach wagons to a train which incur costs. These costs must be included in the overall cost structure of the design.
- Therefore, it must be worthwhile for Spoornet to use the particular controlling station from a cost point of view.

Besides the short and medium term goals of making CAPS work and enabling the Channel Managers to use CAPS, there are long term goals that should be reached to enable CAPS and the concept of supply chain management and planning to play a more useful and significant role in the organisation.

The completion of these long-term goals will enable Spoornet to sell this concept to its clients from a much stronger and more tangible position.

14.4 Long Term Plans

The scope of the project should be expanded to include:

- The production system
- Stump to railhead short haul
- Extra mills and regions
- Finished products

Figure 33: Future Initiatives in the CAPS project, below, illustrates the order in which future plans and initiatives should be carried out.

14.4.1 Production System

Once CAPS produces a plan, the plan must be double-checked against service provider (SP) capacity to find if it is in fact feasible from an operational point of view. If the plan is satisfactory, it must be sent to the various SP planning departments so that works orders etc. can be generated.

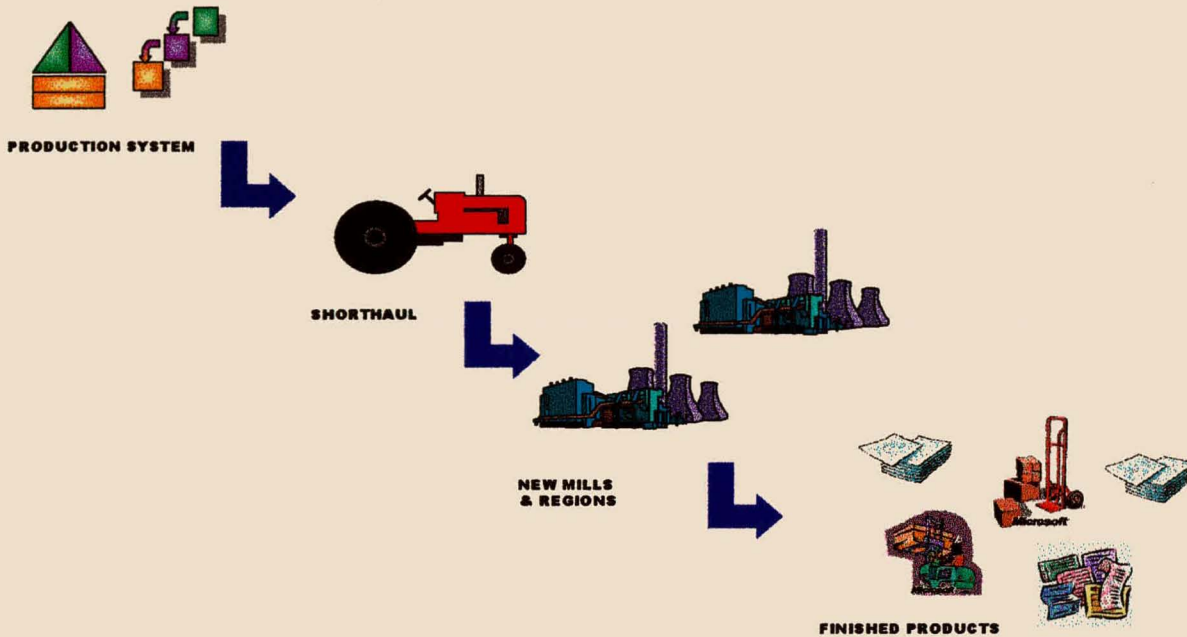


Figure 33: Future Initiatives in the CAPS project

The final plan must also be received by GLM. GLM must monitor the supply chain operations and benchmark against the plan to see if things are going according to plan.

This production system is necessary for execution of the plan that is produced in CAPS. In this section the process that is required to make CAPS work is detailed as well as the organisational structure that will support the use of the tool.

14.4.2 Shorthaul

One of the major benefits of CAPS is its ability to route transport, source multiple products, along multiple routes, modes and from many potential sources. The present pilot project is very limited, as it does not include these.

It will include these:

- Decision of where to source from and when, bearing in mind the quantity of a certain tree type that can be harvested at a spot and the requirements for a certain quantity of each tree type.
- The routing/scheduling of the shorthaul delivery from stump to railhead.

- Decision whether to use certain railheads and when, bearing in mind the source and shorthaul variables.

These will enable SpoorNet to look at the inbound supply chain as a whole instead of segmented optimisation as in the initial pilot project.

After the completion of this, the benefits for both parties will become much more visible.

Customer A tangible benefits:

- Optimise the number of trips on shorthaul
- Optimise the distance travelled in shorthaul
- Optimise the number and usage of loading operations
- Sourcing will take place from the most appropriate region bearing in mind all the lead times and complications of all the operations that must take place to ensure delivery to the mills.

These tangible benefits can be realised in a financial sense and a reliability/ predictability sense.

The trend in the forestry industry seems to be moving towards more detailed and strict specifications of product types and their quantities. CAPS will be able to handle this without a problem. In fact, software like CAPS will be a necessity if that type of planning is to be done at all without its resulting in chaos.

14.4.3 Extra Mills and Regions

This is the next natural progression in the project and relationship with Customer A. The real benefits of any supply chain design increase if a full holistic supply chain view is adopted. Since regions supply many mills and mills are supplied from many regions, naturally these regions and mills form a part of the same supply chain and in terms of planning, forecasting and operations it should be treated as such.

The rest of the mills and forest regions should be incorporated into the CAPS model. It should be done in the same manner as the initial pilot project.

14.4.4 Finished Products

As discussed before, a supply chain should be looked at holistically so that supply chain optimisation and improvement takes place (not just localised optimisation). To feel the full effect of these benefits, the final product/s should be incorporated into the model.

This is because Customer A has a number of customers that must be supplied with products by mills or through distribution centres (DC). These products are made from raw materials and therefore the demand for the final product should be reflected in the demand for the raw materials.

Questions such as what mill should supply what customer or DC and what DC should supply what customer. This global approach could change how much of what product and when the mills produce i.e. also how much raw material they need and from where and when.

The benefits are for Customer A and Spoornet:

Spoornet:

- More business on the outbound side. This means not only financial gain but strategic market penetration. More existing clients and potential clients will become aware of Spoornet's logistical capabilities. This could also mean more business in the outbound sectors.

- Improved knowledge of what is required on the supply chain will lead to savings through better planning etc.

Customer A:

- Improved service levels to end clients
- Lower total logistics costs
- Better utilisation of assets such as DC and mill
- All benefits that come with the inbound logistical solution can be further improved by realising that end customers demand should initiate action in the supply chain. Therefore surpluses of inventory and capacity are decreased.

Many of these benefits, especially inventory, can be translated directly to Rands and cents.

15 LESSONS LEARNT

15.1 Data

CAPS is a data hungry tool. It requires not only large quantities of data but also accurate data. Much of this is, of necessity, unique and has not been commonly used in decision making in that form and manner.

The owners of the data are usually located in different departments and organisations.

This causes it to be very time consuming to negotiate and collect all the information. Often, it can take so long that the role players lose focus and interest in the project. It is also too long to be used in prompt and efficient decision making.

In future, it will not only be essential for sufficient time to be allocated to the collection of data but also to the negotiations with various parties, internal and external, for the availability of the data.

The knowledge of supply chains and CAPS should enable the team to be able to determine the data requirements very soon after the project kick-off. This will enable all parties to gear up in time for the data collection.

It is very important that facilities are provided for storage of the data that is used in all the projects. Much of it can be re-used in new projects. This would mean a creation of a type of Knowledge Base to support CAPS.

15.2 Company Culture and Trust

As with all partnerships, considerable trust is required ^[32]. If this trust is not present, neither party will be willing to share data or to allow part of its decision making to be done by CAPS.

These partnerships take time ^[29]. A CAPS project should not be started in a partnership where the relationship is unknown or uncertain. It will cause the project to fail.

The principles of supply chain management in terms of total cost etc. are not new. However, many companies in South Africa are not aware of them and hence do not practice them. CAPS operates on these principles.

If a company is not aware of co-operation, data transparency and does not believe in new technology and the adoption of the "win-win" principle ^[29], then CAPS will also fail.

That company will neither be able to see the benefits of CAPS nor agree to support it.

It is essential to realise that the choice of the partner in a CAPS project is of the utmost importance.

In this case study the partner was not ideally suitable for this type of venture, especially for a pilot project. Customer A limited the scope of the project so it did not bear any risk in the success of the project. One of the major discussion points was the rail tariff. Their focus should have been on lower total cost rather than lowered rail tariffs.

15.3 Organisational Structure to support CAPS

Who will use CAPS after design and implementation of the model? Who will review the model? Who will measure the performance of the plans produced by CAPS?

All these questions need to be answered. There must be someone to hand the model over to, to run and use it. This would be the Channel Manager. He/she must be trained in usage of the tool. It must also be clear to all parties who in fact will be the user after the design and implementation stage ^[31].

Without after design support, it will not be used or those who should be using it, will reject it.

The entire chain of organisations must be aware of what CAPS will do. It must have support of top management and all role players. They must be aware of how CAPS will influence their business and how they will benefit from it.

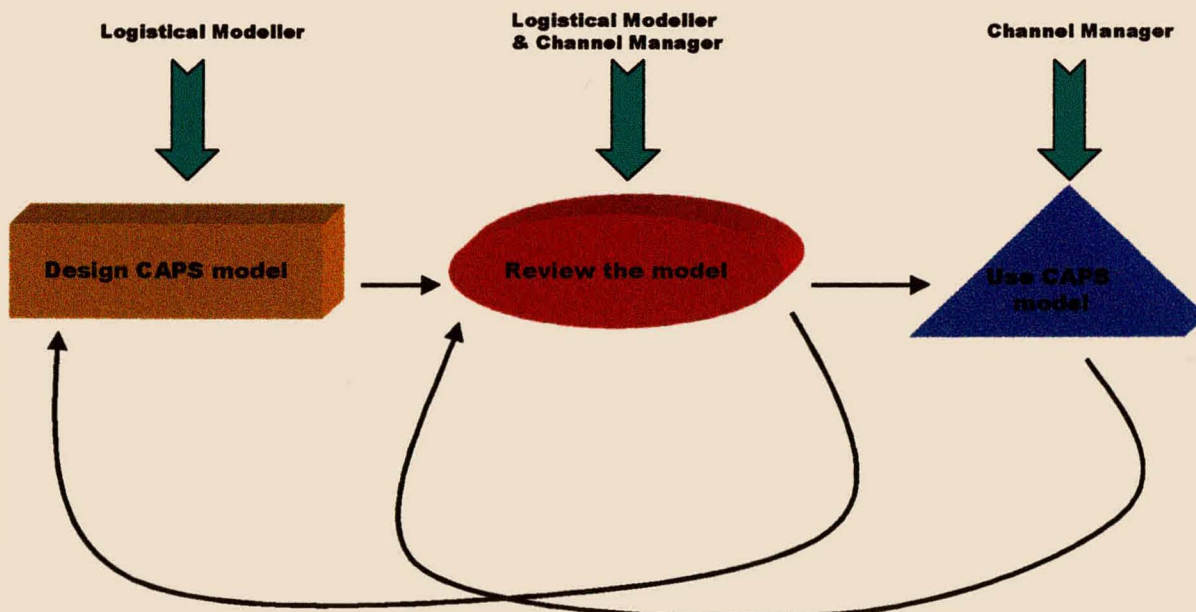
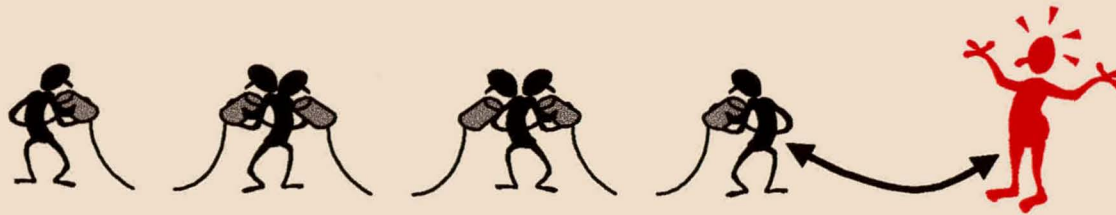


Figure 34: Personnel supporting the immediate use of CAPS



Current Situation: No one has responsibility over the supply chain



Future Scenario: Roles in the supply chain

Figure 35: Roles in the Supply Chain

Figure 35: Roles in the Supply Chain, above, indicates that in current supply chains no one has assumed responsibility for the efficient and effective operation of the total supply chain, obviously to the detriment of all parties. In future, one of the organisations must take a holistic responsibility for the supply chain and globally plan and manage it, e.g. by using CAPS.

It is essential that the right company be involved. If not, there will be conflicting interests and the project will not succeed.

It is equally detrimental to the project if the company does not know what its role is in the supply chain. This indecision will also cause conflict and the project will fail ^[30].

15.5 Pricing

Pricing has been touched on already and involves the distinction between total cost, cost of the value of the service, and ordinary pricing.

It is essential that both parties realise that the aim in a supply chain should be to lower the total cost. This will enable them to share the savings and obviously experience a cost saving themselves.

It will be done by optimally designing and planning the various elements and activities in the supply chain. It may cause one supply chain element to increase in price but will enable overall decrease in costs. The project will fail if all parties do not agree to do this.

All too often, parties want to lower the rail tariff they are currently paying. They do not realise that with the use of CAPS optimisation, they should be paying for value of rail service not just the basic tariff because they are getting a better service. This new rail cost will not contribute towards an increased total cost, but rather a decrease.

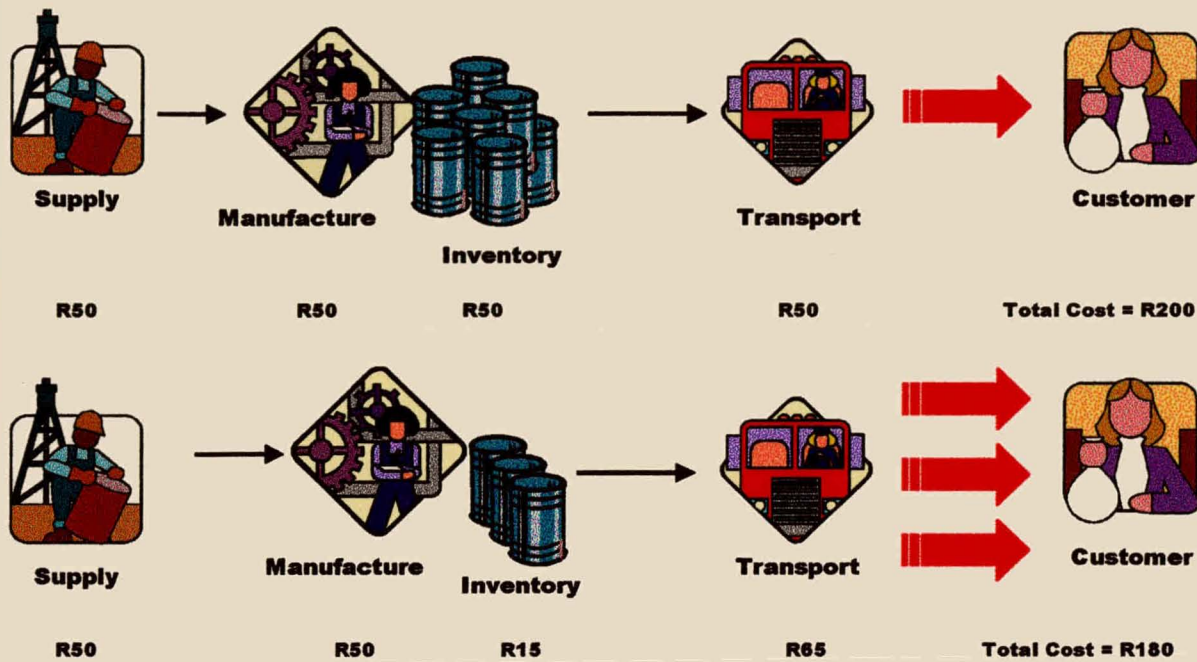


Figure 36: Concept of Total Optimal Cost vs. Local Optimal Cost

These principles are explained in Figure 36: Concept of Total Optimal Cost vs. Local Optimal Cost, above. The top row of the diagram shows the current situation, all services cost R50 giving the total cost of R200. If global optimisation of the supply chain takes place the least total cost will be R180.

However, if one looks at the situation on a local level, the cost of transport has increased to R65. This would be viewed negatively if this were the only cost that is considered in decision making. Meanwhile, due to the improvement in the transport service provided, the inventory levels have decreased to R15 and a saving was realised there.

This serves to illustrate that a local optimum and lowest local price may not necessarily be an optimum and lowest cost on a global level.

15.6 Performance Measurement

Part of the success of CAPS depends on organisations knowing how they are performing. If there is no indication of this then it will be very difficult for CAPS to illustrate where improvement has taken place. It will also be difficult to identify potential areas for improvement.

To prove the success of a project is very difficult. The manner in which the organisation is measured is also significant. If it is evaluated on incorrect measurements with respect to supply chain best practice and principles, the organisation will not be keen to adopt CAPS as it will "lower" the performance of its personnel.

E.g.: a transport manager is measured on the transport price he negotiates. The CAPS optimisation may cause this cost to increase. It will seem as if the manager has performed badly.

However, this may have enabled the organisation to decrease inventory levels and increase inventory turnover. Overall it lowered the service costs of the organisation. This will not be illustrated and CAPS will receive resistance.

16 CURRENT THINKING

It is important to consider several other factors when considering Supply Chain Management (SCM) tool other than suitable technology. It is important to fit the SCM tool into the organisation in the best possible manner in order to utilise and gain the best possible benefits from the solutions provided.

Even though these tools have been on the market for some time, it is only in the last couple of years that there has been a flood of interest in them. They have begun to be seen as the ultimate solution.

It is important that organisations are aware of their need for such a system as well as of the demands that the system will make on their organisation.

16.1 Assessing the Organisational Role in the Supply Chain

Not every organisation needs an SCM tool. It is important to make sure that your organisation is part of a supply chain or a supply chain that can use such tools to design and plan their operations ^[34].

It is up to the organisation to assess its role in the supply chain and decide whether it should "be the drummer" in the supply chain i.e. play the role of the administrator or whether it is the one that listens to someone else's "drumbeat".

Figure 37: Graphical Representation of a Typical Supply Chain, contains a graphical illustration of a supply chain. Every role-player has a certain duty in the supply chain, depending on whether he is a supplier, manufacturer or the distributor ^[14]. In order for the supply chain to run smoothly, the organisation must conform to those duties. There will also

be the champion, administrator or virtual head ^[14]. This organisation will have the overall view and control of the supply chain. This role will be very different to that of a service provider.

It is not essentially important who plays this role in the supply chain as long as there is someone who will do it. It is preferred that the organisation should be relatively close to the end customer and a major player in the supply chain in the past ^[30].

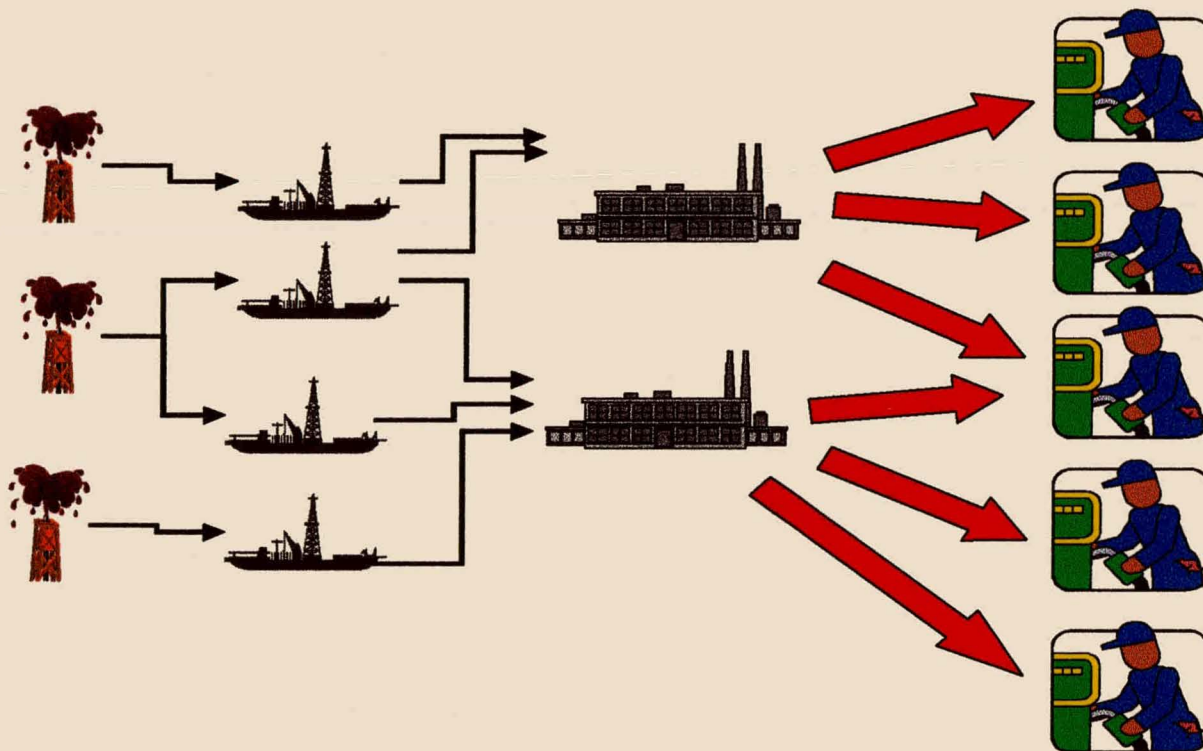


Figure 37: Graphical Representation of a Typical Supply Chain

Only after choosing its role in the supply chain, should the organisation start looking at what software and capability it should establish. If the role were that of a service provider, ERP software would be recommended.

If the role is that of the “virtual head” of the supply chain, SCM software is a must ^[31].

16.2 Do I really need Supply Chain Management software?

Every organisation asks itself this question at one time or another. Software is expensive, considerable effort and expense is needed to implement, use and provide data for it ^[20].

In the past this type of software was only really used by organisations with a Research and Development department. They were considered "pie in the sky" applications and only a few could afford them.

Figure 38: Software Solution Segmenting Quadrants, below, illustrates four groupings that software applications can fall into. In quadrant one, the software will enable your organisation to become more efficient but is not critical to the success of your organisation. In quadrant two -Key Operational, these tools are necessary for your success but will not provide you with any competitive advantage.

Quadrant three - Competitive Advantage, includes applications that will provide your organisation with a jump in the market and will make you the leader in that market. The quadrant with High Potential is tools that are not yet well developed and are still being experimented with. In the near future they will become tools that will give you a competitive advantage and it will be necessary for an organisation to procure such a tool ^[33].

3. COMPETITIVE ADVANTAGE	4. HIGH POTENTIAL
<ul style="list-style-type: none"> • Applications which are critical to sustaining the future business strategy <p><i>Differentiation drivers</i></p> <p>Supply chain management systems</p>	<ul style="list-style-type: none"> • Applications which may be important in achieving future success <p><i>Technological drivers</i></p>
<ul style="list-style-type: none"> • Applications on which the organization currently depends for success <p><i>Effectiveness drivers</i></p> <p>Order management & dispatch</p>	<ul style="list-style-type: none"> • Applications which are valuable but not critical to success <p><i>Efficiency drivers</i></p>
2. KEY OPERATIONAL	1. SUPPORT

Figure 38: Software Solution Segmenting Quadrants

Currently SCM software packages fall into quadrant three. It is necessary to get ahead in the market as well as to keep your existing market share. Soon this software will be an absolute requirement in order for your company to survive. It will not even provide you with a competitive advantage.

This type of software is no longer a pipe dream but reality. Organisations must realise this and utilise them ^[29].

16.3 Monitoring

After a supply chain has been planned and designed, how does one know in time if the operations are running according to plan? How does one know if the order will be delivered late before it actually arrives late? How do you know that one supplier cannot perform in time to change to a different suppliers? ^[35]

Effective and efficient monitoring is an essential part of the Supply Chain Management process^[32]. Monitoring the activities as and when they happen across the entire supply chain will enable organisations to know what is going wrong and rectify it in time.

The plan produced by the SCM tool can be used as a baseline. The Channel Manager can observe if the operations as they happen on the ground are in accordance to the plan. If they do not, he/she can use the information from the monitoring toll to re-plan the supply chain or sectors of the supply chain to find a new suitable feasible as well as optimal solution.

This could mean alternative routes for vehicles, use of different pooling stations or different schedules for the vehicles. The Channel Manager would communicate this change to the relevant service providers so they could change their operations accordingly.

This analysis by the Channel Manager can be used to rectify a fault or an incident with the minimum effect on the rest of the supply chain and will enable the Channel Manager to provide a solution that is as optimal as possible.

The monitoring function exists as either a separate software and hardware application that collects data from key points in the supply chain and sends warning signals if there is a non-conformance to the plan or it may also be part of the Supply Chain Management tool. Many vendors of such tools are adding modules to the more traditional SCM software to enable the monitoring function.

The benefits extend further than just knowing if you are running to plan and being able to re-plan. It can be used to provide data for performance measurement of your organisation and for the supply chain. Various service providers can be measured and compared to their service level agreements. The data can be used on higher levels of supply chain planning and design to analyse long and medium term trends and design them into the strategic and tactical plans.

Monitoring of the supply chain provides data that was previously not available and enables continuous improvement of the supply chain.

16.4 Customer Intimacy

In the current international markets and businesses, the customer is actually the one that runs the supply chain. The customer has become very demanding and as a result of increased competition between organisations and supply chains; companies have to satisfy these customer needs.

One of the keys is reacting to changed customer needs as quickly as possible and satisfying those needs before your competitors. Much of this depends on a flexible and efficient supply chain ^[21].

As a result supply chains have attempted to find out more about their customer. This has often meant linking the Supply Chain Management tool to software either used by the customer or to various business intelligence tools that would indicate changes in consumer demand.

Forecasting has been taken to another dimension where intelligence and accuracy are emphasised.

Many of these tools are being linked to the SCM tool to provide input in terms of customer demand or changes in the markets.

This fierce competitiveness and dynamics of the market underlines the need for a Supply Chain Management tool. It requires fast time to market, cheaper distribution and lower inventory levels to prevent obsolescence ^[29]. These cannot be accomplished by Channel Mangers without SCM tools.

Organisations are using these tools to enable them to get closer to their customers, operationally and technically ^[31].

16.5 Supply Chain Management Tools and the Internet

(reference 29 and 31)

The improved functionality of the Internet and its more widespread use have further enabled supply chain management ^[31]. The tools require timely and accurate communication of information from the service provider or from the monitoring system.

The Internet can do all this securely, effectively and efficiently. Figure 39: Example of how EC could enable inter and intra organisation communication, below indicates how such a set-up could be structured. External parties such as service provider as well as clients can connect to the organisation via electronic commerce. The organisation's own internal communication between databases, tool and systems can also take place via electronic-based communication.

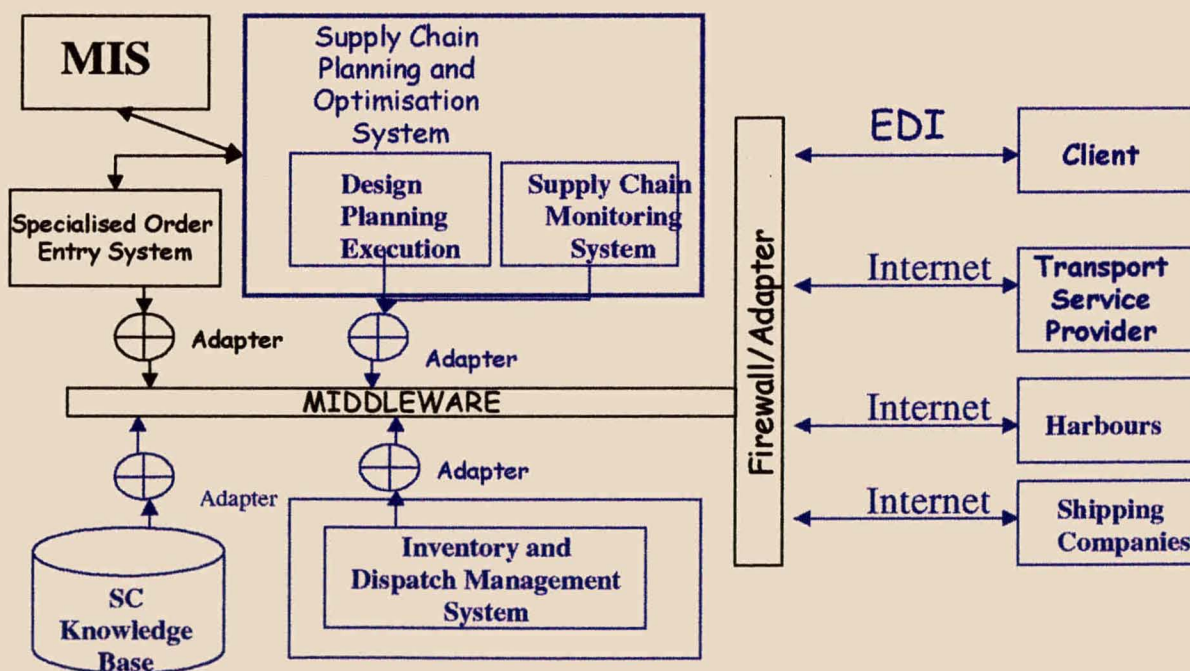


Figure 39: Example of how EC could enable inter and intra organisation communication

This type of communication does depend on each service provider having access to it. This is currently not always the case. However, it is becoming cheaper and easier to operate and will enable a paperless system to function in the supply chain.

It will further compress the supply chain in terms of time. All resources and time wasted in filling out paper and transporting documentation to the required locations and storing it will be significantly decreased.

The impact will also be on the interaction with the consumer. Placement of orders, invoicing, billing and payment can all be done through the Internet. The concept of customer intimacy is taken a step further as offers, promotions and advertising can be done on the Internet ^[29]. A specific customer can be reached directly by E-mail and products he/she is interested in are offered to him/her.

It will also have a major impact on the market and increase the rate of globalisation. Any customer can be reached electronically regardless of where your organisation is and where they are.

It is now possible for manufacturers to sell their goods without the need for retailers. With the widespread use of the Internet, organisational niches are becoming blurred and one must establish them in the market before their function is made redundant ^[31].

Similarly to other leading edge systems, currently in South Africa, the Internet is not a must for every organisation or supply chain. However, the growth of markets and the increase in competition will necessitate the use of Internet in the near future in order for the organisation to keep its markets.

Yesterday it was a luxury, today it is leading edge and tomorrow it will be necessary for survival.

16.6 Fitting the Supply Chain Management System into the organisation.

One does not just fit a software tool into an organisation. The tool must be able to solve the problems that the organisation is facing.

The organisation should not be re-engineered to fit the system, rather the organisation should be re-engineered (if necessary) to enable it to solve the problems or deliver its products more efficiently and effectively.

The following three sections discuss factors that should be considered when deploying new software tools into an organisation.

16.6.1 Organisational Structure

Supply Chain Management systems are complex and require support in terms of data, hardware, networks as well as human resources to create an output and effectively utilise that output.

Figure 40: Roles and Competencies supporting Supply Chain Management, below, illustrates a potential human resource set-up that would function in a supply chain management process to utilise such a tool.

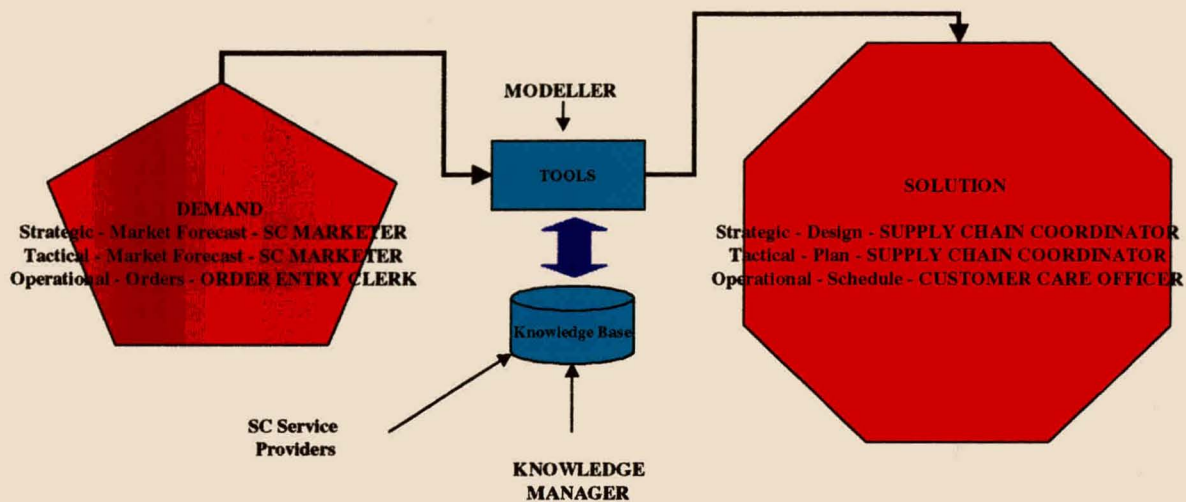


Figure 40: Roles and Competencies supporting Supply Chain Management

16.6.2 Process

All activities and deliverables in an organisation start and end with a process. It is this set of activities that delivers the final product. The human resources and systems are just mechanisms that allow one to carry out these activities and processes.

The organisation should not have systems or people that do not contribute to its value adding processes. These redundancies can be considered as waste.

The process on the following page in Figure 41: High Level Supply Chain Management, is a high level process that was designed to enable supply chain management and the utilisation of an appropriate tool. The further breakdown detail of each of the activities is available in Appendix G.

The supply chain management tool is utilised in nearly all the tasks in the high level process. It will carry out "what if" analyses, optimise distributions and design optimal network layout. It comes into each activity from the bottom and is illustrated by a red line.

Its use is always coupled with the use of personnel to set up the models, run them and obtain the outputs.

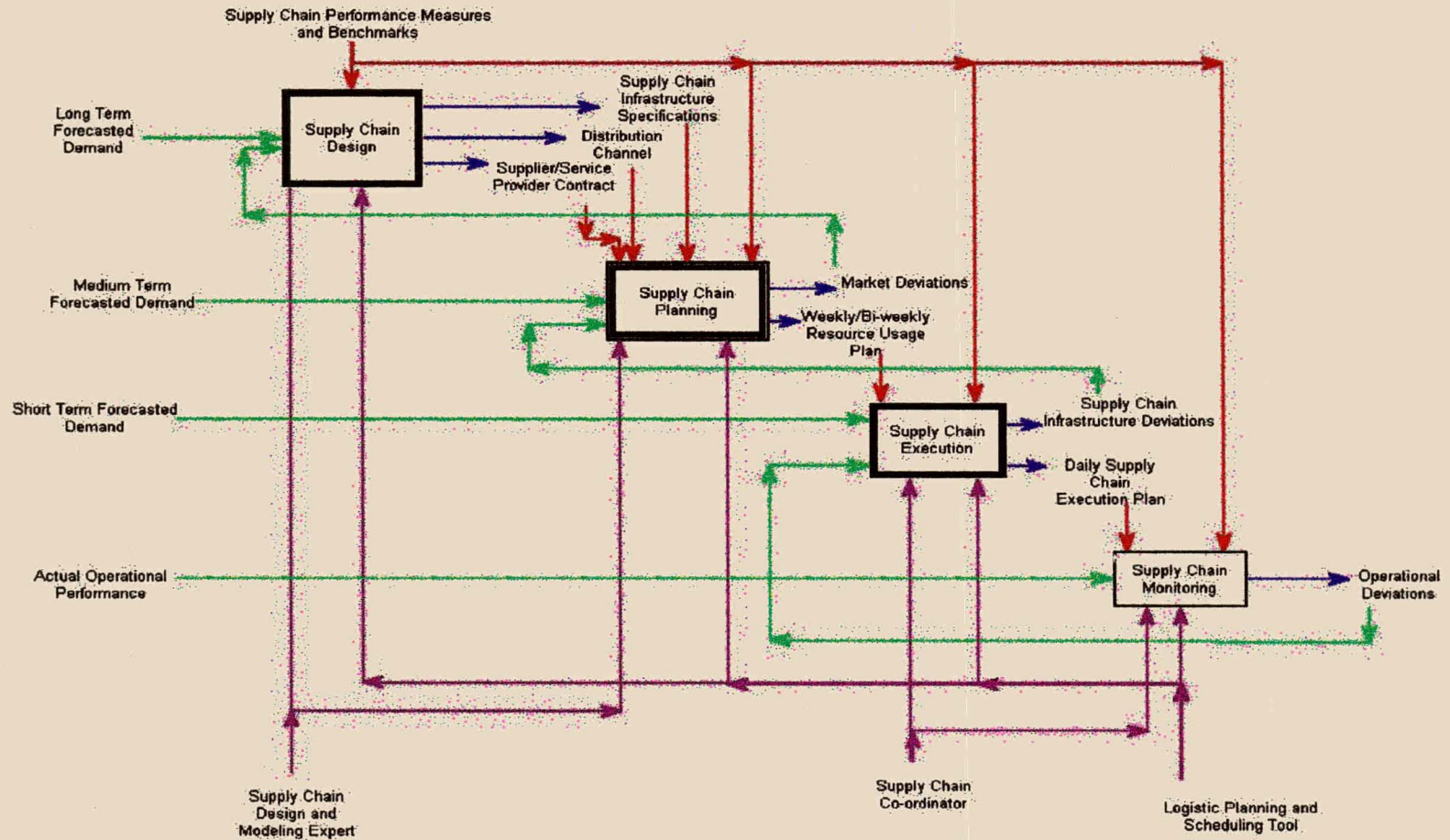


Figure 41: High Level Supply Chain Management Process

16.6.3 Culture

The correct culture in the organisation and in its partners in the supply chain is essential, not only for the successful implementation of a Supply Chain Management tool, but also to the success of the supply chain as a whole.

The entire process and the system requires trust and co-operation from all the parties. It requires sharing of important information and the understanding that it is necessary for the success of the supply chain and, hence, for the success of their own organisations as well.

If this is not present, the system cannot be successfully implemented and used. Values such as the following are needed in an organisation:

- Trust**
- Awareness that all the organisations in the supply chain aim for the same goal i.e. they are not competing against each other.**
- Openness**
- Awareness that products alone does not compete, supply chains do.**
- Empowerment to allow supply chain managers to make and take decisions that significantly impact on the supply chain. This includes financial decisions.**

17 CONCLUSION

From the birth of the idea that a decision support tool is needed to the development of the idea that it is a supply chain management system and the realisation of what technology could and should be used to perform the primary functions of such a tool, took over a year.

Thereafter, the refining of the applications and uses of the tool took a further twelve months.

This is a lengthy process. It is therefore important for organisations to realise that such a tool is required and to develop it in their organisation very soon before this type of tool becomes just the run of the mill tool and no competitive advantage can be gained from of it.

In a PA Consulting Group survey carried out in the early part 1997 on supply chain insights for the new millennium, it was agreed upon by those surveyed that major technological trends affecting businesses in the next five years will be as depicted by Figure 42: Technological Trends Effecting Business in the next 5 years

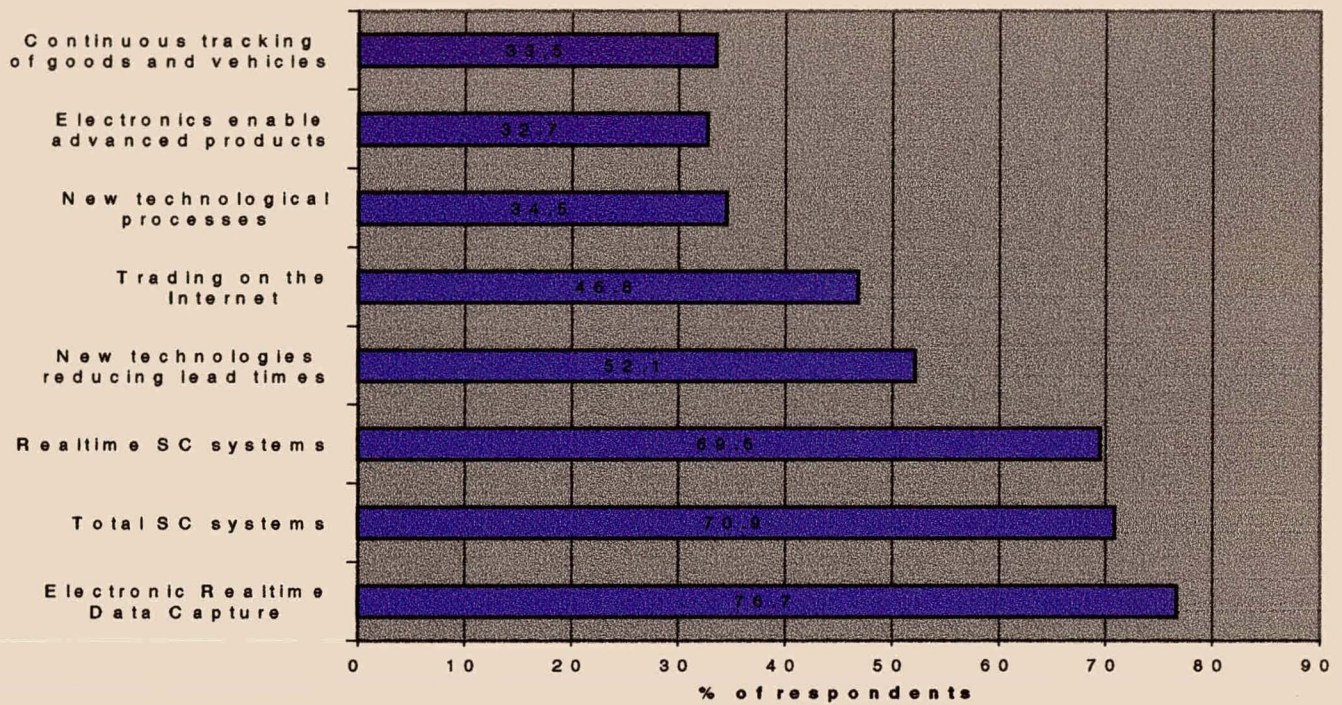


Figure 42: Technological Trends Effecting Business in the next 5 years ^[31]

The group that took part in the survey consisted of a wide range of industry sectors known to have a proactive approach to supply chain management. In total 800 directors and managers from 14 countries were consulted.

From the survey results it can be seen that both Total Supply Chain System and Real-time Supply Chain systems are in the top three. The top one being Electronic Real-time Data Captures. This works symbiotically with supply chain systems as much real-time or very quick data capture is required to fully enable supply chain management.

Trading on the Internet, discussed in this report, is also considered very highly (in fifth place).

As a result, globalisation of markets is necessitating this type of system. South African organisations have been isolated up to now and it is important that they bridge not only this

technological gap but also the gap, in terms of organisational behaviour and culture to enable these tools to be implemented and fully utilised.

18 RECOMMENDATION

During the early to mid 1990s these SCM tools were in an experimental and research phase. As we head into the new millennium these tools have become one of the mechanisms for world leading organisations to compete with.

These types of tools are strongly recommended to organisations looking not only to streamline their costs and operations but also to increase revenue and market share. In conjunction with traditional transaction systems such as the ERP, these tools can be very powerful means of intelligently and analytically assessing and solving various operational and planning problems and inefficiencies.

They are, however, not immediately suitable for all organisations. A level of technical, cultural and innovative capability and sophistication is required from an organisation as well as its trading partners. An organisation should ensure that it is at a suitable level of sophistication or that it and its partners are capable and willing to achieve that level before they attempt to implement and utilise these tools in business decisions.

If this is not the case, organisations should consistently develop suitable capabilities and climate by developing an environment of trust and co-operation within and outside their organisations. In addition they should ensure the awareness of the supply chain principles amongst their employees and partners.

Technical requirements such as implementation of ERP systems and the design and adoption technical and business architectures should be engineered into organisation business strategies for time to come to ensure their readiness to handle the extensive technical and data requirements of the supply chain management tools,

19 SUMMARY

A number of important lessons were learnt not only from the completion of this thesis but also from taking part in all the initiatives that are discussed in the body of the report.

Human interaction and partnering is essential in a supply chain initiative. While it is not technologically complex, it is complex from a political and a change management point of view. It is this part on any initiative that can easily cause a project not to succeed and yet it is often underestimated in terms of its importance as well as the impact it can have.

Preparations for a project are also of the utmost importance. This part of the project seems relatively unimportant as it is seen not as delivering any visible results and taking too long. However, without this preparatory stage, the work that will be done in the later parts of the project will not be as effective and may even be unsuccessful.

The preparatory stages should include activities such as:

- Determining the complexity of the supply chain.
- Finding out the maturity of the culture and determining the technical sophistication of the role players.
- Determining the shortcomings and developments of the supply chain and role players to indicate where emphasis should be placed when collecting data, carrying out of negotiations, looking for bottlenecks in the system and estimating the duration of the project.
- Etc.

Delegation of responsibility is an essential factor in a project. It is important to delegate various activities and tasks to responsible and perhaps more qualified people (in that particular field). This will ease the flow of the project.

It may also cause difficulty and delay in the project, especially if those people do not perform as expected. It is, therefore, of high priority to choose these partners well to minimise potential problems when/if they do not perform.

Overall, the project was not a total success. It was not completed and therefore the benefits and savings that were to be gained from the use of CAPS were not realised at this customer.

The partial success of this project was in the form of providing the groundwork for other CAPS models e.g. GIS maps and costing information. Some models were built and several specialised macros had to be written. These provided experience for further supply chain modelling projects.

The project did provide an indication of what all the potential benefits of the use of a tool such as this could be to the supply chain as well as for all the organisations (and their partners) using it.

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21 APPENDIX A: ERP SOFTWARE

This Appendix consists of various documentation describing the characteristics and the capabilities of a number of ERP software applications available on the market. They are:

- SAP
- PeopleSoft
- Baan

For each of these vendors the literature provides an overview the various modules that are available, their applications and strengths. A general description of the tool and the integration capability of the modules is also displayed.

Although this literature contains reference to many forms of supply chain management, in reality they are unable to provide this service as comprehensively as these brochures would like us to believe. This is mainly in a effort to catch up to the supply chain management tools in this sector of the industry.

It is a case of a sales person wishing to make the sale regardless on the actual fit of the tool to the organisation.

Despite this fact, however, these brochures provide a very good indication of the capability and the core area of ERP application.

The data in this Appendix was used as one of the sources for information during the selection of supply chain management tools. Because its contents is very basic and not objective, it was used to provide the initial view of what the tool does and the areas of business it operates in.

Business Solutions for Companies of all Sizes.



SAP, the world's largest inter-enterprise software company, provides companies of all sizes with business solutions that deliver A Better Return on Information. SAP products and services integrate an organization from financials and human resources to manufacturing and sales and distribution. This integration enables companies to optimize supply chains, strengthen customer relationships, and make more accurate management decisions.

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E-Commerce

- SAP B2B Procurement
- SAP Online Store

SAP Employee Self Service

SAP Customer Relationship Management

SAP Business Intelligence

- SAP Business Information Warehouse
- SAP Knowledge Management
- SAP Strategic Enterprise Management
- SAP Corporate Finance Management

SAP Supply Chain Management

- SAP Advanced Planner and Optimizer
- SAP Logistics Execution System

SAP R/3

- SAP R/3 Financials
- SAP R/3 Logistics
- SAP R/3 Human Resources

SAP Treasury

SAP Real Estate

SAP Environment, Health & Safety

SAP Industry Solutions

Complementary Software

SAP Accelerated Solutions

SAP Business Technology

Year 2000

Euro

The SAP R/3 System – Thinking and Acting in Business Processes

As a company, you need dynamic strategies to meet the challenges of today's fast-paced business world. The ability to respond nimbly to new customer needs and seize market opportunities as they arise is crucial. The answer? A powerful, open IT infrastructure that will optimally support your business activities and let you adjust flexibly to change and progress: SAP's R/3 System, the world's most-used standard business software for client/server computing.

Flexible...

R/3 enables you to respond quickly by making you more flexible – so you can leverage changes to your advantage. Your everyday business will surge, letting you concentrate on strategically expanding to address new products and markets.

Comprehensive...

SAP's R/3 System is ideal for companies of all sizes and industries. It gives them both a forward-looking information management system and the means to optimize their business processes. Why not yours as well?

At SAP R/3's core are powerful programs for accounting and controlling, production and materials management, quality management and plant maintenance, sales and distribution, human resources management, and project management. Information and early warning systems are also available. And the Business Information Warehouse conveniently edits external and internal data to support decision-making at all corporate levels.

Open...

The SAP R/3 System is an unbeatable combination of functionality and technology. Although designed as an integrated system, SAP R/3's modules can also be used individually. You can expand it in stages to meet the specific requirements of your business. SAP R/3 runs on the hardware platforms of leading international vendors, and will mesh smoothly with your in-house applications. Open to allow interoperability with third-party solutions and services, it is quick and efficient to install. The SAP R/3 System enjoys full, 24-hour support from SAP's global service network. Companies in over 90 countries are already benefiting.

Integrated...

SAP R/3 overcomes the limitations of traditional hierarchical and function-oriented structures like no other software. Sales and materials planning, production planning, warehouse management, financial accounting, and human resources management are all integrated into a workflow of business events and processes across departments and functional areas. Employees receive the right information and documents at the right time at their desktops. SAP R/3 knows no organizational or geographical boundaries. Corporate headquarters, manufacturing plants, sales offices, and subsidiaries all merge for integrated handling of business processes.

Beyond the company...

But SAP R/3 does more than open up completely new IT solutions within your company. Its applications also link your business processes with those of customers and suppliers to create complete logistical chains covering the entire route from supply to delivery. SAP R/3 lets you integrate banks and other business partners into intercompany communications, both nationally and internationally.

Best business practices...

SAP R/3 software lets you integrate all your business operations in an overall system for planning, controlling and monitoring. You can choose from 800-plus ready-made business processes – and their number continues to grow. They include best business practices that reflect the experiences, suggestions and requirements of leading companies in a host of industries. SAP R/3 lets you profit directly from this wealth of business and organizational know-how.

New technologies...

SAP R/3 continues to evolve in close dialog with our customers. We incorporate cutting-edge technologies such as object orientation into our development work and translate them into practical customer benefits. We also harness innovative applications to extend the ways in which you can use

SAP R/3. Take the Internet, for example. More and more companies are using the Internet not just for marketing and communications, but also for procurement, customer service, and order processing. SAP R/3 is directly linked to the Internet and ready for electronic commerce.

Safely into the new millennium...

The euro, the new European common currency, is coming in 1999. Its effects will be far-reaching, especially for companies operating in Europe. All your payment, account rendering, and processing procedures will be affected. Can your software cope? SAP R/3 is already prepared for the euro. With multi-currency capabilities, dual-currency functionality, and exchange-rate support, SAP R/3 meets the requirements associated with the imetable for introducing and converting to the euro. With SAP R/3, the approach of January 1, 2000 won't give you any sleepless nights: We'll take you smoothly into the new millennium. Because SAP R/3 already works with 4-digit years, planning in the human resources, financial accounting, and logistics areas poses no problems at all, and there's no need to worry about modeling your long-term purchasing and delivery contracts either.

SAP R/3 – Dynamic Information Management for Enterprises of All Sizes from Diverse Industries

Today companies compete fiercely for market share and work hard to operate profitably. SAP R/3 is a major strategic tool for achieving these aims. SAP R/3 gives enterprises of all sizes and from all types of industries a flexible software base for their business infrastructure.

Moreover, they profit from the quality and powerful functionality of SAP R/3's applications, which meet the information management needs of both medium-sized and large multinational companies. This flexibility as regards enterprise size is demonstrated by the fact that over 50% of SAP R/3 installations are in small and medium-size companies.

SAP R/3 solutions are hard at work in some vertically structured industries. Automobile manufacturers use SAP R/3 to build flow factories, in which just-in-time materials and assemblies flow from the supplier into production and then as finished products to the customer. Retail companies use SAP R/3 to boost consumer response. The pharmaceutical and chemical industries use SAP R/3 to integrate commercial and technical applications.

Banking and insurance businesses use SAP R/3 to coordinate revenue and risk management and optimally manage their financial assets. Manufacturing companies use it because SAP R/3 simultaneously supports several types of production. Special enhancements to the SAP R/3 System enable government agencies to make their services more efficient and cost-effective. In wholesale businesses, SAP R/3 speeds up all processes from suppliers to final customers and permits simultaneous optimization of wholesale and consumer prices. Publishers and media take advantage of SAP R/3's flexibility to respond to short-term changes in the markets. Utilities use SAP R/3 to reorganize their business processes and improve the quality of their services. These examples illustrate the versatility that has persuaded companies in over 90 countries around the globe to adopt SAP R/3.

Let's Talk


SAP R/3 is a software product that unlocks the path to efficient organization units and to new IT structures, with the ability to continuously adapt to dynamic market and competitive changes.

With its integrated processes for complete handling of enterprise processes, SAP R/3 holds considerable potential for reengineering conventional structures and organizational methods. SAP R/3 enhances performance by redesigning your core business processes to revitalize and optimize them. This overcomes the divisions of labor that restrict productivity. For multi-enterprise business processes, SAP R/3 covers companies, their vendors, customers, and banks.

Talk with us about how to use SAP R/3 as your company's business infrastructure.

We look forward to beginning a long-term partnership with you.

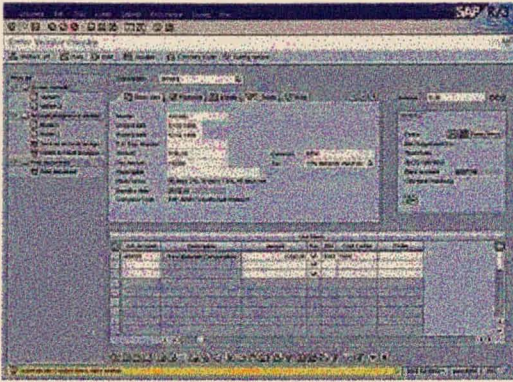
More Information |

 Overview "SAP R/3 System" (1.6 MB)

 Overview "Implementing SAP R/3 in Record Time ..." (1.2 MB)

 Overview "SAP R/3 System References" (1.9 MB)

SAP R/3 Financials






SAP's suite of integrated financial application components encompasses all aspects of financial accounting, investment management, controlling, treasury management, and enterprise controlling.

Accounting lies at the core of your enterprise. SAP's R/3 System improves your bottom line by letting you interpret and work with your financial data more effectively than ever before.



"The Software works the way I do." [Experience it yourself!](#)

More Information

-  [Overview SAP R/3 Financials](#) (1,4 MB)
-  [Overview SAP R/3 - Release 4.0](#) (1.3 MB)
-  [Overview SAP R/3 - Release 4.5](#) (525 KB)



Order SAP R/3 Knowledge Products, Computer Based Training, Delta Study Guides, Delta Kiosk CDs, Online Documentation CDs, and Print Files CDs through the [SAP Store](#) now!

SAP R/3 Financial Accounting

Company-wide control and integration of financial information is essential to strategic decision making. SAP R/3 Financial Accounting gives you the ability to centrally track financial accounting data within an international framework of multiple companies, languages, currencies, and charts of accounts. For example, when raw materials move from inventory into manufacturing, the system reduces quantity values in inventory and simultaneously subtracts dollar values for inventory accounts in the balance sheet.

The Financial Accounting component complies with international accounting standards such as GAAP and IAS. It also fulfills the local legal requirements of many countries and reflects fully the legal and accounting changes resulting from European market and currency unification.

Although SAP R/3 Financial Accounting transactions are processed individually, they are integrated with all other relevant financial areas.

General Ledger

SAP R/3 General Ledger (GL) is essential both to the financial accounting system and to strategic decision making. Through active integration with business processes in SAP R/3 Logistics and in the accounting subledgers, SAP R/3 GL serves as a central pool of financial data for financial reporting as well as for other accounting areas. The General Ledger supports all the functions needed in a financial accounting system. This includes flexible structuring of the chart of accounts at group and company level, distributed application scenarios using Application Link Enabling (ALE), real-time simultaneous update of subledgers and the general ledger, elimination of time-consuming reconciliation, and parallel views of data in both the general ledger and managerial accounting applications.

As an enhancement to the General Ledger, the Special Purpose Ledger system provides summary information from other components at a user-defined level of detail. By creating combinations of entered data, you generate data summaries that can be used in planning, allocation, distribution, and reporting.

SAP R/3's Special Purpose Ledger also allows you to take advantage of more functions in General Ledger and in Cost Center Accounting. For example, you can create your own database tables and define non-standard fields to suit specialized accounting or reporting requirements.

Accounts Receivable and Payable

SAP R/3 offers a financial overview of global business partner relationships in the Accounts Receivable and Payable subledger functions. These subledgers are integrated both with the General Ledger and with areas in SAP R/3 Sales and Distribution (SD) and Materials Management (MM), where financial data originates. Accounts Receivable and Payable transactions are performed automatically when related processes take place in other SAP R/3 components.

This module uses standard business rules for procedures ranging from data entry and reporting to processing payments and bank transactions. Accounts Receivable and Payable functions include Internet integration; document management; full support for EDI processing, including automatic clearing by lockbox processing; integration with cash management; and flexible reporting using customer and vendor information systems. The module also provides flexible dunning, enterprise-wide credit management with workflow integration, payment automation with EFT and check processing, and document parking with various approval procedures.

Fixed Asset Accounting


SAP R/3 Asset Accounting manages your company's fixed assets. Within the Financial Accounting system, FI-AA serves as a subledger to the General Ledger, providing detailed information on asset-related transactions. Significant features include country-specific charts of depreciation complying with local legal requirements, full support throughout the asset life cycle from acquisition to retirement, depreciation simulation and interest calculation, and integration with project management and order accounting for management of capital assets. Asset Accounting also provides integration with plant maintenance for management of machinery and equipment, management of leased assets and assets under construction, mass processing with workflow integration, and interactive reporting.

Legal Consolidation

Consolidated financial statements need to be integrated effectively with operational data at the individual company level. Using different valuation methods, you can plan balance sheet strategies to suit your requirements.

SAP R/3 Legal Consolidation (FI-LC), is closely linked to the Financial Accounting system, permitting direct data transfer from individual statements into the consolidated report. In addition to the consolidated statements required by law, Legal Consolidation also allows you to create multiple views of your consolidation data. With these views you can generate reports about legal entities or segments of your business.

More Information

 [Fact Sheet "FI Financial Accounting" \(84 KB\)](#)

SAP R/3 Investment Management

Making the correct strategic decisions on capital spending is increasingly important to overall success. The cost of capital plays an ever more significant role. Your capital investment planning should be an integral part of your business plan. SAP's Investment Management (IM) offers a comprehensive array of functions supporting you in the capital investment process.

Corporation-Wide Budgeting

SAP R/3 Investment Management facilitates investment planning and budgeting at a level higher than specific orders or projects. As a result of subsequently assigning the specific investment measures (internal orders or projects) to positions in the hierarchy, you are kept up-to-date about available funds, planned costs, and actual costs already incurred from internal and external activities. The investment program allows you to distribute budgets which are used during the capital spending process. The system helps you monitor, and thereby avoid, budget overruns.

Appropriation Requests

SAP R/3 IM provides tools enabling you to plan and manage your capital spending projects starting at their earliest stages. In the initial stage of the capital spending process, you enter the application for the spending project as an appropriation request. You define your own evaluation and approval process, during which the system keeps a detailed history of the status of the appropriation request. You transfer the data from the appropriation request to the investment measure when the request is approved for implementation. You enter detailed plan values in the appropriation request, and its different variants, for use in the pre-investment analysis.

Investment Measures

Depending on their complexity, investment measures that need to be monitored individually can be represented either as internal orders or projects. These internal orders or projects provide the means for actually carrying out the capital investment; that is, they serve as the objects for collecting primary and secondary costs, for calculating overhead and interest, for managing down payments and commitments, and for handling other related tasks. As the result of having an asset under construction assigned to it, the investment measure also benefits from all of the required asset accounting functions. Settlement is both flexible and almost fully automatic. This kind of settlement ensures complete integration with business planning and control, and provides consistently up-to-date values.


Automatic Settlement to Fixed Assets

SAP R/3 IM recognizes the importance of the asset accounting aspects of investment measures. The system automatically separates costs requiring capitalization from costs that are not capitalized, debiting the correct costs to the asset under construction. For different accounting needs, the system can use different capitalization rules for making this split. At its completion, the investment measure can be settled to various receivers by line item. Asset accounting provides precise proof of origin for all transactions affecting acquisition and production costs.

Depreciation Forecast

SAP R/3 IM budgeted balance sheets and cost planning are always based on current values. Planned depreciation values for investment measures and appropriation requests can be transferred directly to ongoing overhead cost planning. The system recalculates expected depreciation amounts whenever planning data is updated.

More Information

 [Fact Sheet "IM Investment Management" \(129 KB\)](#)

SAP Treasury

For more and more companies, efficient management of short, medium and long term payment flows and the corresponding risks is growing into a significant competitive advantage.

Tasks such as short-term monitoring and aggregation of the various bank account balances, medium-term planning and forecasting of incoming and outgoing payments in accounts receivable and payable through to a longer-term view of areas such as purchasing and sales underline the importance of integrating information from various company divisions.



Linking these operational divisions to realized and planned investment and borrowing activities in Treasury has a significant impact on the success of a company in today's world. SAP Treasury's aim is to provide companies with a business package for efficient liquidity, portfolio and risk management.

Are you looking for a better Treasury solution? Do you want to improve your return on investment? Then take a look at the SAP Treasury solution:

- [Cash Management](#)
- [Transaction Management](#)
- [Market Risk Management](#)

For further information [contact us](#).

News

- [Euro-Certification](#) for SAP R/3 Treasury (PDF, 160 KB).

Events

- [International Cash and Treasury Management Conference](#)
Lisbon, Portugal, Oct 6 - 8, 1999

More Information

- [Overview "SAP R/3 - Release 4.5 Highlights"](#) (1.4 MB)
- [Presentation "Enterprise-wide Treasury Solutions & New Dimensions Initiative"](#) (711 KB)
at SAPHIRE'99, Nice, May 2 - 5, 1999
- [Presentation "Enterprise Resource Planning Solutions for Treasury"](#) (1.2 MB)
given by Colgate at the Treasury Management Association Conference in San Francisco

Cash Management

The **Cash Management (TR-CM)** component allows you to analyze financial transactions in closed review periods. TR-CM also helps you identify and record future developments for the purposes of financial budgeting. Alongside the traditional financing rules and statistical ratios, dynamic liquidity analysis methods such as cash flow analysis and flow-of-funds analysis are increasingly gaining in importance. Flow-of-funds analysis in particular, is increasingly used to acquire information about the origin and use of funds. In R/3, flow-of-funds analysis is located in the Financial Information System.

Funds origin

TR-CM uses the criteria cash holdings, funds inflow and funds outflow to categorize your company's payment transactions, providing you with information about the origin and use of funds. It also supports the following objectives:

- Securing of liquidity to fulfill due payment commitments.
- Monitoring and control of incoming and outgoing payment flows.
- Provision of information for control of short-term financial investments and borrowings.

Depending on the time period under review, a distinction is made between cash position, liquidity forecast and medium- and long-term financial budgeting. Although the review periods merge into one another (a short-term view leads into a long-term view), different objectives play a role in the different planning forms.

Bank account management

TR-CM therefore ensures that all relevant liquidity information is available and can be evaluated, both fulfilling market requirements and providing a basis for cash management and forecast decisions. Its bank account management tool comprises electronic banking and control functions for running evaluations and making preparations for cash management and forecasting.

Cash position and account clearing

The cash position provides you with information about your current financial situation in bank account terms. You can run the related evaluations at different aggregation levels and vary the level of detail. The cash position therefore serves as the starting point for account clearing. In account clearing, the system concentrates the balances of various bank accounts into a target account while referring to defined minimum balances.

Liquidity forecast

The liquidity forecast additionally integrates anticipated funds inflows and outflows from financial accounting and purchasing and sales to show the mid- to long-term liquidity trend. Within the liquidity forecast you can gain relevant information about debit- and credit-side payment flows from sub-ledger accounting. Payment flows generated by financial transactions in Treasury Management enter both the liquidity forecast and the cash position.

The cash position and the liquidity forecast contain both **foreign currency** balances and anticipated foreign currency items. You can also add **manual planning information** such as payment advice notes or target data to the evaluations. Depending on the organizational structure of your company, analyses are possible both on group level and on individual enterprise level.

More information |

 [Fact Sheet "TR-CM Cash Management" \(134 KB\)](#)

SAP Transaction Management

Using information gained from current liquidity and risk analyses, you consider the conditions prevailing on the money and capital markets before making a concrete **decision** about your company's future investments and borrowings. You implement this decision in the form of financial transactions in **SAP Transaction Management (TR-TM)**. This component brings together the functions from Treasury Management (Money Market, Foreign Exchange, Derivatives and Securities) and Loans Management.

The objectives of the **Transaction Management** component are to:

- Manage financial transactions and positions from trading through to transferring data to Financial Accounting.
- Provide highly automated functions to take advantage of the considerable rationalization potential that arises when representing typical processes.
- Provide flexible reporting and evaluation structures for analyzing financial transactions, positions, and portfolios.

For short-term liquidity and risk management, you can use money market or foreign exchange transactions to smooth out liquidity squeezes and gluts or to hedge against currency risks. In the medium and long-term, securities and loans instruments also come into play. Derivative financial instruments facilitate active management of interest rate and currency risks.

By integrating Transaction Management with SAP Treasury, you can also directly measure the effects of financial transactions on the liquidity or interest rate risk.

Transaction and Position Management process

To take advantage of the rationalization potential for financial transactions, Transaction Management provides flexible processes for transaction and position management, which at the same time fulfill the organizational requirements for process security. This means that standard security measures, such as the dual control principle, can be incorporated using additional release requirements.

These processes, together with the direct transfer of relevant information to Financial Accounting, help you achieve a high degree of automation and manage your business transactions efficiently. All financial instruments in Transaction Management have standardized basic structures or flows, which you can adjust to suit your company.

Function areas

The transaction and position management process for the financial instruments from the Money Market, Foreign Exchange and Derivatives areas is divided into trading, back office and accounting activities. The **trading area** contains functions for recording financial deals, exercising rights, performing evaluations, and calculating prices (e.g. option price calculator). In the **back office area**, you enter additional data required for processing transactions (such as account assignment and payment details) and generate automatic confirmations. Position management functions, such as securities account transfers or corporate actions relating to securities, are also supported in the back office. The **accounting area** features automatic posting functions for transferring data to financial accounting, a real-time general ledger update, flexible functions for processing payment transactions as well as valuation and accrual/deferral procedures.

Loans Management

The function areas in Loans Management, which allow you to represent both loans given and loans taken, are divided into transaction management, portfolio management and accounting to reflect business practice. The **transaction management** area supports functions for new business, from the creation of loan offers for an interested party, through to contract disbursement. It incorporates complex collateral management functions and support for decision-making, and offers a flexible condition structure for drawing up your contracts. The **portfolio management** tool contains functions for processing existing contracts, such as contract changes, contract transfers (grouping or split), or for automatically generating rollover offers once fixed interest rate periods have come to an end. In addition to subledger and open-item management, support is provided for loans accounting with tools for generating debit items manually or automatically, transfer postings, closing activities - such

as the accrual of interest or discounts - and portfolio valuations.

Flexible conditions structure

You can flexibly configure the structure and conditions of your various transactions. Since condition items are assigned individually, you can represent even the most complex condition combinations in the system. In the Loans component, the task of drawing up standard contracts is supported with predefined condition tables and reference loans.

Central functions

Central functions and tools ensure that business partner and address management, financial mathematics, the flexible instrument generator, status-controlled transaction processing and real-time reporting are available to all the Transaction Management components. For example, basic functions such as the central business partner management or the Treasury Information System provide you with a comprehensive overview of the relationships maintained with your business partner. By using common organizational elements, you can represent different organizational structures such as a group-wide treasury departments or "in-house banks" in the system. The common elements also ensure full integration of Treasury with other SAP R/3 applications.

Real-time datafeed

The real-time datafeed interface enables you to quickly recognize and respond to changes on the financial markets by providing you with constant access to current market data.

Documentation and monitoring functions

Running umbrella evaluations for all activities in Treasury is no problem due to extensive documentation and monitoring functions. These functions, which support documentation and monitoring tasks in Financial Accounting and Treasury, facilitate evaluations for specific instruments, as well as evaluations covering all instruments, at any stage of the Treasury processes.

Flexible reporting

The reporting tool allows you to trace financial transactions, the origins of cash flows and the impact on Financial Accounting at any given time.

You can monitor the current status of financial transactions and trace their history (for example: order, contract, exercise, termination, reversal and rollover). The flexible reporting tool allows you to monitor deadlines and evaluate positions and displays all transactions together with their history and their status at a level of detail which you yourself define. You can branch directly from the aggregated display screens to single transactions. Business partner information provides you with a detailed overview of your loan partner's total commitment.

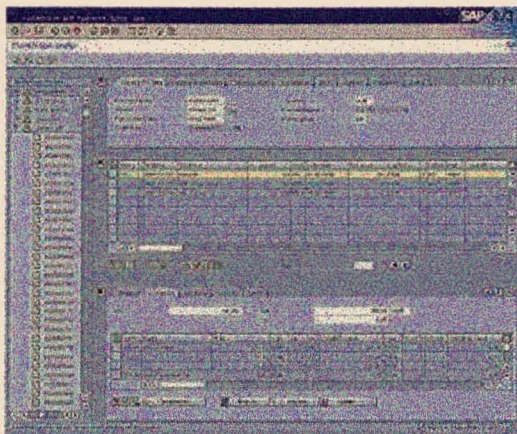
Even in this area, it is easy to see how interfacing to other SAP applications is used. Not only can you monitor your transactions and positions, but also the corresponding posting documents. You can use the drilldown reporting tool to generate and edit your own reports in addition to making use of predefined standard reports.

More information

 [Fact Sheet "Treasury Transaction Management" \(111 KB\)](#)

 [Fact Sheet "Real-Time Datafeed Interface" \(405 KB\)](#)

SAP R/3 Logistics



The logistics applications of the SAP R/3 System let you design your business processes to have the flexibility, innovativeness, and effectiveness your customers would like.



"The Software works the way I do." [Experience it yourself!](#)




No matter which concepts you choose for optimizing your enterprise, the SAP R/3 Logistics applications always work hand in hand with you to help you improve your supply chain. All functions of these applications are planned, controlled and coordinated within the system across all organizational units. Since the SAP R/3 System automatically links all

the elements that logically belong together, no work is duplicated. You only need to enter your data once. In the SAP R/3 System, the processes involved in logistics, financials, and human resources are harmonized with one another, opening up a new dimension of business efficiency.

SAP R/3 Manufacturing

Supply chain management is one of the hottest topics of the moment. Demand planning, distribution and production optimization, e-commerce, and logistics management are just some of the important features that supply chain software now delivers. But before they can leverage this concept to gain real competitive edge, companies must take a close look at the foundation on which supply chain management rests: [manufacturing](#).

More Information

-  Overview "[SAP R/3 Logistics](#)" (1.1 MB)
-  Overview "[SAP R/3 - Release 4.0](#)" (1.3 MB)
-  Overview "[SAP R/3 - Release 4.5](#)" (525 KB)



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SAP R/3 Sales and Distribution

Improve your customer service with a reliable, fully-integrated sales system. The SAP R/3 System's Sales and Distribution application offers access to realtime, online information from sales support to the billing process.



Improve your sales planning and management

The Sales Support component provides you with easy-to-use tools to manage information on sales leads, sales calls, inquiries, quotations, marketing campaigns, competitors, and their products. Sales and marketing personnel can access this data at any time to perform sales activities or carry out direct mailings. You can use Sales Support not only to make your sales process more efficient and boost service to existing customers, but to identify new sources of business as well.

Save time and reduce errors with user-friendly order entry

Order entry in the SAP R/3 System is highly automatic. Referring to information that you enter in the simple user interface, the system assembles information, such as the terms of payment and delivering plant. It then proposes this information in the sales order. The SAP R/3 System deals just as easily with materials. You can enter materials manually, select from customer-based product proposals, or work with variant configurations to configure a product to meet customer requirements.

Let the application SD work for you

Pricing is carried out automatically in the sales order. To determine relevant predefined prices, surcharges, and discounts, the system works from price lists and customer agreements, or it determines an amount according to the product, product group, or product cost. The pricing function is very flexible and can manage even the most complicated price structures. You can maintain pricing information with data from sales deals and promotions as well.

The system also carries out a dynamic credit limit check, checking against credit, financial, and sales data to verify the customer's credit limit. You can set the system to automatically alert credit or sales personnel when a sales order fails the check.

The availability check is just as comprehensive. Run in connection with the Materials Management (MM) and Production Planning (PP) applications, it verifies that you have sufficient quantities on the requested delivery date to satisfy a sales order. If you cannot meet the requested delivery date, the system immediately determines when the desired quantity will become available so that you can instantly quote a new date to your customer. You can also review availability in multiple locations. In the case of customers requiring specific quantities of a product, you can use the make-to-order production features in Sales and Distribution.

Offer your customer the best possible service

Sales and Distribution supports a wide range of contracts, from general contracts to more specific rental contracts. With them, you can specify delivery quantities, delivery dates, and prices. Scheduling agreements and more complex requirements such as just-in-time delivery schedules are also supported. Or you can follow up on your products with the Service Management component which includes a complete suite of customer service functions, including call management, warranty management, and service and maintenance contract processing.

Make on-time delivery your standard

Shipping Management offers you easy-to-use functions for managing picking, packing, and loading tasks, and monitoring delivery deadlines. The system provides a list of all sales orders due for delivery, and gives you the option of delivering the order completely or partially, individually or collectively. At the same time, you can initiate picking for the available quantities with full integration to the Warehouse Management System.

The Transportation module offers functions for transportation planning and processing, as well as monitoring and controlling functions. By land, by air, by sea: No matter where you send your products, you can represent your transportation chain in the SAP R/3 System for individual shipments or stop-off shipments involving several deliveries and several destinations. You can also

select forwarding agents and track shipments.

Sales and Distribution also provides comprehensive support for foreign trade processing, offering you automated export control to determine whether you can export specific products to a particular country, to a particular customer, and at a specific time. The system handles all the necessary customs forms automatically. To declare your shipments of goods to the government authorities, the SAP R/3 System collects all the data required for the declarations and creates the necessary forms. Preference agreement processing is another feature. It helps you manage the shipment of products that are eligible for customs tariff preferences, track the origin of component parts, and assign a tariff classification to materials.


Automatically bill your customers

On the basis of your orders and deliveries, the system automatically carries out billing for all due items. The system then creates an invoice, debit memo, or credit memo for each item or collectively for several transactions. You can send a billing document directly to the customer either by mail, fax, or EDI. At the same time, revenues and receivables are immediately visible in the Financial Accounting (FI) and Controlling (CO) components. You can also process rebates based on a customer's purchase volume.

Stay ahead in recognizing market trends

SAP offers the best possible support to decision-makers in the form of the Sales Information System. As soon as you enter a Sales and Distribution document into the system, the relevant information is updated in the Sales Information System. This ensures that the information you access is always up to date. How the information is displayed is up to you: by customer, material, or region, in an easy-to-interpret list or informative graphic. By using the Sales Information System, you are in a strategic position to address market trends and changes.

More Information

 [Fact Sheet "SD Sales & Distribution" \(76 KB\)](#)

SAP R/3 Production Planning

Equipped with the SAP R/3 System's Production Planning and Control application, you can reach your full potential when planning, executing, and controlling your production. The SAP R/3 System's Production Planning and Control application covers the complete production process from the creation of master data to production planning, MRP, and capacity planning, right down to production control and costing.



Production planning modules

Using Sales & Operations Planning (SOP), you can create realistic and consistent planning figures and dates on the basis of expected sales or other key figures of your choice. Then, in Demand Management, these planning figures are split down to product level and the demand program is created. In material requirements planning (MRP), the system calculates the quantities and procurement dates for the necessary materials, right down to the raw materials. You can already plan capacities at this planning phase. Therefore, you can recognize possible capacity bottlenecks with

plenty of time to take the necessary preventive measures.

Production control modules

Depending on your method of production, you have the choice of using Production Order Processing, Repetitive Manufacturing, or KANBAN Production Control.

The production order is primarily a tool for discrete, job-shop production. It provides extensive status management functions, controlling per order as well as various operation-related functions.

Repetitive manufacturing is especially designed for manufacturers of products that are typically produced repetitively on a particular production line over a longer period. Here, production planning and control as well as controlling are usually carried out based on periods and quantities. R/3's Repetitive Manufacturing module provides a tool based on production rates and lines to cover the requirements of this type of production.

Capacity planning is integrated with production order processing as well as with repetitive manufacturing. Various dispatching strategies and a flexible graphic planning table support you in planning your resources.





If you control production using KANBAN techniques, replenishment or the production of a material is not triggered until a higher production level actually requires the material. In R/3's KANBAN module, various replenishment strategies are available for inhouse production, external procurement, and stock transfer. The signal for replenishing a material can be triggered by bar code or using a graphic KANBAN board.

Quality management, interfaces to PDC systems, distributed control systems, laboratory information systems as well as extensive data analysis functions in the Open Information Warehouse are all also integrated in R/3's Production Control.

Integrated solution for all industry sectors

PP covers the complete production process from the creation of master data to production planning, MRP, and capacity planning, right down to production control and costing. It can be used in all sectors of industry and provides a whole palette of production methods ranging from make-to-order production/variant processing to repetitive manufacturing/mass production. The PP application provides you with tools which guarantee a high performance level planning and control of the complete material flow in your production processes. It also provides you with easy-to-use information systems that you can adjust to suit your own particular needs. As a result, planners, work schedulers, and production schedulers are relieved of routine tasks and therefore have more time to concentrate on more business-critical activities.

More Information |

-  Fact Sheet "Process Flow Scheduler (PFS)" (284 KB)
-  Fact Sheet "PP-KAB KANBAN/Just-In-Time" (108 KB)
-  Fact Sheet "Long-Term Planning" (115 KB)
-  White Paper "KANBAN" (382 KB)

SAP R/3 Materials Management



Optimize the procurement process and the logistics pipeline within your company.

The efficiency of your business processes for procuring raw materials and the effectiveness of the logistics pipeline through which your materials flow are factors crucial to your corporate success. The SAP R/3 System's Materials Management application not only contains all the functions required to simplify your business processes in Requirements Planning,

Purchasing, Inventory Management, Warehouse Management, and Invoice Verification, but also introduces a high degree of automation into standard procedures. All functions are closely integrated with each other and with other functions in SAP R/3.

Save time and money in Purchasing

Consumption-based planning provides you with up-to-the-minute order proposals for purchase requisitions, based either on reorder levels or on forecast data. Logistics applications, such as Sales and Distribution, Plant Maintenance, Production Planning, or the Project System, can also require materials or services to be procured externally. Individual departments can enter purchase requisitions manually.

The system passes these purchase requisitions directly to Purchasing, where they are converted into purchase orders. Your buyers have at their command a wide array of sophisticated tools, from special purchasing master data and requests for quotations, to quotations and outline agreements. You can, for example, compare prices during the procurement process or automate the vendor selection or order creation processes. The Vendor Evaluation application enables you to find the best vendors using criteria of your choice. You also have the option of requiring purchasing documents to be part of a release and approval procedure before they can be further processed. Purchasing activities are approved by authorized members of staff by electronic signature. You can send purchase orders or forecast delivery schedules to the vendors either on paper or electronically (by EDI, for example). The purchase order history allows you to monitor the status of your order and track deliveries or invoices already received.

Reap the benefits of up-to-the-minute Inventory Management

The stock of your materials is managed on a value and quantity basis in Inventory Management. This application component supports all the most common types of receipts, issues, and stock transfers and allows you to manage special stocks (such as batches, consignment stocks, project stock, returnable transport packaging, or components at a subcontractor). Goods movements postings automatically result in an update of values in Financial Accounting, Asset Accounting, and Controlling.

Whether you perform physical inventories periodically or continuously, or whether you count the total stock, or use sampling or cycle counting methods - the system supports you with a number of convenient aids for entering data and with a variety of automatic evaluations. You can use a number of inventory valuation methods, such as LIFO or FIFO, for balance sheet valuation.

Reduce costs with efficient Warehouse Management

The Warehouse Management (WM) module provides flexible, automated support that enables you to process goods movements and maintain a current record of all materials stored in highly complex warehousing structures. Using advanced putaway and picking techniques, WM optimizes material flow and capacity in the warehouse, storing goods in the most favorable locations so that they are readily available when needed. The capability of WM to be interfaced to hand-held terminals, bar-code scanners, and automated warehousing systems complements the many automatic processes already available in the WM component.

Improve the efficiency of invoice verification

Invoices you receive on paper or by EDI are checked automatically in the system. If you enter an invoice referencing a purchase order, the system can automatically generate the invoice it expects to receive. An invoice is automatically blocked for payment if variances occur that are not allowed, such as in the delivery date, the quantity delivered, or the agreed price.

The Evaluated Receipt Settlement (ERS) functionality allows you to do away with vendor invoices altogether. The system automatically creates invoices periodically based on the goods receipts posted in the system for purchase orders.

Invoice Verification provides a special method of entering vendor invoices which is much faster than standard procedures.





Integrate further processes in Materials Management

The MM application comprises countless additional functions that can help you shape your materials management system as efficiently as possible. A pipeline material that flows directly into the production process can be entered in the system for an order, a cost center, or a network and is managed in a similar way to consignment stock. You can use the stock transfer functions to model stock movements among different plants in the system. You also have the option of entering stock transport orders with or without a purchase order or delivery. Transportation activities are made easy with a whole suite of functions, such as shipping point determination and route determination. And to ensure smooth and efficient foreign trade processing, you can quickly prepare the necessary data (for customs declarations, for example) for export or import activities.

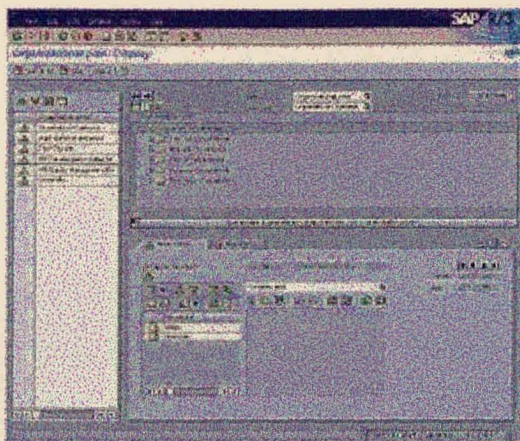
Identify and control new developments in your company and in the marketplace

With the Purchasing Information System, you have at your command all the facts and figures necessary for negotiating with vendors. You can choose which data to include in reports and how you want the information presented. With Inventory Controlling, you can, for example, determine stock values, find out inventory turnover rates, and carry out analyses. The information systems enable you to identify trends and developments, giving you a sound basis for decision-making.

More Information

-  [Overview "MM Materials Management" \(482 KB\)](#)
-  [White Paper "MRP Areas" \(212 KB\)](#)
-  [White Paper "Handling Unit Management" \(121 KB\)](#)
-  [White Paper "Engineering Workbench" \(154 KB\)](#)

Total solutions for human resources.





SAP HR offers the most comprehensive global HRMS solution, with human resources, payroll and time management capabilities, including standard language, currency and regulatory requirements, for more than 30 countries. The total SAP HR solution includes Employee Self Service, Manager's Desktop and SAP Accelerated HR. SAP Accelerated HR allows organizations to implement SAP HR quickly and cost-effectively through pre-configured settings, comprehensive data transfer utilities, end-user training materials and documentation, a pre-configured



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AcceleratedSAP blueprint, and implementation materials for consultants and project teams. In addition, the SAP HR solution is supplemented by a comprehensive set of solutions provided by Complementary Software Partners.

More Information

-  Overview "[SAP Human Resources](#)" (1.5 MB)
-  Overview "[SAP Human Resources - Release 4.5](#)" (835 KB)



Order SAP R/3 Knowledge Products, Computer Based Training, Delta Study Guides, Delta Kiosk CDs, Online Documentation CDs, and Print Files CDs through the [SAP Store](#) now!



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PeopleSoft is a world leader in enterprise application software. PeopleSoft provides eBusiness and analytic applications for human resource management, financials, distribution, manufacturing, and supply chain, along with a range of industry-specific solutions.

For more than 3,000 customers, PeopleSoft applications offer greater flexibility, rapid implementation, scalability across multiple databases and operating systems, and lower cost of ownership. Customers include some of the largest multi-national organizations in the world, as well as small and medium-size businesses.

All PeopleSoft products are backed by PeopleSoft Advantage, a comprehensive consulting, education, and technical support program. Headquartered in Pleasanton, California, PeopleSoft employs more than 6,000 people and had 1998 revenues of \$1.3 billion.

Learn more about PeopleSoft by reading our track record and our corporate report. Find out about the visionaries who lead PeopleSoft to success—the PeopleSoft management team.

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PeopleSoft provides global solutions to cover core enterprise functions, as well as industry-specific operations. Below is a list of our business process solutions and industry solutions.

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- eBusiness Backbone

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PeopleSoft Select for Small and Medium-Sized Companies

PeopleSoft Treasury Management

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- Deal Management
- Risk Management

PeopleSoft Enterprise Performance Management (EPM)

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- Balanced Scorecard
- Workforce Analytics
- Workbenches
- Performance Measurement

PeopleSoft Project Management

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PeopleSoft Sales and Logistics

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Transform The Way You Work

PeopleSoft Human Resources Management helps you track your most important asset: people. Our modular, global solution set enables you to:

- Manage positions and compensation
- Recruit, hire, and train employees
- Promote, allocate, and retire personnel
- Comply with local and international regulatory requirements

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The Great HR Debate

Considering a global HRIS implementation? You'll want to read this Think Tank article.

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“Our human resources systems are critical to achieving our growth strategies. PeopleSoft enables us to incorporate new people into our compensation and benefit systems very quickly.”

- Stephen E. Johnston, Senior Vice President of Human Resources, Analysis & Technology, Inc.

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Accounting and Control

A Solid Financial Backbone

PeopleSoft Accounting and Control helps you capture and administer financial data smoothly, quickly, and accurately--across the enterprise. It fulfills both internal and external reporting requirements, ensures regulatory compliance worldwide, and provides controls consistent with your organization's practices and policies.

PeopleSoft Accounting and Control applications are designed to support the following integrated business processes, but can also operate as stand-alone modules.

- Record to Report
- Plan and Budget
- Manage Employee Expenses
- Asset Lifecycle

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“PeopleSoft financial management solutions will help us achieve savings and improve the productivity of our business units by eliminating non-value added activities and reducing the paper flow. Plus, we'll be able to improve our decision-making with more timely information.”

Howard Rosen, Vice President and Controller, Time Inc.

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Synchronize Your Money Chain

PeopleSoft Treasury Management provides cash management, risk management, and deal management capabilities to support global, multicenter treasury units.

PeopleSoft Treasury Management helps synchronize your entire money management chain, including:

- High-volume cash transaction traffic
- Complex foreign exchange risk hedging
- Trading multi-instrument debt or investment portfolio

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The biggest treasury event in Europe, designed to keep executives up to date on the latest issues affecting treasurers.

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Enterprise Performance Management

Enhance Decision-Making and Organizational Performance

PeopleSoft Enterprise Performance Management (EPM) is a family of products specifically designed to collect, transform, and deliver relevant information for analysis and strategic decision-making.

Expanding on the PeopleSoft Performance Measurement solution, EPM is a unique set of components that can be tailored for specific industry functions. Components include:

- Enterprise data warehouse
- Analytic applications
- Desktop reporting
- Analysis templates

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"What PeopleSoft is allowing us to do is keep data consistent as we redefine our business. That's a huge benefit, and I'm not sure we would get it from any other piece of software."

--Bob Jackson, CFO, American Century Investments

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Materials Management

Optimize Your Internal Supply Chain

PeopleSoft Materials Management enables you to closely track and control the purchase, inventory, and flow of materials throughout your organization. Our solution helps you:

- Purchase the right material at the right price
- Analyze and control inventory across the enterprise
- Calculate replenishments
- Distribute accurate materials on time
- Track consumption of goods and services

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From Order Creation to Cash Receipt

PeopleSoft Sales and Logistics helps you place accurate orders, provide reliable promise dates, and create flexible product configurations. This solution set enables you to:

- Capture, maintain, and share product and distribution information across the enterprise
- Define and verify make-to-order or assemble-to-order requirements
- Enter configured sales orders and quotes on a laptop, in front of customers
- Determine the available material and capacity in the supply chain
- Prepare, calculate, and submit accurate invoices

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Collaborative Planning Through Order Fulfillment

PeopleSoft Supply Chain Planning helps you meet customer demand for on-time and accurate delivery of products, on a global basis. With PeopleSoft Supply Chain Planning you can:

- Forecast demand based on order history, economic indicators, and input from employees, suppliers, and customers
- Determine when and where to produce and distribute finished products, based on the availability of raw materials, aggregate capacity, and finished goods
- Establish reliable promise dates for customer orders
- Share realtime planning information with suppliers and customers
- Reduce inventory, and improve throughput of goods

What's New:
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[Supply Chain Management: The PeopleSoft Edge](#)

Free Download:
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“The PeopleSoft Supply Chain solution enables us to concurrently look at both the supply and demand balances and respond quickly to market opportunities.”

- David McCartney, Director of Global Information Management and Strategic Initiatives, Bausch & Lomb

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Materials Requisition, Procurement, and Tracking

PeopleSoft Procurement enables service-based organizations to efficiently procure operating materials, then track the distribution and consumption of those materials throughout the enterprise.

Our Procurement solution helps you:

- Procure a variety of operating materials, from office supplies to advertisements
- Effectively bill for all operating materials
- Procure the right material at the lowest cost
- Manage inventory
- Accurately allocate operating materials
- Track consumption of goods and services

Platforms and Compatibility

PeopleSoft applications run on a variety of leading hardware and database platforms. Now you can protect your previous technology investments, or upgrade to something new. [See Supported Platforms](#)

Critical Issues

[European Monetary Union \(EMU\)](#)

[Year 2000](#)

SELECT
Are you a medium-sized company?

About PeopleSoft Procurement

- [Features & Benefits](#)
- [Literature](#)
- [News](#)
- [Events](#)

Procurement Product Modules

- [PeopleSoft Purchasing](#)
- [PeopleSoft Payables](#)
- [PeopleSoft Inventory](#)
- [PeopleSoft Expenses](#)
- [PeopleSoft Asset Management](#)

Featured Stories

[Procurement Reform Pays Off](#)

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1 800 380 SOFT (7638) or 1 925 225 3000.
[Legal Terms](#)

About Baan

The Baan Company is one of the world's leading providers of scalable enterprise business software solutions, with more than 3,000 customer systems implemented in 5,000 sites worldwide. At the core of The Baan Company is a continuous effort to reduce software complexity and increase customer value. Baan makes this possible through its BaanSeries products, which feature component open architecture and integrated business application functionality. [Click here for an overview of The Baan Company \(.PDF\)](#)



The Baan Company's corporate philosophy is characterized by the three I's: Innovation, Integrity and Initiative. These three pillars form the foundation for the entire organization.

Innovation is a continuous process, one that is important to both The Baan Company and our customers. Our customers face the constant challenge of keeping pace with economic changes and developments within their respective industries. To help customers meet this challenge, The Baan Company produces software that supports their current business processes, and, through its component architecture, can adapt to changes in these processes in the future. The Baan Company's continuous attention to innovation in our products, services and delivery of support provides our customers with a high degree of value and service.

Integrity is equally important in our relationships, not only with our customers, but with our colleagues, partners and shareholders. For The Baan Company, integrity means acting responsibly, honestly and fairly, on both the individual and team level. We are committed to providing our customers with the highest quality in our products, services and business interactions.

Initiative implies action instead of reaction. If organizations don't offer their members opportunities to take initiative, then decisiveness and continuous development will disappear. The Baan Company supports initiatives in our various programs for customers, partners and employees.

At The Baan Company, we strive to blend the three I's together in all of our business activities. An example of this effort is our cooperation with strategic partners to provide innovative system solutions for various large customers. We hope that you find our corporate philosophy reflected in every association you have with us.

LECTURES TO GO



Corporate News

- **BAAN COMPANY APPOINTS NEW HEAD OF EUROPE, MIDDLE EAST AND AFRICA REGION**
September 10th, 1999
Baan Company has appointed Mike Shinya as President of its EMEA (Europe, Middle East and Africa) region. Shinya will have overall responsibility for a streamlined, customer-focused operation comprising some 16 countries, and will report directly to Mary Coleman, CEO, Baan Company.
- **BAAN COMPANY ACQUIRES PROLOQ HOLDING B.V.**
August 31, 1999
Baan Company today announced that it has signed an agreement to acquire Proloq Holding B.V.

Complete Listing

Employment Opportunities

- **Information Technology Engineer**
Req #8127
Reston, VA
Full Time

Duties/Responsibilities

- Work on complex problems where analysis of situations or data requires an in-depth evaluation of various factors.
- Responsible for the analysis of business problems to be solved with automated systems.
- Responsible for the analysis, installation, modification and support of database and application software.
- Responsible for providing user support by phone or in person on computer applications.

Qualifications Sought

- Education: Typically requires a BS/BA degree or an equivalent combination of education, training and work experience.
- Industry Experience: 5-7 years in software development, application support or system administration.
- Strong knowledge of desktop computing software products.
- Knowledge of the Baan application from a technical viewpoint preferred.
- Knowledge of financial systems and the requirements to support



Why the Theme Extending the Enterprise? (2.245KB)

"BaanWorld '98
Kevin Calderwood, President Baan Americas and Global Baan ERP, illuminates the theme of BaanWorld '98 by exploring the need to move beyond traditional ERP."

[Complete Listing](#)

Events



The Drive Behind Baan: Ongoing Innovation (2.680KB)

"BaanWorld '98
Kevin Calderwood, President Baan Americas and Global BaanERP, outlines the core elements of Baan's strategic direction."

[Complete Listing](#)



Vision Strategy Execution (324KB - pdf)

BaanWorld '98
Tom Tinsley, Chairman, Baan Company, presents Baan's vision for the Extended Enterprise and outlines how Baan will extend enterprise systems to new areas of business.

[Complete Listing](#)

Software Products



Choose a Business Process Solution Choose a BaanSeries Element

YOUR LICENSE
TO SIMPLY
BETTER BUSINESS



Ongoing value innovation across the extended enterprise

BaanSeries is an innovative product family designed to support the ongoing delivery of open components for enterprise applications. Built on Baan's commitment to reducing the complexity of IT solutions, the BaanSeries assembles best-of-class components, keeps them "evergreen" through ongoing release cycles, and enables enterprises to update their information infrastructure in manageable, incremental initiatives.

Products that lead to better business

The latest Baan applications are a key milestone in Baan's longtime effort to reduce the complexity of information technology and to provide ever-greater value and innovation to its customers within a dynamic, global marketplace. Three advantages distinguish each component element within the BaanSeries family of products:

- **Assemble Best-in-Class Components:** Baan product elements will enable companies to choose state-of-the-art componentized software solutions from Baan and hundreds of technology and BaanWeb partner companies, effectively configuring functionality from many vendors to suit each business need across a company's value chain.
- **Evergreen Delivery:** An ongoing stream of new BaanSeries component elements will deliver the benefits of evolving technology at a pace that preserves best business practices while meeting dynamic business demands.
- **Version Independent Integration:** Baan product component elements break the monolithic model with an "assemble to order" system that grows with business needs and reduces the cost, complexity, and risk of information technology integration.

Evergreen Delivery: Ongoing value and more manageable change

Evergreen delivery further extends the adaptability and scalability of Baan products through independent components, ongoing release cycles, and up and downward compatibility. Baan customers will gain improved configuration management, the ability to preview the impact of new functionality on their operations, and migration tools that help them move to new component versions.


Solutions That Improve Your Business Processes

Each of the elements or product families in BaanSeries are designed to help your company optimize and improve your business processes across your enterprise. Choose the business processes below to learn about Baan's solution.

Business Processes	Offering
<ul style="list-style-type: none"> ● Sales order management ● Procurement ● Inventory ● Warehousing ● Project Management 	<p>BaanERP</p> <p>BaanERP, the successor to BaanIV, provides complete end to end Enterprise Resource Planning software. BaanERP is an integrated suite of back-office components for manufacturing, finance, project, and distribution.</p>

<ul style="list-style-type: none"> ● Manufacturing 	For BaanERP on the IBM platform please click here
<ul style="list-style-type: none"> ● Sales Management ● Marketing Management ● Call Center ● Product Configuration 	<p><u>BaanFrontOffice</u></p> <p>BaanFrontOffice offers a complete software package for Customer Interaction and Relationship Management. BaanFrontOffice includes components that enable salesforce automation, product configuration, and call center management.</p>
<ul style="list-style-type: none"> ● Accounting ● Finance ● Human Resource Management 	<p><u>BaanCorporateOffice</u></p> <p>BaanCorporateOffice includes CODA-Enterprise and CODA-Financials, offering a powerful financial accounting software solution for the enterprise. Baan Corporate Office Solutions also has close partner relationships with Hyperion, with its leading budgeting and consolidation applications, and Meta4, a provider of human resource software.</p>
<ul style="list-style-type: none"> ● Supply Chain Management ● Demand Forecasting ● Manufacturing Execution 	<p><u>BaanSCS</u></p> <p>BaanSupplyChain applications are the most tightly integrated in the industry. The scope of our applications span from demand planning, all the way to manufacturing execution and tracking. These are successfully being used worldwide by industrial enterprises in such vertical markets as aerospace, industrial equipment, automotive, consumer packaged goods, and other multimode manufacturing companies.</p>
<ul style="list-style-type: none"> ● Plant Maintenance ● Aviation Maintenance 	<p><u>BaanMaintenance</u></p> <p>BaanMaintenance is a set of fully-integrated modules that can be used alone or in combination to meet the unique needs of a maintenance organization. The first industry focused solution for BaanMaintenance addresses the aviation maintenance market with Baan Maintenance Aviation (formerly MRO). BaanMaintenance includes: Maintenance engineering, Maintenance planning and control, Line maintenance, Base maintenance, Shop maintenance, and Component management.</p>
<ul style="list-style-type: none"> ● Field Service 	<p><u>BaanService</u></p> <p>BaanService, together with BaanMaintenance, addresses the specific needs of manufacturing centric service and maintenance organizations in support of all after sale/after market activity.</p>
<ul style="list-style-type: none"> ● Product Documentation Management 	<p><u>BaanEngineering</u></p> <p>BaanEngineering provides advanced product, document, and change order management solutions that integrate and control the flow of product information throughout the enterprise. BaanEngineering includes: Baan PDM, Baan PDM Cad Toolkit, Baan PDM Microsoft Office 97 Integration, Baan PDM 2 View, and Baan PDM Web.</p>
<ul style="list-style-type: none"> ● Workflow Modeling ● Decision Support 	<p><u>BaanDEMse</u></p> <p>Baan's Dynamic Enterprise Modeling Strategy Execution or BaanDEMse is the next generation of Baan's innovative DEMse business modeling environment. DEMse's industry-leading graphic models, such as business control models, define relationships between entities across the value chain, linking core business strategies to the configuration, navigation and execution of business processes throughout the entire system.</p>
<p>Entire range of Baan IV Modules including:</p> <ul style="list-style-type: none"> ● Manufacturing ● Finance ● Sales order management ● Procurement ● Inventory ● Warehousing ● Project Management 	<p><u>Baan-On-Board</u></p> <p>Baan-On-Board is a comprehensive bundled solution that comes pre-installed from the hardware vendor and includes the following components: Baan IV for BackOffice, Hybrid Manufacturing Reference Model, Baan IV Library Set For In-depth Key-user Training and Reference, Baan Global Support and Maintenance, On Demand Remote Consulting, Quick Response Decision Making Tool, Expanded Financial Reporting Templates, Automated User Documentation From Process Level To Individual Roles, Interactive, Comprehensive Implementation Plan, Desktop Reference Materials</p>




 [E-Enterprise Datasheet](#)

In seeking new ways to expand channels of distribution, reduce costs throughout the supply chain, and improve the productivity of knowledge workers, enterprises are expanding the IT infrastructure beyond its traditional boundaries.

 [BaanEDM -Enterprise Decision Manager \(717KB\)](#)

Baan Enterprise Decision Manager introduced to the market on October 12th, 1998 is an end-to-end solution based on an open enterprise intelligence framework. With ready to implement business templates, key business processes can be analysed.

 [The Software Engineering Process Group \(SEPG\) - \(501KB\)](#)

The SEPG exists to ensure process improvement within Baan Development. This four page brochure first states the group's mission and objectives, and then defines the tactical means by which the organization executes these goals. The brochure also relates SEPG to the Capability Maturity Model (CMM), Personal Software and Team Software Processes (PSP/TSP) and the Baan Development Method (BDM).

 [BaanSeries \(747KB\)](#)

BaanWorld '98

Lorenzo Martinelli and Andries Bottema explain how BaanSeries delivers Ongoing Value Innovation across the Extended Enterprise.

[Complete Listing](#)

Industry Solutions

The Baan Company offers complete solutions that are specially designed to meet the needs of key vertical markets. These solutions are built with Baan's best-in-class BaanSeries components and are tailored to the needs of each industry. Today Baan offers industry solutions for Aerospace & Defense, Automotive, Consumer Packaged Goods, Electronics, Engineering and Construction, Forest Products, Heavy Equipment, Primary Metals, Project, Semiconductor, Specialty Chemicals, Wholesale.

Choose Your Industry

Aerospace and Defense



Aerospace & Defense



The past decade has witnessed profound changes in the Aerospace and Defense (A&D) industry. Business consolidation, fluctuating defense budgets, and adopting of commercial practices force A&D companies to examine and streamline the business process. Today's A&D companies can no longer afford to focus exclusively on defense projects. Instead, these companies must be able to work in a hybrid defense/commercial environment in order to survive. Baan is the leading Enterprise software provider in the A&D industry. Baan's BaanSeries based solution offers tools that allow A&D companies to meet important demands such as program life-cycle and supply-chain management.

[Aerospace and Defense Solutions](#)

Automotive



After years of steady and reliable growth, automotive OEMs and suppliers face a period of structural change and challenge that is transforming the industry. In the drive to reduce total production and delivery costs and respond faster to market preferences, OEMs are restructuring the entire automotive supply chain. Baan offers automotive OEMs, suppliers, and distributors a comprehensive system that integrates design, manufacturing, and distribution operations. Baan is the first ERP vendor to fully support high volume, complex manufacturing environments with a standard software package that includes features like final assembly scheduling and line sequencing.

[Automotive Solutions](#)

Consumer Packaged Goods



Today, the Consumer Goods industry is part of a highly competitive and rapidly changing market place. Whether you produce and/or distribute Consumer Packaged Goods like Food & Beverage products or whether you produce and/or distribute Consumer Durables, Baan can help you in employing a variety of strategies enabling your company to offer differentiating products and services from the competition.

[Consumer Packaged Goods Solutions](#)

Electronics



Whether the business is consumer or industrial electronics, semiconductor manufacturing, software, or maintenance services, today's Electronics and High-Tech Companies face a dynamic business environment. With the release of BaanSeries, Baan has created a new product family of open, best-in-class components for extended enterprise applications that give electronics and high-tech companies the choice and flexibility they need to grow.

[Electronics Solutions](#)

Engineering & Construction



The Engineering and Construction industry has evolved into an increasingly challenging environment. Complexity of projects continues to increase as the amount of skill required for each undertaking grows, and the amount of jobs being subcontracted follows. The BaanSeries provides Construction and Engineering companies with a solution that integrates logistics, project management, Maintenance and Service functionality. The BaanSeries easily integrates with third-party applications as well as with the Internet.

[Engineering and Construction Solutions](#)

Forest Products



Whether you are a Paper, Paperboard, Containerboard or Lumber producer, Baan can help you consistently improve profitability and build economic value. Producers and distributors of forest products must focus on return on capital at every step of the process, from tree or recycled paper to finished product. Baan has partnered with the industry to produce a Forest Products solution second to none.

[Forest Products Solutions](#)

Industrial Equipment



Increased competitive pressure on Industrial Equipment Manufacturers has changed the environment of the industry. In order to compete, companies must reduce their cycle time, improve customer services, and reduce operating costs. Adding to the challenge, complexity of products continues to grow, and margin pressure is increasing. By implementing the BaanSeries, heavy equipment manufacturers can gain enormous benefits in time and costs. Total integration of MRP, Project Management and Product Data Management functionality gives an edge in efficiency and productivity for industrial equipment manufacturers. Using BaanSeries and BaanERP, manufacturers have a year 2000 compliant solution for product life-cycle management, supply-chain management, and global business operations.

Industrial Equipment Solutions

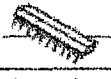
Primary Metals



Whether you are an Integrated Producer supplying to a global market, a Mini-mill rapidly converting recycled materials, or a Metals Merchant focused on supplying high grade alloys to high tech industries, Baan can help you maximize profitability globally, deliver superior customer service, increase order fulfillment, maintain regulatory compliance while reducing overhead, and continuously improve manufacturing processes to reduce cycle times and scrap.

Primary Metals Solutions

Semiconductor



A fast-growing segment of the electronics market is the semiconductor industry. Semiconductor manufacturers play an important role in the supply chain of the electronics industry. They need to co-operate closely with other players in the supply chain, including contract manufacturers, consumer electronics, industrial electronics and telecommunications, distributors, software, and services. The BaanSeries offers semiconductor companies comprehensive integration of all aspects of design, manufacturing, and distribution operations.

Semiconductor Solutions

Specialty Chemicals



Whether you are a producer of Polymers, Flame Retardants, Fibers, Plastics Additives, Catalysts, or one of the many other specialty chemical products, Baan can help you consistently improve profitability and build economic value. Producers and distributors of chemical products must focus on return on capital at every step of the process, from raw materials to finished products. Baan has partnered with the industry to produce a Specialty Chemicals solution.

Specialty Chemicals Solutions

Wholesale



The Wholesale business is changing: the introduction of new communications methods and technologies, declining trade barriers and accelerating mergers and acquisitions are forcing Wholesale companies into a global marketplace. As a result, Wholesalers and Distributors are continuously striving to create competitive advantages through unique features in assortment, prices and product availability. Wholesale companies, like yours, are expanding beyond the traditional buy-and-sell business model and offer additional services. Baan can help you in preserving and enhancing traditional services, and also in performing new services like creating special product configurations, executing final assembly activities, providing store-ready goods and offering after-sales services.

Wholesale Solutions

BaanERP

BaanERP the proven foundation for the BaanSeries



- Order to Cash foundation for the BaanSeries
- Open Component Architecture
- Fully integrated allowing for consistency and visibility across the enterprise
- Comprehensive international capabilities, supporting multiple languages, tax structures and currencies including the euro.
- Year 2000 Compliant
- Modular components that allow for incremental implementation and migration.

BaanERP, the successor to Baan IV is a proven enterprise resource planning software application which is fully integrated and provides exceptional functionality across the enterprise. BaanERP consists of a number of interdependent components that can be deployed to meet your business needs. The flexibility within BaanERP allows customers to maximize the benefits of both best in class solutions and a fully integrated, high-performance system. BaanERP includes the following components: manufacturing, finance, project, distribution, and tools.

[BaanERP Distribution](#)
[BaanERP Finance](#)
[BaanERP Manufacturing](#)
[BaanERP Project](#)
[BaanERP Tools](#)
[BaanERP on AS/400](#)

Brochures To Go



[BaanEDM -Enterprise Decision Manager \(717KB\)](#)

Baan Enterprise Decision Manager introduced to the market on October 12th, 1998 is an end-to-end solution based on an open enterprise intelligence framework. With ready to implement business templates, key business processes can be analysed.

[Baan ERP. Today's Standard of Success \(1,136KB\)](#)

BaanERP offers a comprehensive and flexible suite of Year 2000 compliant enterprise applications for small, medium and large enterprises.

[BaanProject: Descriptive Brochure \(676KB\)](#)

To keep pace with rapid change, project-driven businesses need an integrated and flexible enterprise system that supports all aspects of their business with state-of-the-art functionality. Baan offers an innovative solution that upgrades effortlessly and

BaanERP Products

BaanERP Distribution

What's New

- [FIVE MIRAGE RESORTS, INC. PROPERTIES GO LIVE WITH BAAN COMPANY'S CODA-FINANCIALS](#)
450 Users Up and Running with Enterprise Financial System in Eight Months
November 16, 1998
Mirage Resorts, Incorporated, a national parent company for luxury entertainment resorts, has gone live at each of its five hotel/casino properties in Nevada with Baan CODA-Financials as its enterprise-wide financial accounting application
- [FIAT ENTSCHEIDET SICH FÜR DIE UNTERNEHMENSSOFTWARE VON BAAN](#)
Turin/ Italien und Barneveld/ Niederlande, 29. Juli 1998 – Die Baan Company und Fiat Auto werden die zwischen den beiden Unternehmen bestehende Geschäftsbeziehung zukünftig noch weiter ausbauen.

BaanERP - Education

- [Baan Education](#)
Accelerate your business performance today with Baan Education. Our solutions accommodate a variety of learning styles with self-paced courses on the Baan Virtual

interfaced easily with third-party applications. This twelve page brochure describes how Baan software solutions are able to incorporate existing systems while extending to the Internet and electronic commerce.

Campus and CD-ROM, interactive instructor-led courses both in the classroom and via the Internet on BaanLIVE!, and step-by-step electronic advice and support on BaanEASE. Click [here](#) to learn more.



BaanProject: Fact Sheet (55KB)

This two page fact sheet describes how BaanProject delivers value to organizations that deal with the management of large projects and contracts requiring the coordination of key functional business process areas. The document defines these key processes as: Starting from estimates and Bids, to Engineering, Budgeting, planning, scheduling, procurement, transportation, production, site execution, service and maintenance, billing and progress tracking.



BaanERP Technology Brochure (439KB)

With the release of the BaanSeries, Baan has created a new delivery mechanism of open components for extended enterprise applications, which gives companies the choice and flexibility they need to grow. The BaanSeries goes beyond a traditional ERP system, offering advanced business modeling and the latest functionality - in an open-architecture environment.

Complete Listing

BaanERP Distribution

Overview

To help develop the best solution for meeting customer requirements and balancing business constraints, this component manages the entire spectrum of distribution, sales and logistics for manufacturers and distributors.

BaanERP Distribution Modules include:

- Sales Management
- Purchase Management
- Warehouse Management

Benefits

- Extensive simulation capabilities optimize purchasing and internal inventory decision making
- Top-down planning supports any distribution strategy
- With integrated workflow management and order templates, order processing is speeded up
- Shipping constraints, order blocking algorithms and multi-level ATP component checks are supported by the system.
- Integration with the Aurum Front-Office suite makes the Baan Sales solution one of the best in its class
- Purchasing is simplified with online requisitioning
- Sophisticated supplier contract and release management enables your company to take advantage of economies of scale
- EDI is key in enhancing the speeds of communication with trading partners as well as providing a solid link between distribution operations and manufacturing planning

Product Brochures

- **US BaanERP Distribution Brochure (338KB)**
This brochure describes how the BaanSeries provides all types of companies with the flexibility they need to grow. The BaanSeries delivers real-time knowledge across the entire value chain, from front-office activities such as prospect management and proposal generation to core manufacturing, finance, and - with BaanERP Distribution - the supply/distribution chain and beyond.

[Complete Listing](#)

BaanERP Finance

Overview

Baan's comprehensive solution is designed to meet dynamic financial management and reporting requirements around the world.

BaanERP Finance Module includes:

- Accounts Payable
- Accounts Receivable
- Financial Budgets System
- Cash Management
- Financial Reporting System
- Fixed Assets
- General Ledger
- Cost Accounting
- Sales Invoicing

Benefits

- This independent system allows for easy solution configuration to meet changing business strategies
- Integration with Hyperion financial software provides advanced budgeting, consolidation, reporting and analysis
- Accounting operations are simplified and duplicate data entry is eliminated with parameter-driven posting and updating tools
- Baan Accounts Payable streamlines vendor payments - supports checks, electronic banking and payment on consumption.
- Superior visibility enables you to immediately focus and act on financial information to help increase margins, revenue and cash flows.
- International business requirements are met with the use of multi-dimensional ledger and dual sets of books.
- Provides cost analysis and cost allocation functionality on both a detailed and summarized level
- Costs can be proactively tracked via budget links
- Multi-currency functionality allows you to hold up to 3 home currencies therefore complementing and complying with the euro regulations
- Central point invoicing

White Papers

Product Brochures

- **BaanFinance Product Brochure (887KB)**
This brochure describes BaanERP Finance, which features a fully integrated approach to managing financial operations. The system simplifies accounting operations by eliminating the need to re-enter purchasing, manufacturing and sales transactions into the financial system, thereby optimizing productivity. With BaanERP, these transactions are automatically copied and processed to the financial ledger. BaanERP's rapid access to high-quality information enables companies to focus and act on information in a timely manner to increase margins, revenue and cash flow.

[Complete Listing](#)

BaanERP Manufacturing

Overview

Flexibility, speed and continuous high quality are key to maintaining a competitive edge in the manufacturing world. Baan's unrivalled manufacturing functionality delivers a comprehensive solution for a wide range of production typologies and in addition, its extensive planning and scheduling capabilities translate your companies business goals into manufacturing plans. This component is key to manufacturing success.

BaanERP Manufacturing Module includes:

- Bills of Material
- Cost Price Calculation
- Engineering Change Control
- Engineering Data Management
- Hours Accounting
- Product Classification
- Product Configuration
- Production Control
- Production Planning
- Project Budgeting
- Project Control
- Repetitive Manufacturing
- Routings
- Shop Floor Control
- Tool Requirements, Planning and Control
- Capacity Requirements Planning*
- Master Production Scheduling*
- Material Requirements Planning*

*come with extensive enterprise planning capabilities

Benefits

- A comprehensive solution whatever your production strategy, process operation or industry specific requirements
- Open architecture design allows for a seamless and simplified integration with popular CAD packages via BaanEngineering elements
- High quality graphical simulations help analyze a 'what if' impact on financial requirements, capacity and inventory
- The systems object orientated configurator supports different production strategies
- Planning is integrated at every level and across multiple sites allowing smooth and consistent operational activity
- Within a dynamic environment , enterprise planning simulates alternative plans and reactive planning
- Planning and tracking capabilities are extended to improve production resource management issues such as inventory.
- The integrated quality management tool enables a wide range of statistics (from raw material to finished goods) to be monitored resulting in continuous improvement in manufacturing quality
- Multiple valuation methods help your company identify cost drivers and reduce product costs
- Planning, monitoring control and execution of shop floor activities

White Papers

- [US BaanERP Manufacturing Product Fact Sheet \(49KB\)](#)
This two page, document illustrates the following BaanERP Manufacturing modules: Engineering data management, Item control, Cost accounting, Bills of Materials, Work Center, Routings, Extended enterprise planning, Production, Planning and Control, Project Control, Repetitive Manufacturing, and Shop Floor Control.

Product Brochures

- [Quality Management Product Fact Sheet \(50KB\)](#)
For organizations that require the collection of measurable quality data, BaanERP Service delivers value through allowing the ability to glean both quantitative and qualitative data, which the customer can specify for further analysis. Baan Quality Management collects quality information from the key activity areas from within BaanERP. This two page, Industry Fact Sheet defines the benefits of Baan Quality Management through a listing and explanation of the functional modules.
- [US BaanERP Manufacturing Brochure \(543KB\)](#)
To keep pace with rapid change, businesses need an integrated and flexible enterprise system that supports all aspects of their business with state-of-the-art functionality. An innovative solution that upgrades effortlessly and interfaces easily with third-party applications. Software that is able to incorporate existing systems while extending its reach to the Internet and electronic commerce. The BaanSeries components deliver on

these requirements and give businesses the competitive edge they need to succeed.

Complete Listing

these requirements and give businesses the competitive edge they need to succeed.

Complete Listing

Baan Supply Chain Solutions

Achieving Supply Chain Velocity



"Velocity through the entire supply chain will become a key competitive weapon as companies respond to time based competitive factors. Even the best e-commerce strategy will fail in an organization that has not addressed the speed related supply chain issues that inevitably arise as a result of different demand patterns. Closer relationships with customers is clearly the number one issue on the minds of CEOs today and many companies believe the answer lies with the Internet. Successful organizations will recognize that e-commerce is part of a holistic e-business strategy that includes creating an 'e-Supply Chain'."

"The real winners in today's business climate will be those organizations that synchronize and add velocity to the execution of all supply chain processes. These participants - the supplier of raw material, the manufacturer of component parts, the assembler, the logistics provider and the transportation carrier - need to align their supply chain in reaction to customer demand."

Katrina Roche, Senior Vice President, Chief Marketing Officer, Baan Company

Extending the Enterprise through Supply Chain Management

Supply chain management is the handling of the flow of material and information through the supply chain. This process requires the coordinated efforts of countless knowledge workers distributed across numerous functional areas. The competitiveness of an organization in today's markets is directly related to how well they can synchronize and accelerate the flow of material through the enterprise. Those that do it well, gain a significant time based competitive advantage.

Baan Supply Chain Solutions is a suite of best-of-breed advanced planning products that focus on Supply Chain management. Each product plays a role in providing solutions in specific planning domains. Collectively, the products provide an overall solution for managing the flow of material through an enterprise and between trading partners.



Enterprise News

- **BAAN COMPANY TO ACQUIRE CAPS LOGISTICS, INC.**
September 24, 1998
Strategic Acquisition of Leading Logistics and Transportation Planning and Scheduling Software Vendor.
- **Synchronizing Organizational Performance to Create Market Value (110KB - pdf)**
Companies around the globe have begun changing the way they do business. During the next five years, they will change even more to further improve their responsiveness, agility and efficiencies. At the heart of these changes is the vision and development of sophisticated value chain networks that pool resources, synchronize supply with demand, and integrate organizations for mutual process efficiencies, inventory reductions and customer responsiveness.

[View More](#)

- **Organizations / Associations**
Companies around the globe have begun changing the way they do

BaanSCS Applications

Supply Chain Designer

Customers

- **Russell Stover**
Russell Stover This two page article lists the benefits the Russell Stover Candies company derived from Baan Supply Chain Solutions, which included improvements to inventory management and more efficient production.

[View More](#)

BaanSCS - Education

- **Baan Education**
Accelerate your business performance today with Baan Education. Our solutions accommodate a variety of learning styles with self-paced courses on the Baan Virtual Campus and CD-ROM, interactive instructor-led courses both in the classroom and via the Internet on BaanLIVE!, and step-by-step electronic advice and support on BaanEASE. Click [here](#) to learn more.

Supply Chain Management Research

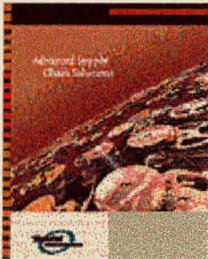


business to meet these requirements and increase market share. During the next five years, they will change even more to further improve their responsiveness, agility and efficiencies. At the heart of all these changes is the vision and development of sophisticated value chain networks that pool resources, synchronize supply with demand, and integrate organizations for mutual process efficiencies, inventory reductions and customer responsiveness.

White Papers

[View abstracts and download documents](#)

Brochures To Go



[English Brochures](#)

[French Brochures](#)

[German Brochures](#)

[Supply Chain Journal - 2nd Edition \(1.515KB\)](#)

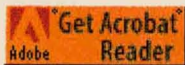
The Promise of Supply Chain Management by Anil Gupta, Are your customers putting you out of business? by Tom Hall, Demand Planning: a Manager's Practical View Yoni Cheifetz, Fresh Express Keeps On Truckin' Its Ready-To-Eat Salads, Nortel Streamlines Supply Chain To Prepare For Increased Sales Volume and Market Growth, Capsugel Discovers Potent Remedy For Optimized Scheduling and Return on Assets.

[Supply Chain Journal - 1st Edition \(826KB\)](#)

This 1st edition of the Journal of Supply Chain Management highlights the "Value-Driven Strategies by Industry Directions", "Russell Stover Looks To Optimizing SUPPLY CHAIN To Sweeten Bottom Line", "10% Increase in Capacity Production Can Have a Dramatic Impact on the Bottom Line" and much more.

[Email us with your questions](#)

[BaanSCS Headquarters](#)



22 APPENDIX B: SUPPLY CHAIN MANAGEMENT SOFTWARE

This Appendix contains documentation describing the capability and modules of the various APS or SCM software suites that were analysed in this report. They are:

- CAPS
- I2
- Manugistics
- Numetrics

Similarly to the ERP software literature, this literature is biased towards the individual tools it discusses.

A general overview of the tool and the vendor is provided as are their principle on supply chain management. A description of the modules and their capabilities follows and is discussed from the eyes of the vendor of the tool.

The various features and capabilities of the tools may appear to be very similar. To be able to fully differentiate between the various tool, one would have to investigate further, interview current users and consult knowledge groups.

The value of the information in this Appendix is limited. The sales brochures lack detail and objectivity. They do, however, provide a good starting point to get to know the tool as well as the market out there. They do provide an indication of the core values of the tool. If the tool is not at all suitable to particular need it will be obvious from these brochures.

[About CAPS](#)
[Corporate Overview](#)
[Career Opportunities](#)

about CAPS Logistics, Inc.

A Baan Company

CAPS Logistics, Inc., A Baan Company is a software development firm specializing in providing quality logistics decision support systems. Our clients span a wide range of industries, but all share the need for decision support in the areas of distribution supply chain design, supply chain planning, transportation planning, and vehicle routing and scheduling. CAPS Logistics develops software that assists clients in making these decisions on strategic, tactical, and operational levels and our strong record of success is directly attributable to CAPS' commitment to provide only quality business solutions.



Highly qualified personnel and state-of-the-art software are effectively integrated to produce the superior results clients expect. CAPS senior personnel have considerable experience in the fields of logistics planning, industrial engineering, and operations research. Our analysts are skilled industrial engineers and computer scientists, over half of who hold advanced degrees in their field.

CAPS employs state-of-the-art techniques in optimization, graphics interfacing, planning, and scheduling to create decision support systems. CAPS has received several Small Business Innovation Research (SBIR) awards in the areas of logistics and manufacturing from sponsors including the National Science Foundation (NSF), the Office of Naval Research (ONR), and the Air Force Office of Scientific Research (AFOSR), demonstrating our technical innovation. CAPS was selected by the Atlanta Olympic Committee to provide the software platform for showcasing Atlanta's qualifications to host the 1996 Olympic Games. CAPS is also featured in Logistics 2020, Andersen Consulting's showcase of logistics technology located in Atlanta.

About Baan Company

Founded in 1978, Baan Company is a global software product company defining the market for high volume, packaged enterprise applications by delivering the most comprehensive portfolio of integrated, Year 2000 compliant, software components to address the core business processes common to companies of all sizes and industries. Baan Company uniquely supports continuous business improvement with its Dynamic Enterprise Modeling capabilities and with products that are faster to implement and use, and more flexible in adapting to business changes. Its evergreen products help clients respond more quickly to changing customer needs by optimizing the management of real-time information throughout the entire value chain.

Baan is a global supplier of software solutions, consulting and implementation services designed to help enterprises optimize supply chain planning, production synchronization and execution control across the extended enterprise. Baan's best-in-class, scalable solutions are equally effective for single manufacturing plants, multi-plant operations with centralized control, or across an entire decentralized supply chain network of independent suppliers, distributors and transportation partners.

Baan Company has dual headquarters in Barneveld, The Netherlands and Reston, Virginia, USA. The Company's Common Stock is registered on the NASDAQ Stock Market under the symbol BAANF and on the Amsterdam Stock Exchange under the symbol BAAN.

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[Career Opportunities](#)

corporate OVERVIEW

Our Mission

CAPS Logistics, Inc., A Baan Company leads our customers toward supply chain efficiency through state of the art technology. We empower our clients with world class decision support software and superior service, so that they benefit from optimal logistics solutions. By providing technology that leads to maximum efficiency and quick return on investment, we make it possible for companies to lower inventory and transportation costs, improve customer service, and increase profitability.

Our Growth

Incorporated in 1979, CAPS Logistics has become the premier vendor of logistics planning and scheduling optimization software. We evolved from providing logistics consulting services to developing custom solutions. While these systems were quite innovative, developing them was time consuming and expensive. In 1989, CAPS Logistics revolutionized the software industry with the CAPS Logistics Toolkit®, a rapid application development environment for building memory-resident optimization models of supply chain systems.

From 1989 to early 1997, we remained a custom shop with the CAPS Logistics Toolkit as our flagship product. CAPS Logistics grew from 30 people in 1992 to 100 people in 1996 with revenue growth of 400% over those five years. Throughout the industry, the CAPS Logistics Toolkit developed a reputation as the best tool for modeling supply chain problems.

In 1997, CAPS Logistics released three software applications built on the foundation of the CAPS Logistics Toolkit. These products—Supply Chain Designer™, TransPro™, and RoutePro—had more power and flexibility than any application on the market. In 1998, advancing once again, we enhanced the CAPS Logistics Toolkit and expanded Supply Chain Designer, TransPro, and RoutePro Dispatcher™ into suites. In addition, CAPS Logistics introduced five new products: Supply Chain Coordinator™, BidPro™, RoutePro Designer™, RoutePro Residential™, and RoutePro VMI™.

Our Results

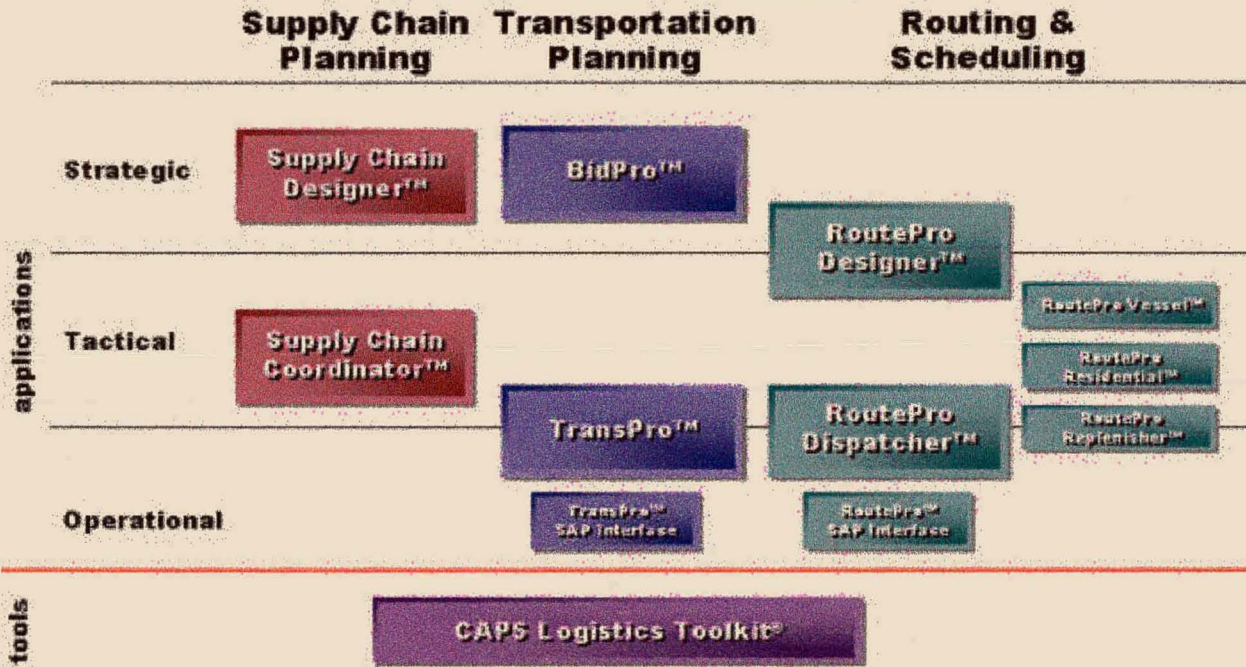
More than 25% of Fortune 100 companies and 15% of Fortune 500 companies in 31 countries have used CAPS Logistics solutions to reduce transportation and inventory costs, improve customer service, and increase profitability. Clients have achieved savings between 8% and 30% of their total transportation costs and recognized CAPS Logistics' reputation for providing superior service. Implementation, training, enhancements, and customer support are integral parts of our offering. Whether our client has one site or hundreds worldwide, CAPS Logistics finds the optimal solution for their business.

CAPS Logistics—the premier vendor of software for optimizing logistics planning and scheduling.

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The CAPS Logistics, Inc., A Baan Company Product Line

(Click on a Product for more details.)



Hardware and Software Requirements

[The CAPS Logistics, Inc., A Baan Company](#)
[Geographic Data Catalog](#)

[Supply Chain Designer](#) | [Supply Chain Coordinator](#) | [BidPro](#) | [TransPro](#) | [RoutePro Designer](#)
[RoutePro Dispatcher](#) | [RoutePro Residential](#) | [RoutePro Replenisher](#) | [RoutePro Vessel](#)
[The CAPS Logistics Toolkit](#) | [SAP™ R/3™ Interface](#) | [Back to the Products Page](#)

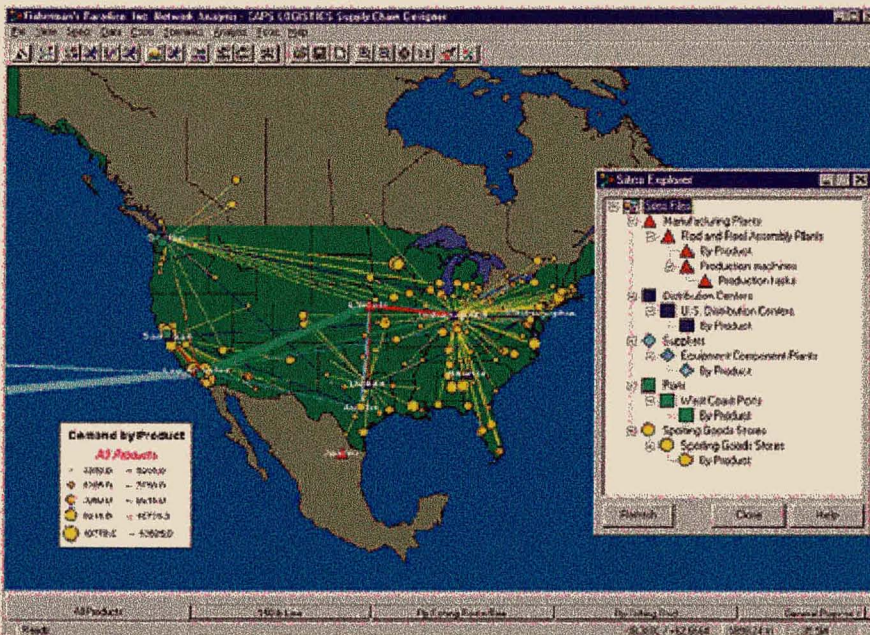
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SupplyChainDesigner™

Supply Chain Modeling and Optimization

Supply Chain Designer™ For supply chain modeling and optimization; used to model and optimize design and planning of global logistics supply chains including infrastructure design, facility location and sizing, resource allocation, transportation and inventory strategies, service level analysis, and profitability studies. Supply Chain Designer optimizes even the largest and most complex global supply chain models thanks to its workstation class performance and efficient handling of enterprise-scale data.



“We’ve done strategic network analysis jobs that have found savings ranging from \$2 million to \$65 million for our clients.”

*Tim Brown
IBM Global Services*

SupplyChainDesigner™ addresses:

Strategy

Supply Chain Infrastructure Design
Site Location
Transportation Strategy
Inventory Strategy
Capacity Sizing

Planning

Resource Allocation
Inbound Sourcing
Customer Distribution Channels
Vendor Selection

About Supply Chain Designer

[Additional Software Information](#)

[Product Features](#)

[Supply Chain Case Study](#)

Product Screen Shots

[European Supply Chain Analysis](#)

[Perform Global Supply Chain Analysis](#)

[Scenario Manager](#)

[Latin American Supply Chain Analysis](#)

[Supply Chain Data Input Template](#)

[Supply Chain Graphics](#)

[More Supply Chain Graphics](#)

[Supply Chain Report](#)

Operations

Production Allocation
Transportation/Inventory Tradeoffs

Evaluation

Benchmarking
Profitability Analysis
Cost Analysis
Resource Utilization
Service Measurement

Supply Chain Scenario Manager Form

**Are You Finding the Best Answers
to these Questions?**

**How can I best use free
trade zones, border crossings, and
ports of entry and exit?**

[Supply Chain Designer](#) | [Supply Chain Coordinator](#) | [BidPro](#) | [TransPro](#) | [RoutePro Designer](#)
[RoutePro Dispatcher](#) | [RoutePro Residential](#) | [RoutePro Replenisher](#) | [RoutePro Vessel](#)
[The CAPS Logistics Toolkit](#) | [SAPTM R/3TM Interface](#) | [Back to the Products Page](#)

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SupplyChainDesigner™

Supply Chain Modeling and Optimization

Supply Chain Designer™

Product Features

User Interface

- Point and click to change all data from map view
- Drill down data browsing
- Model Setup Wizard to walk user through model building process
- Easy data setup and cleanup via Microsoft® Excel/Access templates
- Tabbed views of individual product flows
- Explorer views for sites, lanes, products and constraints
- Infeasibility Wizard to help diagnose problems with a model

Scenario Management (Interactive model building)

- Configurable data changes from one scenario to another
- No limits on number of products, sites, lanes, or tiers
- Automatic lane generation by road distance, time, or service standards
- Include/remove sites and lanes from model Include/remove constraint sets from model
- Include/remove cost components from model
- Constraint Building Wizard
- Solve batches of scenarios
- Custom pre- and post-solve reports and graphics
- Side-by-side scenario comparison

Models

- Minimize cost or maximize profit
- "Green field" site selection
- Candidate site selection
- Multi-stage production

Site Cost Models

- Safety stock
- Aggregate inventory
- Material handling
- Manufacturing Production
- Processes
- Purchasing
- Any number of custom fixed, variable, or product fixed cost components

Graphics

- Preview and print graphics when generated
- Create custom graphics and add to your model **Scenario specific standard graphics include:**
- Landed costs/customer/product
- Profit/customer/product

Lane Cost Models

- Transportation: parcel, air, LTL, truckload, rail, container, vessel, and custom modes
- Mode profiles
- Cycle stock and in-transit inventory
- Duties/tariffs
- Taxes
- Transfer prices
- Any number of custom fixed or variable cost components

Business Rules/Constraints

- Enforce service standard at sites
- Single source any type of site
- Production constraints to transform products
- Multi-level bill of materials
- Limit number of open sites or lanes
- Limit sets of flows, or make open/close decisions
- Limit flows at sites by property of lane
- Local content rules
- Bundled product flows
- Lock sites/lanes either open or closed
- Constraint Wizard to assist user with additional constraint development

Solvers

- CAPS proprietary algorithms for supply chain problems
- CPLEX Linear Programming Library
- CPLEX Mixed Integer Programming Library
- Write standard MPS file and export to IBM's OSL, Dash's XPRESS-MP, LINDO, and other MPS compatible solvers
- Call user's own solver DLL with access to all data
- User controls all solution parameters including tolerances and algorithm
- Run interactively or silently in batch mode
- Limited only by hardware and operating system limits

Reports

- Crystal Reports,™ Excel/Access reports, ASCII text
- Preview, print and/or save reports when generated
- Create custom reports from a library of over 50 standard Crystal Report formats

Scenario specific standard reports include:

- Landed costs
- Total costs broken down by components/products
- Site costs broken down by sets of sites/cost component/products

- | | |
|--|---|
| <ul style="list-style-type: none">● Color/size by supply and/or supply utilization● Color/size by demand and/or demand satisfaction● Color/size by production and/or production capacity● Color/size by flowthrough and/or flowthrough utilization● Display individual product flows● Display product flows and color or size demand and/or supply● Others | <ul style="list-style-type: none">● Flow at sites broken down by site type/products● Lane costs broken down by sets of lanes/cost component/products● Flow on lanes broken down by product● Landed cost by product at each site● Pre-solve data check comparing product supply, demand, capacity for sites and lanes● Others |
|--|---|

[Back to Supply Chain Designer](#)

[Supply Chain Designer](#) | [Supply Chain Coordinator](#) | [BidPro](#) | [TransPro](#) | [RoutePro Designer](#)
[RoutePro Dispatcher](#) | [RoutePro Residential](#) | [RoutePro Replenisher](#) | [RoutePro Vessel](#)
[The CAPS Logistics Toolkit](#) | [SAPTM R/3TM Interface](#) | [Back to the Products Page](#)

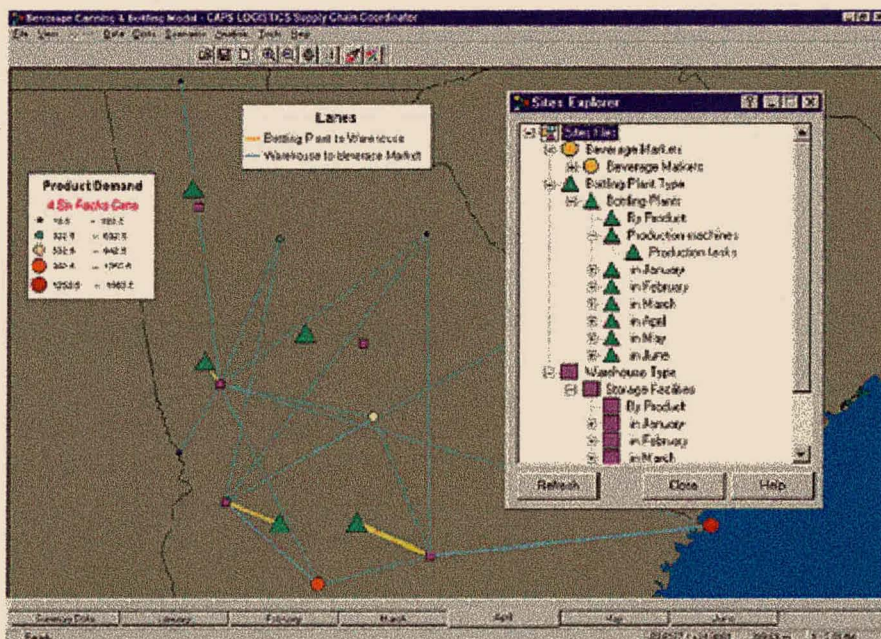
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SupplyChainCoordinator™

Tactical Supply Chain Planning

Supply Chain Coordinator - A tactical manufacturing and distribution planning tool which optimizes the tradeoffs among production, inventory and transportation over multiple time periods. It is ideal for supply chain problems involving seasonal changes in demand and production changeover costs and setup times.



“Supply Chain Coordinator represents breakthrough technology to optimize enterprise-wide tradeoffs among sourcing, production setup, transportation, and inventory.”

*Dr. Bill Nulty
Senior VP of Products
CAPS Logistics, Inc.*

SupplyChainCoordinator™ addresses:

Strategy

- Seasonal Inventory Building
- Transportation Strategy
- Capacity Sizing
- Production Run-length vs. Inventory Size

Planning

- Multi-plant/DC Sourcing
- Resource Allocation
- Inbound Sourcing
- Vendor Selection
- Promotion Planning
- Customer Distribution Channels

Operations

- Production Allocation

Supply Chain Coordinator Topics

[Additional Software Information](#)

[Product Features](#)

[Supply Chain Case Study](#)

Product Screen Shots

[Using the Sites Explorer](#)

[Viewing Graphics and Reports](#)

[Using the Scenario Manager](#)

[More Reports and Graphics](#)

[Scenario Comparisons](#)

[Using Crystal Reports](#)

Are You Finding the Best Answers to these Questions?

Transportation/Inventory Tradeoffs
Supply Chain Scheduling

**How do I balance lead-time and the cost
of faster transportation in meeting
varying customer requirements?**

Evaluation

Benchmarking
Profitability Analysis
Cost Analysis
Resource Utilization
Service Measurement

[Supply Chain Designer](#) | [Supply Chain Coordinator](#) | [BidPro](#) | [TransPro](#) | [RoutePro Designer](#)
[RoutePro Dispatcher](#) | [RoutePro Residential](#) | [RoutePro Replenisher](#) | [RoutePro Vessel](#)
[The CAPS Logistics Toolkit](#) | [SAPTM R/3TM Interface](#) | [Back to the Products Page](#)

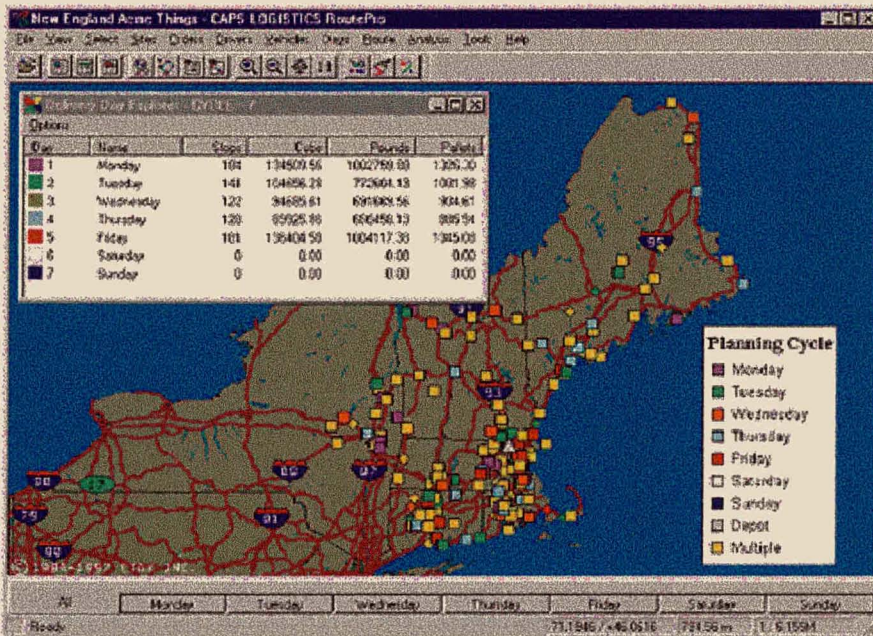
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RoutePro Designer™

Strategic Route Optimization and Analysis

RoutePro Designer - This strategic route planning tool optimizes fixed or master routes, designs territories, balances and optimizes customer service frequency over days of the week, and sizes fleets. This product integrates seamlessly with RoutePro Dispatcher in that strategies such as master routes can be automatically exported to RoutePro Dispatcher for operational use.



“Schneider Logistics recently went through an extensive routing software selection process and we believe CAPS Logistics has the best routing package commercially available.”

Larry Sur
President
Schneider Logistics, Inc.

RoutePro Designer™ addresses:

Strategy

- Fixed Route Design
- Master Route Design
- Territory Planning
- Service Day Analysis
- Frequency Analysis
- Fleet Sizing

Planning

- Weekly Route Building
- Daily Route Building

Operations

- Adapting Master Routes

RoutePro Designer Topics

- [Additional Software Information](#)
- [Product features](#)
- [Routing Case Study](#)

Product Screen Shots

- [Balancing Routes and Workloads](#)
- [Service Frequencies and Patterns](#)
- [Viewing Data in RoutePro Designer](#)

Are You Finding the Best Answers

Daily Dispatching
Routing New Orders
Dynamic, Real-time Dispatching

to these Questions?

How large should my fleet be?

Evaluation

Benchmarking
Post-route Analysis
Capacity Utilization
Service Measurement
Cost Analysis

[Supply Chain Designer](#) | [Supply Chain Coordinator](#) | [BidPro](#) | [TransPro](#) | [RoutePro Designer](#)
[RoutePro Dispatcher](#) | [RoutePro Residential](#) | [RoutePro Replenisher](#) | [RoutePro Vessel](#)
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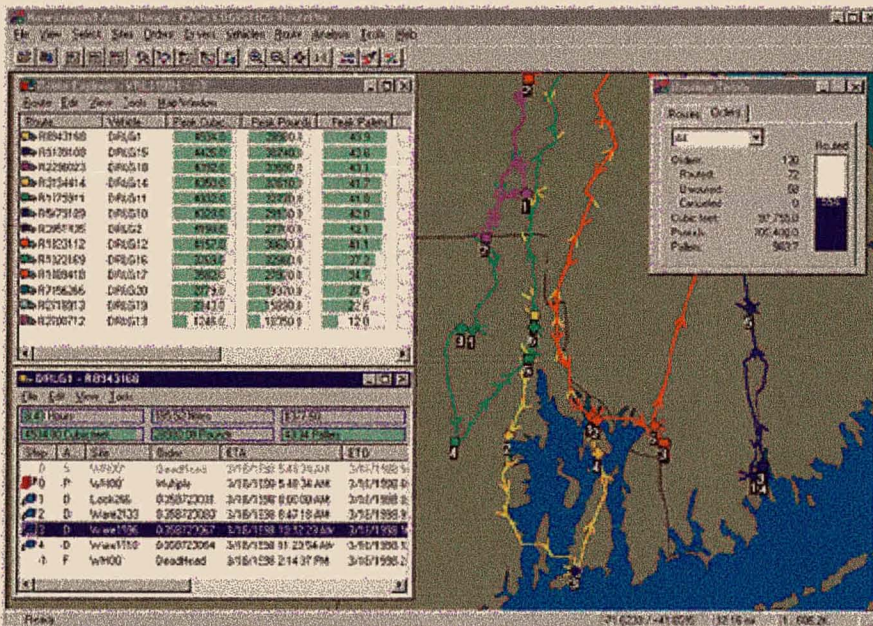
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RouteProDispatcher™

Operational Vehicle Routing

RoutePro Dispatcher - For optimization of the routing & scheduling of transportation assets, usually private or dedicated trucking fleets.



“Schneider Logistics recently went through an extensive routing software selection process and we believe CAPS Logistics has the best routing package commercially available.”

Larry Sur
President
Schneider Logistics, Inc.

RouteProDispatcher™ addresses:

Strategy

- Fixed Route Design
- Master Route Design
- Territory Planning
- Service Day Analysis
- Frequency Analysis
- Fleet Sizing

Planning

- Weekly Route Building
- Daily Route Building

Operations

- Adapting Master Routes
- Daily Dispatching
- Routing New Orders
- Dynamic, Real-time Dispatching

RoutePro Dispatcher Topics

- [Additional Software Information](#)
- [Routing Case Studies](#)
- [Product features](#)

Product Screen Shots

- [Local Area Routing Scenario](#)
- [Longhaul Routing Scenario](#)
- [RoutePro™ Graphics](#)
- [RoutePro™ Administrator Wizard](#)
- [RoutePro™ Create Site Wizard](#)
- [RoutePro™ Route Cards](#)
- [Using the Route Explorer](#)

Are You Finding the Best Answers to These Questions?

How can I lower costs and improve service?

Evaluation

Benchmarking
Post-route Analysis
Capacity Utilization
Service Measurement
Cost Analysis

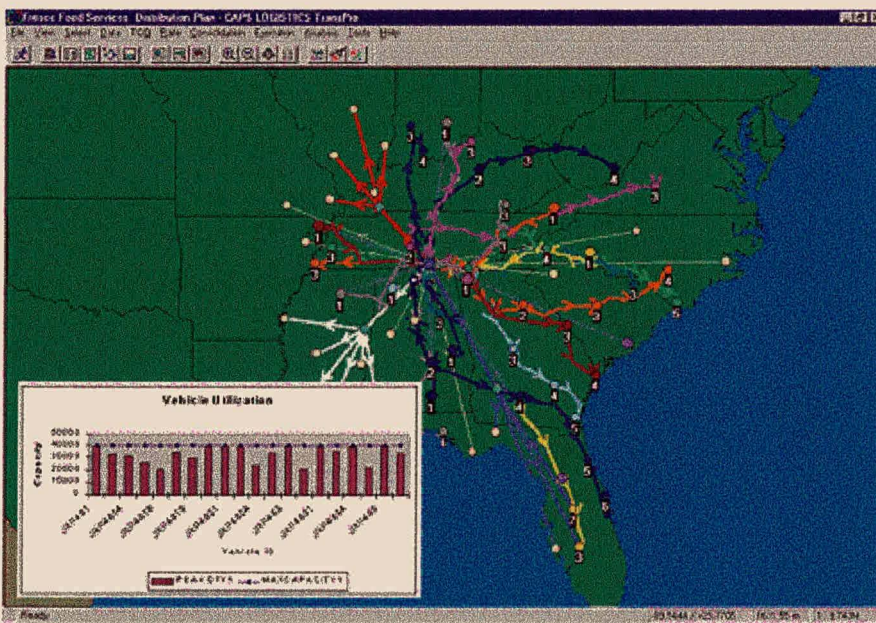
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[RoutePro Dispatcher](#) | [RoutePro Residential](#) | [RoutePro Replenisher](#) | [RoutePro Vessel](#)
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TransPro™ Transportation Planning

TransPro - For transportation planning; optimizes planning & operational transportation decisions involving freight consolidation, mode/carrier selection, and pooling. This product is for companies that use 3rd party carriers in addition to or instead of using their own or dedicated fleets.



“We are experiencing a five percent reduction in inbound transportation costs alone. And, the return on investment has occurred in just a few weeks.”

*Chris Tobe
Director of Logistics
Systems
Service Merchandise*

TransPro™ addresses:

Strategy

- Pool Point Location
- Dedicated Fleet Sizing
- Shipment Sizing
- Mode Analysis
- Fixed/Master Route Design
- Customer Sourcing

Planning

- Multi-stop TL Route Optimization
- Mode/Carrier Selection
- LTL to TL Order Consolidation
- Pooled Shipment Operations

Operations

- Daily/Weekly Transportation Plans
- Dynamic Planning
- Routing New Orders

TransPro Topics

- [Additional Software Information](#)
- [Product features](#)
- [Transportation Planning Case Study](#)

Product Screen Shots

- [Consolidating Shipments](#)
- [Creating documents](#)
- [International Transportation Planning](#)
- [TransPro™ and Continuous Moves](#)
- [TransPro™ Mode Selection](#)
- [TransPro™ Report](#)
- [TransPro™ Schedule Window](#)

**Are You Finding the Best Answer
to These Questions?**

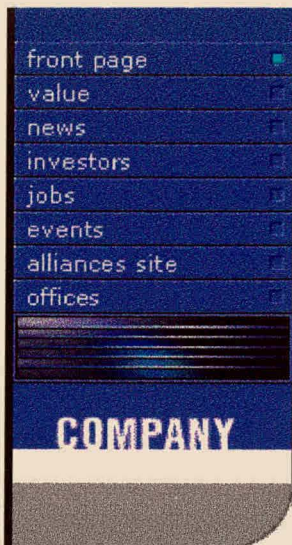
Evaluation

Benchmarking
Post-route Analysis
Capacity Utilization
Service Measurement
Cost Analysis

How can I lower costs and improve service?

[Supply Chain Designer](#) | [Supply Chain Coordinator](#) | [BidPro](#) | [TransPro](#) | [RoutePro Designer](#)
[RoutePro Dispatcher](#) | [RoutePro Residential](#) | [RoutePro Replenisher](#) | [RoutePro Vessel](#)
[The CAPS Logistics Toolkit](#) | [SAPTM R/3TM Interface](#) | [Back to the Products Page](#)

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company information

Our story is simple. We deliver value.

i2 creates innovative solutions that generate measurable value for business. Our intelligent planning and optimization software, **RHYTHM®**, helps companies maximize efficiency, collaborate with suppliers and customers, conduct [intelligent eBusiness](#) over the Internet, and become more responsive to market demand. i2's world-class customers learn to make **better decisions, faster** than their competitors.

i2 was founded in 1988 on the principle that manufacturing planning could not only be executed faster, but based on the real business goals and conditions of the enterprise. Since then, i2 has consistently developed new intelligent planning technologies for every phase of producing, delivering and selling goods and services, including solutions that support intelligent eBusiness and eCommerce.

This cycle of buy-make-move-store-sell is called the [supply chain](#), and today i2 Technologies is the leading provider of supply chain optimization solutions, with customers worldwide. Our RHYTHM family of software provides comprehensive decision support across both inter-enterprise and intra-enterprise supply chains: from your suppliers' suppliers to your customers' customers.

Now we are delivering a new set of solutions that enable **BPO**, or **Business Process Optimization** - a new layer of decision intelligence for planning and optimizing across multiple enterprises. BPO tightly integrates forward-thinking supply chain planning with every key business process - from superior product design to better customer relationships. With BPO, your enterprise connects front-end Web applications with back-end process optimization for intelligent eBusiness.

But despite all of the growth and innovation i2 has experienced [over the years](#), our core beliefs have not changed. We are still about making **better decisions, faster**, based on the real constraints and goals of your

[claim your share!](#)



[get your own i2 online Value Proposition](#)

business. And every i2'er is motivated and dedicated toward providing our customers with the highest level of business value.



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OVERVIEW: RHYTHM SOLUTIONS

i2's RHYTHM solutions offer the intelligent answer for decision-making across the enterprise. RHYTHM software optimizes and integrates key business processes, while delivering intelligent eBusiness through collaboration with trading partners. RHYTHM offers a complete solution for Business Process Optimization (BPO) by offering the optimization, integration, and forward visibility required for high-velocity business. The RHYTHM solution has delivered billions of dollars in measurable value for major companies in a wide range of industries.

the competitive edge

Historically, leading companies have achieved success by mastering one of three core business disciplines:

product leadership -- developing and launching innovative products at the right time, while managing the product lifecycle from concept to phase-out.

operational excellence -- manufacturing and delivering the right products at the right time, while collaborating with trading partners.

customer intimacy -- engaging the right customers, managing their relationships, and providing superior customer service.

In the past, a company could succeed by pursuing excellence in just one of these areas.

However, the terms of engagement have changed. Globalization, increasing customer demands, intensified competition and the Internet have added incredible variability and complexity to today's business landscape. *Velocity*, or the ability to make intelligent decisions at high speed, is a necessity in this real-time economy.

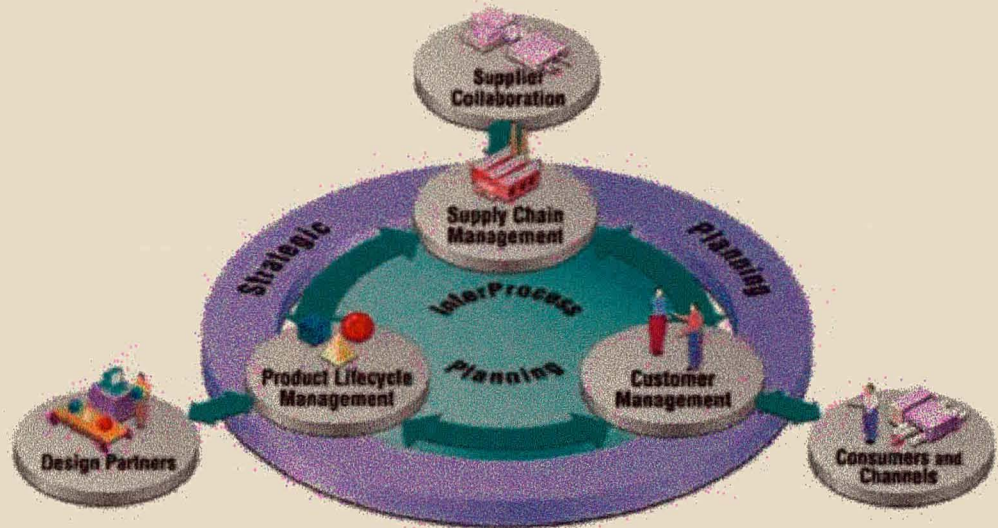
"The increased velocity of information, combined with intelligent use, will differentiate companies into the next millennium."

Larry DeBoever, META Group

What type of decision intelligence will give your company the velocity to achieve excellence in all areas of your business?

The answer is RHYTHM. Representing a natural extension of i2's recognized leadership in optimizing business processes, RHYTHM provides advanced planning and optimization of the following key processes:

- **Product Lifecycle Management** for product leadership
- **Supply Chain Management** for operational excellence
- **Customer Management** for customer intimacy
- **InterProcess Planning** to integrate the above three processes, maximizing resource utilization and profitability
- **Strategic Planning** for accurate long-term decision-making and scenario-based analysis of competitors.



In addition, RHYTHM leverages the Internet to intelligently connect your business processes with customers, suppliers and partners to deliver the results you expected from your eBusiness and eCommerce efforts. RHYTHM integrates Web front-end applications with back-end business process optimization.

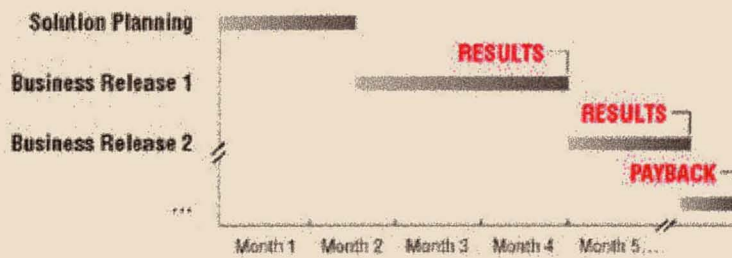
RHYTHM is the end-to-end solution that fully enables Business Process Optimization, or BPO. BPO is a new class of decision-intelligence software that features multi-enterprise optimization and integration, while powering e-business initiatives through intelligent collaboration. What is the difference between BPO and RHYTHM? Simply put, BPO is the concept, while RHYTHM is the solution that makes BPO a reality. In fact, RHYTHM is the first comprehensive suite of software that makes BPO happen.

Are your present systems enough?

ERP, legacy and other transaction systems are built for recording ***what already happened***, rather than planning for ***what will be***. This lack of advanced planning capability hinders your company's ability to make the right decisions at the right time. To maximize your investment in ERP and other systems, RHYTHM leverages your current infrastructure. First, RHYTHM derives raw data from ERP systems or any other existing data source. Next, RHYTHM engages an integrated set of planning engines to produce an optimal solution based on a complete view of the enterprise and its trading partners. Last, RHYTHM feeds the optimal solution data back into the transaction system for execution. RHYTHM is the complete decision-intelligence system that turns ERP data into actionable business intelligence.

i2 Technologies

i2 Technologies is the recognized leader in Supply Chain Planning and Optimization, with more than ten years of experience in optimizing business processes.



To deliver the full value of business process optimization, RHYTHM features an implementation that is both incremental and value-based. The RHYTHM implementation proceeds step by step, with a focus on components that have the most impact first. As a result, companies see fast, measurable results that pay for the next phase and beyond.

i2's single mission: value

i2's business model is focused entirely on delivering value to customers. In 1995, i2 raised the bar in the software industry by establishing the goal of providing \$50 billion in value to customers by the year 2005. Even conservative third-party estimates show we are well on our way toward achieving this goal. The latest improvements to RHYTHM make it the complete solution for intelligent eBusiness enabled by BPO, delivering more measurable value for customers than any other business software application. In fact, major companies across industries are already realizing billions of dollars in value through the enhanced RHYTHM solution. We encourage you to discover for yourself the value i2 is generating for customers by reading our "[1998 Customer Value Report](#)" on www.i2.com. This unique report, prepared by a third-party auditor, describes the extraordinary return on investment customers are realizing from i2's solutions.

i2's RHYTHM solutions arm companies with a competitive weapon that streamlines operations, boosts customer service, expands market share and enables intelligent eBusiness. If you agree there is a better way of doing business, then we invite your enterprise to achieve maximum velocity with RHYTHM.

"At the end of the day, if you use i2 software and your competitor doesn't, you win."

Barron's, November 1998



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PRODUCT LIFECYCLE MANAGEMENT

The objective of i2's RHYTHM Supply Chain Management (SCM) solution is to achieve operational excellence throughout the extended supply chain by maximizing revenues, minimizing expenses, and making full use of all assets. The result is superior profitability, market share, and responsiveness to customer demand.

i2's market leading SCM solution enables companies to leverage powerful back-end fulfillment and optimization to create the intelligent eBusiness. SCM is a part of electronic Business Process Optimization or eBPO, comprehensively integrating all sub-processes that exchange information and movement of goods between suppliers and end customers, including manufacturers, distributors, retailers, and any other enterprise within the extended supply chain.

SCM is composed of three sub-processes: Demand Planning, Supply Planning, and Demand Fulfillment. SCM is composed of Demand Planning for the effective anticipation of market demand, Supply Planning for the optimal positioning of enterprise resources to meet demand and Demand Fulfillment for the efficient fulfillment of demand as it is realized. Examples of the problems supply chain management addresses:

The Challenge	The RHYTHM Solution
How can I improve my responsiveness to supply and demand fluctuations, and minimize inventory?	Intelligent, collaborative workflows that extend the supply chain into the customer and supplier bases.
How can I improve reliability of my delivery commitments, and maintain my margin targets?	Intelligent, high-performance Available To Promise (ATP) and backlog management.
How can I reduce the overall inventory levels in my supply chain without sacrificing customer service?	Rapid, end-to-end supply chain planning workflows, with JIT procurement and production.

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Solutions

- [Product Lifecycle Management](#)
- [Supply Chain Management](#)
- [Customer Management](#)
- [InterProcess Planning](#)
- [Strategic Planning](#)

<p>Is my supply chain positioned to accommodate a new product introduction?</p>	<p>Inter-process integrated workflows for product-transition planning that synchronize the product development and launch capabilities with the supply chain's ability to support the new product.</p>
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Value

The RHYTHM Supply Chain Management solution increases profitability and boosts market share through:

- **Maximized revenues and minimized costs.** By effectively managing constraints and response buffers to ensure maximum throughput and demand coverage, the resources of an enterprise are aligned to generate maximum revenue and eliminate unnecessary costs.
- **Improved customer satisfaction.** Dependable delivery promises and consistent execution against those promises creates customer loyalty.
- **Inventory-lean supply chain.** With customer information propagating through to the raw-materials level, there is need for limited finished goods inventories and safety stocks at any of the intermediate manufacturing, storage, or transportation points.
- **Improved agility.** By eliminating unnecessary inventory from the supply chain while ensuring coverage against demand and supply fluctuations, an enterprise can maneuver more effectively against the competition.

Differentiators

- Allows front-end eCommerce solutions to directly interact with the company's back-end supply chain processes for intelligent eBusiness.
- Greatest depth and breadth of functionality/optimization, enabling companies to slash costs and respond faster to customer demand than anyone in their industry.

- Fully templated solutions including best-practice workflows for rapid implementation and maximum return-on-investment.
- Technology infrastructure enabling multiple enterprise transaction systems to be integrated with a cohesive planning and optimization layer. RHYTHM leverages the ERP investment, turning ERP data into actionable business intelligence and delivering maximum value.
- Event-based workflows, coupled with real-time planning, providing forward visibility to react quickly to variability and complexity in the marketplace.

SCM includes the following sub-business processes:

Demand Fulfillment—The objective of the demand fulfillment process is to provide fast, accurate, and reliable delivery-date responses to customer orders. Demand Fulfillment is mainly an execution-level sub-process that includes order capturing, customer verification, order promising, backlog management, and order fulfillment.

Demand Planning—The objective of the demand planning process is to understand customers' buying patterns and develop aggregate, collaborative forecasts. Demand planning is by definition a planning process and feeds into the supply planning process, and subsequently the demand fulfillment process. Demand planning involves long-term, intermediate-term and short-term time horizons.

Supply Planning—The objective of the supply planning process is optimally position enterprise resources to meet demand. This is a planning-level sub-process that spans the strategic and tactical supply-planning processes. Strategic planning, inventory planning, distribution planning, collaborative procurement and transportation planning, and supply allocation are all part of this sub-process.





SUPPLY CHAIN MANAGEMENT

The objective of i2's RHYTHM Supply Chain Management (SCM) solution is to achieve operational excellence throughout the extended supply chain by maximizing revenues, minimizing expenses, and making full use of all assets. The result is superior profitability, market share, and responsiveness to customer demand.

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The Challenge	The RHYTHM Solution
How can I improve my responsiveness to supply and demand fluctuations, and minimize inventory?	Intelligent, collaborative workflows that extend the supply chain into the customer and supplier bases.
How can I improve reliability of my delivery commitments, and maintain my margin targets?	Intelligent, high-performance Available To Promise (ATP) and backlog management.
How can I reduce the overall inventory levels in my supply chain without sacrificing customer service?	Rapid, end-to-end supply chain planning workflows, with JIT procurement and production.

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<p>Is my supply chain positioned to accommodate a new product introduction?</p>	<p>Inter-process integrated workflows for product-transition planning that synchronize the product development and launch capabilities with the supply chain's ability to support the new product.</p>
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CUSTOMER MANAGEMENT

RHYTHM Customer Management enables the creation of long-term, profitable relationships with customers through increased customer intimacy and improved business process effectiveness. i2s' solution is a comprehensive, scalable business process optimization solution that enables intelligent eBusiness and maximizes return on marketing, sales, and customer support investments.

- **Customer Management encompasses the following customer-centric activities:**
 - Creating needs through identifying and acquiring customers, and developing marketing content and offers
 - Matching needs with customized product offerings
 - Fulfilling needs by executing the sales transaction (either directly, or through indirect channels), and providing real-time, integrated order fulfillment
 - Managing long-term customer relationships, by servicing customer needs and cross-selling and up-selling opportunities

i2 provides intelligent eBusiness solutions for the various processes involved—segmenting the market, identifying potential customers, attracting, profiling, and acquiring customers, customizing and defining the product or service being offered, defining and executing the sale (either directly, or through indirect channels), delivering the product or service, retaining the customer through superior after-sales service and maintenance programs, and creating long-term up-selling and cross-selling opportunities.

RHYTHM Customer Management includes the following sub-processes: "**Marketing**" seeking and attracting customers, and defining the appropriate product and service offering; "**Commerce**" the process of

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executing the sale, fulfilling the order, and delivering the product or service; and "**Customer Care**" providing effective, profitable customer care and maintaining loyalty through a life-long relationship.

- The real payoffs come from managing extended business transactions that go beyond specific purchases of individual items—that extend to all critical partners in the value chain and create sustainable customer loyalty leading to profitable repeat business.

RHYTHM customer management solutions provide extensive customization and personalization capabilities. This gives customers the power to view the enterprise in a way that they can relate to, thereby making it easier for them to do business with it, and creating stronger and more profitable customer relationships.

- **RHYTHM Customer Management solutions:**

- **RHYTHM eCustomer Marketing Suite**—identifying, segmenting, and profiling customers, delivering personalized marketing content, and creating purchasing intent through customized marketing offers that best match customer needs. RHYTHM provides sophisticated capabilities including marketing automation, campaign management, information libraries, content creation and management, promotions/incentive planning, and marketing operations planning. The solution is channel transparent, enabling enterprises to reach customers directly or through a variety of channel intermediaries. Enterprise marketing solutions include demand forecasting, brand and account planning, and collaboration planning.
- **RHYTHM eCustomer Commerce Suite**—provides a comprehensive electronic commerce application featuring

product catalogs, temporary shopping carts and persistent shopping lists, credit card processing, tax calculations, cross-selling capabilities, auctions, billing, order status and payment processing capabilities.

- **RHYTHM Sales Configuration**—allows the configuration of complex products.
- **RHYTHM Sales Pricer**—A pricing optimization engine allows the administration of highly sophisticated and complex pricing schemes based on different user categories, product hierarchies, multi-level discounts, geographical variations and currency conversions.
- **RHYTHM Internet Fulfillment Server**— integrates the Commerce solution with back-end supply chain processes to ensure in real-time that the customer offering is simultaneously valid, deliverable, and profitable.
- **RHYTHM eCustomer Care Suite**—Customer-facing capabilities include electronic help desk, support contracts management, online product registration, self-service support, logging and tracking for order and returns, knowledge bases, electronic billing.
- **Customer Care planning and scheduling capabilities:**
- **RHYTHM Service Parts Planner**—provides a solution for forecasting, replenishment planning and inventory management of service parts. Maintaining the optimal level of service parts in stock results in better customer satisfaction due to having appropriate parts on hand, while minimizing the inventory asset costs.
- **RHYTHM Service Scheduler**—a decision support tool for intelligent scheduling of service calls to ensure that enterprises can cost-effectively provide their customers with reliable, timely

service. RSS can be used either to schedule repair crews who use a standard inventory of parts, or concurrently schedule crews and material that is not on site and needs to be available at the time of repair. RSS handles the logistics issues for these situations, and generates an optimal (capacity-feasible, minimum-travel-time) solution.

- **RHYTHM Parts Storage Optimizer**—automates storage capacity planning and facilitates effective and rapid balancing of on hand parts inventory requirements based on available parts storage capacity by location. PSO can be used in conjunction with a spare parts planning solution to intelligently iterate between parts availability and storage, resulting in reduced on hand parts inventories while increasing customer service levels and technician productivity.
- **RHYTHM Strategic Budget Optimizer**—provides strategic decision support functionality to determine the optimal level and deployment of spares part inventories while meeting budgetary limitations.
- **RHYTHM Global Logistics Manager**—provides strategic decision support for distribution planning and simulation. Customer care solutions that provide improve the speed and quality of customer service interactions while lowering overall service expenses and assets deployed.

RHYTHM solutions are based on a customer-centric data model and are architected to use common services such as profiling, personalization, security, tracking, and tracing.

- The RHYTHM Customer Management solution increases profitability and boosts market share through:

Increased Revenues and Reduced Costs

- Increased market share due to

- superior customer relationships.
- Decreased marketing and promotion expenses.
- Improved channel efficiency.
- Increased parts and service revenues.
- Improved demand-creating collaboration.
- Profitable cross-selling and up-selling opportunities to existing customers.
- Increased repeat business revenues from customized, personalized, customer online experience—maximize lifetime profit per customer.
- Reduced service expenses with online self-service.

Increased Return on Service/Support Investments

- Reduced service parts inventory.
- Reduced physical storage space of service parts.
- Improved service personnel productivity.
- Increased equipment uptime, first-time fix rates.
- Improved inventory forecasting with service parts suppliers.

Increased Customer Satisfaction and Responsiveness

- Reduced lost sales and stock outs due to poor planning.
- Increased critical parts availability.
- Increased desire fulfillment and service response times.
- Better management of wider product assortments that meet segmented customer demands while managing profitability.

• Differentiators

- RHYTHM Customer Management is the only solution that combines a cohesive, personalized, forward-looking, customer-centric view of all customer-related business activities with back-end demand fulfillment and supply chain management capabilities. It integrates workflows across different functional silos,

- different geographies, multiple enterprises, channels, and media.
- o RHYTHM enables synchronized, high velocity, channel-transparent customer relationships that shorten the cycle between discerning customer desires and fulfilling needs.
- o RHYTHM Customer Management solutions are based on a customer-centric data model and a distributed, scalable architecture that provides common services such as profiling, personalization, security, tracking, and tracing.
- o RHYTHM provides world-class decision support to optimize the value provided to customers as well as to the enterprise, its partners, suppliers, and service providers.
- o Fully scalable for optimal management of eBusiness initiatives of any size.

Competing solutions are industry-specific, point solutions aimed at automated transaction execution.

• **Examples of Questions RHYTHM Customer Management Answers**

The Challenge	The RHYTHM Solution
How do I acquire new customers in a cost-effective manner and provide them with the right mix of products and services?	Integrated marketing techniques that marry sophisticated campaign management and demand forecasting capabilities with operational customer segmentation, profiling, and account planning.
How can businesses profitably deliver solutions to the broad range of customers and systems they need to support, while maintaining the agility to be able to rapidly take advantage of changes in the	Real-time, internet-based configuration systems that can determine feasibility, profitability, and delivery dates, while understanding the constraints of the entire supply, production, and logistics chain across multiple channels

market?	and enterprises.
How do I optimize service costs and investments while maintaining customer satisfaction?	Online self-help capabilities personalized using customer's profile and purchase information. Optimal scheduling and planning of service resources and parts.
How do I provide a holistic web shopping experience that maintains customer satisfaction and loyalty?	Personalized self-service shopping and service solutions for customers and channel partners integrated with solutions for secure online transaction processing, order fulfillment, order tracking, and billing.

Sub-processes of Customer Management include:

Creating Needs

Seeking and attracting customers, identifying and segmenting markets. RHYTHM provides sophisticated demand creation capabilities include forecasting, lead management and tracking, account planning, promotions/incentive planning, and marketing operations planning. Customers seek products and reveal preferences in an interactive manner. Enterprises can maximize the effectiveness of demand creation through activities directed both at consumers (end users) and customers (channel intermediaries).

Matching Needs

Defining the appropriate product and service offering and matching it to the customer's unique requirements. RHYTHM solutions provide extensive customization and pervasive personalization capabilities that give customers the power to view the enterprise-in-a-way that they can relate to, thereby making it easier for them to do business with it, and creating stronger and more profitable customer relationships. A key differentiator is the integration with back-end supply chain processes that ensures that the customer offering is simultaneously valid, deliverable, and profitable.

Fulfilling Needs

The process of executing the sale, fulfilling the order, and delivering the product or service. The RHYTHM Commerce Suite that leverages configuration, pricing, quotation,

catalog and proposal generation capabilities to harness the power of networked computing on the Internet, while ensuring the flexibility to respond quickly in an environment of rapid technical and business change. The Commerce Suite also supports added-value eBusiness through a web store front, commerce engine, online product catalogs, temporary shopping carts and persistent shopping lists, cross-selling capabilities, online order entry, credit card processing, tax calculations, auctions, billing, order status and payment processing capabilities. A key competitive advantage is its ability to communicate important information from the supply chain modules to the customer interface in real time. This capability is provided by the Internet Fulfillment Server (IFS). By ensuring timely, satisfying responses to customer needs, the configuration system strengthens customer relationships, while delivering maximum revenue.

Servicing and Extending Needs

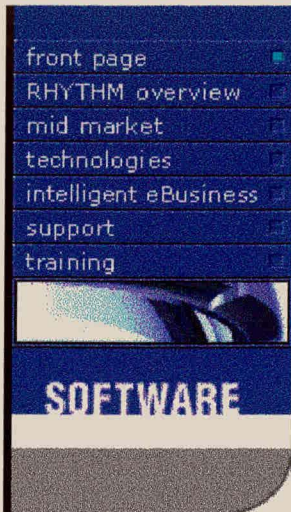
Providing effective, profitable customer care and maintaining loyalty through a life-long relationship. RHYTHM provides an online customer care solution that provides support information, online product registration to an electronic help desk, self-service support logging and tracking, and integration with call centers. RHYTHM also provides a powerful set of decision support tools for enterprise level service management for large, complex products including spare part planning, field service, and scheduled maintenance/repair/overhaul (MRO). The need for such a solution is driven by three related business drivers:

1. The increasing importance of customer service in retaining customers. Studies show the cost to acquire a new customer far exceeds the cost of retaining customers.
2. The revenue opportunity in selling additional services and products to existing customers. Service is a substantial profit generator.
3. In certain industries with complex products and high down-time costs, there is a need to efficiently manage the maintenance, repair, and overhaul (MRO) process to reduce service expenses and increase customer service levels.



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INTERPROCESS PLANNING

The objective of i2's RHYTHM InterProcess Planning (IPP) solution is to help companies maximize profitability by optimizing resource use and minimizing conflicts among various business processes, both inter-enterprise and intra-enterprise.

The IPP suite of solutions, which help enable electronic Business Process Optimization or eBPO, are crucial to achieving the responsiveness required for intelligent eBusiness. IPP allows the effective collaboration of various authority domains within a company. IPP is designed to synchronize operational activities across the major processes—customer management, supply chain management, and product lifecycle management—with the global objectives of the enterprise. Thus, InterProcess Planning is a tactical planning tool that integrates across multiple business processes within an organization to achieve an enterprise-wide optimal solution.

IPP is composed of two sub-processes: Financial Planning and Integrated Sales and Operations Planning.

Examples of Questions InterProcess Planning Addresses

The Challenge	The RHYTHM Solution
How can I balance resource requirements and budgeting across my core business processes?	InterProcess Planning workflows across business processes to provide comprehensive sales and operations planning.
How can I align my strategic goals with day-to-day operational objectives?	Integrated strategic and operations planning capability with ability to optimally resolve conflicts.
How do I respond rapidly to changes in the marketplace?	A comprehensive model of the company and capability for constraint identification to pinpoint possible solutions for



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	external changes in minutes.
Where am I with respect to the plan for the quarter?	Projection of financial performance based on latest information

Business Benefits

- Better utilization of human, physical, and financial resources.
- Frequent, detailed updates and validation of strategic plan.
- Ability to react to changes in the marketplace in days, not months.
- Provides the responsive multi-process and multi-enterprise collaboration required for intelligent eBusiness.

Unique Differentiators

- Enterprise-wide control and ease of insight for clear understanding of the enterprise among employees at any level.
- Most comprehensive modeling system.
- Real-time, detailed updates and validation of strategic plan.

Sub-processes of InterProcess Planning

Integrated Sales and Operations

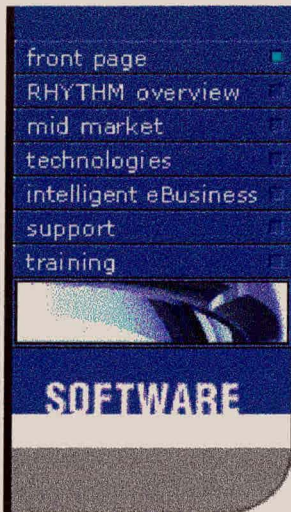
Planning—This will provide the ability to review the operation plan with the revenue objectives for the financial periods—based on the different plans of the different authority domains—including promotion plans, new product introduction plans, possible long-term contracts etc.

Financial Planning—This will provide the ability to project revenues, earnings and other financial measures for the next few financial periods. It is based on the plans of the different authority domains with the organization on a continual basis and changes in the market conditions. It will also be able to suggest corrective actions to alleviate the deviations from the strategic plan. This will help in monitoring metrics for different authority domains of the organization to provide them quick feedback on their impact on the entire financial plan.



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STRATEGIC PLANNING

The objective of i2's RHYTHM Strategic Planning solution is to respond quickly and intelligently to changes in the marketplace by optimizing long-term strategic decisions and engaging in advanced scenario analysis of competitors' strengths and weaknesses.

Strategic Planning is a key process addressed by electronic Business Process Optimization or eBPO, helping the forward-looking enterprise to achieve intelligent eBusiness. Strategic Planning is the process by which senior executives set company performance objectives and make longer-term decisions of revenue planning, product portfolio management, and supply chain design. It represents a coherent, unifying, and integrative pattern of decisions a firm makes. In addition, Strategic Planning involves scenario analysis to better understand the strengths and weaknesses of competitors.

Examples of Questions Strategic Planning Addresses

The Challenge	The RHYTHM Solution
What will be the impact of new competitors in my market space?	Scenario-based simulation of current and future business conditions.
How can I align my strategic goals with day-to-day operational objectives?	Integrated strategic and operations planning capability.
How can I make better long-term decisions about suppliers, partners and channels?	Collaborative forecasting and planning based on up-to-the-minute business models.

Value

- Feasible Aggregate Financial Plans (AFPs) replace infeasible annual budgets.
- Critical strategic decisions are optimized with planning engines rather than with executive assertion.

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- Strategic planning cycle time (which involves senior executives and not planners) is shortened.
- With a shortened cycle, AFPs are based on recent information and are therefore more accurate.
- Better-managed information flows to the investment community.
- Accurate enterprise model for effective cash-flow management.

Differentiators

- Superior planning engines to enable optimization of critical strategic decisions.
- End-to-end financial planning based upon accurate, feasible enterprise models. The most complete solution scope in the marketplace.
- Allows intelligent eBusiness by helping companies shape and react to customer demand and changing market conditions.



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Corporate Overview

Manugistics, Inc. (Nasdaq: MANU) is a leading provider of solutions for customer-centric supply chain optimization and has the largest client base of any supply chain provider. The company's solutions dramatically improve the flow of product within and among companies from raw materials or parts through manufacturing to delivery of product to the end customer. Manugistics' solutions uniquely allow its clients to create and optimize their supply chains around their customers and are quick to implement, adapt easily to change and deliver rapid results.

With Manugistics software, clients make the most informed operational decisions, resulting in increased revenues, reduced inventories, improved customer service, better relationships among trading partners, greater speed to market and lower overall costs throughout the supply chain - with results often achieved within months. Manugistics currently has nearly 900 clients around the world across a broad spectrum of industries which represents the largest market penetration in the supply chain management market.

Corporate Overview - continued

Contact Us

- Information Request Form.
- Phone/E-mail
 - Americas: 301-984-5263
 - Europe (UK): 44-1344-354-645/Fiona Moon
 - Europe (Germany): 49-2102-495-421/Karin Kraft
- Press inquiries
 - 301-984-5336/Lora Cecere, Director, Corporate Communications

###

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Corporate Overview - continued

[Delivering Rapid Results](#) | [Partnerships with Industry Leaders](#) | [Customers Reap Rapid Results](#) | [Supply Chain Solutions](#) | [Company Management](#)

Manugistics, Inc. (Nasdaq: MANU) is a leading provider of solutions for [Customer-Centric Supply Chain Optimization](#). With Manugistics software, clients make the most informed operational decisions, resulting in reduced inventories, improved customer service, better relationships among trading partners, greater speed to market and lower overall costs throughout the supply chain - with results often achieved in less than a year.

The company's products are used by companies with dynamic supply chains, that are consumer-driven and have a desire to leverage e-commerce across their supply chains. Dynamic supply chains often include any number of the following characteristics: multiple channels, short product life cycles, lengthy product development times, complex distribution networks, a variety of customers seeking new ways of doing business, and third parties such as contract manufacturers and logistics providers.

Examples of these

consumer-driven industries include: Agricultural Products, Apparel/Footwear/Textiles, Automotive, Consumer Products, Durables, Electronics, Food & Beverage and Over-the-Counter Pharmaceuticals.

For example:

- **Warner Lambert**, a leading pharmaceutical manufacturer, received significant benefits within 12 months of implementation, increasing order fill rate to 99 percent and reducing supply chain costs by \$2.2 million.
- **Tenneco Automotive** increased order fill rates to 96 percent, improved inventory turns by 25 percent, and reduced inventory levels by 50 percent at both its own facilities and at its customer sites.
- **Alcatel**, one of the world's largest telecommunication component manufacturing companies, obtained ROI in less than 12 weeks, and posted a 25 percent reduction in past due orders.
- **Payless Cashways**, a full-line building materials and lumberyard retailer, saved "hundreds of thousands" of dollars in shipping costs just 4 months after implementing the first phase of its Transportation Management implementation.

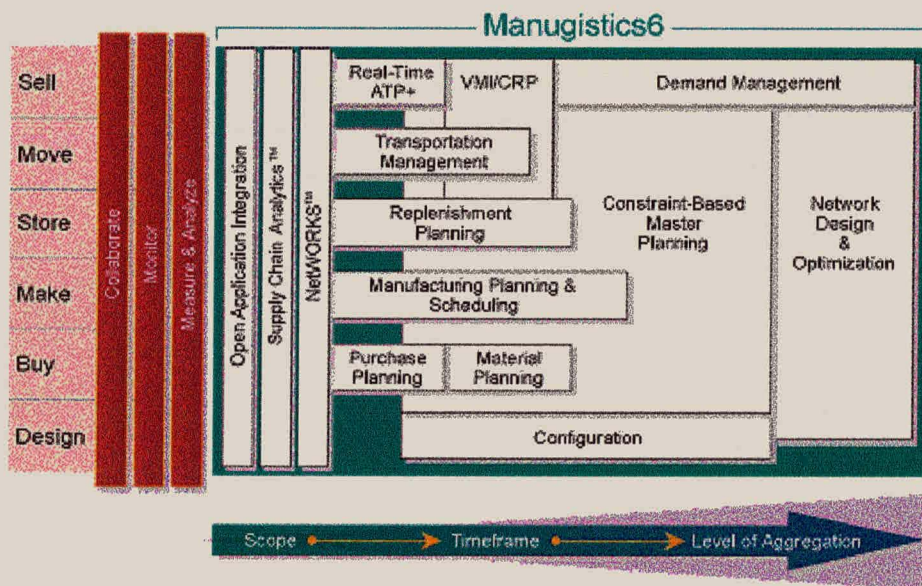
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Applications

To rapidly drive results, best practice business processes must be enabled with applications. Our applications have been designed specifically to optimize each of our key supply chain business process areas; design, buy, make, move, store, sell, collaborate, monitor, and measure.



Manugistics6 enables a truly customer-centric approach to your business. Our newest generation of proven supply chain optimization applications, Manugistics6 anticipates customer needs, orchestrates actions both within and across enterprises to meet those unique needs, and maximizes customer satisfaction. And Manugistics6 is designed specifically to optimize each of the key supply chain business process areas - design, buy, make, store, move, sell, collaborate, monitor, and measure & analyze.

[Configuration](#)

[Constraint-Based Master Planning](#)

[Demand Management](#)

[Manufacturing Planning & Scheduling](#)

[Material Planning](#)

[Network Design and Optimization](#)

[NetWORKS™](#)

[Open Application Integration](#)

[Purchase Planning](#)

[Real-Time ATP+](#)

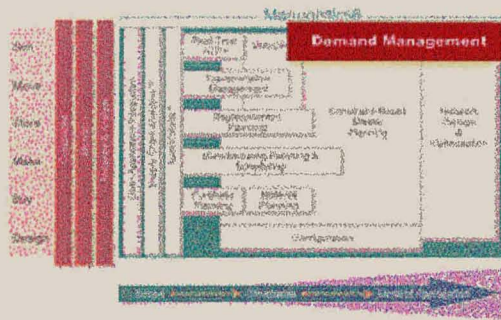
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Demand Management

Scenario:

Your competitor just lowered the price on their product. You are launching new sales and marketing campaigns. Can you accurately predict your customers' buying plans? Can you determine the demand for your product? Are you able to quantify the key drivers of demand to maximize your sales and marketing effectiveness? Can you proactively predict future customer demand to avoid costly mismatch of demand and supply?

Accurately Predict Future Customer Demand

Costly mismatch of demand and supply results in missed sales opportunities, lost profits, excessive expediting costs, lost market share, and poor customer service. To maximize sales and marketing effectiveness, companies must accurately predict future customer demand and use this information to drive the synchronized supply chain - from manufacturing to operations to distribution.

Demand Management acts as your early-warning system, accurately predicting future customer demand, alerting of potential supply problems, and finding patterns undetected by traditional solutions. It enables your company to understand customers' demand drivers, to accurately predict customers' future needs, and to unify disparate planning processes through its multi-model framework and collaboration.

Integrate Sales and Marketing into the Supply Chain

Demand Management offers multiple forecasting algorithms in conjunction with advanced causal modeling to assist you in identifying critical factors that drive demand. Intelligent modeling accurately predicts future customer demand and allows for management overrides, all avoiding the costly mismatch of demand and supply. By including both market planning and demand planning capabilities, Demand Management links product mix, promotion, and price analyses with traditional demand forecasting. And, unlike conventional forecasting tools, Demand Management enables the simultaneous tracking and understanding of demand along multiple dimensions such as sales, marketing,

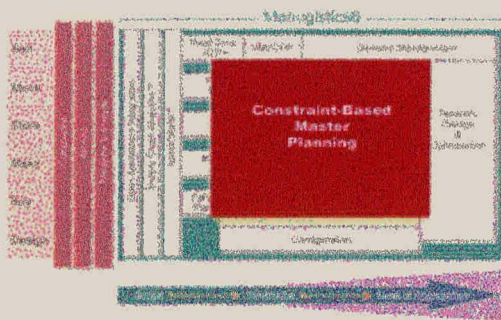
and logistics. Demand Management also supports industry-specific solutions for customer/channel management, such as promotions and trade funds management in consumer sectors, release management in motor vehicles and parts, and sales configuration in the high tech arena.

By combining advanced forecasting techniques with real-time collaboration, the Manugistics6 solution optimizes the entire supply chain with a customer focus. And by enabling extended supply chains to interact, you can plan the demand fulfillment strategy with direct input from your customers - eliminating buffer inventories, cycle time, and, most importantly, cost.

Features and Benefits:

- Multi-model framework: Increases Responsiveness
- Consensus process: Maximizes Accuracy
- Advanced causal modeling: Increases Revenue
- Life cycle forecasting: Minimizes Obsolescence
- Cannibalization modeling: Optimizes Product Mix

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Constraint-Based Master Planning

Scenario:

You have three business strategies for key channels - build-to-order, make-to stock, and vendor managed inventory (VMI) or continuous replenishment planning (CRP). How should you allocate critical resources across the network? Can you produce an optimized plan to allocate and coordinate limited resources based upon these different business strategies? Do you have the ability to simultaneously optimize constraints across multi-site manufacturing, distribution, and supplier networks?

Supply Chain Command Center

Customer-focused coordination across multi-site manufacturing, supply, distribution, and transportation constraints is critical to improving revenue, decreasing inventory, and maintaining production efficiencies. A solution that optimizes all constraints in real time as changes occur is the key to minimizing asset investments and increasing customer service and profit.

Constraint-Based Master Planning acts as your supply chain 'command center,' simultaneously optimizing the use of constrained resources to improve customer service and profit while reducing asset investment. It also provides simultaneous optimization of materials, capacity, inventory, transportation, and distribution constraints across multi-site manufacturing, distribution, and supplier networks. As the command center of the supply chain, Constraint-Based Master Planning produces an optimized plan to allocate and coordinate limited resources based upon your own user-defined strategies. These strategies not only respect customer, item, and location prioritization, but also optimize to your pre-determined business goals such as increased revenue and improved service. In addition, Constraint-Based Master Planning utilizes the network design and sourcing policies generated in Network Design and Optimization to provide seamless integration between strategic business goals and operational activities.

And with Manugistics' unique algorithm synthesis capabilities, Constraint-Based Master Planning provides

tailored toolsets for addressing the key business challenges encountered across a wide variety of industries.

Single View of the Supply Chain

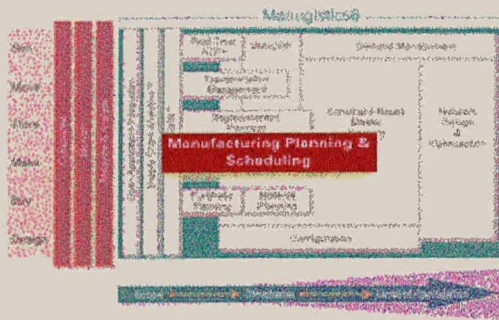
As unexpected events such as production breakdowns, distribution delays, or material shortages occur in the supply chain, Constraint-Based Master Planning sends you an alert and then immediately employs the appropriate optimization technique to quickly repair the plan to meet customer commitments. This coordinated, synchronized response enables you to quickly capitalize on new revenue opportunities and instantly identify and overcome supply chain challenges. Constraint-Based Master Planning provides real-time graphical support to identify supply chain constraints throughout the network - by item, by customer, and by location - giving you the tools for quick resolution and easy drill-down.

And unlike other constraint-based master planning solutions, Manugistics6 seamlessly integrates distribution planning, manufacturing planning, and detailed material planning with flexible supply chain optimization techniques to enable the simultaneous execution of unique business strategies across multiple channels, driving increased revenue and market share.

Features and Benefits:

- **Simultaneous optimization:** Increases responsiveness to profitability trade-offs
- **Multiple strategies:** Improves supply chain flexibility
- **Customer profit points:** Increases profitability of customization
- **User-controlled optimization:** Accelerates optimization to business goals
- **Algorithm synthesis:** Improves responsiveness
- **Phase-in/phase-out:** Decreases obsolescence

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Manufacturing Planning & Scheduling

Scenario:

You have some sites manufacturing finished goods. You have others exclusively manufacturing components or semi-finished goods. Do you optimally use machine, labor, and material within each facility? Can you allocate constrained capacity to the appropriate parts based upon customer service, profitability, and cost? Do you have single and multi-site planning, detailed scheduling, and real-time communication with the plant floor so you can deliver simultaneous optimization of constraints and improved customer service?

Shrink Manufacturing Cycle Times

Increasingly demanding customers and the surge of strong global competition require reduced manufacturing cycle times and increased customization of products and services - all in addition to the traditional allocation challenges of constrained resources. With a real-time manufacturing planning and scheduling solution that simultaneously enforces multiple constraints, you can address these issues while optimizing resource utilization and minimizing cycle times when generating single and multi-site production plans and schedules with immediate shop floor information.

Manufacturing Planning & Scheduling is seamlessly integrated with Constraint-Based Master Planning for enterprise-wide planning guidelines. Manufacturing Planning & Scheduling provides detailed production information to Replenishment Planning for real-time updates to projected inventory on-hand and in-transit.

Manufacturing Planning & Scheduling dramatically reduces your manufacturing cycle times and improves customer service by optimizing constrained resources and profitably producing and/or packaging customized products. To do this it utilizes guidelines from Constraint-Based Master Planning to perform detailed planning and scheduling across single or multiple sites.

Manufacturing Planning & Scheduling provides a full range of planning and scheduling capabilities - from regenerative

to incremental. Its rescheduling capability is particularly valuable as it allows the schedule to evolve from day to day as conditions change instead of being thrown away every time a new schedule is generated. This evolving schedule provides two key advantages: control, enabling the schedule to remain stable because it's not continuously destroyed and re-created, and speed, so the schedule can be quickly revised to meet new conditions.

Reduce Manufacturing Costs

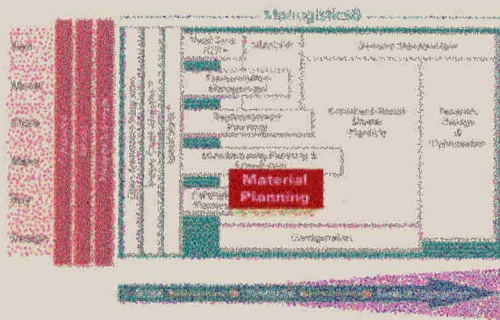
Many companies experience manufacturing delays, expediting costs, higher material costs, and poor customer service when the right materials are not available when and where they are needed. Manufacturing Planning & Scheduling optimizes material planning and control based on product life cycles, customer-specific needs, and manufacturing plans and schedules.

Unlike other manufacturing planning solutions, the Manugistics⁶ suite supports detailed bills-of-material (BOMs) explosions and optimizes both finished goods and components production plans. Manufacturing Planning & Scheduling also gives you improved time-to-market of new products, reduced work-in-progress (WIP) and finished goods inventories, enhanced efficiencies in production, reduced manufacturing costs, improved margins, better utilization of scarce resources, and strengthened relationships with suppliers.

Features and Benefits:

- Production optimization: Maximizes throughput
- Flexible solution techniques: Improves response time
- Multiple materials flows: Increases market share
- Plant floor connectivity: Reduces obsolescence
- Synchronized allocations: Maximizes inventory use.

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Material Planning

Scenario:

You have many products that utilize the same critical material components. You don't have enough of those components to satisfy all product demand. Can you ensure you utilize those components in the best product mix to support your business goals? Can you provide time-phased material availability and dynamic part/ingredient substitution and allocation to reduce work-in-process inventory? Are you able to position the right materials effectively to support customer service and profitability? Are you able to manage and reduce the costs associated with those actions?

Reduce Material Costs and Manufacturing Delays

Many companies' experience manufacturing delays, higher material costs, and poor customer service when the right materials are not available when and where they are needed. A solution that optimizes material planning and control based on product life cycles, customer-specific needs, and manufacturing plans and schedules is the key to addressing these issues.

In combination with Manufacturing Planning & Scheduling, Material Planning optimizes critical material planning decisions and dynamically substitutes and allocates constrained materials. The results are a quick and dramatic reduction in cycle time and material costs with increased service and market share.

Unlike other material planning solutions, the Manugistics6 suite supports detailed bills-of-material (BOMs) and optimizes the use of constrained materials through advanced substitution logic that even considers alternate suppliers, and supports the complete product life cycle from design through end-of-life.

Optimizing Critical Material Planning Decisions

Traditional MRP allocates parts to orders regardless of shortage conditions for other parts that prevent completion of the order. This approach unnecessarily ties up inventory that could be used on orders for other models using the same parts. In addition, traditional MRP allocates parts

according to date priorities and is incapable of creating a plan that recognizes other priorities or directly supports period business objectives. To overcome these problems and other limitations of conventional MRP logic, Material Planning utilizes unique synchronized allocations and matched sets logic.

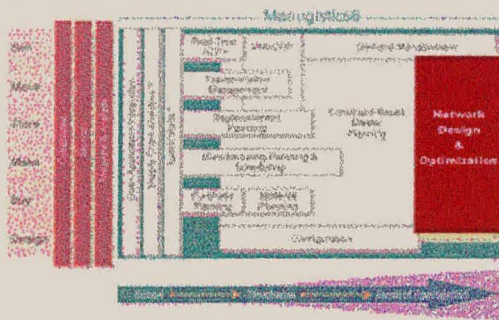
Synchronized allocations ensures that all necessary materials for production of a product are available in the appropriate time-phased allocation before beginning production - ensuring that production and materials are not wasted on products that cannot be completed.

With Material Planning time-phased needs from distribution, production, or customer orders are brought together across multi-site internal and, if applicable, external networks. You can balance your constrained material needs against production or current supplier commitments and evaluate potential shortages for substitution. Material Planning will explore substitution and allocation alternatives simultaneously in real time and contact supplier alternatives via the Internet for availability. You can scan purchasing alternatives and rules for cost reduction opportunities and incorporate the resulting decision automatically into the appropriate planning and enterprise transaction systems.

Features and Benefits:

- "SmartBILL" substitution: Increases responsiveness
- Synchronized allocations: Maximizes inventory use
- Matched sets logic: Prevents unnecessary work-in-progress
- "Can Build" analysis: Minimizes parts obsolescence
- Configuration alternatives: Increases customer service

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Network Design and Optimization

Scenario:

You make many products. You have multiple facilities or contract partners. What locations should you use at what times of the year? Which products should you manufacture at what facility? When moving into the next global region, will you produce locally, distribute from other sites, or sub-contract? What is the most profitable channel strategy that takes into account your manufacturing capabilities, materials, labor, transportation, facilities, inventory, product life cycle and customization requirements? What is the optimal combination of ALL these considerations?

Design and Optimize Global Supply Chain Networks

Inability to create supply chain design and policy that balances limited resources, global suppliers, multi-echelon networks, and international trade requirements causes companies to experience poor asset utilization, unnecessary customs fees and delays, and decreased cash flow. A solution that designs and optimizes global supply chain networks over time by product, customer, product life cycle, and location for maximum profits is a necessity.

Network Design and Optimization eliminates guesswork by enabling you to quickly and easily make optimal supply chain network design and policy decisions and seamlessly integrate these decisions into operational and tactical planning processes.

Network Design and Optimization provides an accurate, time-phased supply chain view to support optimal design and policy decision-making. By modeling end-to-end supply chain implications, Manugistics6 determines your most profitable supply chain strategy, including:

- optimal inventory levels
- appropriate product mix across the network
- optimal production, storage, and distribution locations
- optimal lane volumes
- appropriate seasonal pre-builds

Sophisticated Optimization Techniques

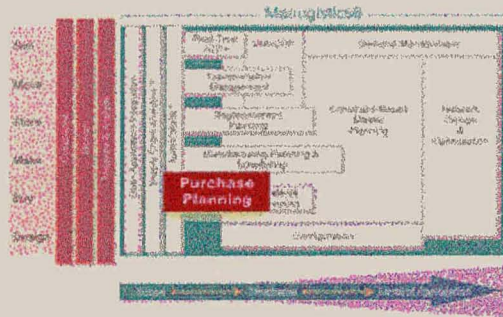
Unlike other network optimization tools, Network Design and Optimization recognizes the multiple dimensions of time, location, product, customer, cost, and profit. Its sophisticated optimization techniques simultaneously balance profits, time-phased demand and supply, fixed and variable costs, varying transportation and manufacturing lead-times, and global constraints such as tariffs and value-added taxes.

Manugistics6 provides a global view of the supply chain that not only allows you flexible units-of-measure and multi-currency capabilities, but also recognizes that policy and design recommendations must consider international trade regulations and local content compliance.

Features and Benefits:

- "AccuMap": Increases Responsiveness
- QuickChange models: Improves Asset Utilization
- Multi-dimensional optimization: Maximizes Throughput
- International trade logistics: Decreases Global Trading Costs
- Common supply chain model: Reduces Cycle Time

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Purchase Planning

Scenario:

You want to deliver the right product, at the right time, at the best cost. Do you have the optimal purchasing plan for materials in place? Can you take full advantage of vendor pricing and shipment rules, balancing acquisition cost with carrying cost, transportation cost, and other supply chain implications? Can you enable real-time connectivity with your suppliers?

Dramatically Cut Purchasing and Expedite Costs

It is becoming increasingly important for companies to optimize planning decisions and increase customer service through real-time connectivity to suppliers. A solution that decreases the time for resolving critical parts shortages and reduces expediting and procurement costs can address this issue as well as increase buyer productivity.

Purchase Planning dramatically cuts purchasing and expediting costs by optimizing purchase planning decisions and increases customer service through real-time supplier connectivity. Purchase Planning enables you to rapidly share new schedule projections, including flex ranges, directly with suppliers. The schedule information is made available either on a part-by-part basis or as a bulk file that is communicated to the supplier. The supplier is then able to respond with its ability to meet the scheduled material requirements.

In addition, Purchase Planning allows you to leverage a no-cost 'virtual inventory' based on time-limited supplier offers. Virtual inventory is defined as material that a supplier has committed is available on or before a supplier-defined expiration date. As responses are collected from suppliers on material availability, it is inevitable that your requirements will change. By holding these responses in virtual inventory, you can use them to fill future material needs rather than seeking out new commitments from the supply chain community.

Enable "Order Building" Capabilities throughout the Supply Chain

The order building capability of Purchase Planning applies purchase optimization techniques to orders from suppliers, internal divisions, or trading partners in a VMI/CRP relationship. Order building respects the product quantities needed to satisfy the projected demand and supply plan while also recognizing benefits associated with particular trading partner rules, such as vendor minimums, product grouping minimums, location minimums, and price/quantity breaks. By recognizing discounts that are associated with reaching particular tiers or brackets within a supplier's pricing rules, Purchase Planning makes the appropriate trade-off between decreased acquisition costs and potential increases in storage and carrying costs.

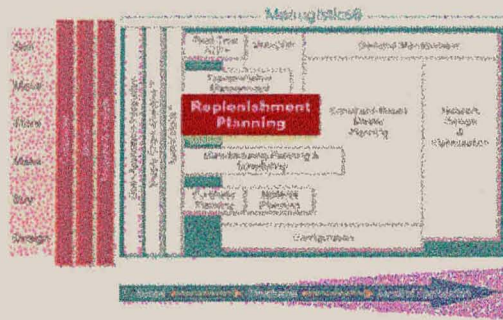
In addition, Purchase Planning allows you to specify constraints associated with building loads of orders so you make the best use of your resources.

Features and Benefits:

- User-defined supplier allocation logic: Decreases supply variability
- Purchase optimization and order building: Reduces purchasing, transportation, and storage costs
- Internet-enabled supplier connectivity: Provides real-time response
- User-defined flex ranges: Decreases purchasing errors

- Simultaneous alternate supplier and multi-supplier sourcing: Improves purchase flexibility

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Replenishment Planning

Scenario:

There is an unexpected delay in production. You have a pending cross-border shipment. Can you dynamically search for product availability throughout the network to address the situation? Can you create time-phased inventory plans that meet customer requirements while minimizing inventory and maximizing profit? Should you carry inventory at all?

Orchestrate Flow of Supply to Match Demand

Lack of distribution coordination and demand visibility results in excessive inventory costs, expedited shipments, decreased customer satisfaction, and lost revenues. A solution that orchestrates the flow and staging of inventory through a multi-echelon distribution network is the ideal answer for meeting customer service objectives while also minimizing inventory investment and logistics costs.

With Replenishment Planning you can orchestrate the time-phased storage and flow of supply to match demand, and you can provide end-to-end visibility, minimize inventory investment, and reduce logistics costs while you maximize customer service.

Replenishment Planning integrates inventory and replenishment planning to create time-phased inventory plans that respect multiple time horizons - days, weeks, and months - and that recognize the interdependencies of the network on customer service and inventory investment. Warehouse space, shipping and receiving capacity, and customer delivery windows are all simultaneously respected, providing you with real-time network visibility of planned shipments, in-transits, available inventory, and expiring product.

Ensure Product Availability

By dynamically searching for product availability throughout the network, Replenishment Planning minimizes lost revenue by ensuring customer requirements are met despite unanticipated delays in production, cross-border shipments, or transportation. In addition, through the use of user-controlled allocation strategies, Replenishment

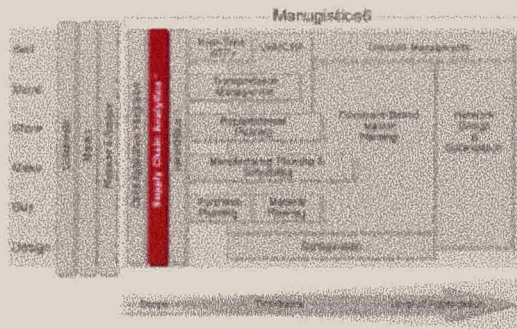
Planning ensures that in times of prolonged product shortage, your customers continue to receive appropriate supply allocations. By launching proactive alerts to distribution planners when product replenishments are in danger of falling unexpectedly short, Replenishment Planning ensures that product shortages are averted whenever possible.

And unlike other distribution planning tools, Replenishment Planning also alerts you at the first sign of excess, obsolete, or expiring inventory. Through this early intervention process, "push" logic and customer-specific date sensitivity tracking, potentially unusable inventory can be appropriately redeployed within the network.

Features and Benefits:

- Optimal inventory planning: Decreases inventory costs
- Dynamic deployment: Improves service
- Procurement optimization: Decreases supply costs
- Date sensitivity: Reduces obsolescence

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Supply Chain Analytics

Scenario:

You need access to critical information on how your business is performing. Can you proactively discover opportunities to adjust plans, fix execution problems, or initiate collaboration sessions? Even with your standardized reports, do you leverage metrics and measures to evaluate the performance of global operations? Do your current data warehouse and online analytical processing (OLAP) tools still leave you with information gaps? Does your data warehouse integrate supply chain optimization, enterprise resource planning (ERP), point-of-sale (POS), and other data sources for global views of the supply chain?

Extend Your Insight with Supply Chain Analytic Applications

Today, the supply chain environment demands proactive decision making and access to information. Measuring and analyzing supply chain performance is critical to optimizing planning, execution, and collaboration activities. Adopting comprehensive performance measures and metrics is required to uncover hidden performance opportunities. The key to addressing such issues is leveraging business applications designed specifically to provide intuitive, powerful business intelligence. By incorporating OLAP and data warehousing technology, a new breed of analytic applications provides significant business value and high return on investment (ROI).

Supply Chain Analytics is a set of applications based on industry-standard OLAP technology that enables operational monitoring, performance measurement, business process design, and supply chain policy setting. Its multi-dimensional analyses will increase the speed, accuracy, and efficiency of knowledge discovery and proactive decision making. These applications extend your insight by providing business process-specific analyses based on data synthesized from Manugistics applications, ERP systems, financial systems, marketing systems, and POS data providers.

Supply Chain Analytics provides you with an intuitive, out-of-the-box decision-support system that alerts where action

is required, analyzes causality, and supports the best decisions for the business issues faced each day. These analyses are based on data available from a variety of disparate sources, brought together in a usable form for a particular business issue.

Make more timely, proactive decisions

The time it takes to realize these benefits is critical to your business success. By implementing a packaged analytical application, versus building a solution from scratch, you dramatically reduce the time and cost of implementation. And Supply Chain Analytics yields quick, measurable results, including increased customer service, improved supply chain efficiency, reduced supply chain costs, and enhanced partnerships. In addition, the applications' components are extendable over time and configurable, meaning that they can align with your specific business processes. And because they provide multiple interaction styles and information delivery modes, the applications support an extended user base throughout your global supply chain. Supply Chain Analytics empowers you to make more timely, proactive decisions.

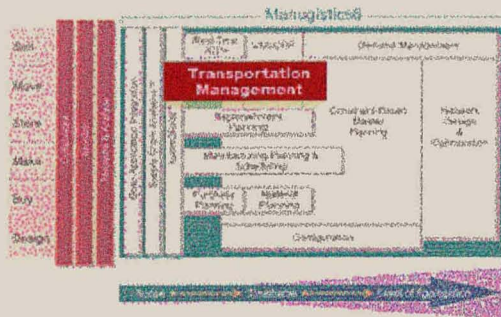
A Dynamic View of the End-to-End Supply Chain

The architectural foundation for Supply Chain Analytics is Supply Chain Knowledge Warehouse™. It supports the applications as well as ad hoc multi-dimensional browsing and reporting. And it provides an understandable view of business data, reusable metrics and measures and analytical support for optimized design and performance.

Features and Benefits:

- Pre-built analysis, logic, and data marts: Dramatically reduces implementation time and costs
- Libraries of pre-defined measures and metrics: Increases power of analyses
- Extendable and configurable components: Aligns with customer's business processes and eases future extensions
- Analytical breadth and multiple delivery modes: Extends user-base
- Robust OLAP/data warehouse architecture: Provides scalability, integration and lower costs

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Transportation Management

Scenario:

You move freight in and out every minute. Can you simultaneously optimize transportation plans and execute all transportation moves - inbound, outbound, and inter-company, including freight payment, tracking, and reporting? If you ship small package, are you maximizing your consolidation opportunities? Can your deployment plan meet your tight customer delivery windows? If you use your own fleet or core carriers, are the resources optimally utilized?

Optimal Customer Service at the Least Cost

As global competition intensifies, enterprises are experiencing increased order cycle time and cost, as well as heightened sensitivity to customer service levels and in-transit visibility. An enterprise transportation management solution that integrates seamlessly into a total supply chain solution can address these issues by providing global capabilities for optimization and execution.

Transportation Management dramatically cuts supply chain cost and order cycle time. It provides global transportation planning and execution capabilities, whether you are a manufacturer, distributor, retailer, or third-party service provider. Your transportation professionals worldwide can reduce freight costs and access real-time shipment information.

Transportation Management's global optimization and execution gives you the capability of running your entire transportation organization with a single application. Its multi-modal capabilities help you orchestrate the most efficient combinations of modes to fully optimize your transportation plans. Its optimization creates continuous moves, allowing you to maximize carrier equipment and reduce costs. Its execution capabilities allow you to pay your freight bills, track your shipments, and analyze and report on historical transportation data.

The premise of Transportation Management is to provide optimal customer service at the least cost, while maximizing

resource utilization. Because customer service requirements drive every decision, you can increase customer satisfaction through on-time deliveries of the right products to the right locations. Manugistics' intelligent messaging capabilities allows you to pro-actively respond to exception notices, which decreases operating cost and increases customer responsiveness.

Reduce Costs and Cycle Time

Transportation Management provides enterprise-wide capabilities and provides interoperation within our entire supply chain optimization suite. You have full visibility of all freight movements, including inbound, outbound, and inter-facility shipments. Also, using Transportation Management as a part of Manugistics' integrated supply chain solution allows you to avoid the traps of optimizing only one aspect of the supply chain, or attempting to optimize each aspect separately, guaranteeing reduced costs and cycle time.

Routing and Resource Management

Manugistics is the only transportation management solution provider to also deliver routing and resource management capabilities. You can achieve incremental benefits of increased customer satisfaction and reduced costs by managing transportation for private fleets or dedicated common carriers at the street address level.

Features and Benefits:

- Globalization: Increases service
- Enterprise optimization: Increases visibility
- Enterprise execution: Reduces cost
- Supply chain integration: Maximizes asset return
- Resource management: Improves asset utilization

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Numetrix/xtr@

The xtr@ opportunity

The Internet is redefining the way businesses operate. The speed, global availability, cost effectiveness and collaborative power of the Internet promises to create an environment in which companies can establish highly competitive supply/demand networks by using appropriate internet-leveraged business applications.

The xtr@ Solution

Numetrix offers xtr@, the first and only business application in the market which is designed to facilitate true collaboration between organizations both inside and outside the enterprise using the Internet. Available on low-cost user platforms and using a standard Java-capable Internet browser, xtr@ constructs channels of collaboration that allow companies to share real-time, accurate and appropriate information for the purposes of optimizing their supply/demand networks.

xtr@ delivers real-time business processes that foster simultaneous network-wide collaboration among suppliers, production, distribution and customers. For instance: real-time sales and operations planning (S&OP); vendor managed inventory (VMI/ECR); available to promise (ATP) and capable to promise (CTP). Up-to-the-second information enables companies to accurately manage and interpret the massive flow of data that passes across their supply/demand networks. Companies are able to respond immediately to changes in demand and effectively coordinate activities and processes to reach maximum efficiency and gain competitive advantage.

"In a sense, collaboration is the highest form of e-commerce as it involves joint planning and plan execution." AMR Research, The Report on Supply Chain Management, July 1998.

How xtr@ works

The flexibility, scale and responsiveness of the Internet demands an application architecture that is based on distributed data, local processing, a high degree of configurability, real-time messaging, collaboration and integration. xtr@ is built upon this kind of architecture - Numetrix's unique distributed object messaging architecture (DOMA) allows all users in the supply/demand network to work concurrently on up-to-the-second synchronized data.

Real-time alerts and messaging

All users, whatever their role, location or platform, are provided with an individual 'alert list.' Using push technology, problems within the supply/demand network are brought to the individual's attention.



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Demand Planning

Numetrix/3 Demand Planning is the part of the Numetrix/3 application that allows companies to create successful and complete demand plans.

Corporations today understand the importance of a good demand plan in managing their supply chains. They also understand the importance of creating a feasible demand plan; yet, forecasting tools found in traditional supply chain management systems create plans without regard to feasibility. With this in mind, how do downstream planners effectively manage distribution and production when they must also cover unanticipated problems caused by "infinite" forecasts?

Constraint-based forecasting is part of Numetrix/3's complete demand management capability. Incorporating optimization and messaging capabilities that create a collaborative planning and execution environment, Numetrix/3 Demand Planning allows planners to apply network-wide material or resource constraints when generating forecasts.

Numetrix/3 produces a comprehensive and optimal plan but how do I know if the plan is feasible?

Numetrix/3 alerts users to any infeasibilities and recommends changes in order to produce a constrained, feasible demand plan. This means users can simulate forecasts and see infeasibilities in the plan instantly when taking into consideration constraints such as material availability, production, transportation and storage capacity.

Numetrix/3 Demand Planning also addresses planned marketing events; for example, Demand Planning recommends the proper timing of promotional events based on the ability to meet the demand. As a result, demand planners provide "finite" demand plans to the rest of the business, which increases certainty across the network, allows downstream planners to meet demand, and eliminates wasteful inventory and capacity buffers.

How does Numetrix/3 encourage collaboration among all participants in the supply chain?

A significant capability of Numetrix/3 Demand Planning is the use of dynamic demand alerts. Taking advantage of the Distributed Object Messaging Architecture (DOMA) within Numetrix/3, changes to the demand plan propagate real-time alerts. For example, requirements for additional production, logistics resources or material are communicated in seconds to the right decision makers. The application immediately adjusts plans to accommodate the new factors, dramatically reducing lengthy planning cycles. Also, demand planners receive real-time alerts to conditions in the network; for example, users are alerted to orders that exceed

forecast or to significant changes in network capacity. Numetrix/3 Demand Planning creates a threaded decision flow by allowing collaboration with other planners in much shorter time horizons and with greater forecast accuracy.

How does Numetrix/3 provide industrial strength, multi-dimensional modeling? Today's systems must be able to model the elements - product hierarchies, geographic organizations, customer types, sales channels - that affect demand. Modeling allows planners to see, understand, and manage the different elements. Numetrix/3 Demand Planning uses a standard relational database that provides the flexibility of multi-dimensional modeling without sacrificing industrial strength performance.

How does optimized model selection work?

Numetrix/3 Demand Planning uses state-of-the-art optimization technology to improve forecast accuracy. Instead of the automated "best fit" method used to apply a single statistical model to a given item forecast, Numetrix/3 Demand Planning optimizes the model selection by applying Bayesian algorithms to select the appropriate models and the appropriate mixture of models.

Other forecasting tools require the user to decide the right level in the planning hierarchy to use in forecasting each SKU. Numetrix/3 Demand Planning, however, automatically selects the optimal level for forecasting, such as the product or SKU level, or a combination of dimensions, such as sales channel and product group. Optimized model and level selection results in optimal and more accurate statistical forecasts.

How does the Numetrix/3 iSCan statistical engine incorporate causal factors?

While other forecasting systems use external engines for causal analysis, Numetrix/3 uses its own sophisticated iSCan engine (Integrated Statistical-Causal Analysis). The iSCan engine considers all components of the demand model - seasonality, trend, holidays, events, product dependencies - simultaneously when generating a forecast.

With the iSCan engine, Numetrix/3 conducts an integrated analysis, accurately capturing the significance of each component instead of misinterpreting demand patterns. This analysis is critical for understanding the impact of events and causal factors in the total demand plan.

My company wants to introduce a new product into the market. Can Numetrix/3 adapt the plan to include the new product?

Numetrix/3 projects forecasts for new products by learning from the behavior of similar products. The application allows complete management of the new product forecast, including the impact of release dates, promotions and other causal factors. This is far superior to the simple old item/new item copying that other systems employ.

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Production Scheduling

Numetrix/3 Production Scheduling is the part of the Numetrix/3 application that allows companies to create successful and complete finite-capacity schedules and master production plans.

Numetrix/3 Production Scheduling provides a powerful way to synchronize decisions at the detailed planning level through to the master production planning level. Its wide range of algorithms model simple and complex manufacturing processes to produce optimal and feasible schedules. Customizable and easy to use, Numetrix/3 Production Scheduling is ideally suited to meet the diverse requirements of tactical production planning, execution-level scheduling and shortening planning cycles, while providing optimal solutions and quick responses to "what-if" scenarios.

Numetrix/3 produces a comprehensive and optimal plan but how do I know the plan is feasible?

Numetrix/3 Production Scheduling factors in production constraints and corporate objectives, ensuring enterprises produce schedules that are feasible, low cost and demand driven. The application understands and adjusts to the key factors and business objectives at each of your production sites. Production Scheduling is unlike traditional production planning systems, which frequently ignore preferred production sequences, crew capacities and other constraints. The bucketless, event-based design provides the detail necessary to ensure feasibility across all manufacturing stages. Numetrix/3 Production Scheduling does not overlook the realities of the production floor and does not produce infeasible production schedules that call for capacity utilization in excess of 100%.

How does Numetrix/3 minimize my production costs?

Numetrix/3 Production Scheduling's speed and intelligence allows enterprises to arrive at optimal solutions in real time. The powerful just-in-time logic creates production plans by simultaneously balancing line capacities with optimal run sequences and quantities to meet customer demand. Numetrix/3 Production Scheduling creates schedules that allow you to produce the right amount of product when it is needed, with the least amount of inventory, changeovers, overtime and other costs.

How can Numetrix/3 represent my scheduling problem?

Numetrix/3 Production Scheduling evaluates site-specific data, capacities and multiple cost factors. Hundreds of problems can be analyzed in seconds and solutions are displayed through interactive graphics. In addition, you can manually modify the schedule or direct it to explore new alternatives. Numetrix/3 Production Scheduling contains all your company's pertinent scheduling information such as rates, capacities, line capabilities, multi-step

processes, changeover times, preferred sequences, minimum run times, shelf-life factors, storage levels and shop floor calendars.

What different scheduling techniques does Numetrix/3 offer?

A selection of scheduling algorithms allows you to develop schedules using a variety of rules, including synchronization across production stages (using the make/pack algorithms) and optimal lot sizing.

How does Numetrix/3 allow me to interact with other planners?

Numetrix/3 is designed to coordinate planners in real time and help them take advantage of whatever flexibility and resources they have access to. With Numetrix/3's unique Distributed Object Messaging Architecture (DOMA), changes to the production plan propagate real-time alerts throughout a Collaborative Enterprise Network. Numetrix/3 Production Scheduling uses these alerts to ensure that the production schedule remains current with your changing business environment and customer requirements.

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Distribution Planning

Numetrix/3 Distribution Planning is the part of the Numetrix/3 application that allows companies to create successful and complete distribution plans.

Unlike conventional Distribution Requirements Planning (DRP) systems, Numetrix/3 Distribution Planning takes into account real-world constraints and costs associated with managing the flow of material from supplier to manufacturer to customer. The application recommends time-phased distribution plans rather than requiring single plant to warehouse sourcing. Also, with Numetrix/3 Distribution Planning, plans are immediately visible to the people responsible for execution. The result is a synchronization of the many people, processes, and systems that traditionally operate as disparate functional units, and the elimination of the inventory that invariably accumulates at the boundaries of the organizations.

How does Numetrix/3 foster collaboration among all players in the supply and demand chains?

A significant capability of Numetrix/3 Distribution Planning is the use of dynamic demand alerts. Numetrix/3's unique Distributed Object Messaging Architecture (DOMA) is designed to coordinate all users and allow visibility of accurate information across the supply chain in real time. Using intelligent messaging, Numetrix/3 Distribution Planning allows management by exception; for example, problems with material availability, resource utilization, inventory violations and product delivery trigger alerts for the appropriate users. With Numetrix/3, the collaborative planning process allows users to make intelligent and informed decisions.

What are the capabilities of Numetrix/3 Distribution Planning?

Numetrix/3 Distribution Planning is able to model multi-echelon distribution networks. The application understands the various material handling and storage constraints at distribution centers, transfer facilities, and at customer sites, and understands the costs, constraints, and lead-times associated with different transport modes involved in the delivery of product. The application is capable of: enterprise-wide planning, cost-optimized replenishments for materials, work-in-process and finished goods, and reverse logistics for items such as empty containers and pallets. Numetrix/3 Distribution Planning also helps the enterprise determine the optimal way to load vehicles to best execute deployment orders. Numetrix/3 Distribution Planning automates and optimizes the process of selecting carriers and vehicle types, building loads and determining ship dates. Numetrix/3 Distribution Planning considers transportation costs and constraints and understands fleet sizes, which carriers can service which lanes, and weight and volume restrictions by vehicle type.

How does the application support Vendor Managed Inventory relationships?

Unique to Numetrix/3, the DOMA architecture and Internet capabilities of Numetrix/3 Distribution Planning enable high levels of visibility and communication between vendors and customers. Numetrix/3 offers enterprises the ability to take advantage of the benefits offered by "e-business." Numetrix/3 Distribution Planning is highly configurable, allowing partners to phase-in levels of information-sharing and process responsibilities. As the vendor/customer relationship evolves to incorporate increased levels of trust, more information can be shared, thereby enhancing customer service levels.

How does Numetrix/3 Distribution Planning use Available to Promise (ATP) and Capable to Promise (CTP) functionality?

Numetrix/3 Distribution Planning allows real-time response to customers. The Numetrix/3 DOMA architecture lets customer service representatives give accurate and timely order delivery date information to the customer. If the inventory is not expected to be available by the ship date, the CTP functionality will analyze the possibility of producing the inventory. Salespeople as well as actual customers can collaborate directly with customer service representatives via the Internet to receive commitment on delivery of orders.

What are the manufacturing planning capabilities of Numetrix/3 Distribution Planning?

Numetrix/3 Distribution Planning takes into account the various costs, constraints, and tradeoffs that are everyday realities in any manufacturing process. Optimal manufacturing plans, which synchronize upstream supply and downstream delivery, can be generated for companies with complex multi-plant, multi-resource, manufacturing operations. Planners can easily model multi-level processes, storage, process lead-times and yields to produce executable plans that reflect a company's reality.

[\[TOP\]](#)

23 APPENDIX C: ILOG CPLEX

This Appendix illustrates who ILOG is and the type of industries they are involved with as well as examples of some of the applications that they have built components for.

ILOG is a provider of re-usable, high tech optimisation components. It provides products that carry out the optimisation of resources. This is known as the optimisation suite. Part of this are applications such as ILOG solver, planner and scheduler.

A complementary suite called the Visualisation suite. This is used to create the user interface between the optimisation engine and the user.

The final suite is used for structured data distribution and filtering and is known as Infrastructure suite.

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ILOG Corporate Profile



Headquarters, Paris France

Code reuse was a prized, but largely elusive goal until ILOG pioneered commercially available, highly sophisticated software components. Developers, systems integrators and independent software vendors are now able to reduce development time and cost by constructing large portions of applications with modular code elements.

ILOG was founded in 1987 to develop and market optimization and visualization software as reusable components of unmatched power and flexibility. ILOG products are used by thousands of developers and tens of thousands of end users in telecommunications, manufacturing, transportation, defense and other industries. ILOG components have been continually updated to reflect insights gained from over a decade of close collaboration with the world's leading software creators.

ILOG Facts:

- An international company created in 1987 by Pierre Haren, President and CEO, and Patrick Albert, CTO
- 470 employees in seven countries
- More than 1,500 customers throughout the world
- Main corporate headquarters in Gentilly, France, and U.S. headquarters in Mountain View, California
- Subsidiaries in England, Germany, Japan, Singapore, Spain and the United States
- Offices in Atlanta, Boston, Chicago, Dallas, Denver, New York, Tampa and Washington, D.C.
- Partners and distributors in more than 30 countries
- \$63.7 million in revenue for the year ended June 30, 1999
- Publicly held on NASDAQ, under the symbol [ILOG](#)
- Web site: www.ilog.com



Pierre Haren, Founder, CEO and Chairman

A Rich Product Offering with Proven Benefits

ILOG customers meet business challenges with sophisticated applications that allow them to rapidly improve the quality, service profitability and responsiveness of their operations. To provide a competitive edge, their strategic software needs to be highly customized and tightly integrated with their business activities. With an open, scalable architecture, ILOG software components allow for rapid creation of such powerful applications. Even more importantly they provide rich functionality that translates into ongoing cost savings that packaged applications can not match.

ILOG's award-winning products solve key problems in data visualization, resource optimization and real-time control.

Reducing Development Time, Risk and Cost

For customers, the key benefit of using ILOG products is a faster, more predictable implementation of sophisticated applications. Applications are finished sooner, much more flexible, abundant in features, and more customizable than would otherwise be possible. Functionally rich ILOG classes let your project goals be verified and refined more quickly, leading to a significant reduction in the overall time, risk, and cost associated with software development.

Lowering Operational Costs and Improving Quality

Besides the software development benefits, ILOG products help make applications better at streamlining strategic operations. High performance applications let you make business decisions quicker and with more confidence. Furthermore, a more dynamic business can pursue new revenue opportunities by taking advantage of situations previously considered overconstrained or problematic.

Highest Possible Performance

Representing hundreds of man-years of development, refinement performance enhancement, ILOG software components have significant runtime and size advantages over other classes and custom-built applications. Customer benchmarks have shown that ILOG products far outperform competitors, particularly under heavy workloads of more than 10,000 objects.

Extensibility for Evolving Applications

The requirements of applications change continually, and projects often redefined many times before being completed. ILOG software is both portable and modular, so choosing among UNIX and Windows platforms does not affect application code.

ILOG Software Components

- **ILOG Visualization Suite:** The suite provides an unmatched set of tools to expedite and enrich user interface development across Windows and UNIX platforms. This suite facilitates development of Business Graphic Objects (BGOs) professional applications in C++ and Java. The Visualization Suite easily connects business objects to all the leading databases. Users report development time reductions of 35% to 85%.
- **ILOG Optimization Suite:** This suite enables users to develop powerful resource optimization, scheduling, logistics planning applications. The suite includes modules from CPLEX, the leader in linear optimization, and for ILOG Solver, leading optimization engine in constraint programming. The business impact of optimization can be immediate and dramatic. Customers have reported 5% to 30% efficiency gains amounting to millions of dollars annually.
- **ILOG Control Suite:** This suite is dedicated to command, control, communications and intelligence (C3I) applications. The ILOG Control Suite facilitates the development of efficient modularly distributed applications through an object-oriented development environment and implementation of business rules.

These products are available independently, and their open architecture ensures customers are not locked into purchasing only ILOG classes.

Markets

ILOG products are used by leading organizations in a wide range of industries, including telecommunications, transportation, manufacturing, aerospace, and defense.

ILOG components are used widely in strategic business applications such as network management, customer service, financial analysis and trading, logistics, maintenance planning, personnel planning, operation and production scheduling, process control, command and control, and system configuration.

Customer Service and Training

ILOG provides a complete range of technical services, including on-site installation, software support and maintenance, and consulting for specifying and implementing projects. Professional, expert training is provided by the ILOG training department at each ILOG regional office. The training covers all the ILOG products in depth and can be given at the customer site when requested. ILOG continues to support its customers at all times by maintaining on-line discussions.

When problems are solved, the alerts disappear automatically. With other software, the user must find the problem by repeatedly querying the system. This generates prohibitively large volumes of network traffic and forces problem-finding activities to be done in batch - often only once a day. Decision response takes days and weeks as problems must 'cascade' overnight from user to user. This information cycle-time often exceeds the time required to make or ship the product.

In contrast, xtr@ is dynamic, message-aware software - software that can both send and receive messages between users and systems while preserving application and data integrity - providing each user with information updates in real-time and indicating the relevant problems that should be addressed.

Collaboration and optimization

A major barrier to successful collaboration is the lack of optimization. Every user should be able to see and consider all relevant information in the supply/demand network and be able respond to changes quickly. xtr@ exploits a myriad of optimization capabilities that satisfy orders, optimize costs/profits and respect the capabilities of the enterprise. They also identify when critical intervention is necessary, allowing users to make the right decisions quickly. xtr@ allows concurrent business processes to take place throughout and between enterprises so that the right person interacts with the right data, in the right place, at the right time.

Interfacing with other software

As the supply/demand network is made up of a number of distinct autonomous enterprises, xtr@ is able to integrate transparently with non-Numetrix systems using Collaborative Enablers. Numetrix's Collaborative Enablers are configured to work with common supply chain and ERP software. An enabler is a small, non-intrusive agent installed on your trading partner's machine that makes their client/server application partially message aware. Each enabler comes pre-configured to attach itself to a subset of the external application's data and reports changes. xtr@ is able to monitor key planning information throughout the entire supply/demand network without the time, expense or maintenance cost of EDI.

Distributed data

Where other systems are based on a centralized, client/server architecture, xtr@ is not - it exploits a system that distributes data close to the users. This approach allows users to read data at any time, consuming server resources and bandwidth only on their fast local area network. The slower and more expensive wide area network is only required to synchronize modifications to the data. Since 80-90% of all user interaction is read-only for analysis, system functionality can be distributed efficiently and effectively. The data is synchronized, regardless of its location, which makes current data available to all users, from the "supplier's supplier" to the "customer's customer" and all parties in between.

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Site questions: webmaster@numetrix.com

forums, organizing annual user-group meetings, and publishing quarterly newsletters.

Executive Management	
Pierre Haren—Founder, CEO, and Chairman	Roger Friedberger—CFO
Patrick Albert—Founder and CTO	Stuart Bagshaw—COO
Edouard Efiră—Executive Vice President	Bill Scull—VP Marketing
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ILOG Rules Products:

- [ILOG Rules](#)
- [ILOG JRules](#)

ILOG Product Overview

Code reuse was a prized, but largely elusive goal until ILOG pioneered commercially available, highly sophisticated software components. Developers, systems integrators and independent software vendors are now able to reduce development time and costs by constructing large portions of applications with modular code elements.



ILOG products are used by thousands of developers and tens of thousands of end users in telecommunications, manufacturing, transportation, defense and industries. ILOG components have been continually updated to reflect insights gained from over a decade of close collaboration with the world's leading software creators.

ILOG Optimization Suite

Optimizing resources means extracting the highest value from capital intensive resources: routing more telephone calls through satellites, driving more products through the supply chain, moving more freight containers through shipyards.

The business impact of optimization can be immediate and dramatic: ILOG customers report efficiency gains up to 30%, amounting to millions of dollars in annual savings. The ILOG Optimization Suite is supported by a team of expert consultants and partner companies whose services range from feasibility study and application design to complete application development.

ILOG Visualization Suite

Uncommonly fast, complex or vitally important data streams such as those found in network management and air traffic control require careful, ergonomically correct display to be fully meaningful to the human eye. The critical importance of user interfaces means they can consume up to 70% of total development resources. Creating user interfaces with ILOG advanced software components can greatly enhance their ease of use and operator accuracy, while dramatically reducing development time and effort.

The ILOG Visualization Suite provides an unmatched set of tools to expedite and enrich user interface development across Windows and UNIX platforms.

ILOG Rules Products

C++ and Java components for structured data distribution and filtering. Used in applications such as network management, process monitoring and fraud detection.



ILOG Solver

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ILOG Optimization Products:

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ILOG Solver

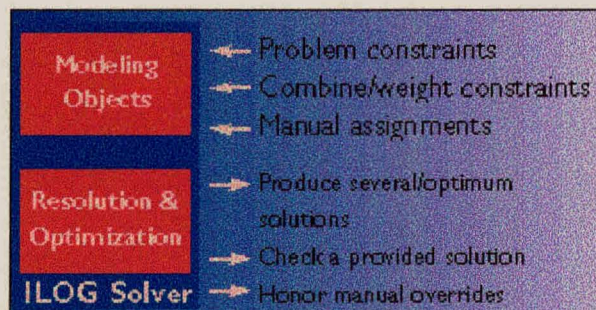
Constraint Programming for Resource Allocation

ILOG Solver's constraint engine rapidly finds optimal solutions for complex multivariate problems. These real world problems have huge solution spaces that are impractical or impossible to solve with conventional calculation techniques.

ILOG Solver is based on constraint programming. It provides the optimal technology to model the relationships and constraints of your problem accurately. Its cutting edge solvers and tree search engines compute solutions quickly.

ILOG Solver shortens your application development time and enables you to maintain code more easily:

- Problem modeling is separate from problem solving
- You can build straightforward models using C++ classes and objects
- Each class of constraints is handled by its specific optimization solver



Constraint solvers

ILOG Solver's constraint solvers dynamically compute the consequences of each decision during the search, and remove infeasible alternatives. Its solvers are implemented as C++ classes embed the latest operations research algorithms:

- Finite domain reduction solver for logical and set constraints
- Simplex optimizers for linear constraints
- Flow algorithms for distribution and assignment constraints
- Edge finder for scheduling constraints

Since constraint solvers are objects, you can add new constraints s

by extending the provided classes.

New strategies and control

ILOG Solver lets you:

- Compute solutions from scratch
- Update an existing solution to include new constraints
- Check a given solution against the constraints

A wide range of search control functions is provided to generate optimal solutions, including tree search, branch and bound optimization, a solution repair and improvement methods.

ILOG Solver lets you program specific search algorithms and recommend new search strategies based on problem knowledge



ILOG Planner

ILOG Optimization Products:

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- [ILOG CPLEX](#)
- [ILOG OPL Studio](#)

ILOG Planner

A C++ Interface for CPLEX Algorithms

ILOG Planner provides a C++ interface to the world renowned CPL algorithms for solving linear and mixed integer programming problems. The object-oriented Planner library allows users to represent these problems easily and intuitively without resorting to mathematical data structures like matrices, providing a fast path for developers to take advantage of high performance CPLEX algorithms.

ILOG Planner is ideal for applications such as

- Production planning
- Staff scheduling
- Telecommunications network design
- Procurement planning

For problems with linear constraints on real and integer valued variables, ILOG Planner can be used independently as a core solver. For problems that involve mixes of linear constraints, logical constraints, and competing preferences, and objectives, ILOG Planner can be used in conjunction with ILOG Solver to develop hybrid solution strategies. ILOG Planner's optimizers focus on the linear constraints of these problems, while ILOG Solver handles the logical constraints and search strategies.

ILOG Planner shares a common object framework with [ILOG Solver](#), [ILOG Scheduler](#) and [ILOG Dispatcher](#), so businesses can use the same software framework to address the full range of requirements from short term scheduling to long term strategic planning. As part of the [ILOG Optimization Suite](#), users can try different techniques for solving different problems while using a common set of software tools.



ILOG CPLEX

▣ [The CPLEX Home Page](#)

ILOG CPLEX Products

The following links lead to the CPLEX web site:

ILOG Optimization Products:

- ▣ [ILOG Optimization Home Page](#)
- ▣ [ILOG Solver](#)
- ▣ [ILOG Planner](#)
- ▣ [ILOG Scheduler](#)
- ▣ [ILOG Dispatcher](#)
- ▣ [ILOG CPLEX](#)
- ▣ [ILOG OPL Studio](#)

CPLEX Base Development System

The foundation for all CPLEX software. Includes the exceptionally fast and robust primal Simplex, dual Simplex, and network Simplex solvers for linear programming problems, provided in an easy to use interactive format and in the [CPLEX Callable Library](#). Provides all basic features and utilities for using these solvers: sophisticated problem preprocessing, file reading and writing utilities, reporting, messaging control, interactive revision capability, efficient restart from an advanced basis, sensitivity analysis, and a simple command structure with an online help system. The CPLEX Callable Library provides CPLEX algorithms and features in a true, comprehensive library of CPLEX algorithmic and utility routines allowing users to embed the powerful CPLEX engine within their applications with ease. Provides unparalleled flexibility, as well as efficient and seamless integration into user-written programs developed in C, FORTRAN, and other languages.

CPLEX Mixed Integer Solver Option

Adds the capability to solve problems with mixed integer variables (general or binary.) Utilizes state of the art algorithms and techniques including cuts (cliques & covers,) heuristics, and a variety of branch and node selection strategies. Includes a sophisticated mixed integer preprocessing system. Solves even large and difficult integer problems quickly and efficiently.

CPLEX Barrier/QP Solver

An optional primal-dual log barrier algorithm with predictor corrector. Very useful for solving certain classes of linear programming models. Includes a fast crossover to basic solutions; also solves quadratic programming problems.

CPLEX Parallel Solvers

CPLEX Simplex, barrier, and mixed integer solvers are available in parallel forms for supported parallel computing environments.



Visualization

Search

PDF The [ILOG Visualization Suite Data Sheet](#)
(.pdf, 299k)

PDF The [ILOG Visualization Suite White Paper](#)
(.pdf, 510k)

ILOG Visualization Suite

The industry's most comprehensive C++ and Java graphics libraries: components for developing high performance, portable, intuitive, and data-aware user interfaces.

The **ILOG Visualization Suite** provides:

- A [2D toolkit for building advanced user interfaces](#), including a range of portable features to display controls, graphs, maps, animated objects, tables, charts, and Gantt charts
- [Telecommunications specific](#) icons and symbols
- [3D graphics](#)

The **ILOG Visualization Suite** products **reduce the time, cost and** in developing applications and dramatically **extend their power, speed and functionality.**

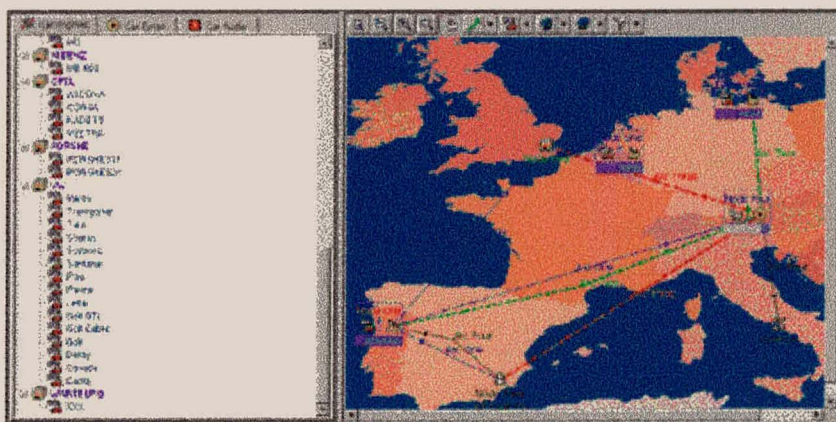
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ILOG Industry Solutions:

- [Telecom](#)
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- [Transportation](#)

2D Graphics



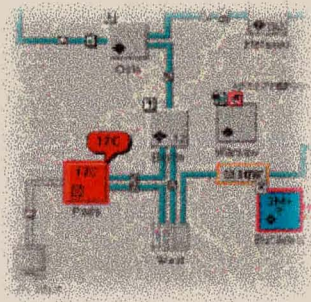
[ILOG Views](#) (C++)

- Real time charts and spreadsheets
- Interactive Gantt Chart
- Graph nodes and links
- Map images
- Customizable, data-aware business graphic objects
- Scripting language
- Easy link to data sources

[ILOG JViews](#) (Java)

- Certified 100% Pure Java
- Unmatched display speed
- Full JavaBeans compliance
- Automatic graph layout
- Rich mapping support

Telecom Graphics Objects



Ready-to-use icons and symbols, fully compliant with and Bellcore standards.

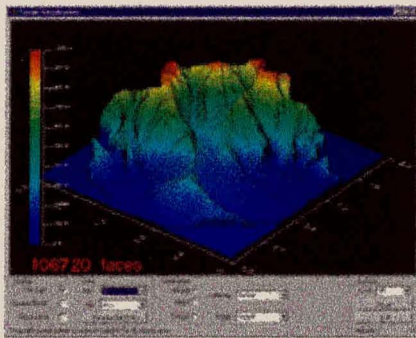
Optimal presentation of information:

- State and alarm displays
- Nodes, links, groups, levels and others
- Automated layout of network displays

ILOG TGO
(C++)

ILOG JTGO
(Java)

3D Graphics



A 3D graphics library above OpenGL providing

- structured graphics model
- high-level display
- interface services

ILOG Vision
(C++)



ILOG Rules

Search

ILOG Rules:

- [ILOG Rules Home Page](#)
- [Creating Intelligent Applications](#)
- [Four Steps to Success](#)
- [White Paper](#)
- [Analyst Report](#)
- [Rules in Business](#)

ILOG Rules

<p><u>ILOG Rules creates intelligent applications</u></p> <p>Business rules enhance the effectiveness of your application, whether you're building a new application from scratch or upgrading an existing application</p>	<p><u>Four steps to success w ILOG Rules</u></p> <p>Implementing flexible, modular, maintainable C++ and Java applica is simple and intuitive with ILOG Ru</p>
<p><u>Where business rules make the difference</u></p> <ul style="list-style-type: none"> • Network and process management • Simulation • Customer management • Transaction Management 	<p><u>White paper</u></p> <p>The ILOG Rules white paper provid technical overview of the product</p>
<p><u>Analyst report</u></p> <p>Learn what the Giga Information Group has said about business rules and today's applications</p>	

24 APPENDIX D: CAPS WHITE PAPER ON PRODUCT ARCHITECTURE

This Appendix discusses the hardware and software requirements and would be required of an user organisation.

Many organisations have an information management and system architecture that was designed for integration of systems, minimisation of hardware variety in the organisation.

As a result, before CAPS could be accepted into Spoornet, its technical and hardware requirements had to be determined and a match found between them and the Spoornet architecture.

This includes:

- Data base Architecture
- Integration
- Maintenance requirements
- User Interfaces
- Etc.

CAPS LOGISTICS
Technical White Paper
Toolkit Architecture Overview
Author: David B. Wyatt
Date: Jan 13, 1997

Toolkit Architecture

The CAPS LOGISTICS Toolkit is a 32-bit Windows application developed for Microsoft Windows 95 and Microsoft Windows NT. The software is written in C and C++ and consists of a single executable and almost 100 Windows DLL files. The Toolkit executable is based on the Microsoft Foundation Class version 4.0 using the Microsoft C++ compiler version 4.2. The source code revisions are maintained using Microsoft Visual Source Safe version 4.0.

The Toolkit is architecturally modular, composed of the Toolkit core and tool set modules. The Toolkit core is the Toolkit executable program and several DLLs that communicate through standard Microsoft DLL calling conventions. The Toolkit core handles shared and common Toolkit functionality: the database engine, the macro interpreter and compiler, menus and toolbars, graphics engine, memory management, printing, reports, error handling, forms control, etc. The tool set modules are Windows DLLs that contains CAPS LOGISTICS Toolkit tools, which are functions (or algorithms or heuristics) in the CAPS LOGISTICS Toolkit modeling language, MODL.

Most of the tool set modules are independent of each other. A tool set module may or may not be included in any given CAPS LOGISTICS Toolkit application. The major Toolkit modules are: Network Management, Network Optimization, Route Management, Route Optimization, Arc Routing, Geocoding, Network Construction, Schedule Window, PC Miler rating, and Czar rating.

The tool set modules communicate with the Toolkit core through a proprietary C API. When the Toolkit loads, it searches the executable directory for all Windows Dynamic Link Libraries (DLLs) that understand the proprietary API. These DLLs are assumed to be Toolkit tool set modules. During the initialization process, the tool set DLLs register their tools (i.e. MODL functions) with the Toolkit core.

Database architecture

The CAPS LOGISTICS Toolkit uses a proprietary internal database system that recognizes primitive Toolkit logistics objects: POINTS, LINKS, ZONES, MAPS, ROUTES, VEHICLES, PARAMeters, LABELS, PRODUCTS, and SETS. Each logistics object has a predefined set of field specifications (known as object fields) which specifies logistics object fields' name, data type, and display attributes. The data types include: BOOL, CHAR, DATETIME, DOUBLE, FLOAT, INTEGER, LONG, STRING, STRING20, and STRING30. MODL tools automatically recognize and use the predefined

object fields. The internal Toolkit database can also handle user defined object fields. User defined object fields are created using MODL.

The Toolkit database can load several different file formats: BINARY, BINARY32, DELIMITED, FIXED, and FREE. The BINARY and BINARY32 file formats are proprietary file formats. The DELIMITED, FIXED, and FREE formats are flat ASCII files. In a delimited data file, the fields are separated by a user defined delimiter character (usually a comma ‘,’ or a pipe ‘|’). Fields in a fixed formatted data file have exact start and end columns. Fields in a free formatted data file are separated by a space character.

The database actually requires two files for each data file, a file with the actual data (.LTD file extension) and a file with the format specification of the data (.LTF file extension). The format specification file is an ASCII file that details the file format of the data file, lists the fields contained in the data file, specifies relationships with other Toolkit files, and optionally specifies default file attribute values. When a Toolkit data file is saved, the file attribute values are automatically saved to the format specification file. The file attributes control how the data file information is displayed in the Toolkit, both graphically and textually.

User Interface and Applications

The CAPS LOGISTICS Toolkit is an application development environment for logistics models. The logistics models can be decision support systems, executive information systems, or turn key operational logistics systems. Most of the user interface is controlled through the use of MODL macros. A MODL source macro is an ASCII file (.LTM file extension) containing programming logic understood by the Toolkit. A MODL compiled macro is a binary file (.LTX file extension) that has been converted by the MODL compiler into a format that loads and executes quickly. The Toolkit automatically compiles a MODL source macro if the MODL compiled macro does not exist or the time/date stamp is greater than the MODL compiled macro’s time/date stamp.

Menus and Toolbars are defined through MODL. Each Menu and Toolbar selection executes a MODL macro. A Toolkit Application is a predefined set of compiled MODL macros that creates menus and toolbars and provides specific end user functionality for addressing a company’s logistics issues. CAPS LOGISTICS applications include Route Planning, Route Dispatcher, Shipment Planning, Shipment Dispatch, Production Planner, and Supply Chain Designer Optimizer (note: actual product names may be change).

Data can be displayed both graphically and textually. The CAPS LOGISTICS Toolkit utilizes a geographic map display for visualizing spatial relationships in a logistics application. The map display requires the data to have spatial coordinates. Spatial coordinates are assigned to data sets through a process called geocoding. Geocoding is accomplished by matching data with databases of spatial information (e.g. address ranges, postal code centroids, and city centroids).

The CAPS LOGISTICS Toolkit displays data textually through either a Data Window or a Form. The Data Window is predefined in the Toolkit to textually display data of all logistics object types. The Data Window resembles a spreadsheet. Forms are dialog boxes embedded in an MS Windows DLL called from the Toolkit. The Toolkit exposes Toolkit database objects through OLE automation. These Toolkit database objects can be embedded in forms created by Borland Delphi. This allows

Delphi to retrieve and update Toolkit database fields. The Delphi forms are saved in a DLL. The Delphi function that controls a Form is executed through a MODL tool in the Toolkit.

Integration

The CAPS LOGISTICS Toolkit has several means of interfacing with other applications: DLL function calling, DDE, Clipboard, OLE Automation, and ODBC. The Toolkit macro language, MODL, includes tools for executing a function in an MS Windows DLL. Toolkit data can be passed to the DLL function.

Dynamic Data Exchange (DDE) and the Windows Clipboard can also be used to integrate with other MS Windows applications. The Toolkit only supports the command interface of DDE (i.e. there is no linking of data). The Toolkit can send commands to other applications and other applications can execute macros within the Toolkit. The Toolkit can put data on the Windows Clipboard and command another application to retrieve the data. Similarly, another application can put data on the Windows Clipboard and paste it into the Toolkit.

Toolkit version 5.0 will support OLE automation, exposing some database and MODL functionality giving other applications access to Toolkit functionality. Toolkit data forms are supported through OLE Automation.

ODBC is used to interface with many personal computer and client-server database systems. MODL has tools that connect, upload, and download data from ODBC compliant databases.

Protection mechanisms

Current Toolkit versions utilize hardware software protection devices known as dongles. There are two types of dongles, single and LAN. The single dongle plugs into a 25-pin parallel port and allows the Toolkit to work on a single computer. The LAN dongle can monitor concurrent usage of Toolkits on a LAN. The LAN dongle can be placed on any workstation with a parallel port connected to the same LAN the Toolkit resides.

Toolkit version 5.0 may have a new software protection mechanism that does not use hardware dongles. CAPS LOGISTICS is currently evaluating several software only protection schemes.

25 APPENDIX E: COMPOSITE LOGISTICS MODELLING

This Appendix includes a lengthy discussion on how modelling should be theoretically done using the CAPS toolkit as well as how logistics and the supply chain should be viewed from a CAPS point of view.

It was put together by Nulty and Ratcliffe. Both are associated with CAPS logistics and therefore it view the logistics and the supply chain world from a point of view very similar to that of the principles of the CAPS tools kit.

It provides a very good understanding logistics and supply chain management to the beginner in the field. Further, it provides a good view of how CAPS functions and the assumptions and principles the tool is based on.

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The Logistics Supply Chain

Logistics

A *supply chain* is the collection of all components and functions associated with the creation and ultimate delivery of a product or service. ■ Figure 1 illustrates an example product supply chain.

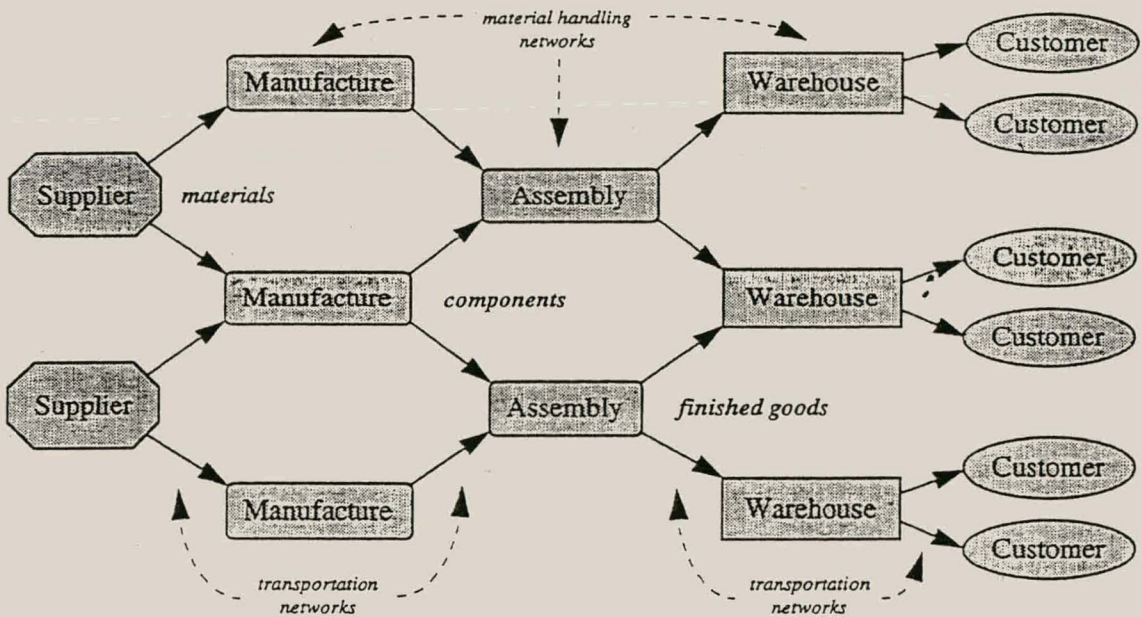


Figure 1
example logistics
supply chain.
Transportation
networks move
goods among
facilities; material
handling networks
move goods within
facilities.

What is logistics?

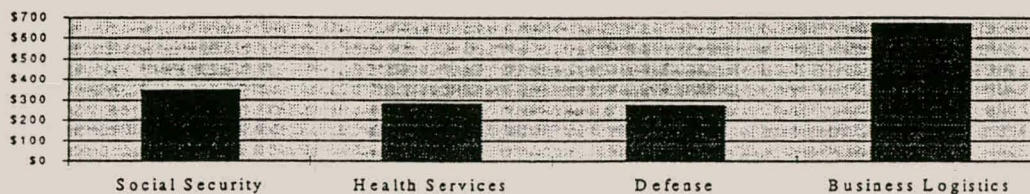
Logistics is the collection of activities associated with acquiring, moving, storing and delivering supply chain commodities (i.e., products in all stages of manufacture, services and information).¹ Logistics encompasses the business functions of transportation, distribution, warehousing, material handling, and inventory management, and interfaces closely with manufacturing and marketing.

Logistics supply chains (also called *logistics systems* or *logistics networks*) arise in numerous business segments and government functions, including: manufacturing firms, retailing firms, food producers and distributors, the military, transportation carriers (such as trucking and railroad companies), service companies, postal delivery, utilities, petroleum pipelines, and public transportation, among others.

The Logistics Supply Chain (continued)

Significance of Logistics

Logistics is a key business function for many reasons, including the high cost of operating a supply chain. Estimated total logistics costs incurred by United States businesses in 1993 was 670 billion dollars², or roughly 11% of the U.S. Gross Domestic Product (GDP). This cost is higher than the annual U.S. government expenditures in social security, health services, and defense (■ Figure 2)³.



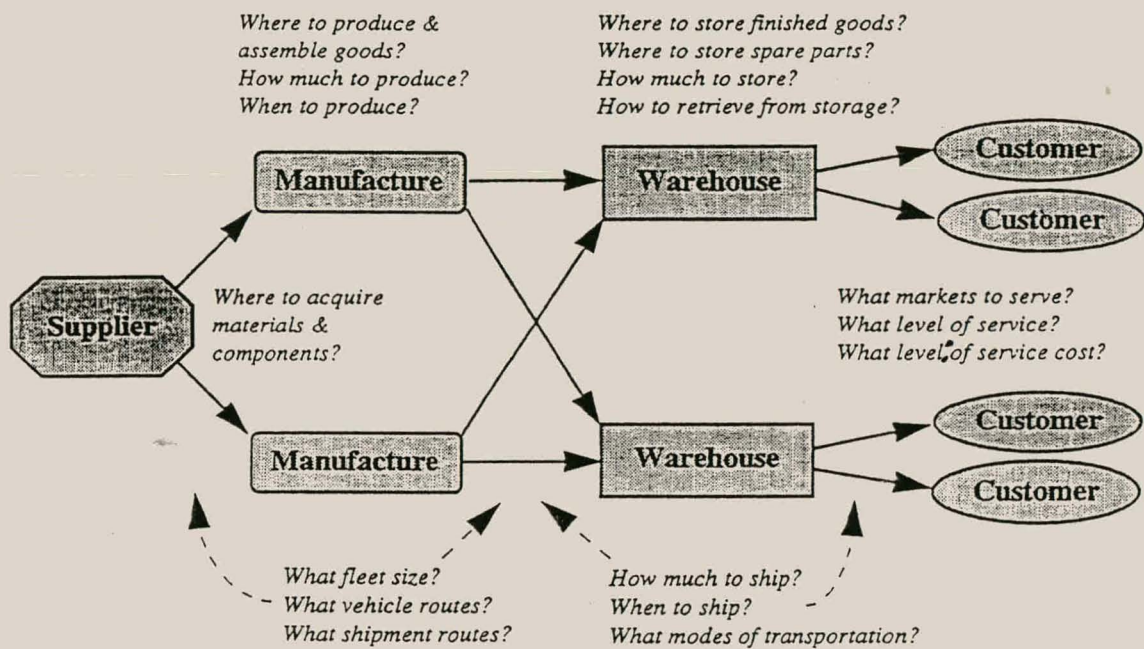
Beyond costs, business logistics is *increasing* in importance due to the following:

- *Deregulation.* In the U.S., transportation (including rail, trucking, and air modes) has shifted from a highly regulated to an increasingly free market industry. The result is more choices and complexity regarding logistics services and costs, and more opportunities to improve business operations.
- *Global Markets.* The business marketplace is increasingly global in scope, with world trade projected to increase from four trillion U.S. dollars in 1993 to over 16 trillion dollars by 2010⁴. Moving products from point of origin to point of consumption on a global scale has obvious logistical challenges. Further, manufacturing wages vary widely among countries, adding complexities in determining smart locations to produce goods. For example, the average manufacturing wage is projected to be \$25.40 in the U.S. in the year 2010, compared to \$45.80 in Germany, and \$4.00 in Mexico⁵.
- *Customer Service.* Deregulation, global markets, and other factors create a more *competitive* business environment, resulting in the need for supply chains that can deliver products quickly and accurately and can adapt to rapid market changes.
- *Environment.* Current and future environmental regulations have significant implications on logistics, and may fundamentally impact the locations of facilities including plants, storage facilities, and recycling centers.
- *Technology.* Accelerating advances in technology significantly change and improve logistics operations. Examples include automated bar code tracking of equipment, management of transportation assets via satellite communications, electronic commerce, and computerized decision support.

Logistics Decisions

Types of Logistics Questions

■ Figure 3 illustrates fundamental questions arising in the design and operation of a logistics supply chain:



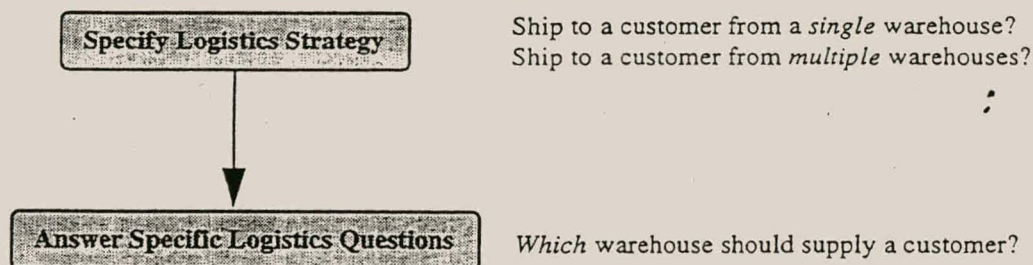
While this is only a sampling of logistics questions, the questions lead to a wide variety of difficult issues involving the design and operation of logistics systems. Most of these logistics decisions embody five fundamental characteristics:

1. *Multiple* business functions are impacted.
2. There are *tradeoffs* among conflicting objectives.
3. Logistics system impacts are difficult to *precisely* evaluate.
4. There are business issues *unique* to each logistics system.
5. *Quantitative* analysis is essential for intelligent decisions.

Logistics Decisions (continued)

■ Figure 3 illustrates *specific* logistics questions - at a higher level, an organization must select appropriate logistics policies or *strategies* to support the company's financial, service, or other goals. Logistics strategies provide a framework for the type and scope of specific logistics decisions. Often, choosing the right strategy is more significant (from a financial or customer service standpoint) than optimizing specific lower-level decisions.

As an example, a common distribution strategy is to ship all products to a customer from a single distribution center (DC). Another common strategy is to ship to a customer from multiple DCs. Choosing the best DC(s) to serve the customer is a specific logistics decision in either strategy, but the allowable choices are shaped by the respective strategies (■ Figure 4). (The *Logistics Strategies* section discusses contemporary logistics strategies in more detail.)



The following section describes a simple case study designed to illustrate a particular set of questions and an associated analysis. Subsequent sections generalize and organize ideas in this case study analysis into a logistics modeling framework.

Logistics Decisions (continued)

Case Study Illustration

Background

Sheridan Technologies, Inc. is an industrial products company operating three plants in the United States, located in Huntsville, Alabama; Fort Wayne, Indiana; and Tucson, Arizona. The plants are dedicated to product groups A, B, and C, respectively.

The plants ship finished products in Truckload (TL) quantities to five DCs, located in Allentown, Pennsylvania; Atlanta, Georgia; Columbus, Ohio; Richardson, Texas; and Covina, California. The company groups customers into three-digit ZIP code territories, with each ZIP3 assigned to a single DC. The company ships via Less-Than-Truckload (LTL) common carriers out of the DCs, typically weekly for each customer.

■ Figure 6 illustrates the company's current supply chain facilities and customer groups. Note the customer groups are scaled to relative average order quantities.

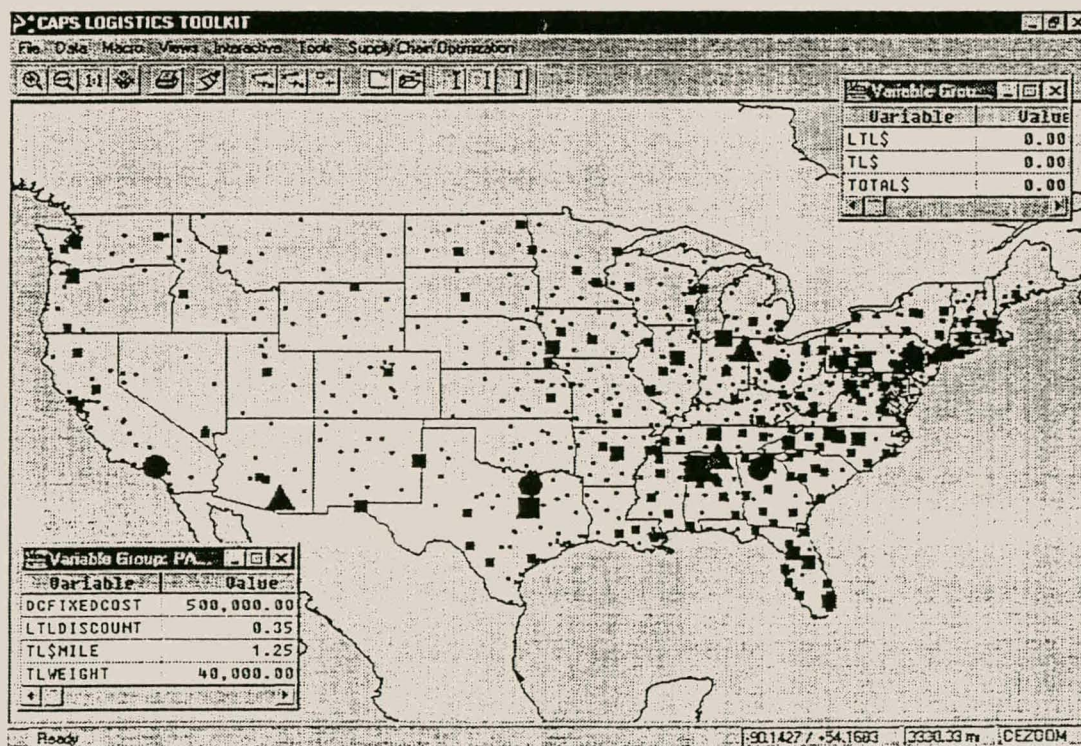
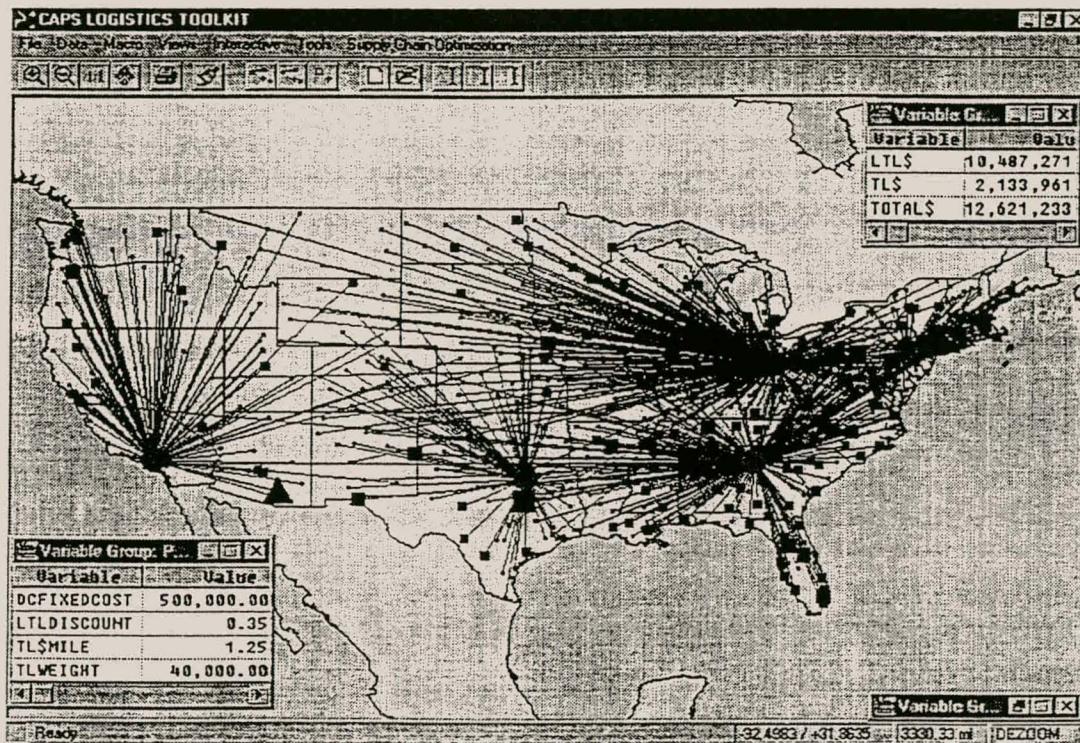


Figure 5 illustrates the facilities composing the Sheridan Technologies supply chain - plants are triangles, distribution centers are circles, and customer groups are squares.

Logistics Decisions (continued)

■ Figure 6 illustrates the company's current assignment of market territories to DCs. The current sourcing assignments have developed historically over several years, and have been influenced by various factors including workload balance, company growth, politics, and historical partnerships.



The new Vice President of Logistics at Sheridan Technologies has initiated a study of the company's logistics supply chain operations, and formed a project team to analyze the following:

1. Given the company's single sourcing distribution strategy (supplying all products shipped to a customer from a single DC), are the customer territories being supplied from the *right* DCs?
2. Should the company consider changing to a *split-sourcing* distribution strategy? Which customers should be served from which DCs under this strategy?
3. Under the company's current single sourcing distribution strategy, what is the optimal *number* and *location* of DCs that minimizes logistics costs?

Logistics Decisions (continued)

Developing a Model of the Logistics System

Computer-based model needed

The project team decides to develop a computer-based decision support model of the company's logistics supply chain, so potential changes to the system can be quickly generated and evaluated (both interactively and using automated algorithms). Graphics are needed to better understand the supply chain structure and tradeoffs of possible alternatives and to interactively specify alternatives.

The model is a simplified representation of the actual system

Before generating and analyzing any changes to the current system, the project team first wants to create a simplified model representation and ensure the model accurately represents the actual logistics system. A simplified model is desirable to better understand the significant elements and costs of the supply chain and to allow alternatives to be rapidly generated and easily interpreted.

Aggregate historical shipments to estimate future demand

One year's historical shipping information will be analyzed to capture any monthly or quarterly seasonal variations in customer ordering patterns. The company's mainframe computer holds over 100,000 freight bills paid to trucking companies last year, so the team decides to simplify the analysis by calculating the average order quantity and order frequency by each three-digit ZIP region.

Shipment costing and cost allocation

For each average order quantity the corresponding outbound LTL cost is determined using LTL freight rating tables. The team notes that there may be some error introduced by calculating costs in this manner (as the LTL rates are not linear but are discounted for higher volumes), but the error should be small as the company's just-in-time policy requires a fairly steady flow of products. As Truckload shipments inbound to the distribution centers are actually composed of orders from many different customer regions, the associated inbound TL costs must be fairly allocated over individual customer territories and products. The project team uses the average order quantity by product family to estimate a customer's portion of a Truckload shipment.

Evaluating the accuracy of the model

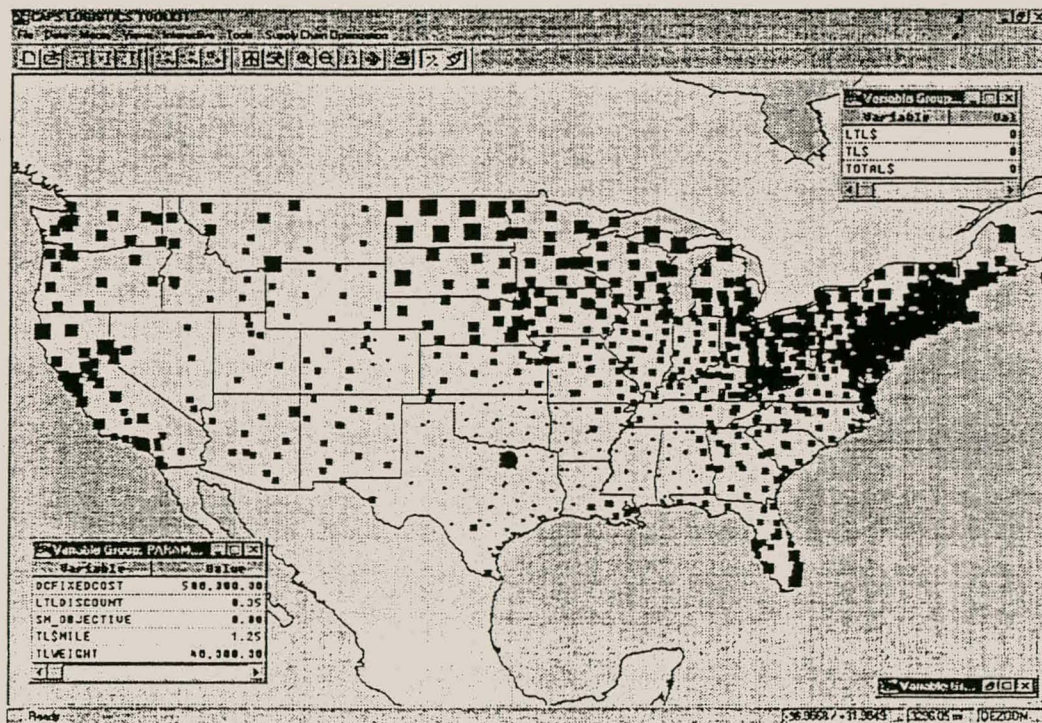
Using average order quantities, the estimated annual LTL and TL costs are about 10.5 million dollars and about 2.1 million dollars, respectively. The team decides to ignore storage and handling costs as they are roughly comparable among the DCs. The estimated transportation costs are very close to the actual company TL and LTL expenses for the past year. The team also checks several customer territories and compares the estimated LTL costs to the actual LTL freight costs to that customer. In all cases the estimates are within a few percent, so the team believes the cost estimation method based on average quantity shipping costs and allocated TL costs are a reasonable model of true transportation costs.

Logistics Decisions (continued)

Generating and Evaluating Alternatives

Armed with a reasonable model of the company's logistics supply chain, the project team sets out to analyze and improve the transportation configuration. It is not clear if the current assignment of customer territories to distribution centers is smart - many of the current assignments in ■ Figure 6 do not look very intuitive, but the team knows LTL transportation rates are influenced by factors other than just shipping distance, such as the trucking company's own transportation infrastructure.

For example, trucking rates are disproportionately more expensive shipping to Florida, because Florida is a consuming state and trucks must often leave the state empty. The team generates graphics of LTL rate contours to better understand the relationship of current DCs and customer territories - ■ Figure 7 illustrates the rate contours for 1000-2000 pound shipments originating from the company's Richardson, Texas DC.



Logistics Decisions (continued)

Next, the best assignment of markets to DCs is evaluated, given the company's current single sourcing strategy. The team decides to treat DC throughput as uncapacitated as each current DC is not nearly fully utilized, and additional shifts can be run if necessary. Thus the best assignment for each market is simply the DC delivering the average market shipment at minimal total transportation cost. The team calculates the inbound TL costs to each DC and weights the TL costs to each market depending on individual product volume.

■ Figure 8 illustrates the assignment of markets to DCs minimizing total transportation costs. The total annual LTL and TL costs for this solution are roughly 10 million and 2.1 million dollars respectively, a savings of roughly 500 thousand dollars annually. The team notes the influence of the LTL rate structure and inbound TL costs on market assignments - obviously the DC nearest a market is not always the best.

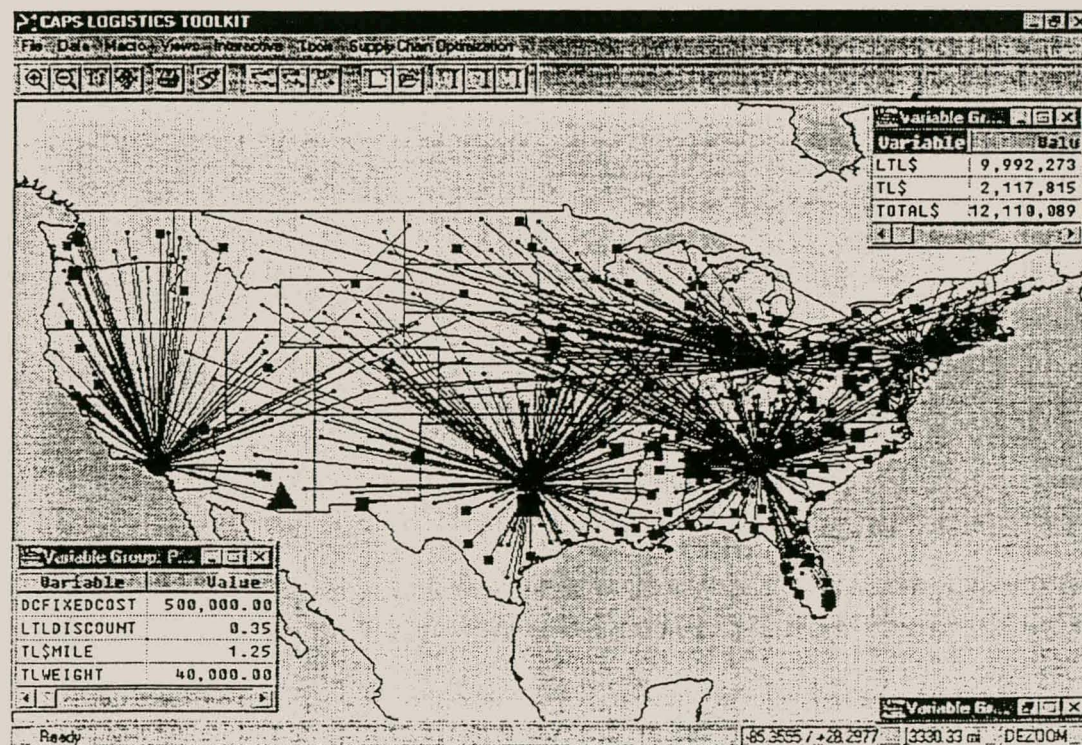


Figure 8
Optimal single
sourcing
assignment using
current set of
distribution
centers. Each DC
defines a general
geographic
territory, but the
territories
overlaps do
overlap due to
differences in LTL
shipping rates.

The best split-sourcing solution is calculated in the same manner, with total annual LTL and TL costs roughly 11.2 million and 2.1 million dollars, respectively. Thus the split-sourcing solution increases costs by roughly 700 thousand dollars annually over the current configuration. The project team rationalizes that single sourcing reduces costs because shipping all products together in larger shipment volumes is less expensive (though individual products may be sourced from a more expensive DC).

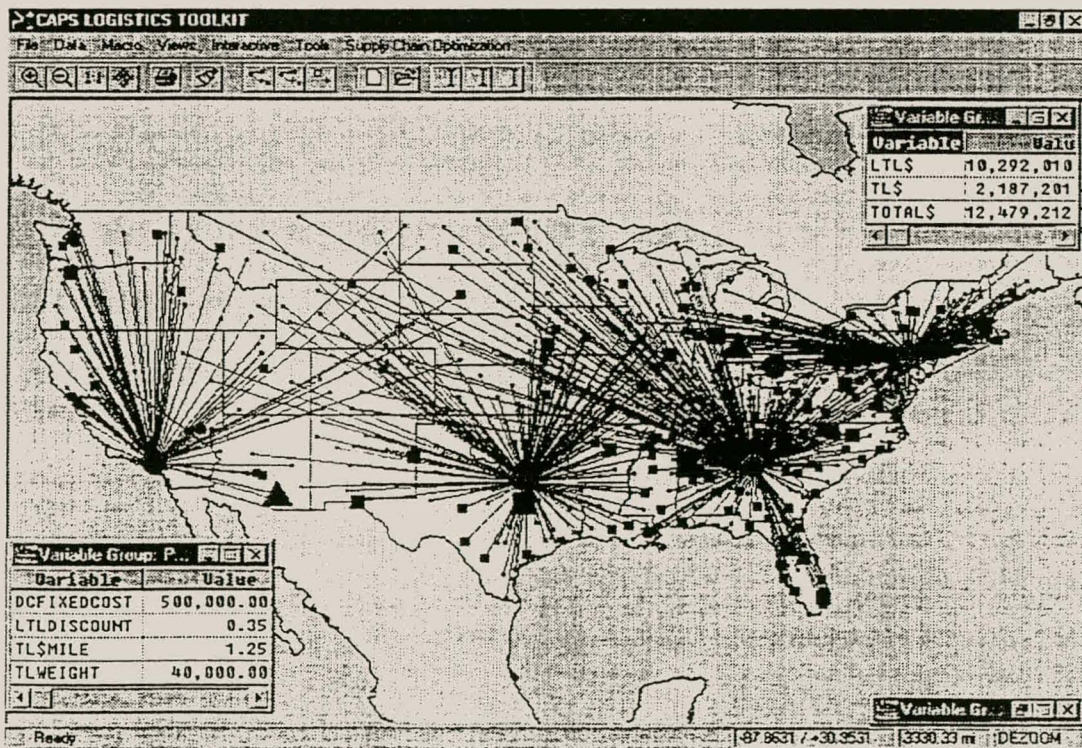
Logistics Decisions (continued)

Next, the project team decides to investigate the effect of consolidating existing distribution centers. As there are only five DCs it is easy to enumerate the respective solutions with each DC closed. ■ Table 1 illustrates the total inbound TL and outbound LTL costs associated with closing each existing DC one-by-one.

<i>best</i>	<i>Allentown</i>	<i>Atlanta</i>	<i>Columbus</i>	<i>Richardson</i>	<i>Covina</i>
\$12.1	\$12.9	\$13.4	\$12.5	\$12.75	\$12.9

Closing Columbus increases transportation costs by the least amount, resulting in the allocation illustrated in ■ Figure 9. If the cost to operate this facility is greater than \$400,000 annually, then closing this DC reduces total costs. The team intuitively believes this is the least important DC, as it is close to Atlanta and Allentown and these DCs are needed for the heavy Southeast and Northeast regions.

The project team next decides to investigate a supply chain configuration not restricted to the current distribution centers. By visual inspection of customer geographical proximity and average order volumes, the team selects 25 DC locations to be analyzed as candidate sites. Each DC is estimated to cost \$200,000 annually to operate, independent of the actual shipment volume handled by the DC.



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Logistics Decisions (continued)

Lastly, the team develops a mixed-integer mathematical optimization formulation with open/close integer variables representing opening/closing candidate DCs. ■ Figure 10 illustrates the candidate DCs and the optimal selection of DCs to open and associated market assignments.

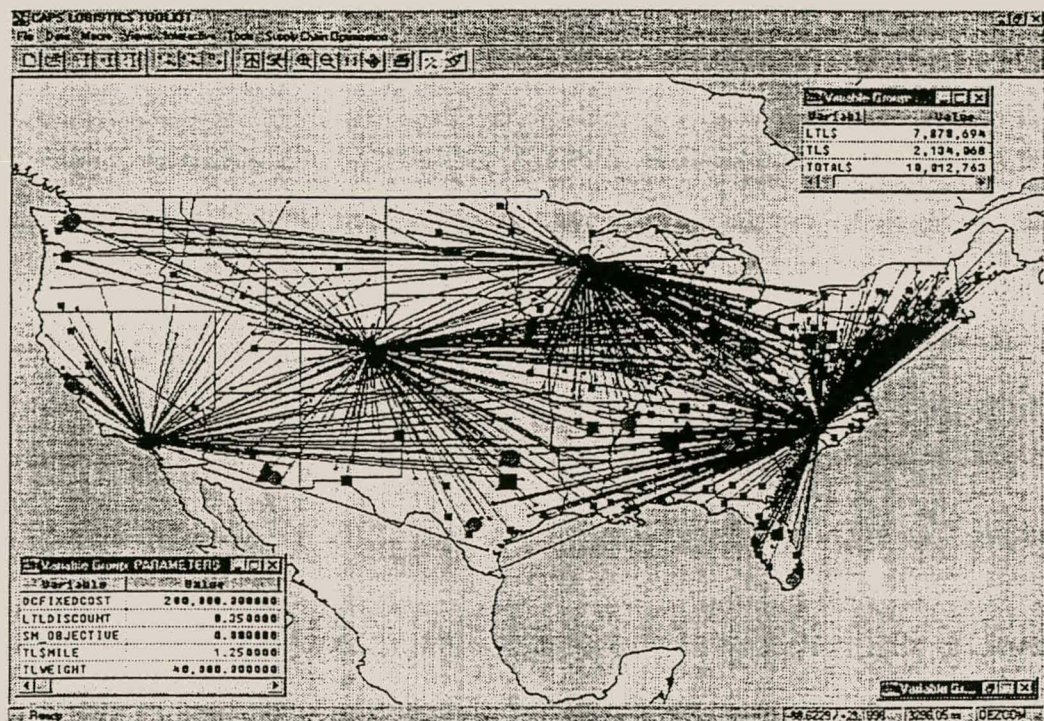


Figure 10
Optimal number
and location of
distribution
centers, and the
optimal allocation
of customer s to
DCs. This
configuration of the
supply chain
reduces annual
costs by over 2
billion dollars.

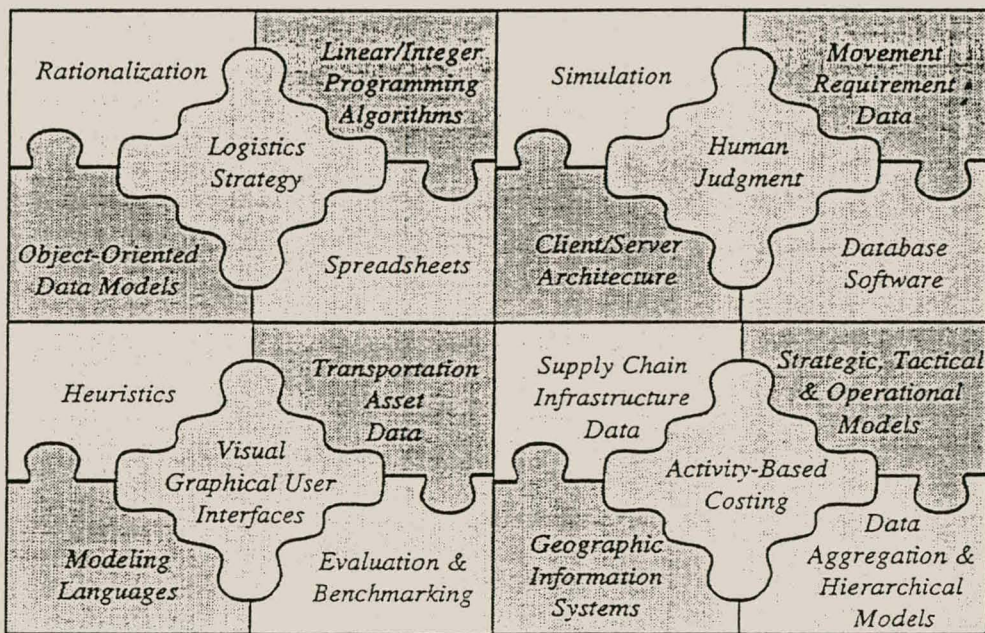
Note the existing Covina facility is selected, but Charlotte is selected to handle the Southeast and Northeast, and Denver and Minneapolis are opened to handle the Midwest and parts of the Northwest and Southwest. The total transportation cost of this solution is roughly \$10 million annually, a savings of over \$2 million annually compared to either the current supply chain configuration or the best single sourcing solution. The project team notes the severe overlap of DC-customer allocations due to the disproportionate structure of LTL rates.

Logistics Composite Modeling

Elements of Composite Modeling

The scope and complexity of the logistics questions outlined in the previous section suggests *there is no single best approach, best representation, best model, or best algorithm for optimizing logistics decisions*. Each logistics supply chain has some unique characteristics which will always frustrate and complicate the job of the logistics decision maker.

However, there are a growing array of decision support concepts and tools from operations research, geographic information systems, database management and graphical user interfaces that (when properly brought together under the decision maker's control) immensely improve the quality and timeliness of logistics decisions. ■ Figure 11 illustrates concepts and tools useful in logistics analysis.



Logistics analysts are naturally biased to their particular modeling expertise: for example, a logistics practitioner may focus on benchmarking models; an operations research analyst may focus on mathematical optimization models; and a computer scientist may focus on object-oriented data models. However, each of these elements is important and should be included in a *composite* model. The next section organizes these elements into a framework for logistics analysis.

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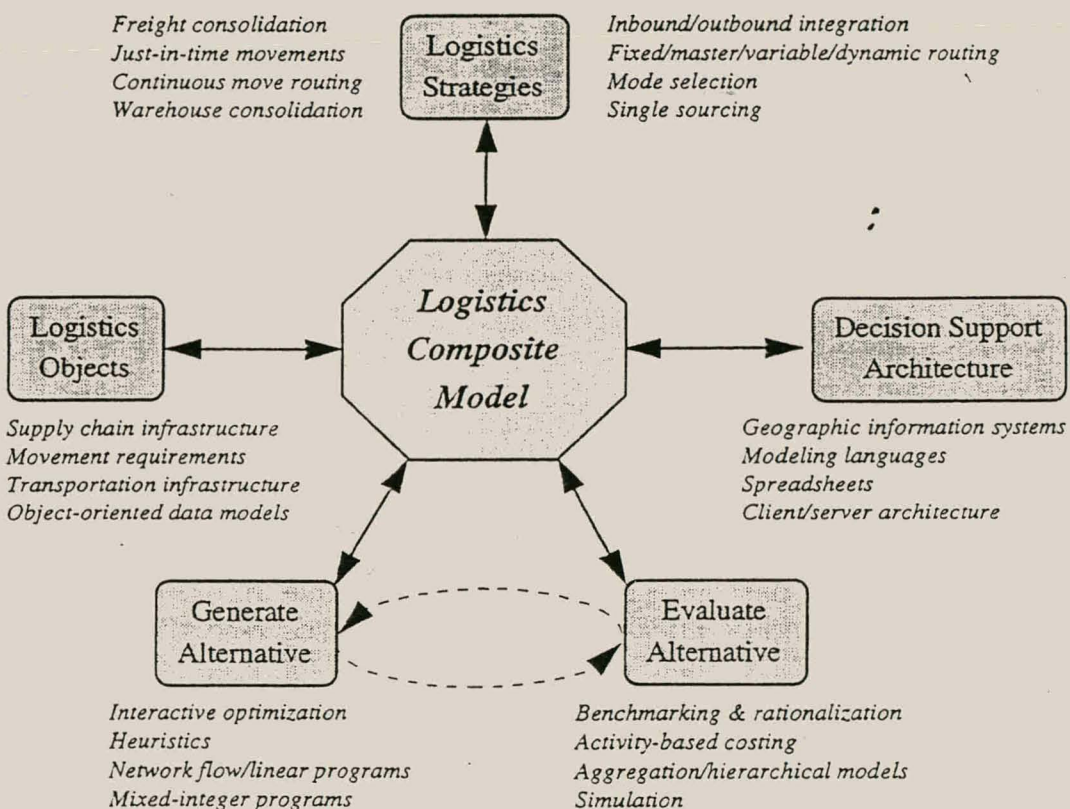
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Logistics Composite Modeling (continued)

The Composite Modeling Process

Given the complex questions and tradeoffs involved in a logistics supply chain, the only practical way to determine how to improve logistics operations is to generate and evaluate logical alternatives. The structured approach presented here brings together a variety of tools and the logistics decision maker into a *Logistics Composite Model (LCM)* for optimizing logistics decision-making. ■ Figure 12 illustrates the major elements of the *LCM* analysis process.

■ Figure 12
The elements of composite modeling are organized into an iterative analysis process. Iteratively generating and evaluating alternatives may suggest refinements to strategies, logistics objects, and decision support architecture.

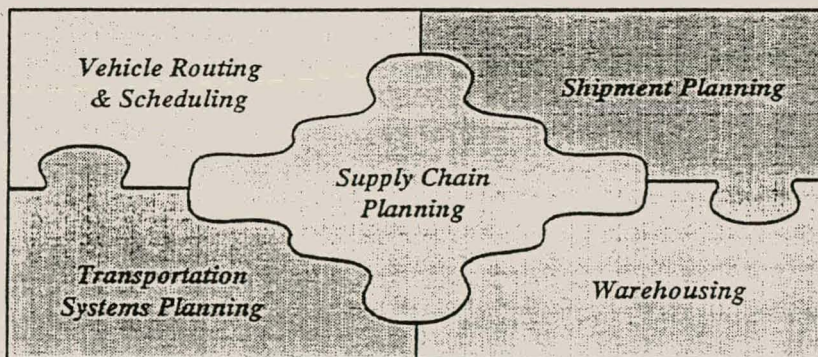


These modeling concepts and tools of *LCM* are described in detail in the following sections.

Logistics Strategies

Introduction

Logistics Strategies includes the business goals, requirements, allowable decisions, tactics, and vision for designing and operating a logistics system. Although some logistics strategies impact decisions throughout the supply chain, for clarity the application areas of strategies can be generally organized as illustrated in ■ Figure 13:



Supply Chain Planning includes the location, sizing, and configuration of plants and distribution centers, the configuration of shipping lanes and sourcing assignments, the aggregate allocation of production resources, and customer profitability and service issues.

Shipment Planning is the routing and scheduling of shipments through the supply chain, including freight consolidation and transportation mode selection.

Transportation Systems Planning includes the location, sizing, and configuration of the transportation infrastructure, including fleet sizing and network alignment.

Vehicle Routing & Scheduling includes the routing and scheduling of drivers, vehicles, trailers, etc. Other applications include dynamic dispatching, customer zone alignment, and frequency of delivery questions.

Warehousing includes the layout design and storage/picking operations of distribution centers.

Logistics Strategies (continued)

Strategic, Tactical, & Operational Model Views

Analyzing the various logistics strategies requires the appropriate modeling views of a logistics supply chain. *Strategic*, *tactical*, and *operational* models are three fundamental classes of modeling views, with general properties shown in ■ Figure 14:



The logistics application areas in ■ Figure 13 can be organized into modeling views as shown in ■ Table 2. Examples of strategies for these application areas are illustrated in the next section.

	<i>supply chain planning</i>	<i>transportation planning</i>	<i>shipment planning</i>	<i>vehicle routing</i>	<i>warehousing</i>
<i>strategic</i>	site location capacity sizing sourcing	site location fleet sizing	outsourcing bid analysis fleet sizing	fleet sizing	warehouse layout material handling design
<i>tactical</i>	production planning sourcing	routing strategy network alignment	consolidation strategy mode strategy	routing strategy zone alignment	storage allocation order picking strategies
<i>operational</i>	MRP, DRP, ERP	load matching	shipment dispatching	vehicle dispatching	order picking

Table 2
Logistics application areas modeling views.

Logistics Strategies (continued)

Contemporary Logistics Strategies

Just-in-Time Logistics

Historically, products have been “pushed” through a supply chain based on forecasts of future customer demand. This strategy allows scale economies in the purchasing of raw materials, manufacturing batch runs, and transportation shipments. However, costly inventories build up to protect errors in forecasts, and the logistics system is slow-moving and inflexible to rapid market changes.

If we knew precisely where, when, and how much material is needed at each stage of a logistics supply chain, goods could be moved through the supply chain *just-in-time* (JIT) for use by the next process, without a need to build up inventories. Thus product replenishments are “pulled” all the way through the supply chain from the point of sale. To control the precise movements of products, computerized integration and tracking of supply chain operations is necessary.

JIT is a shift in thinking from inventory *levels* to inventory *velocity* or “turns.” For a specified time period, the turn rate for a product is calculated by dividing total throughput by the average inventory level. Note the turn rate is only one performance indicator of a logistics supply chain, and by itself is not a very good measure. Often, higher inventory turn rates also mean higher transportation and service costs -

■ Figure 15 illustrates this tradeoff:

Inventory Costs

- *leaner supply chain*
- *reduced inventory levels*
- *reduced inventory costs*



Transportation & Service Costs

- *smaller and more frequent shipments*
- *increased transportation costs*
- *much greater service required from suppliers and the transportation system*

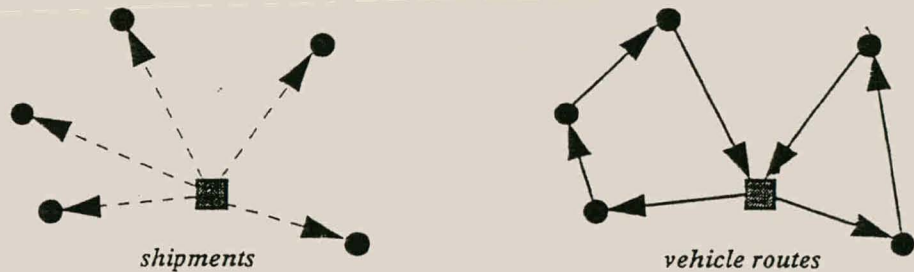
JIT logistics impacts all five application areas illustrated in ■ Figure 13, particularly shipment planning and supply chain design. Shipment planning is fundamentally affected as smaller and more frequent shipments impact transportation mode selection and freight consolidation opportunities. The design of a supply chain is also impacted as there is less emphasis on product storage.

Logistics Strategies (continued)

Freight Consolidation

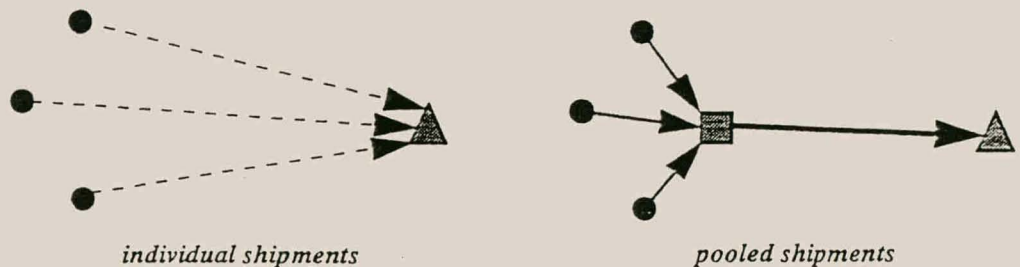
Freight consolidation strategies are one of the key concepts in shipment planning. Shipments in the logistics system can be routed and scheduled independently of each other or can be combined to try and achieve transportation economies-of-scale. There are many ways to consolidate freight, including:

1. *Vehicle routing*. Individual shipments can be combined to share a transportation asset making pickup or delivery stops at different facilities. This type of consolidation is called *multi-stop vehicle routing* (■ Figure 16).



■ Figure 16
Consolidating
freight by
combining
shipments onto
multi-stop routes.

2. *Pooling*. Individual shipments can be brought to a central location or *pooled*, creating large shipments suitable for economy-of-scale transportation modes such as truckload or rail carload (■ Figure 17).



■ Figure 17
Consolidating
freight by pooling
shipments at a
facility.

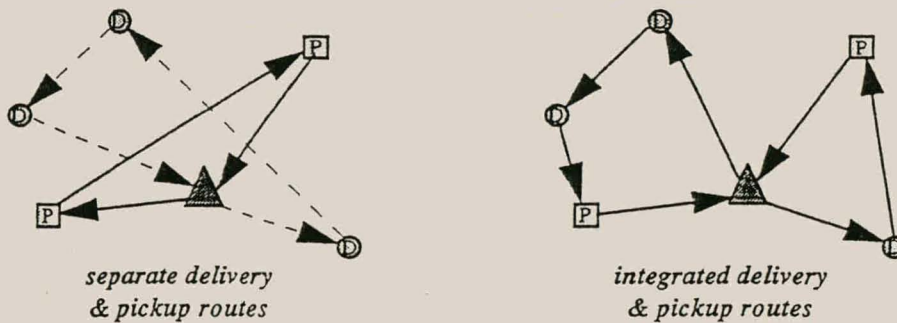
3. *Scheduling*. Sometimes shipment schedules can be adjusted forward or backward in time so they can be combined with other shipments.

Logistics Strategies (continued)

Integration of Inbound and Distribution Logistics

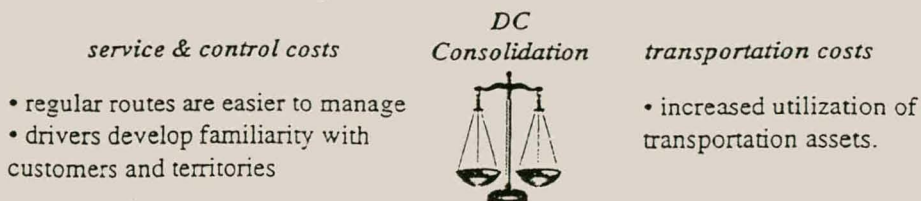
Historically the purchasing and scheduling of supplier-to-plant *inbound* shipments have been treated independently of the distribution of goods coming out of the plant. Coordinating inbound and outbound shipments and resources requires more control of the logistics system, but can increase the utilization of resources.

This strategy particularly impacts shipment planning and vehicle routing and scheduling. For example, ■ Figure 18 illustrates separate delivery and pickup routes (left), and integrated delivery/pickup routes (right).



Fixed/Master Routes & Variable/Dynamic Routes

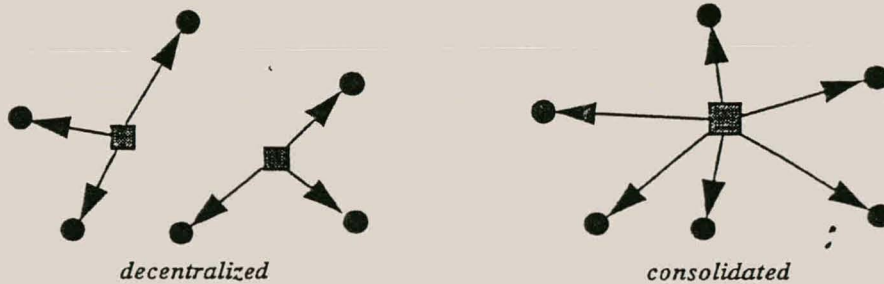
Fixed and master routes are regular vehicle route sequences and schedules developed using average demand forecasts. Fixed routes are regular run each period without considering actual customer demand, while master routes are adjusted slightly based on actual demand. In contrast, variable or irregular routes are tailored to actual customer demand information. The extreme case of variable routes is dynamic routes, which are adjusted dynamically as the routes are run. ■ Figure 19 illustrates the tradeoffs of these strategies



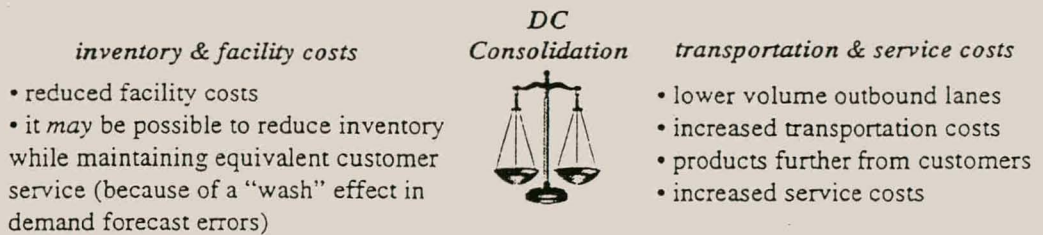
Logistics Strategies (continued)

Distribution Center Consolidation vs. Decentralization

Fundamental decisions in supply chain design include the number, location, sizing, and product configuration of distribution centers. ■ Figure 20 illustrates two basic strategies: *consolidated* distribution (fewer but larger distribution centers) and *decentralized* distribution (more but smaller distribution centers).



■ Figure 21 illustrates the decision tradeoffs involved in the consolidation of distribution centers. Note also that an increased number of distribution centers allows closer positioning of inventory to customers, reducing delivery time to customers.



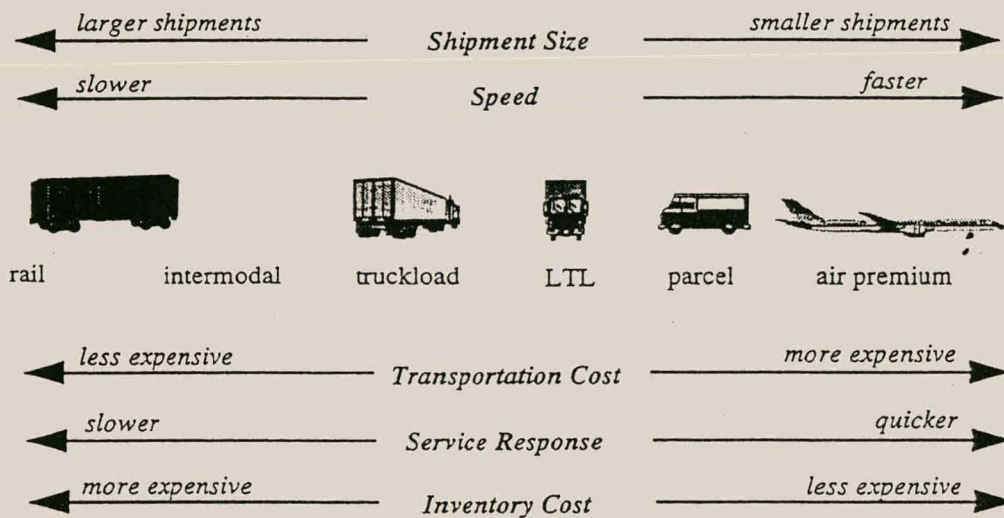
Private Fleet vs. For-Hire Fleet

Some manufacturing and retailing firms choose to own and operate their own transportation fleet. This gives more control over transportation costs and service, but forces the firm into operations secondary to the business. Private fleets are becoming less attractive as competition from transportation deregulation has resulted in better service and lower costs from transportation providers. Additionally, deregulation allows organizations to negotiate discounts for longer-term *dedicated* services from transportation providers.

Logistics Strategies (continued)

Transportation Mode Selection

Mode selection is another fundamental concept in shipment planning. Common transportation modes include overnight package, parcel, less-than-truckload (LTL), truckload (TL), and rail carload (CL), for example. Each mode offers different cost and service advantages and disadvantages - ■ Figure 22 illustrates the tradeoffs in choosing a transportation mode for a shipment.



Transportation mode impacts inventory costs in three different ways. First, slower transportation modes create more *in-transit* or pipeline inventory. Second, larger shipment sizes may create *order quantity* inventory, which arises if the batch shipment size is more than the amount of current demand. Third, slower transportation modes may raise *safety stock* inventories needed to protect uncertainties in supply and demand. A slower transportation mode increases the order lead time (the time between placing an order and actually receiving the shipment), so more safety stock may be needed to protect against the lack of knowledge about demand during the lead time. Thus smaller shipments via faster modes reduces all three types of inventories, but associated transportation costs increase.

Logistics Strategies (continued)

Continuous Move Routing

Some trucking companies offer discounts for *continuous move* routes, where drivers and tractors are kept highly utilized by coordinating the dropoff of an inbound trailer with the pickup of an outbound trailer. ■ Figure 23 illustrates combining two truckload shipments into a continuous movement route. This route reduces costs if the continuous move discount is more than the deadhead cost to travel to the origin of the second shipment

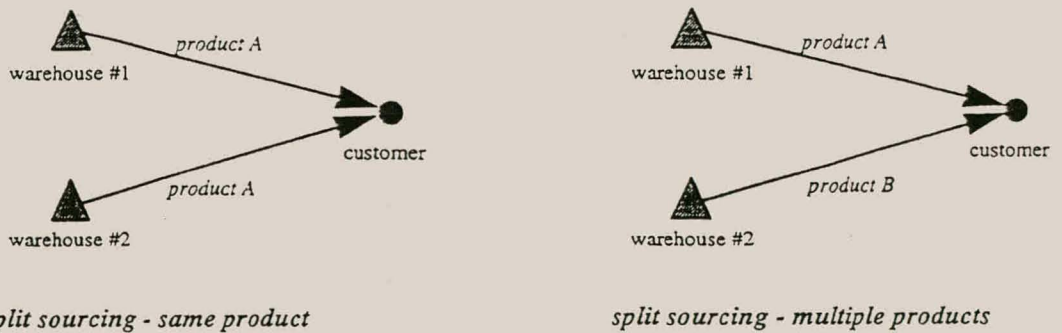
Figure 23
Continuous move routes combine separate trips to ease vehicle utilization.



Single Sourcing

Single sourcing refers to satisfying all product demand at a location from one supplier - in contrast, *split sourcing* refers to multiple suppliers satisfying the same demand location. The most common form of single sourcing is between distribution centers and customers or markets, with each customer assigned a single distribution center. ■ Figure 24 illustrates examples of split sourcing.

Figure 24
Split sourcing can refer to shipping the same product or multiple products from different suppliers.

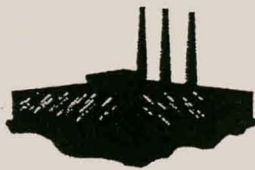


Single sourcing simplifies the logistics supply chain which can reduce management and operational costs. Single sourcing also creates larger volume shipments along lanes, which may reduce transportation costs. However, single sourcing requires each supplier to stock all products - split sourcing allows each product to be shipped via the cheapest shipping route to a customer. Split sourcing can also reduce costs if the supply points are capacitated, as the least cost allocation of supply may require split shipments.

Logistics Objects

Introduction

To develop a computerized model of a logistics supply chain, a strategy for representing logistics information and supply chain operations is needed. *Object-oriented modeling* is one approach which focuses on the natural elements or building blocks of a logistics supply chain. In this approach the *data* and *operations* of a logistics entity are combined to form a *logistics object*. Figure 25 illustrates an example plant object:



Atlanta plant

Sample data attributes

address: 2575 Cumberland Parkway, Atlanta, GA 30339 USA
 number of production lines: 10
 operating hours: Monday thru Friday, 10 hours/day

Sample tools

draw (on a computerized map)
 allocate production capacity to demand
 schedule production lines

There are three basic families of objects in a logistics system:

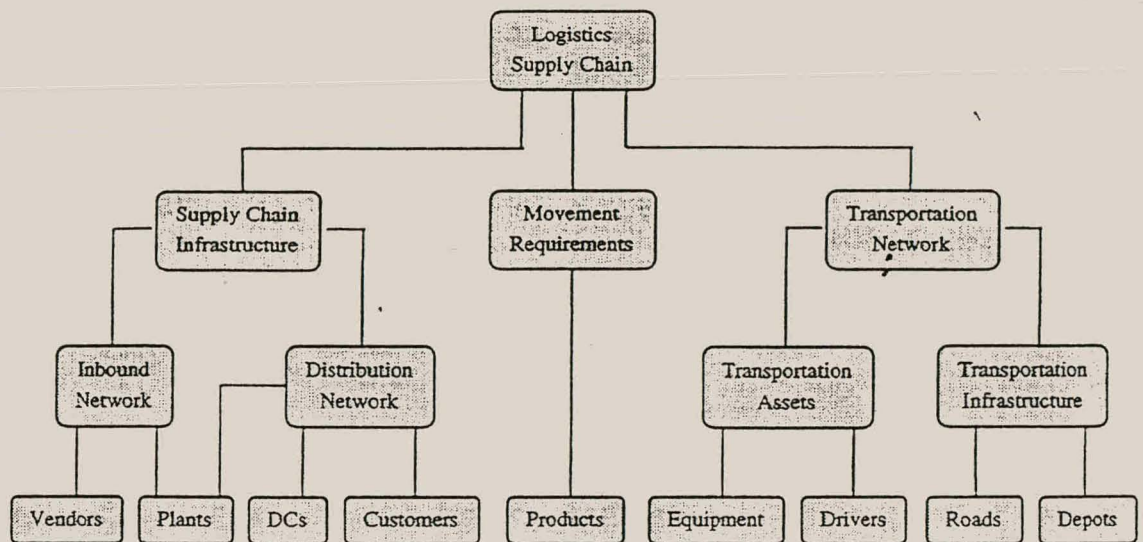
1. *Supply Chain Infrastructure*. This family includes physical sites such as suppliers, plants, distribution centers, and customers. This family also includes connections and territory groupings among sites, such as shipping lanes, facility-to-facility assignments, and customer zones.
2. *Movement Requirements*. This family is all shipment information including what commodities to move, when commodities are needed, special instructions or requirements for movement, etc.
3. *Transportation Network*. Transportation network objects include the physical components of the transportation infrastructure (road and rail networks, ports, depots, pool points, intermodal exchange locations, etc.), assets that are either owned or available for hire (drivers, trucks, trailers, containers, planes, ships, rail cars, intermodal containers, pallets, etc.), and asset locations and transportation capabilities (such as maximum loads or transit speeds).

Logistics Objects (continued)

Class hierarchies of logistics objects

Objects in these three families can be *hierarchically* organized into *classes* to provide an intuitive representation of a logistics system. ■ Figure 26 illustrates one example hierarchical organization of logistics objects, representing the logistics system of a manufacturing firm (note there are many different and valid ways to describe a logistics system using object hierarchies).

Figure 26 is an example hierarchy of logistics objects. Higher-level views of a logistics system are found at the top of the hierarchy - one can “drill down” through the hierarchy for more focused views.



Other properties of hierarchical models

A hierarchical model provides a systematic way to adjust the *resolution* of a model. By navigating a hierarchical model we can back up and look at the “big picture” in a logistics system, or focus in on detailed components. A hierarchical representation also provides a systematic way to *extend* a model - a new object class (such as *European* manufacturing plants) can be quickly created by first *inheriting* data and operations from an existing object class.

Other benefits of object-oriented modeling

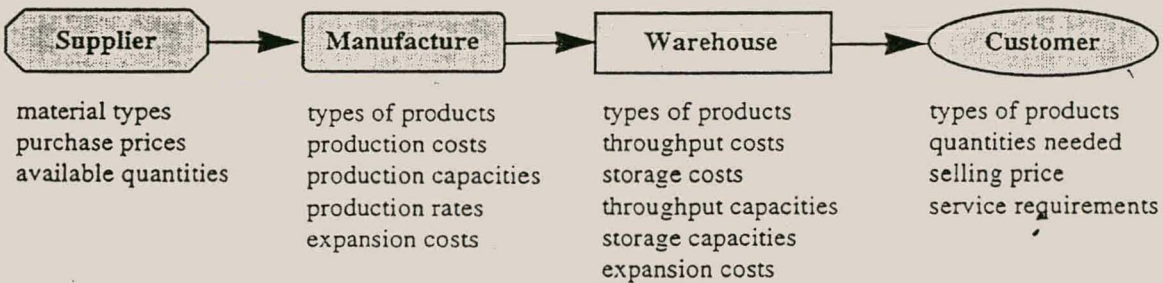
There are many other benefits of an object-oriented modeling approach. Combining data and operations (or *tools*) together into objects allows the tools to protect or *encapsulate* what can be done with data. Further, the binding of data and tools makes it clear how data can be manipulated. Object-oriented modeling is also particularly suitable as a basis for computerized decision support systems. Modularity makes objects easier to maintain and extend, and the hierarchies of object classes encourage reusable programming code.

Logistics Objects (continued)

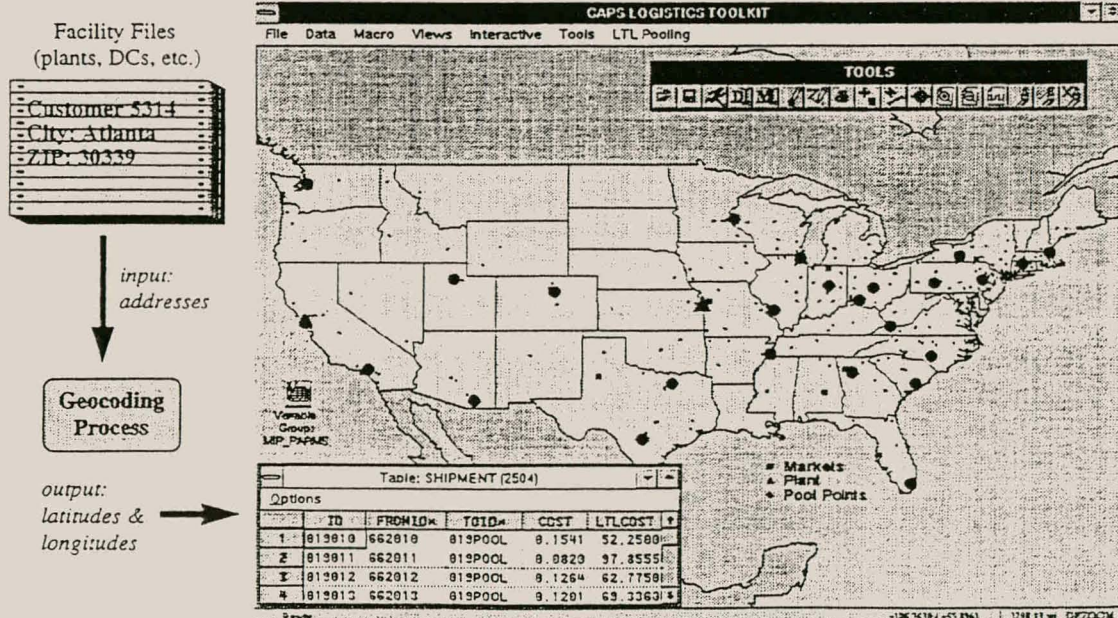
Developing a Supply Chain Model

Facilities

Facilities are the foundation of the supply chain infrastructure and include suppliers, plants, distribution centers, and customers. ■ Figure 27 illustrates facility data that is needed or useful in logistics modeling.



Geocoding is the process of determining the geographic (longitude and latitude) coordinates or *geocodes* of a facility, given a description of the facility (■ Figure 28). The description of a location could be a street address, city name, or postal code.



Logistics Objects (continued)

Geocodes are needed for many types of quantitative analysis tools where nearness among facilities is important, such as the routing of vehicles or the location of new facilities. Geocodes also allow the logistics supply chain to be visually represented using map-based graphical user interfaces (discussed in the *Interactive Generation of Alternatives* section later).

A large number of commercial databases are available to support geocoding, including databases of postal codes and metropolitan streets - an extensive reference of available databases is the GIS World Sourcebook⁶.

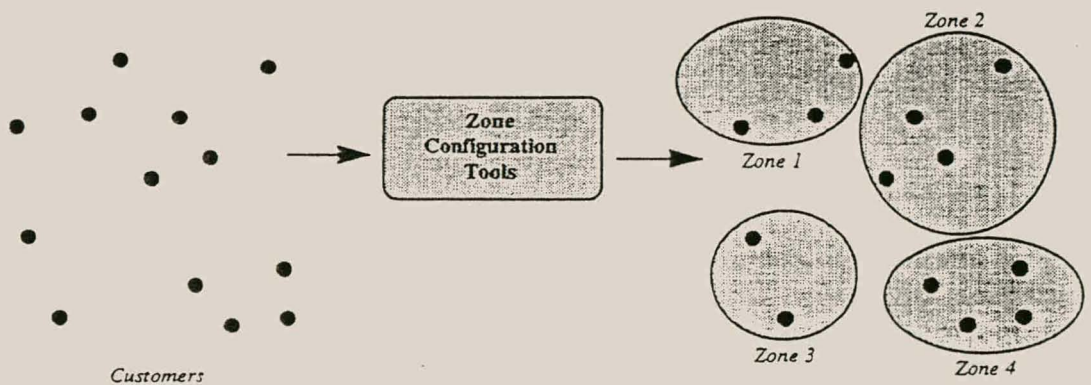
Facility Zones

Zones define the geographical territories of facilities, such as sales regions, customer territories, or distribution center areas. Zones can be pre-determined (such as marketing territories) or can be created automatically by rules or algorithms. ■ Figure 29 illustrates example zones defined for a set of customers - individual customer data such as demand is aggregated to determine total demand by zone.

Facility zones play an important role in *simplifying* a logistics model, as aggregate regions can represent the demand of hundreds of even thousands of individual customers. Effective zones usually define logical geographical clusters of facilities, adjusted to balance some attribute (such as total zone demand or transportation workload, for example).

Why define facility zones?

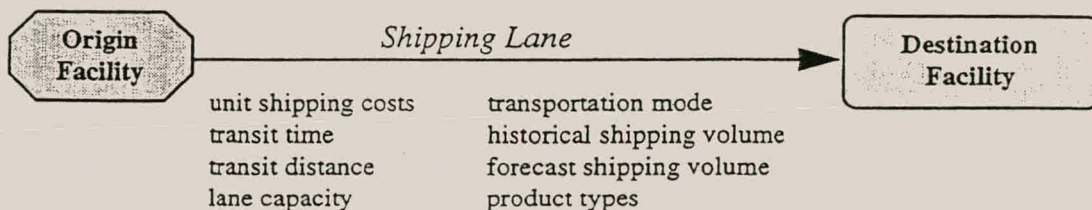
Figure 29 illustrates how facility zones are defined. Individual geographic locations of facilities, with boundaries adjusted to aggregate some attribute.



Logistics Objects (continued)

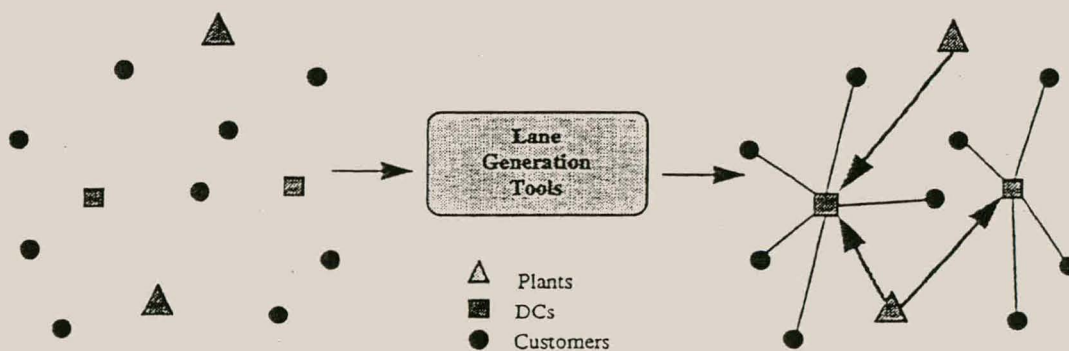
Shipping Lanes

Shipping lanes are the product movement connections between supply chain facilities. ■ Figure 30 illustrates shipping lane data relevant in logistics modeling.



Shipping lane *generation* defines the shipping lanes between facilities that are *candidates* for product flow. Lane generation tools help to pare down the large number possible transportation lane combinations to a practical or logical set. These candidate lanes are inputs to analytical tools deciding actual product flows and schedules.

Shipping lanes can either be pre-determined or generated by rules or algorithms (such as all lanes of distance less than 500 miles, or by product compatibility issues). ■ Figure 31 illustrates example lanes generated between facilities.

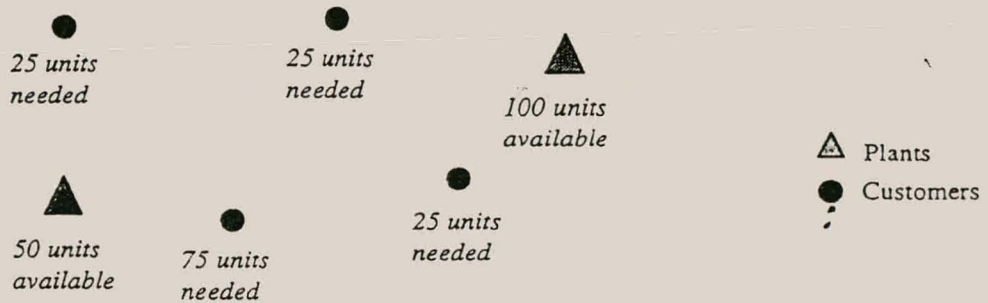


Logistics Objects (continued)

Representing Movement Requirements

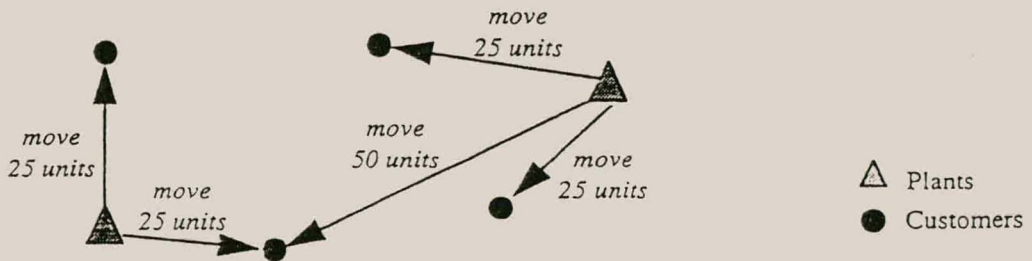
Movement requirements indicate product demand or shipments, including when and how many products or components are needed at specific facilities or zones. One way to indicate movement requirements is to specify the *aggregate* supply and demand for products at facilities or zones (illustrated in ■ Figure 32). Aggregate supply-and-demand models are appropriate where the origins and/or destinations of movements are unknown. Aggregate models are also useful for answering strategic design questions.

■ Figure 32
One way to represent demand for product is to specify aggregate supply and demand information at facilities.



Another fundamental way to represent movement requirements is to describe *explicit* shipments, including origins, destinations, products, volumes, due dates, and pickup dates. Origin-destination shipment models are useful for answering routing and scheduling questions involving explicit shipments and transportation assets. ■ Figure 33 illustrates origin-destination movement requirements.

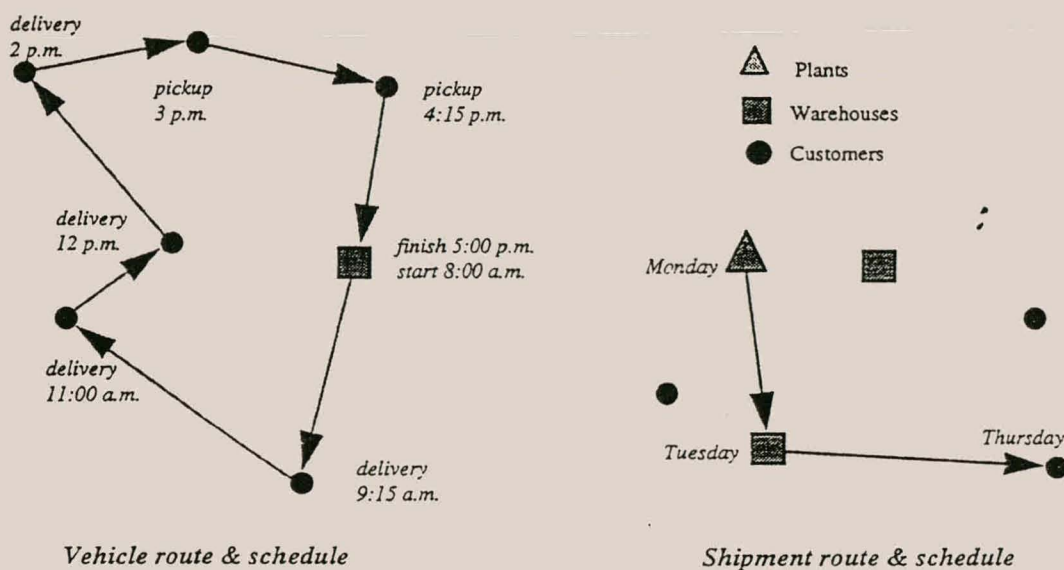
■ Figure 33
Another way to represent product demand is to specify origin-destination shipments.



Logistics Objects (continued)

Representing the Flow of Shipments and Assets

Logistics objects that are *moving* include shipments and transportation assets. *Paths* and *routes* are used to represent the movement of goods and transportation equipment among facilities. *Schedules* describe timing information associated with the movements. ■ Figure 34 illustrates examples paths, routes, and schedules. Note transportation assets include trucks, drivers, and trailers, each with possibly distinct routings and schedules.



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Logistics Objects (continued)

Other Data Issues

Sources of Data

Data for logistics objects can be generated in three basic ways:

1. *Current* information.

Some logistics models are based on current logistics information. For example, vehicle dispatching models need information about today's orders, vehicles available, driver status, etc.

2. *Forecasts*.

Other models are based on forecasts of future information - historical data is used to predict future customer demand, available production capacity, etc. The estimates can be generated in a variety of ways, from using sophisticated forecasting algorithms to simply rolling up a year's worth of historical data to give an annual view of a supply chain.

3. *Historical* information.

Still other models use actual historical data to calibrate model accuracy - model outputs can be compared to what actually happened to ensure the model is a valid representation of the logistics supply chain.

Time-related Data: The Modeling Horizon

A key modeling issue is defining the time span or *horizon* of a logistics model. Some models are *single-period* models - there is only one time period, so data in these models does not change over time. A popular single-period model is a one-year view of a supply chain, with relevant facility data including the total production capacity or demand forecast for the entire year. Single-period models are useful for analyzing solutions to strategic design models.

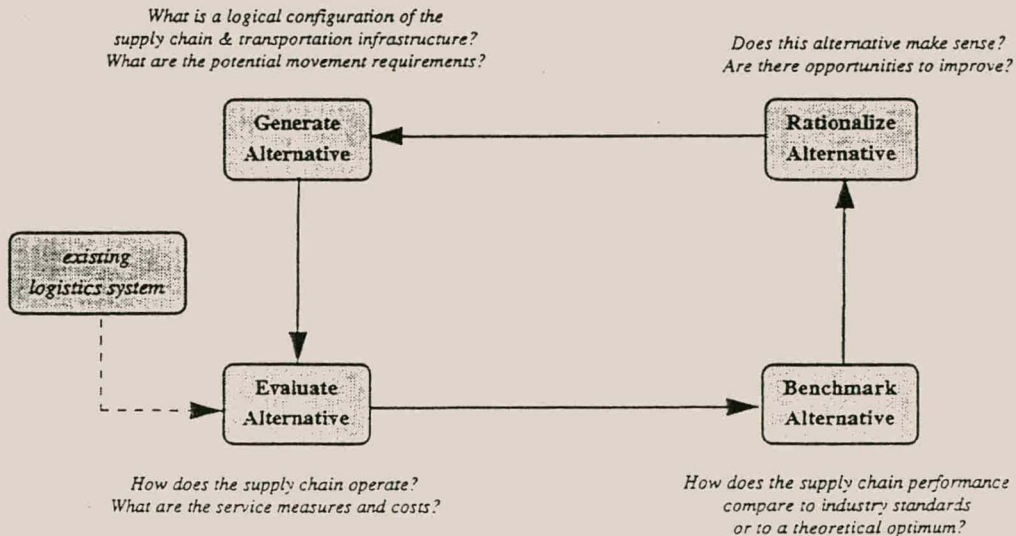
In contrast, some models are *multi-period* models, with data potentially changing from one time period to the next. For example, the customer demand for a soft drink products increases during the summer months. A popular multi-period model is a one-year view of a supply chain by month, with relevant facility data including the production capacity or demand forecast for each month, for example. Multi-period models are useful for analyzing solutions to resource scheduling models.

Evaluating Alternatives

Introduction

Evaluating Alternatives is “playing out” or *simulating* the operation of a logistics supply chain using a model and analyzing the attractiveness of the supply chain configuration. Cost and service performance measures, resource utilizations and bottlenecks, and other statistics of the logistics system are calculated in this phase of *LCM*.

Evaluating Alternatives is composed of the *Evaluate*, *Benchmark*, and *Rationalize* steps, each geared towards answering particular analysis questions. These three steps combined with the *Generate Alternatives* step (discussed later) form an iterative analysis cycle, illustrated in ■ Figure 35. The analysis process is naturally iterative because evaluating one alternative often suggests new alternatives to investigate.



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Evaluating Alternatives (continued)

Model Simplification

Logistics supply chains can be very large systems composed of hundreds of facilities moving tens of thousands of products or more. These systems are far too large and complex to work with all at once in the *Generate, Evaluate, Benchmark, and Rationalize* steps. The only practical way to analyze and improve a logistics system is to *simplify* the logistics decisions into smaller interrelated and manageable components. Two model simplification techniques are *aggregation* and *partitioning*.

Model Aggregation

What is aggregation?

Aggregation is collecting or “rolling up” *related* data up to a simpler or more *approximate* representation. Examples of logistics supply chain aggregation are the following:

- Grouping individual products or stock-keeping units (*SKUs*) into *product families*, representing groups of similar product items.
- Adding up the individual product demand for customers to get the total demand by *customer zone*.
- Adding up the manufacturing capabilities of individual production lines and assembly stations into a *total production capacity* for a manufacturing plant.
- Representing large numbers of individual truck trailers by a few basic *trailer types*, such as refrigerated, 48 foot, etc.

Model Partitioning

Another way to simplify a logistics system is to decouple or *partition* the supply chain into more manageable components. For example, we could divide the distribution system into regions, and develop vehicle routing models separately within each region. Of course, a key part of supply chain modeling is treating the logistics system as an integrated process, so care must be taken to provide enough “linkage” between the components to capture the relevant decisions and issues.

Evaluating Alternatives (continued)

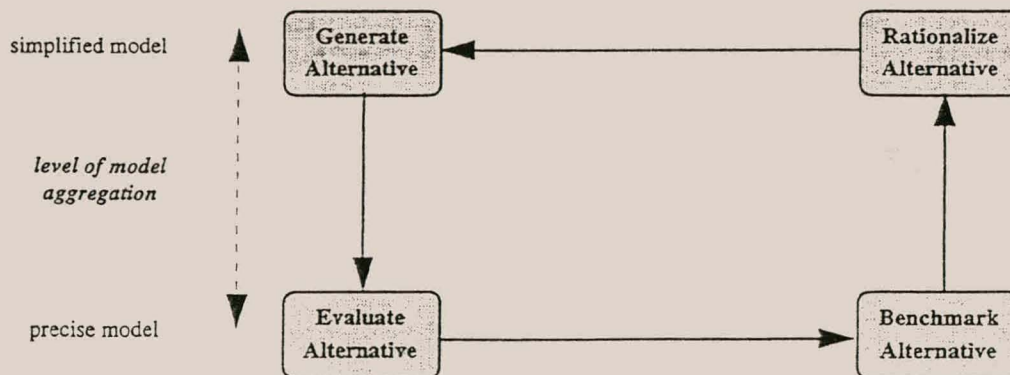
Model Accuracy

In the ideal logistics model:

- All data is available and correct.
- There is no error in forecasts of future data (including customer demand, availability of supply, availability of resources, etc.).
- The model exactly captures all of the relevant issues in the logistics supply chain.

Unfortunately, in most situations some data is missing or incorrect, the forecasts of future data are wrong, and some supply chain characteristics are too fuzzy to capture precisely in a model. Thus most logistics models are at best *approximate* representations of the actual logistics system.

How do we know if an approximate and simplified model is an accurate representation of the logistics supply chain? This is the heart of the *Evaluate Alternatives* step. This modeling step "plays out" a given logistics system configuration, so more detailed data can be used. The result is that baseline statistics can be calculated and used to gauge the precision of more simplified models (■ Figure 36).



Evaluating Alternatives (continued)

Evaluation lets us calibrate aggregate models

For example, in aggregate models it is common to use average or approximate values for costs and demand quantities. Given the movement of actual shipments, we can evaluate the true shipping costs and compare with the approximate costs. We can then modify and improve how we estimate the approximate costs and demands based on what actually happened. Thus the evaluation step measures the accuracy of a simplified model.

The output of Generate is not the answer, but the input to Evaluate

Simplified models are particularly useful in the *Generate* step, as solution generation tools can examine a greater number and variety of decision alternatives using more aggregate models. It is important to note that the output of the *Generate* phase is the input to the *Evaluate* phase. For example, the optimal solution generated by a mathematical optimization model is not necessarily the "answer" but rather must be played out and evaluated to judge the solution's true attractiveness. More aggregate model views are also useful in the *Rationalize* step, as these models are easier to understand and manipulate.

In general, the right level of model simplification balances accuracy (so that judgments based on the model are correct judgments about the actual logistics system) with practicality (illustrated in ■ Figure 37).

:

Simplified (aggregate) model

*easier to understand
more manageable & practical
faster computer processing*



Precise (disaggregate) model

model accuracy

Figure 37
Tradeoffs of simple
and precise
modeling views.

Simulation

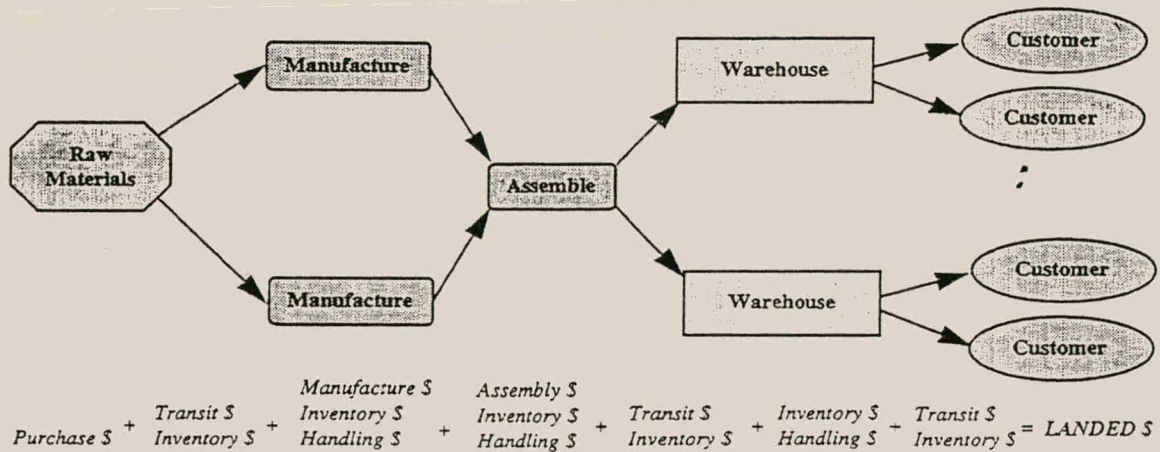
Simulation is a general term for a class of tools and models that play out a given logistics system. While these tools are descriptive only (and do not prescribe smart alternatives), simulation tools can handle a large amount of detail, and can effectively represent the *probabilistic* elements of a logistics system. Thus these tools are effective for evaluating the actual behavior of a logistics system and calibrating the accuracy of more approximate models.

Evaluating Alternatives (continued)

Costing

The process of determining the product cost *delivered to the customer* forces the specification of cost models for the various components of the entire logistics supply chain. The cost to deliver a unit of product to the customer is called the *landed customer cost*.

■ Figure 38 illustrates the various types of costs incurred as a product moves through a logistics supply chain. The result is the cost to get a product to two different customers is *almost always* different.



Some cost components are easy to determine for specific products and customers, but other costs are shared among products or customers and must be fairly allocated. *Activity-based costing* is one allocation method that attempts to accurately allocate resource costs by focusing on the activities performed by the resources. Costs are then allocated based on the activity *levels* needed by individual products or customers.

For example, we could allocate the cost of a vehicle route over a set of customers by first identifying specific route activities, such as driving, loading, and unloading. Some activities are tied to individual customers (such as unloading), and thus the corresponding costs are easy to allocate. Other activities (such as driving) are jointly influenced by customers and must be allocated using some estimate of an individual customer's contribution to the activity.

Evaluating Alternatives (continued)

Benchmarking and Rationalization

Benchmarking is comparing the performance of a logistics supply chain to organizational or industry standards or to some theoretical "ideal." If data is available, it may be possible to compare the supply chain to so-called "best-practice" standards or corporate supply chains that are recognized as industry leaders in logistics operations.

Benchmarking metrics generally fall into two basic groups: *costs*; and *service measures*. Sometimes costs and service measures can be measured directly, but frequently *surrogate* indicators must be used to estimate performance (particularly for service). For example, the inventory turnover rate, the total cycle time of a product in a supply chain, and the movement accuracy (timeliness of actual shipment movements compared to predicted movements) are commonly used as estimates of the level of customer service provided by the supply chain. In general, the more surrogate the metric, the more carefully it should be treated when evaluating supply chain performance.

The *Rationalize* step is the interpretation of the *Evaluation* and *Benchmark* results, and the justification of the logistics supply chain configuration. Tools to use in this step include cost reports, service metrics, and the utilization of resources. Model aggregation is important in this step, as it is important to see the "big picture" of the logistics supply chain and focus on the key opportunities for improvement. Rationalization relies heavily on strong graphical user interfaces that can illuminate resource bottlenecks, high cost elements, service problems, etc.

Generating Alternatives

Introduction

Generating Alternatives includes any change to the logistics strategy, supply chain infrastructure, transportation infrastructure, movement requirements, or the relevant operating parameters. There are four fundamental ways to generate logistics supply chain alternatives:

1. *Existing system.* If the logistics supply chain already exists, then the first alternative analyzed is the current system, and the analysis proceeds directly to the *Evaluating Alternatives* phase.
2. *Specified.* The alternative to investigate could be given, such as a strategic plan that the organization's management would like to evaluate.
3. *Automatic.* The alternative could be generated automatically, using computer algorithms based on mathematical optimization, heuristics, rules, etc.
4. *Interactive.* The alternative could be generated interactively, in an exploratory or "what-if" style.

Automatic Generation of Alternatives

Mathematical Optimization

One of the most important steps of *LCM* is developing an *analytical* or mathematical model of the logistics supply chain. An analytical representation is natural because of the many quantifiable elements in logistics (such as shipping costs, storage costs, transit times, inventory levels, production capacities, and demand forecasts). *Mathematical optimization* is a powerful class of quantitative models, tools, and algorithms that can be used to *automatically* generate and examine vast numbers of decision alternatives and pinpoint smart alternatives.

A mathematical optimization model consists of the following three components:

- *Objective.* Usually we wish to maximize or minimize some quantifiable goal. For example, common logistics objectives include maximizing profitability, minimizing landed costs, maximizing on-time shipments, or minimizing the number of trucks needed.
- *Decision Variables.* Decision variables represent choices in a logistics supply chain. For example, common logistics decision variables include where to locate facilities, how to route freight, and when to send shipments.
- *Constraints.* Constraints represent restrictions or requirements of the logistics supply chain. For example, common logistics constraints are storage space in a warehouse, available manufacturing capacity at a plant, the number of trucks available, and the shipment delivery time required by a customer.

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Generating Alternatives (continued)

"Easy" Optimization Models

"Easy" optimization models, linear programming models

Some mathematical optimization models are "easy" in the sense that there are algorithms available that can consistently find the optimal solution in a predictable amount of time. The most useful models in this class are *linear programming* (LP) models. In an LP model the objective and all constraints are linear equations, and all decision variables are "continuous" (i.e., fractions are okay). Very large linear programs with tens of thousands of decision variables or more can be optimized quickly using efficient computer algorithms.

Network linear programs

A special class of linear programs are *network* linear programs which have many natural applications in modeling supply chain networks. *Minimum cost network flows*, *shortest paths*, and *matching* tools belong to this class, and have applications in resource allocation, production scheduling, and supply chain design.

"Hard" Optimization Models

What are "hard" optimization models?

Some mathematical optimization models are "hard" in the sense that there are algorithms available that can consistently find the optimal solution in a reasonable amount of time, *if the problem size is sufficiently small*. Thus these are "limited size solvable" models. For these models we can optimize small problems but either cannot optimize large problems or cannot solve them with consistency.

Mixed-integer programming models

Many of the most important logistics models fall into the "hard" class. This includes most models of vehicle routing and scheduling, facility location and sizing, shipment routing and scheduling, freight consolidation, and transportation mode selection. These problems can be represented as *mixed-integer programming models*, a class of models with some of the decision variables restricted to integer values. For example, the number of drivers and trucks assigned to drive a certain distribution lane could be 0, 1, 2, etc., but could never be 2.7; a manufacturing plant can either be constructed or not constructed, but not partially built.

Mixed-integer programming models are intractable

Mixed-integer models are often difficult to optimize, as there may be an exponential number of possible decision alternatives. For example, the number of possible combinations of opening or closing n distribution centers is 2^n . There is no algorithm available which can *guarantee* finding the optimal alternative without the possibility of examining many of these alternatives.

A further complication is the effort required to solve a mixed-integer program is often dependent on the specific problem data, and a very slight change to a model may transform a solvable problem to an unsolvable problem. Thus mixed-integer programming models are often better suited for planning when there is sufficient time to use alternative approaches if the solution effort becomes too great.

Generating Alternatives (continued)

Heuristics

Heuristics? *Heuristics* are another important class of methods for automatically generating supply chain alternatives and decisions. A heuristic is simply any intelligent approach that attempts to find good or plausible solutions. The heuristic may be based on mathematical optimization, rules, or any other method that can generate alternatives.

s are often *tion* *es* The word "heuristic" sometimes implies a "seat-of-the-pants" solution approach, with little or no intelligence or sophistication used to make decisions. This is unfortunate, as analytical heuristics can be as technically sophisticated as mathematical optimization approaches. Many heuristics are actually based on mathematical optimization methods and algorithms such as using practical rules to formulate a mathematical optimization model. A powerful heuristical approach is to modify a mixed-integer program by temporarily treating the integer variables as linear variables, creating an approximate but much more solvable logistics model. The solution to this problem is then used as a basis for constructing a solution to the integer program.

Generating Alternatives (continued)

Interactive Generation of Alternatives

One of the most powerful techniques for generating and analyzing alternatives is *visual logistics modeling*. Visual logistics modeling allows logistics analysts to specify decision alternatives via a combination of mathematical optimization, heuristics, and graphical user interfaces (■ Figure 39). The visual interface shows computerized maps, supply chain infrastructures, transportation infrastructures, flow requirements, schedules, etc. Visual logistics modeling is also ideally suited for understanding a supply chain, as graphical solution representations can often best portray resource limitations, service or cost problems, structural problems with the supply chain, inefficient vehicle routes, and other improvement opportunities.

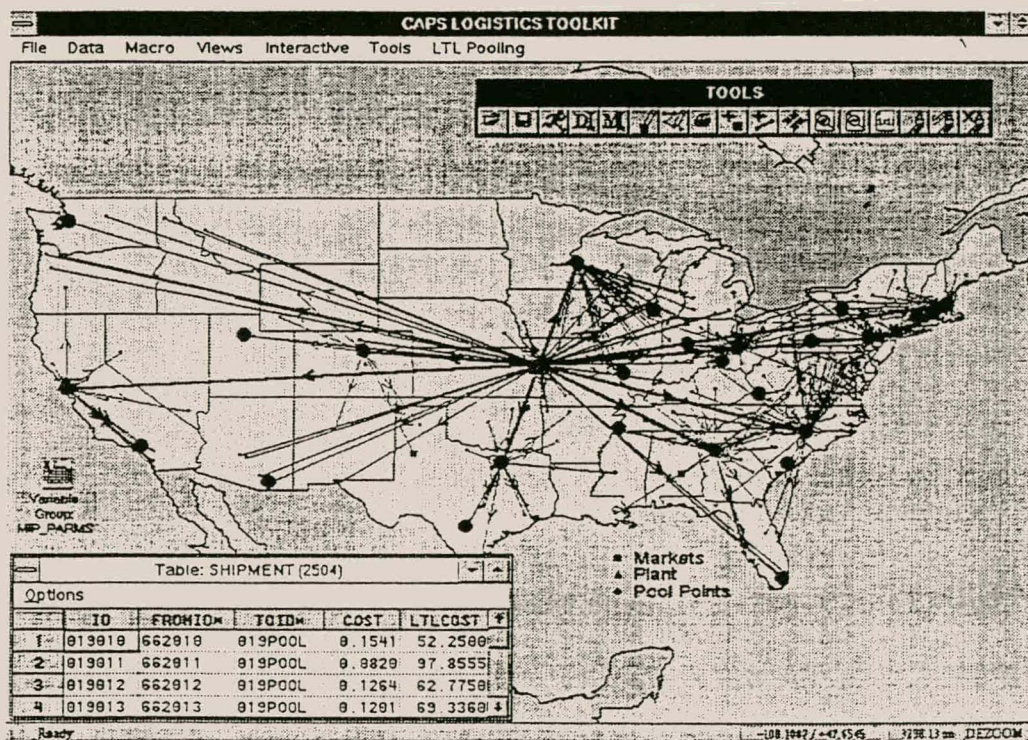


Figure 39
Visual logistics modeling allows the analyst to generate supply chain alternatives through logical and interactive mapped and scheduled user interfaces.

Digital geographic data is an important part of visual logistics modeling, and is also used directly in computations for many types of logistics models. Examples include computing transportation distances, routes and schedules over a highway network, or determining the closest distribution center for a set of customers. Another common application is the use of geographic *zones* as a part of the modeling process (e.g., assign all customers in this area to a particular distribution center).

Generating Alternatives (continued)

Comparison of Solution Generation Approaches

Mathematical optimization, heuristics, and visual logistics modeling are all tools that can generate logistics alternatives. Which method is best?

No single solution generation approach is appropriate for all logistics modeling situations, and each method has certain complementary benefits. In *LCM* we first try to represent logistics decisions using a mathematical optimization model because of the power of quantitative models to consider large numbers of alternatives and pinpoint optimal solutions. Note that this means we may wish to use simplified models in order to pose a quantitative model that can be solved in a reasonable amount of time.

We can rely on the mathematical optimization solution if we are confident that our model is a precise representation of the logistics supply chain. But what if:

- The quantitative model is only an approximate representation of the actual logistics supply chain?
- The data is estimated and likely contains errors, or there is operational variability in the supply chain which cannot be predicted?
- There are objectives, decisions, or constraints which are not naturally quantifiable, and require human judgment?
- The model is a “limited size solvable” optimization model?

These are all common aspects of logistics modeling, and require the “composite” approach of *LCM* to bring together various complementary tools. If the quantitative model is a high-level approximation of the real logistics system, then it is critical that the output of a mathematical optimization model is treated as the *input* to the *Evaluate Alternatives* step rather than the final solution.

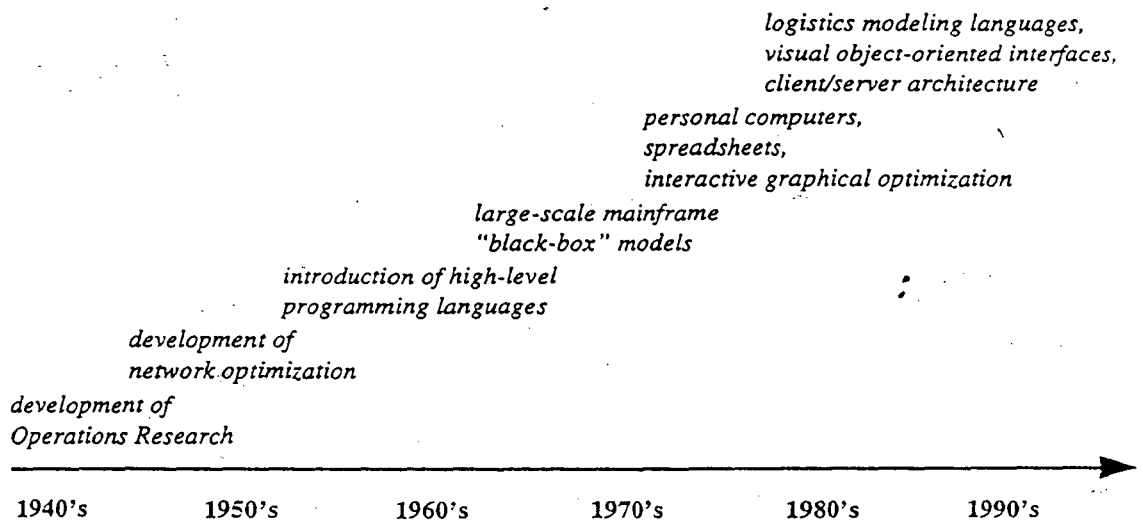
Heuristics are a key part of *LCM*, as heuristics may be able to best handle non-quantitative business issues or rules, imperfect data, and limits on solution time and computing capacities. Generating alternatives using visual logistics modeling software is an excellent way to take advantage of human judgment and control of the decision-making process, increasing the understanding and control of mathematical optimization models.

Decision Support Architecture

Introduction - Evolution of Decision Support Tools

Logistics decision support tools have advanced steadily since the development of Operations Research, and very rapidly in the last ten years. Major milestones are illustrated in ■ Figure 40.

■ Figure 40
The evolution of logistics decision support tools and architecture over the past fifty years.



The next sections summarize classes of these tools particularly useful in logistics modeling.

Decision Support Architecture (continued)

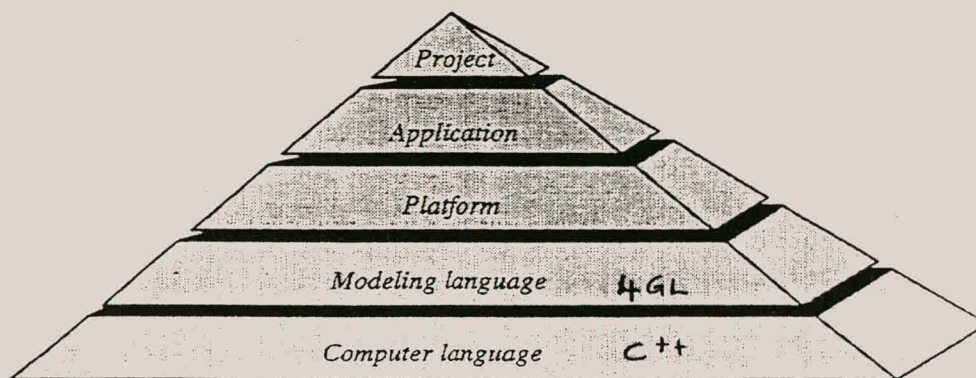
Computing Architecture

Logistics Modeling Languages

The scope and complexity of logistics systems and models necessitate the use of computer-based decision support systems. Two fundamental classes of software applications are "custom-built" systems developed for unique situations, and "off-the-shelf" systems developed for more general use. Each type of system has inherent problems for use in logistics decision support. Custom systems can be tailored to the unique needs of a business, but generally take a long time to build, are expensive, and are difficult to change as the business needs change. Off-the-shelf systems are less expensive and quicker to implement, but often do not fit the unique logistics issues of an organization.

One successful approach for developing flexible and tailored software quickly and cost-effectively features high-level, reusable tools and data objects that can be configured and "programmed" by business analysts and end users. This type of programmable software system features a *high productivity language*. Spreadsheet and database software applications are two excellent examples of high productivity software languages.

Spreadsheet and database systems are useful in logistics modeling, but a richer architecture is needed as a foundation for *LCM*. ■ Figure 41 illustrates a hierarchical architecture for logistics decision support based on a logistics modeling language. At the lowest level, a low-level programming language such as C++ is used to develop the logistics modeling language, comprised of logistics data objects such as those described in the *Logistics Objects* section, analytical tools, and a macro control language.



- WINDOWS '95 & NT
- ODBC
- DDE & OLE
- ORACLE

Decision Support Architecture (continued)

Next, a “platform” or set of macro libraries is assembled, providing an almost off-the-shelf software application to a well-defined set of logistics issues (such as vehicle route dispatching, fleet sizing, supply chain facility location, and production planning). Note that a platform can be easily modified or extended to form a unique application (such as an organization’s private fleet routing scenario), as platforms are written entirely in the modeling macro language.

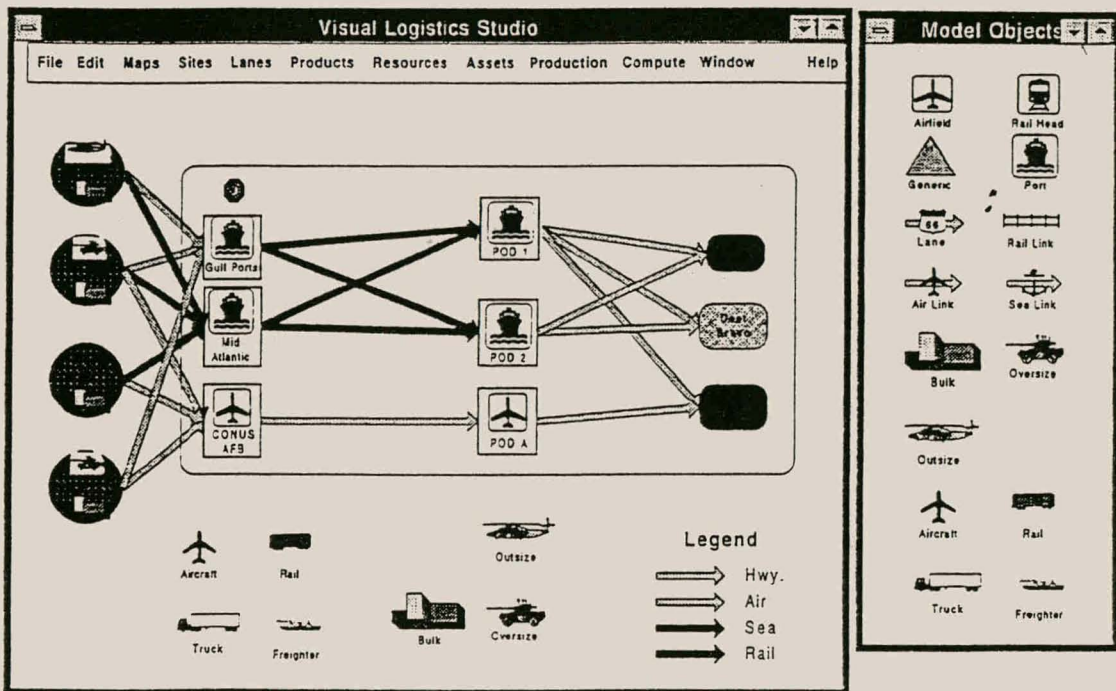
Finally, scenario alternatives to a specific application can be represented as distinct projects. Note each layer of the decision support architecture becomes more focused towards a specific set of logistics issues, culminating in a well-defined problem and set of logistics decisions.

The advantages of the layered architecture approach are many: a custom software solution is possible; systems are developed quickly; platforms and applications can be changed and enhanced; and software quality is high as reusable tools and data objects comprise the foundation. The first commercial logistics decision support system based on a layered architecture supporting *LCM* is the *CAPS LOGISTICS TOOLKIT*^{®7}, introduced in 1989.

Decision Support Architecture (continued)

Visual Logistics Modeling

Contemporary software applications are characterized by highly visual and object-oriented user interfaces, providing a natural conceptual representation of a logistics problem. Data representations are raised to natural and intuitive representations (icons for ports, planes, etc.), and commands are issued through direct manipulation of these visual objects. ■ Figure 42 illustrates this type of user interface.



A visual and object-oriented user interface includes galleries or libraries of logistics objects, strategies, and model templates. The interface manages the various model representations useful in logistics modeling, including map-based geography, time-based scheduling charts, algebra-based mathematical optimization formulations, row-and-column-based spreadsheets, and table-and-record-based database views.

The user can sketch out a conceptual picture of a logistics problem using this type of user interface in a "modeling-by-example" style. Lower-level and more procedural details such as model formulation and generation, data connections, data validation, etc. are handled automatically. Object-oriented approaches in particular are more productive because we can efficiently specify objectives, costs, and constraints for entire classes of logistics elements.

Decision Support Architecture (continued)

Client/Server Computing Architecture

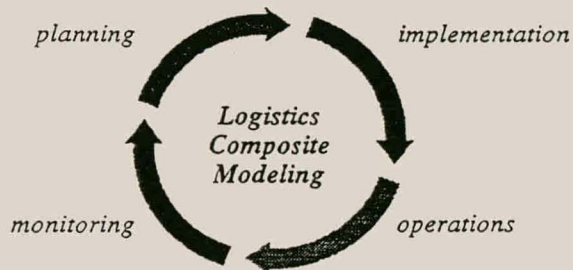
Computing architecture has evolved from mainframe computers, to personal computers, to networks of desktop client computers linked by servers to form a *client/server* architecture. This type of computing architecture is ideally suited to *LCM*. Desktop computers are suitable for highly interactive personal productivity tools such as a logistics decision support system based on visual logistics modeling concepts. Host database servers allow large logistics databases to be shared throughout the various business functions forming an enterprise's logistics supply chain.

Summary

Review

LCM is suitable for logistics business decisions spanning a range from *planning* to *operations*. *Operations* refers to the actual management and execution of a logistics supply chain. Planning includes all of the analysis and design studies undertaken prior to system operation. Planning also includes an understanding of how the logistics system is expected to operate after system implementation and/or modification, although not in as much detail as required during actual operation.

More time is available in planning, so many decision tradeoffs and alternatives can be evaluated and there is greater opportunity for user interaction with models. This is important, because changing a logistics supply chain is complicated, disruptive, time-consuming, and expensive. In contrast, supply chain operations require immediate decisions, so little time is available for generating and testing alternatives. Hence automation is more important here, but pre-planning is still extremely important in order to control and limit the scope of operational decisions. Note planning and analysis activities should continue even after a logistics system becomes operational, in a continuous review and improvement style (■ Figure 43).



Another opportunity to apply *LCM* is in the integration of supply chains across entire enterprises. Similar to the integration of inbound and distribution logistics within an enterprise, enterprise supply chains such as vendor systems, manufacturing systems, and customer systems can be viewed as interacting processes. Further, logistics customers and service providers are increasingly sharing information about future needs and capabilities, allowing service providers time to anticipate and plan for efficient resource utilization, which creates logistics savings that can be passed back to the logistics customer. *LCM* provides a common foundation of logistics objects and analytical processes, allowing closer integration of data and decision support models across enterprises.

Summary (continued)

Notes

- ¹ The United States Council of Logistics Management, Oakbrook, Illinois, defines logistics:
“Logistics is the process of planning, implementing, and controlling the efficient, effective flow and storage of raw materials, in-process inventory, finished goods, services, and related information from point of origin to [point of consumption (including inbound, outbound, internal, and external movements) for the purpose of conforming to customer requirements.”
- ² Fortune, November 28, 1994.
- ³ Via gopher://sunny-state-usa.gov:70/00/budgetfy96/perspectives/bud96p26.txt.
- ⁴ Business Week, January, 1994.
- ⁵ Ibid.
- ⁶ *The GIS World Sourcebook*, published by GIS World Inc., Fort Collins, Colorado, or <http://www.gisworld.com>.
- ⁷ CAPS Logistics, Inc., Atlanta, Georgia, USA, or <http://www.caps.com>.

Suggested Readings

- Ballou, R.H., *Basic Business Logistics* (Englewood Cliffs, N.J.: Prentice-Hall 1987).
- Foley J.D. et. al., *Computer Graphics: Principles and Practice* (Reading, MA: Addison-Wesley, 1990).
- Francis, R.L., L.F. McGinnis and J.A. White, *Facility Layout and Location: 2nd Edition* (Englewood Cliffs, N.J.: Prentice-Hall, 1992).
- Golden, B.L. and A.A. Assad, editors, *Vehicle Routing: Methods and Studies* (Amsterdam, Netherlands: North-Holland, 1988).
- Nemhauser, G.L. and L.A. Wolsey, *Integer and Combinatorial Optimization* (New York: John Wiley & Sons, 1988).
- Ratliff, H.D. and W.G. Nulty, *Introduction to Logistics Modeling*, in preparation.
- Rumbaugh J. et. al., *Object-Oriented Modeling and Design* (Englewood Cliffs, N.J.: Prentice-Hall, 1991).

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This paper is intended for logistics analysts, practitioners, consultants, and other logistics professionals who wish to learn about high-level concepts for logistics modeling and analysis.

26 APPENDIX F: DATA STRUCTURE IN CAPS PLATFORMS

This Appendix contains detailed views of each data element that will be used in CAPS as well as all their attributes that either must or can be incorporated into the model.

The actual modelling and use of CAPS is the final step in a very long process in which the tool is prepared for operations. This involves data collection.

The data needs to be collected in the correct structure, quantity and quality for CAPS to function. The various files that must exist and the field that must be populated are listed in this Appendix. A description of each field is included to illustrate the significance and application of the field.

DATA SPECIFICATIONS

RouteBuilder, Beta 1.5

Tips for Preparing Data

- ◆ Each of the data files listed in the Data File Check List below should be provided.
- ◆ Data should be provided electronically in ASCII file format, spreadsheet format (*.wk1 or *.xls), or database format (*.mbd). If data is provided in ASCII file format, fields should be in fixed columns or be separated by a character that does not appear in any data field (the pipe character “|” is very common). If data is provided in spreadsheet format, each data file should be a separate spreadsheet or a separate sheet within a spreadsheet. If data is provided in database format, each data file should be a separate database or a separate table within a database.
- ◆ The maximum number of digits for fields is listed as (a,b), where a is the total number of digits with a maximum of b digits to the right of the decimal where applicable. Decimals are not required as part of a numeric field. Integers are limited to five digits.

Data File Check List

√	File Name	Data File Type	Required	Description
	SITES	Sites	Yes*	Any stopoff location on the route including where a vehicle begins, makes pickups, makes dropoffs, and ends. Information about the material to move. Information about the vehicles available to transport the material.
	ORDERS	Orders	Yes*	
	VEHICLES	Vehicles	No**	

* In some situations, it is easier to provide one file that combines the site and order information. Providing one file is acceptable. Please include site and order fields in the consolidated file.

** A vehicles file may be generated within RouteBuilder. Therefore, this file may not be required as an input file.

DATA SPECIFICATIONS

RouteBuilder, Beta 1.5

File Name: SITES

Field	Max length	Required	Description	Description
ID	10	Yes	Unique site ID	1234
Name	30	Yes	Site name	CAPS LOGISTICS
Type	10	No	User-defined site type	DC
Dock Type	10	No	User-defined dock type; used for matching vehicles to sites	Long
Address Number*	10	No	Street number; required for street level geocoding	64-2
Street	30	No	Street; required for street level geocoding	Johannes Verhulststraat
City	30	No	City; required for city or street level geocoding	Amsterdam
State / Region / Province	10	No	State/Region/Province; required for city or street level geocoding	NL
ZIP / Postalcode	10	No	ZIP Code or postalcode; required for ZIP/postal code and street level geocoding	
Country	30	No	Country in which site is located	1071NH

*The Address Number can be included in the Street field (Johannes Verhulststraat 64-2 in the Street field).

File Name: ORDERS

Field	Max length	Required	Description	Example
ID	10	Yes	Unique order ID	01229400
Origin site ID	10	Yes	ID of site where pickup occurs, must match an ID in the site file	1234
Destination site ID	10	Yes	ID of site where dropoff occurs, must match an ID in the site file	5678
Quantity 1	10,4	Yes	Order quantity defined in standard units (e.g. weight)	450.00
Quantity 2	10,4	No	Order quantity defined in standard units (e.g. cube)	150.00
Quantity 3	10,4	No	Order quantity defined in standard units (e.g. pallets)	69.83
Type	10	No	The order type may be used to set rules regarding the type of vehicles that may pickup/deliver the order.	DCToCust
Load time	10,4	No	Total variable time in hours to load the order	0.5
Unload time	10,4	No	Total variable time in hours to unload the order	0.5
Current Route ID	10	No	Current route assignment; used to benchmark existing routes	R101
Current Pickup Sequence	5	No	Current pickup sequence; used to benchmark existing routes	1
Current Dropoff Sequence	5	No	Current dropoff sequence; used to benchmark existing routes	2

DATA SPECIFICATIONS

RouteBuilder, Beta 1.5

Additional fields for Time Windows

If you wish to import time windows, all of the following fields must be added to either the sites file or the order file (the sites file must include these 8 fields or the orders file must include these 8 fields).

Field	Max Length	Required	Description	Example
Pickup Open Time*	20	Yes	Time of day the window, for this site or order, opens at the pickup site	8:00am, 8:00, 800
Pickup Close Time*	20	Yes	Time of day the window, for this site or order, closes at the pickup site	1:30pm, 13:30, 1330
Pickup Open Date*	20	Yes	Date the window, for this site or order, opens at the pickup site	5/29/97, 29/05/97
Pickup Close Date*	20	Yes	Date the window, for this site or order, closes at the pickup site	6/1/97, 01/06/97
Dropoff Open Time*	20	Yes	Time of day the window, for this site or order, opens at the dropoff site	9:00am, 9:00, 900
Dropoff Close Time*	20	Yes	Time of day the window, for this site or order, closes at the dropoff site	5:30pm, 17:30, 1730
Dropoff Open Date*	20	Yes	Date the window, for this site or order, opens at the dropoff site	5/29/97, 29/05/97
Dropoff Close Date*	20	Yes	Date the window, for this site or order, closes at the dropoff site	6/1/97, 01/06/97

*The format for all of these fields is flexible and can accommodate formats not shown . However, please be consistent.

DATA SPECIFICATIONS

RouteBuilder, Beta 1.5

File Name: VEHICLES

A vehicles file may either be provided or generated within the system. If the file is provided as input data, the following fields are accepted. Otherwise, please provide the values for the applicable fields listed below based on each type of vehicle. Also include the total number of each type of vehicle available.

Field	Max length	Required	Description	Example
ID	10	Yes	Unique ID of the vehicle. If generating current/existing routes, this ID must match a Current Route ID listed in the Orders file.	R101
Type	10	Yes	Vehicles of unique types may be automatically generated and given the attributes associated with this type.	Dry-48Foot
Fixed cost	10,4	No	Fixed cost per route.	0
Cost per distance	10,4	No	Cost per distance.	1.50
Cost per hour	10,4	No	Cost per hour to operate the vehicle.	0
Cost per stop	10,4	No	Cost per stop.	0
Max distance	10,4	No	The maximum distance the vehicle may run on a single route.	500
Max hours	10,4	No	The maximum number of hours the vehicle may operate on a single route.	10
Max stops	5	No	The maximum number of stops the vehicle may make on a single route.	999
Max orders	5	No	The maximum number of orders the vehicle may pickup/dropoff on a single route.	999
Max loads	5	No	The maximum number of loads the vehicle may have on a single route. How many times may the vehicle reload?	1
Reload site ID	10	No	The ID of the site at which the vehicle may reload. The ID must match an ID in the sites file.	1234
Max quantity1	10,4	Yes	The maximum quantity 1 that the vehicle may carry at any one time on a single route.	40000
Max quantity2	10,4	No*	The maximum quantity 2 that the vehicle may carry at any one time on a single route.	20000
Max quantity3	10,4	No*	The maximum quantity 3 that the vehicle may carry at any one time on a single route.	10000
Single or team drivers	1	No	1 means the vehicle uses team drivers, 0 means the vehicle uses a single driver. 0 is the default.	1, 0
Regular wage per hour	10,4	No	The driver's hourly wage in \$/hour.	0
Overtime wage per hour	10,4	No	The driver's overtime wage in \$/hour.	0
Layover cost per layover	10,4	No	The cost associated with a layover.	50
Labor wage per distance	10,4	No	The driver's wage in term of \$/distance.	1.00
Vehicle start location	10	Yes	ID of the site at which the vehicle starts or the key word "IGNORE" if the vehicle starts at the first stop on the route.	1234, IGNORE
Available date	10	Yes	Date that the vehicle is available to route.	5/29/97
Available time	10	Yes	Time that the vehicle is available to route.	6:00am

* If the Quantity2 and Quantity3 fields are provided for the order data, then the vehicle data must also contain the Max Capacity 2 and Max Capacity 3 fields.

27 APPENDIX G: SUPPLY CHAIN MANAGEMENT PROCESSES

These processes are processes outlining how planning of a supply chain should take place as well as all the elements that should be included in the planning.

Several levels of details are included for each of the three phases:

- Strategic Planning
- Tactical Planning
- Operational Planning

A fourth level exists, Monitoring. However, no detail was included for this activity.

