Supply Chain Management
(A brief introduction)

by

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What is Supply Chain Management?

Supply management is concerned with three core aspects of a company’s operations:

- Material Supply
- Goods Production
- Product Delivery to Customers
A more formal definition is:

“Integrated Supply Chain Management is a process-orientated, integrated approach to procuring, producing and delivery products and services to customers. It has a broad scope that includes sub-suppliers, suppliers, internal operations, trade customers, retail customers, and end users. It covers the management of material, information and funds flows”

Peter Metz “Demystifying Supply Chain Management”
Another description of Supply Chain Management is:

“Effective supply chain management enables you to make informed decisions along the entire supply chain from acquiring raw materials to manufacturing products to distributing finished goods to the customers”.
Supply Chain Management appears at the top of the control hierarchy, as shown on the next slide.
Table 1.1: Typical control heirarchy

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Goal</th>
<th>Time frame</th>
<th>Typical design tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Plant wide optimization</td>
<td>Meeting customer orders and scheduling supply of materials</td>
<td>Everyday (say)</td>
<td>Static optimization</td>
</tr>
<tr>
<td>3</td>
<td>Steady state optimization at unit operational level</td>
<td>Efficient operation of a single unit (e.g. distillation column)</td>
<td>Every hour (say)</td>
<td>Static optimization</td>
</tr>
<tr>
<td>2</td>
<td>Dynamic control at unit operation level</td>
<td>Achieving set-points specified at level 3 and achieving rapid recovery from disturbances</td>
<td>Every minute (say)</td>
<td>Multivariable control, e.g. Model Predictive Control</td>
</tr>
<tr>
<td>1</td>
<td>Dynamic control at single actuator level</td>
<td>Achieving liquid flow rates etc as specified at level 2 by manipulation of available actuators (e.g. valves)</td>
<td>Every second (say)</td>
<td>Single variable control, e.g. PID</td>
</tr>
</tbody>
</table>
A Familiar Household Example

Of course, supply chain management ideas also occur in all walks of life and thus the basic concepts will be very familiar to the reader.

As a trivial example, consider the problem of supplying bread and milk to a household.
There are many options available, for the above task e.g.

- have the items home delivered;
- buy the items at a corner store each day;
- pick them up at a service station when purchasing gasoline for the family car;
- purchase them in bulk every 2 or 3 days from a large supermarket;
- purchase via e-commerce over the internet.
A little thought indicates that, even in this trivial example, there are various competing issues that might be considered:

- reliability of supply;
- freshness of the product;
- cost;
- convenience;
- capacity to combine this task with other functions;
- availability of diversity and variety in the products, etc.
One can readily imagine that if one applies the same kind of thinking to the manufacture of a sophisticated item, e.g. a hi-definition television set, then the issues become considerably more complex but also, potentially more important. Indeed, one can readily understand that making the correct decisions could be of considerable commercial importance and, indeed, could sometimes make the difference between staying in business or losing out to competitors.

Thus Supply Chain Management is a topic of importance.
Costs?

Supply Chain Management is not a trivial matter. The costs of taking this issue seriously can be substantial. Hence, it is important to be able to make the right kind of decisions about the extent to which one embraces this technology.

In this context, these notes are intended as a preliminary guide to aid decision making.
From the literature, we can identify three routes that one might follow to introduce Supply Chain Management into a company. These are:

(1) Via the optimization of the utilization of existing facilities;
(2) Via the use of new technologies - e.g., the internet and e-commerce.
(3) Via a major restructuring;

These are further explained on the next three slides.
1. Optimization of Existing Resources

SCM Software → Optimization of the existing facilities → Little restructuring required
2. Use of new computer and communication technologies

- New computer technologies, Internet
- Electronic and other intermediaries e-commerce
- May lead to the need for restructuring
3. Major Restructuring Route

Inadequate or old infrastructure

New manufacturing technologies such as agile manufacturing postponement, etc.

Major restructuring
The Supply Chain Council

A possible source of information on Supply Chain Management is the Supply Chain Council

Supply Chain Council Inc.
303 Freeport Road
Pittsburgh, PA 15215
Tel: 412 781 4101
http:\\www.supply-chain.org

There are also chapters of the Supply Chain Council in Europe, Australia, Latin America, Japan, etc.
They pictorially represent the issues in Supply Chain Optimization as follows:

These 4 Core Management Processes are further defined as below.
Practitioners select appropriate process categories from the SCOR configuration toolkit to represent their supply-chain configuration(s).

## Level 1 Process Definitions:

SCOR is based on four core management processes.

<table>
<thead>
<tr>
<th>SCOR Process</th>
<th>Definitions</th>
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</thead>
<tbody>
<tr>
<td>Plan</td>
<td>Processes that balance aggregate demand and supply to develop a course of action which best meets the established business rules</td>
</tr>
<tr>
<td>Source</td>
<td>Processes that procure goods and services to meet planned or actual demand</td>
</tr>
<tr>
<td>Make</td>
<td>Processes that transform goods to a finished state to meet planned or actual demand</td>
</tr>
<tr>
<td>Deliver</td>
<td>Processes that provide finished goods and services to meet planned or actual demand, typically including order management, transportation management, and distribution management</td>
</tr>
</tbody>
</table>
At Level 2, Each SCOR Process Can Be Further Described by Process Type

<table>
<thead>
<tr>
<th>SCOR Process Type</th>
<th>Characteristics</th>
</tr>
</thead>
</table>
| Planning          | A process that aligns expected resources to meet expected demand requirements. Planning processes:  
  • Balance aggregated demand and supply  
  • Consider consistent planning horizon  
  • (Generally) occur at regular, periodic intervals  
  • Can contribute to supply-chain response time |
| Execution         | A process triggered by planned or actual demand that changes the state of material goods. Execution processes:  
  • Generally involve -  
    1. Scheduling/sequencing  
    2. Transforming product, and/or  
    3. Moving product to the next process  
  • Can contribute to the order fulfillment cycle time |
| Enable            | A process that prepares, maintains, or manages information or relationships on which planning and execution processes rely |
Many Supply Chain Networks Can be Complex

Multiple Suppliers  Multiple Production Operations within a Business  Multiple Customers
Stages in Development of SCM

❖ Inter-relating Warehousing and Transportation

❖ Shorter order response times via faster warehouse handling and faster transportation lessens the length of forecast period and increases accuracy of forecast. Aided by improved data communications between different levels of warehouse (plant, regional distribution centres, local distribution centre).
Logistics Stage

- addition of manufacturing, procurement and order management functions. Aided by electronic data interchange, worldwide communications, and use of computers to store, retrieve and analyze data.
Integrated Supply Chain Management

- Add supplier and end customers. Utilizes electronic data, electronic funds transfer, computerized decision support systems.

*Key driver*: Explosive development of computer and communications technology.
Success Stories

Some claims made for the success of Supply Chain Management Principles are given below:

❖ Inventory reduced by 50 percent
❖ Supply chain total cost share of revenue reduced 20 percent
❖ 40 percent increase in on-time deliveries.
❖ Cumulative cycle time reduced by 27 percent
❖ Revenues increased 17 percent
❖ Inventory turns up 2x while out-of-stock incidents down 9x.
❖ 50 percent reduction in finished-good inventory by postponing package
Key Factors Associated with Claimed Successes

Five key factors enabling these accomplishments:

- *An overriding, pervasive customer focus.* At every stage in the supply chain, the ultimate customer’s needs are understood and factored into the decision making.

- *Advanced use of IT.* Data and information flow readily to all parts of the supply chain. Computer-aided decision-support systems use this complex information to enable better, faster decisions that then are quickly communicated throughout the supply chain.
Quantitatively based performance management. Measurements of multiple performance factors occur frequently at each stage in the supply chain. Time and cost are key measures, but others are used as appropriate to the specific supply chain. All measures relate to the ultimate supply chain goals.

Use of cross-functional teams. Teams of people from the interrelated functional operations working closely together can cut through the normal organizational barriers to find local and distributed improvements that benefit the overall supply chain performance.
Attention to human factors and organization dynamics. Use of the best human and organization coordination/cooperation/measurement/reward techniques facilitates supply chain innovation and implementation. This level of attention is needed to offset the tendency of individual accountability and work-unit accountability to create barriers to supply chain cooperation.
Static or Dynamic Supply Chain Management?

Supply Chain Management can be static or dynamic:

- **Static** - i.e. based on a steady state understanding of demand, costs, location, etc., or

- **Dynamic** - supply chain reconfiguration to adapt to changing conditions, e.g., fluctuations in cost of raw materials, customer demands, international exchange rates, etc.
Supply Chain Management Software

A report written in 1998 (Eric Allen, University of Texas at Austin) predicts that the demand for SCM software will have reached $3 billion by 2000!

SCM software is aimed at:

- reducing distribution costs;
- maximizing order deliveries;
- maintaining inventory balances;
- maintaining customer and supplier satisfaction.
Suppliers of SCM software include (based on 1998 data):

❖ **I2** - (Founded in 1988, now with 6,000 employees, sales of $183M in 1997).

❖ **Manugistics** - (Founded in 1969 originally called Scientific Time Sharing Corporation, sales level of $94M in 1997).

❖ **SAP** - *(Founded Germany 1972 by 4 former IBM employees).*

❖ **People Soft** - *(Founded 1987).*

❖ **Oracle** - *(Founded 1977, originally named Software Development Laboratories by Larry Ellison. They intended to create the world’s first relational database software).*
Note that the price to implement a full SCM solution can be large (up to a million dollars). However, lower cost solutions are, of course, also available. However, clearly this is not an area that one takes lightly.
An Example of SCM Software

This data was copied from the Mercia web site at:

http://www.mercia.com/products.html
**Supplementary Technical Material**

**Module #1**

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**MerciaLincs**

"Demand planning provides the competitive edge that ERP and transaction tools alone cannot deliver."

Why Demand Planning?
The globalization of business, high customer expectations, and increasing competitive pressure has driven companies to focus on implementing best practice Demand Planning strategies.

These strategies deliver customer service advantage, whilst simultaneously optimizing costs and efficiencies throughout the supply chain.

Demand Planning provides the competitive edge that ERP and transaction systems by themselves cannot deliver.

MerciaLincs allows companies to combine the latest technology with state-of-the-art Demand Planning techniques, which facilitate the implementation of best of breed solutions.

"Ease of integration with ERP systems provides customers with the optimum, no compromise solution."

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**MerciaLincs**

"Our focus is on using MerciaLincs to solve business problems and to deliver rapid return on investment."

MerciaLincs delivers customer service advantages, whilst optimizing costs and efficiencies throughout the supply chain.

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**MerciaLincs**

Inter-enterprise Demand Planning
Inter-enterprise demand planning integrates systems, information processes and people, facilitating the communication of key supply chain data between suppliers, customers, distributors and affiliates across corporate and geographical boundaries.

Why choose MerciaLincs?
- To front-end an implementation of ERP, distribution, manufacturing and transaction processing systems.
- To implement local, regional or global Demand Planning processes.
- To install a scalable planning solution that supports both the improvement of core local forecasting and ERP practices as well as complex, multi-site, multi-country applications.
- To provide an "Open Systems" approach that allows information to flow across the whole supply chain based on a single projection of demand.
- To facilitate ERP driven vendor managed inventory strategies for Continuous Replenishment and Efficient Consumer Response.

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Integrating commercial and operational Supply Chain Planning information to create "one number" process.

Ease of integration
MerciaLincs is designed to be used in conjunction with other business, ERP and advanced planning systems as well as "home grown" applications. To date MerciaLincs has been interfaced with over 40 such systems.
Next we focus on a particular industry (the *Steel industry*) and examine possible SCM issues.
Supply Chain Management in the Steel Industry

We turn to Supply Chain Management issues in the steel industry. In particular, we examine the possible impact of electronic commerce. The next few slides are based on the report:

“Electronic Intermediaries in the Steel Industry”
by S. Ceccotti and D. Satyavolu, Kogod School of Business, American University, Washington, DC, October 1999.
Some Fact about the Steel Industry

- $50B annually;
- 750 million tons worldwide each year;
- Largest steel production countries:
  - China
  - Japan
  - USA
  - Russia
  - Germany
  - Korea

- About 100 million tons each
- About 50 million tons each
Steel use is linked to the economy of a country:

- 20 Kgs/year/person in Africa
- 340 Kgs/year/person in Europe
- 420 Kgs/year/person in USA
- 635 Kgs/year/person in Japan
- 870 Kgs/year/person in Korea
- 970 Kgs/year/person in Taiwan
- 1,200 Kgs/year/person in Singapore
❖ Approximately 350 million tons of steel scrap are recycled annually.

❖ Steel production has risen 30% in the past 25 years, but worldwide employment in this area has fallen from 2.5 million to 1.3 million.
Typical Value Chain in the Steel Industry

Current Supply Chain Conditions

- High inventory levels
- Poor cycle times
- Inconsistent information
- Limited standards
- Significant cost redundancies
“The steel industry is global in nature. The presence of many players on the global scale, makes business co-ordination difficult. Most of the time, steel producers and consumers depend on intermediaries to help buy and sell material”
Service Centres

“Service centres are the intermediaries between steel producers and funded product producers. They distribute steel in the quantities, form and time that customers require”
The amount of value added by the service centre in the supply chain depends upon the job done. The following are estimates of typical value-added amounts.

<table>
<thead>
<tr>
<th>Service</th>
<th>$ per ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage and shipment</td>
<td>5 - 15</td>
</tr>
<tr>
<td>Slitting</td>
<td>15 - 45</td>
</tr>
<tr>
<td>Cold rolling</td>
<td>150 - 275</td>
</tr>
<tr>
<td>Cutting to length</td>
<td>15 - 45</td>
</tr>
<tr>
<td>Edge rolling</td>
<td>2 - 8</td>
</tr>
<tr>
<td>Plate cutting</td>
<td>15 - 35</td>
</tr>
<tr>
<td>Pickling</td>
<td>14 - 45</td>
</tr>
<tr>
<td>Annealing</td>
<td>20 - 85</td>
</tr>
<tr>
<td>Blanking</td>
<td>85 - 175</td>
</tr>
<tr>
<td>Stamping</td>
<td>75 - 150</td>
</tr>
<tr>
<td>Tempering</td>
<td>35 - 120</td>
</tr>
<tr>
<td>Galvanizing</td>
<td>100 - 125</td>
</tr>
</tbody>
</table>
The Use of Electronic Intermediaries

Electronic intermediaries can play a new role in the value chain at all points.

Current e-commerce sites for metal products include:

- **Metal Site**
  *(Source, buy, sell metal products)*

- **e-steel**
  *(Marketplace for exchange of steel on the internet)*
The future?

It is conceivable that, in the future, electronic intermediaries will provide a one-stop-shop that meets all the needs of buyers and sellers. The electronic intermediary will need to interface with other partners such as international banks, shippers, freight forwarders and governments to provide real-time information about transactions.
Production Planning and Scheduling (PPS) Systems

If we specialize SCM to a particular plant, then the term “Production Planning and Scheduling” might be more appropriately applied.

For example, in a steel plant, every production unit (Steel Making, Casters, Hot-strip Mill and Finishing Lines) will typically have its own scheduling considerations.
Typical Scheduling Functions in a Steel Plant

❖ *Material Planner* - decides which in-process inventory will be allocated to which sales orders. It also can generate the net requirement for production. The allocation strategy can be based on a defined product structure or by matching material specifications.

❖ *Production Planner* - creates a detailed, finite capacity plan over a medium to long term horizon. It can use a detailed resource hierarchy including production centre capacities, crewing schedules, planned downtime, alternative production centres, recoveries, process and inter-operation times. It will typically task date all production operations based on available capacity, campaigns and batching requirements.
❖ **Production Scheduler** - uses a simulation to create line-ups over a short term horizon. It will consider set-ups, physical machine limitations and quality constraints. The aim is to produce a detailed, synchronised schedule for all machines that is geared to the performance of the plant as a whole rather than each individual production centre.

❖ **Order Negotiator** - allows the impact of new business on the capacity of the plant to be assessed prior to making a commitment to the customer. The aim is to generate more realistic, achievable promise dates which in turn improve delivery performance.
- **Melt Shop Manager** - provides detailed planning and scheduling capability from steel making through secondary metallurgy, continuous casting to hot rolling. It should balance the competing demands of productivity, costs, delivery performance, slab stocks and hot charging against the technical constraints of the process.
An important aspect is that of coordination of scheduling operations across several production lines via a Master Production Plan. In principle, one can have a fully-integrated finite capacity planning and scheduling system for the entire supply chain. In a steel plant, this would cover the casting, rolling and finished product including dispatch.
Under a Master Production Plan, local schedulers can negotiate material availability constraints, and flow constraints through a flow coordinator. Thus local scheduling decisions can be influenced by scheduling decisions on other lines.

The aim is to converge to a *global* scheduling optimum rather than local scheduling optima for the local lines.
All of these problems require various optimization problems to be solved.

These optimization problems involve many thousands of variables and are typically *hard* problems; i.e. the solution is essentially intractable save for toy problems.

For this reason, a combination of optimization and heuristic schemes will typically be utilized in commercial systems.
Tools include:

- **Mathematical Optimization** - based on some variant of linear programming.
- **Expert Systems** - aimed at capturing human knowledge and experience
- **Search Algorithms** - including
  - branch and bound
  - tabu search
  - constraint based propagation
- **Genetic Algorithms** - where one attempts to improve on a solution by applying a technique which genetically mutates the solution in the hope of improving it.
Planning Horizons

- **Medium Term Planning** - covers a typical 2-3 weeks period, providing detailed slab-by-slab plan showing individual heats and casting sequence.

- **Short-term scheduling** - covers a period of 1 or 2 days. This produces casting and hot rolling sequences, which recognize the technological production constraints and follow specific user defined stabilizers.

- A third level can schedule the movement of ladles through the steel plant from steel making to casting - for up to 8 hours.
The key functions of a typical meltshop scheduling system are as follows:

- To provide user-controlled planning strategies (e.g., productivity, delivery performance, width change);
- The capability for multiple strand and multiple caster operation;
- The recognition of width and grade change rules (e.g., variable width casting), and of hot-rolling scheduling rules (e.g. ‘coffin’ pattern, quality constraints, gauge changes);
The grouping of orders/slabs of same grade, and the automatic creation of stock slabs (e.g., to complete heats, and for width or grade changes);

A capability for mixed hot and cold charge operation;

The ability to react to short-term deviations from the schedule.
A commercially available suite of programs for Production Planning and Scheduling is described on the following slides taken from brochures supplied by Broner Systems.
Supplementary Technical Material
Module #1

PRODUCT PLANNING AND SCHEDULING IN THE METALS INDUSTRY

PLANT-WIDE PLANNING AND SCHEDULING – WHO NEEDS IT?

In today's competitive market place, metal producers need to satisfy ever-stingent customer demands:
- shorter lead times
- on-time delivery

To assure customer satisfaction while maintaining a viable business, producers need to exercise strict plant control to improve production performance and customer service with minimum production costs.

To achieve such control, many metal and wood plants are recognizing the need for a fully integrated order intake and planning and scheduling control system.

THE BRONER SOLUTION

APPLICATIONS

Although production problems are similar across many industries, Broner Systems recognizes that general solutions are not adequate for the specific requirements of the metals industry. Broner Systems has developed the industry, specifically for the industry, a specialized Production Planning and Scheduling (PPS) System, supported by an experienced team of industry experts.

APPLICATION APPROACH

A dedicated team of highly qualified consultants and software engineers work closely with the customer throughout each project to provide a comprehensive planning and scheduling solution, services range, as required, from requirements analysis to final commissioning.

APPLICATION BENEFITS

Due to the specific fit of the PPS Software to the requirements of the metals industry, the expertise of the Broner Systems team, and benefits can be achieved in projects as short as 6 months.

APPLICATION FEATURES

Projects are flexible to meet the varying objectives, budget and timelines of each customer. From short, line-by-line installations of individual modules to full-scale implementations and customizations of a complete system.

FEATURES OF THE BRONER PPS SYSTEM

- Finite Capacity Planning
- Synchronized Scheduling
- Specification Based Material Allocation
- Pieces Individually Planned and Scheduled
- Detailed Planning and Scheduling Reports
- Build/Backfill Management
- Production Forecasting
- Method/Process
- Automatic Routing
- Variable Loading
- Resilience
- Order Filling Quota

THE BRONER PPS SYSTEM – AN INTEGRATED PHILOSOPHY

Based on years of extensive experience in the industry, Broner Systems believes that effective production control requires an integrated layered approach.

PROVEN TRACK RECORD

Broner Systems has over 10 years experience implementing production control systems in the metal industry worldwide. Within 12 months following PPS implementation, one customer has:
- cut inventory by 30%
- reduced lead times by 30%
- increased on-time delivery to a sustained level of over 95%

During the first 12 months following implementation another customer has:
- cut inventory by 30%
- increased delivery performance by 30%

SUPPORT SERVICES

Consultancy: Broner Systems offers training and expertise in the techniques and methods of production planning and control.

Project Management: Broner Systems has the proven ability to deliver complex solutions on time and within budget.

Education: A full program of service training is scheduled for each project, as required. In addition to on-site training, programs are available to introduce management to the concepts and philosophies of advanced capacity planning and scheduling.

Support and Maintenance: With offices in the UK and USA, Broner Systems is able to offer a comprehensive support and maintenance service worldwide.

THE COMPLETE SOLUTION

Designed as a fully integrated package, the individual, sub-system PPS modules are also integrated with existing customer systems.
Supply Chain Management in Practice?

At the time of writing the notes there was a major announcement in the writer’s hometown (Newcastle, Australia) about a possible new steel making project.

This is still rather speculative. However, it is interesting to reflect on the announcement in the light of Supply Chain Management issues.
The Newcastle Herald: Thursday February 15, 2001

Steel comes home

NEWCASTLE is set to become the manufacturing home for a $1.2 billion plus fully integrated iron and steel project, re-establishing its steel industry credentials.

Premier Bob Carr pledged NSW Government support yesterday to the Australian steel producer, Lend Lease, to ensure local production of finished steel products can proceed.

The project will be a $2.2 billion investment, creating 13,500 permanent jobs and about 5000 construction jobs, with steel production expected to start in 2004-2005.

Mr Carr said: "The NSW Government is committed to ensuring that steel production remains an important part of the state's economy."

The project involves the construction of a new steelworks at Port Kembla, with the production of finished steel products expected to commence in 2004.

The project has been developed by Lend Lease, in association with the NSW Government, and is expected to create 13,500 permanent jobs and 5000 construction jobs.

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Clearly, in a potential project such as this there are many SCM issues:

Some of the issues announced were:

- Newcastle was selected for the steel mill because of its port facilities, skilled workforce, access to cheap electricity;
- New wharf facilities need to be built and collaboration with State Government is needed.
❖ The Newcastle electric arc furnace is planned to produce:
  - hot rolled coil
  - hot dipped galvanized
  - cold-rolled coil
  - pickle and oil hot rolled coil
  - thick slab

❖ Raw Material is planned to be drawn from the Pilbara region in Western Australia, the project will involve the construction of an open pit iron ore mine and on-site processing of the ore to produce high grade magnetic concentrate.
❖ Other WA features include

- *Pellet production of 6.8 million tonne/annum using a travelling grate pellet plant*
- *Infrastructure including gas-fired power station, desalination plant, loading facilities needed for shipment to Newcastle.*

❖ A 15 year, $30 billion contract agreement has apparently already been signed to supply steel to MacSteel International Holdings, which will market it worldwide to 70 countries.
❖ It will be interesting to see if this project eventuates.

❖ It is claimed that the new mill will compete for export markets against BHP’s Port Kembla works, but the consortium says it will be able to produce at lower costs by integrating its operations (i.e., SCM).

❖ Time will tell ...