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# Supply Chain Management (SCM), the Wheel and the Manufacturing Engineer

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Author



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April 2002

Dear CASA/SME Member,

The Computer and Automated Systems Association of the Society of Manufacturing Engineers (CASA/SME) is pleased to provide you with the second Blue Book of 2002, entitled **Supply Chain Management (SCM), the Wheel and the Manufacturing Engineer.**

James B. Ayers, the author and principal with CGR Management Consultants, uses his in-depth knowledge and experience to describe how the disciplines of supply chain management impact the manufacturing engineer.

The Blue Book explains the relationship between the CASA/SME Manufacturing Enterprise Wheel, which most of you are so familiar with, and SCM thinking. It does an excellent job of describing the necessary role changes of the manufacturing engineer due to the trend toward SCM thinking and how they can work within the framework of the Wheel to impact their company's performance.

I want to remind you to visit the CASA/SME website, which continues to be enhanced. If you have not visited *www.sme.org/casa* recently, I recommend that you do so. I have found the site's new layout much more friendly and resourceful. I continue to use it more often for information related to computer automation and manufacturing.

One resource that can benefit you and your industry colleagues is SME's Jobs Database found under the Member Services section of SME's website, *www.sme.org*. Given the nature of our economy today, several of your industry colleagues have resumes in the database and would appreciate your consideration for employment as well as you posting any employment opportunities.

Finally, I want to invite you to get more involved with CASA/SME this year. There are many opportunities available that will benefit both you and the association. Please contact the CASA/SME Association Manager, James Adams, at (313) 271-1500, ext. 1832, or *adamjam@sme.org*, for more information.

Sincerely,

Douglas Genord
Technical Fellow
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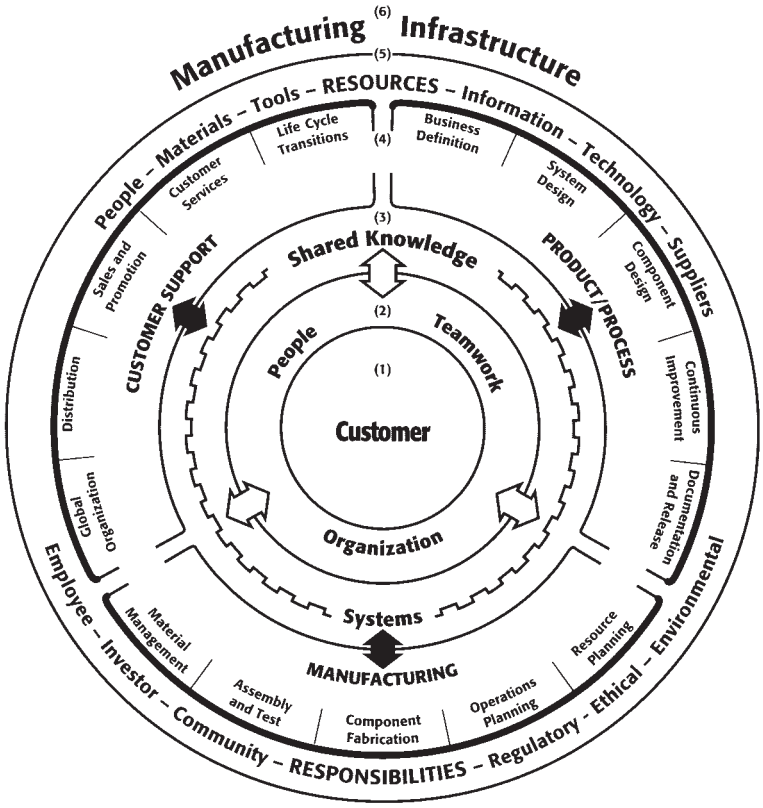
## CASA/SME MANUFACTURING ENTERPRISE WHEEL




## CASA/SME

The Computer and Automated Systems Association of the Society of Manufacturing Engineers (CASA/SME) was founded in 1975 to provide comprehensive and integrated coverage of the field of computers and automation for the advancement of manufacturing.

As an educational and scientific association, CASA/SME has become "home" for engineers, managers and other professionals involved in computer-based technologies and automated systems. CASA/SME is applications oriented and addresses all phases of research, design, installation, operation and maintenance of the total manufacturing enterprise. This book is one example of its wide-ranging activities.

Specific CASA/SME goals are: to provide professionals with a focus for the many aspects of manufacturing that utilize computer systems automation; to provide liaison among industry, government and education in identifying areas of further technology development; and to encourage the development of the totally integrated manufacturing enterprise.■

## ABOUT THE AUTHOR

James B. Ayers is a principal with CGR Management Consultants (Los Angeles). He has consulted for 30 years on strategy, operations improvement and new product development. He has held client management positions with consulting firms Theodore Barry & Associates, Ingersoll Engineers (now the Bourton Group), and Coopers & Lybrand, and is a senior member of the Society of Manufacturing Engineers and a member of the Council of Logistics Management. CGR is active with the Supply-Chain Council in the development of its Supply-Chain Operations

Reference (SCOR) model for supply chain operations. Mr. Ayers is a certified management consultant (CMC) by the Institute of Management Consultants.

He has written the *Handbook of Supply Chain Management* [1], *Improving Competitive Position: A Project Management Approach* [2], and *Making Supply Chain Management Work: Design, Implementation, Partnerships, Technology, Profits* [3]. He was also a contributor to *Making Manufacturing Cells Work* [4].

Mr. Ayers holds a BS with distinction from the US Naval Academy. In the Navy, he served in nuclear submarines. He also has an MBA and MS in industrial engineering from Stanford University (Stanford, CA).

He can be contacted at (310) 822-6720 or via e-mail at *jimayers@cgrmc.com*. For more information on CGR Management Consultants and its services, visit *www.ayers-consulting.com*.■

# *Supply Chain Management (SCM), the Wheel and the Manufacturing Engineer*

## INTRODUCTION

This Blue Book describes how the disciplines of supply chain management (SCM) will affect the everyday life of the manufacturing engineer. It expands on themes already evident in recent CASE/SME Blue Books. These include the following:

- Manufacturers no longer conducting business in isolation. Suppliers, partners and customers are part of the customer-serving "manufacturing infrastructure." Over-focus on one's own company, department or shop will not cut it anymore.
- The CASA/SME Manufacturing Enterprise Wheel continues to be an excellent model for the manufacturing enterprise "infrastructure." However, SCM brings new insights into relationships among the different levels of the Wheel.
- Effective SCM should produce a competitive advantage for your company through better manufacturing infrastructure. Strategists now give increased credit to the role of operation design in providing distinctive, unique competencies. To paraphrase, "Competitive advantage does not come as much from the products produced, but the processes that produce them."

All three themes highlight the growing importance of manufacturing engineers in designing and executing enterprise strategies that bring products to market. One of the CASA/SME's missions is "to provide professionals with a focus for the many aspects of manufacturing that utilize computer systems automation." What follows are pointers to satisfy that mission. This Blue Book argues that due to supply chain dynamics, systems integration is a journey not a destination.

## RELATED BLUE BOOK CONTRIBUTIONS

Michel and Jordan described next generation manufacturing in their Blue Book, "Next Generation Manufacturing (NGM)" [5]. They pointed out six NGM attributes. Five of the six deal with "responsiveness" in several flavors. Primary attributes are responsiveness to customers and global markets. To achieve flexibility in these areas, the culture and practices must also be responsive. To make this happen, people and physical assets in the NGM must be flexible.

The sixth NGM attribute is "teaming as a core competency." This includes teaming both inside—with other functions—and outside the company—with suppliers and customers. Flexibility and effective teaming are also integral to SCM.

More recently, the CASA/SME Board of Advisors detailed the impact on the Wheel of the "virtual enterprise" in their Blue Book, "Virtual Enterprise Integration: Creating a Sustainable Manufacturing Life Cycle" [6]. The authors point out that people will be as important as technology. They assert that the CASA/SME needs to "reinvent the Wheel" to keep pace with change. Integration of the virtual enterprise requires an easy flow of information among partners through systems for shared knowledge.

These Blue Books acknowledge the displacement of narrow, company-centric thinking with broader, supply chain thinking. Terms like virtual enterprise, NGM, supply chain and the Wheel's infrastructure support this idea. This Blue Book looks further at how the trend will change the roles of individual engineers and the paradigms inherent in the Wheel. Critical questions include:

- "How will my job change?"
- "What do I need to do differently?"
- "Is my company doing all it can to stay competitive?"
- "How can I lead change in my company?"

The goal of this Blue Book is to describe the interaction of the Wheel with supply chain thinking and how the engineer working within the Wheel framework can really make an impact on his or her company.

## OLD TASKS—NEW WAYS OF PERFORMING

In this author's opinion, supply chain management brings changes to five tasks for managing the manufacturing enterprise. *Figure 1* shows the five tasks. Task 1, in the middle, plans the strategy; tasks 2-5 make it happen. The CASA/SME Manufacturing Enterprise Wheel closely parallels the way a supply chain should be built—starting with customer requirements at level 1 and then constructing infrastructure layers to meet those requirements all the way out to level 6 *(Table 1).*

*Figure 1* makes an important point that often escapes senior executives. Supply chain design and the resulting manufacturing enterprise infrastructure are fundamental to strategic advantage. Unfortunately, most infrastructures and supply chains grow over time without the benefit of a "clean sheet" design. Manufacturing engineers spend their time maintaining that infrastructure making, at best, "tweaks" that produce only incremental improvement.

| | SCM Task | Wheel Components |
|---|---|---|
| 1 | Design supply chains for strategic advantage | Translates needs of the customer (level 1) into a design for a manufacturing infrastructure (levels 2-6). |
| 2 | Implement collaborative relationships | Primarily a level 2 and 3 task, focusing on internal cooperation among functions. |
| 3 | Forge supply chain partnerships | Focuses on external collaboration—customers, suppliers and partners. Permeates the Wheel because interactions are at all levels. |
| 4 | Manage supply chain information | Supports levels 3 for shared knowledge and level 5 enabling technology requirements. |
| 5 | Remove cost from the supply chain | Level 4 captures the costs of the supply chain and the importance of cost reduction. |

*Table 1. Five SCM tasks and the CASA/SME Manufacturing Enterprise Wheel.*

**A customer-centric mission provides a clear direction to align activities and empowers the work of teams in the new manufacturing enterprise. [7]**

Capable manufacturing engineers should play increasing roles not just in operations and maintenance (level 4) but also in strategy design and execution (levels 1-6). The Wheel will be used as a framework, noting new ways to think about and use each of the six levels.

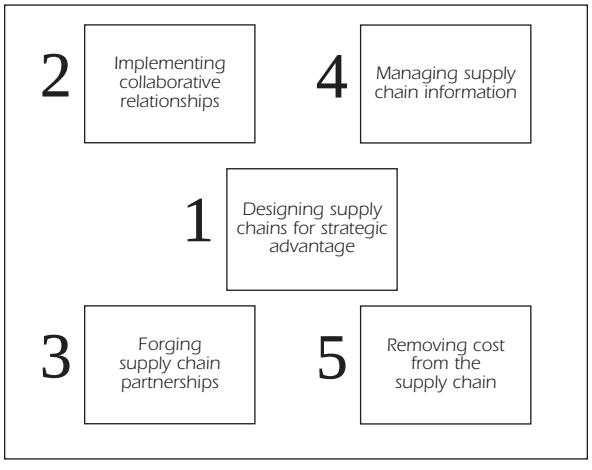



*Figure 1. Five tasks changed by SCM.*

## LEVEL 1. "CUSTOMER"—EASIER SAID THAN KNOWN

The "customer" is at the center of the Wheel because all Wheel activities must add value to the customer. The logical and correct conclusion is that, if one does not read their customers' requirements well, the whole infrastructure is likely to be uncompetitive. When designing supply chain infrastructure, it is necessary to understand what is going on with customers.

The Wheel description makes that job look deceptively easy. In fact, market shifts, technology and product dynamics make the job of reading customer requirements exceedingly difficult. There are many complications in trying to discover "clear direction" for "knowing" the customer, and the manufacturing engineer needs to be wary. The sections

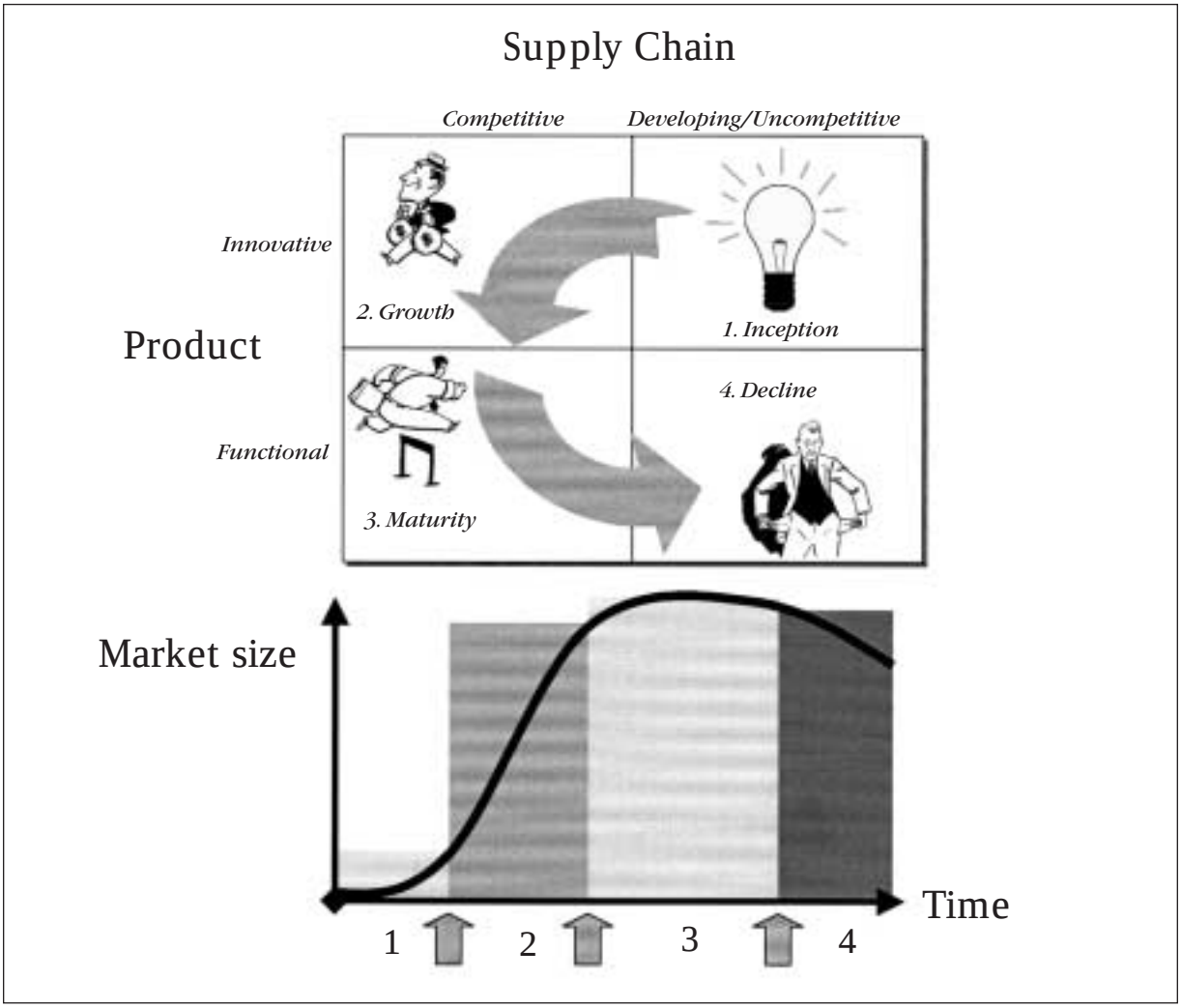



*Figure 2. Product life cycle and the supply chain.*

that follow provide guides to interpreting customer requirements.

## PRODUCT LIFE CYCLE

*Figure 2* helps illustrate the interaction of the supply chain infrastructure, products and the customer. The figure shows the product "life cycle," which is a model long used by marketers to understand product positions. An understanding of *Figure 2* is indispensable for insights into what customers want. The reason is that the four life cycle stages have different customer requirements necessitating different types of supply chain and accompanying manufacturing infrastructure. The following paragraphs describe the environment in each of the four stages.

1. In stage 1, products are just beginning to be sold. Sales are quite low and uncertain. There is little in the way of supply chain infrastructure; what is made is made in small batches. The product type is "innovative," a descriptive term originated by Marshall Fisher [8].
2. Stage 2 is high growth. Profits are plentiful, customers cannot get enough of the product and margins are high. The product is still considered innovative. As the supply chain takes shape, product availability is its main mission. Missing product cuts into profits, so it is acceptable to carry "just-in-case" inventory and have excess capacity.
3. Sales stop growing in stage 3 as competition stiffens. Most of us work for companies that

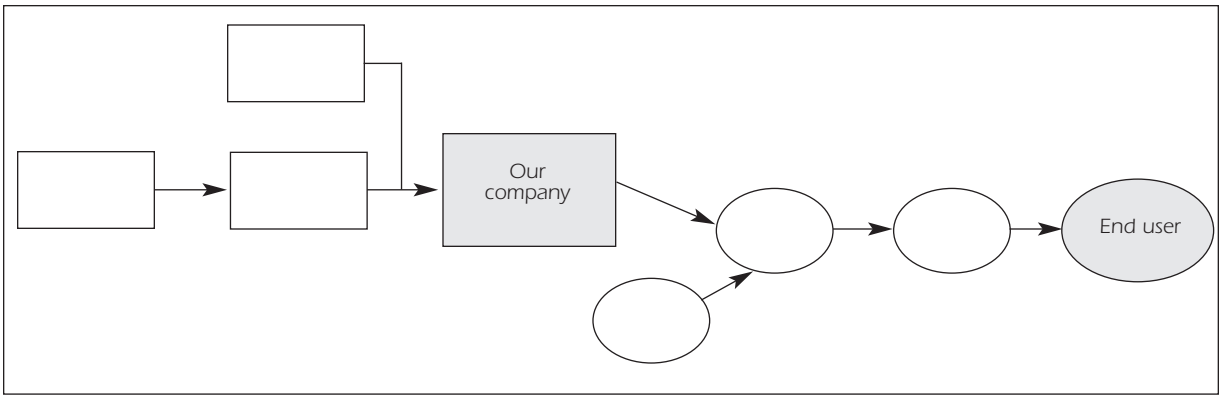



*Figure 3. The end-to-end supply chain.*

sell stage 3 products. In Fisher's terminology, the product is now "functional." Cost matters as much as delivery, and supply chains must be cost-effective. Competitors that cannot reduce costs drop out.

4. In Stage 4, the market declines. Only those able to eke out a small profit remain.

The product life cycle says that what the "customer" wants is a moving target, complicating the job of building a competitive supply chain and related infrastructure. As we proceed, the effects of the product life cycle on supply chain and infrastructure building will be referred to.

## VIEWPOINT: WHAT IS A SUPPLY CHAIN?

Terms like "infrastructure" and "virtual enterprise" have different meanings to different people. For many executives, the term "supply chain" calls to mind their own incoming materials from their suppliers. A more comprehensive view, illustrated in *Figure 3*, is that the "supply chain" starts with the end user. "Our Company," a sub-tier supplier, in *Figure 3*, is far back in the chain but may be vital to the product. The end user views all these contributors, including "Our Company" and "Its Partners" as the supply chain.

With the onset of supply chain thinking, a manufacturing engineer in "Our Company" must consider his or her customer's customer and his or her supplier's supplier. The challenges for stage 1 life cycle products are quite different than those for stage 3 products. In stage 1, the race is on to line up qualified suppliers or to develop new processes for competitive manufacture. In stage 2, the company is constrained by demand and must work hard to keep up. At stage 3, the engineer squeezes out costs to keep the product competitive. These varied missions require different skill sets.

So when we use the term "infrastructure" with regard to level 6 of the Wheel, a supply chain view would consider the end-to-end supply chain shown in *Figure 3*. This is implied in the Wheel but is seldom put into practice. It is likely that many limit their view of "infrastructure" to their assigned duties—a natural response.

Because they are immersed in day-to-day problems, few engineers think like this. Perhaps the engineer supports a particular shop. In fact, the shop is part of the supply chain and must be considered so. "Manufacturing enterprise" in the context of the Wheel should be thought of as the company and the supply chains of which it is a part. Engineers should look up at least occasionally and take the supply chain view.

## VIEWPOINT: WHAT IS A CUSTOMER?

As was discussed above, the "customer" is not monolithic. Unless the business is very simple, "customer" is likely to have multiple meanings. *Figure 4* illustrates this view. On top, it shows the "customer" as a single circle, as depicted in the Wheel. The reality is that the customer circle fragments into segments, shown by the smaller circles in *Figure 4*.

Customer segmentation is a marketing tool for analyzing distinct requirements and

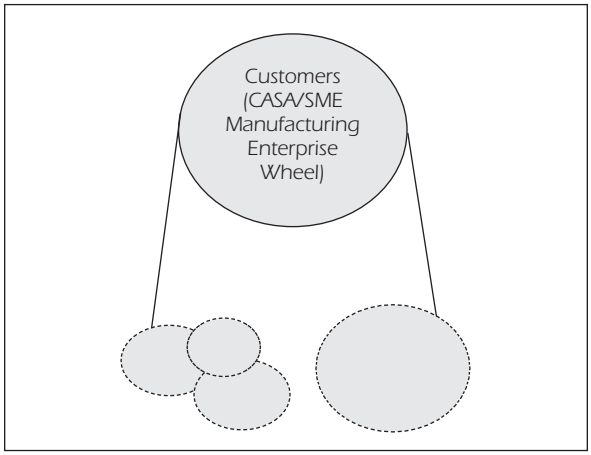



*Figure 4. Market segments.*

setting strategies. Supply chain thinking calls for building product supply chains that cater to attractive segments. So it should be with manufacturing infrastructure.

The Wheel oversimplifies by implying all customers speak with a common voice. This can lead the engineer to design an infrastructure good for one segment but lousy for others. In fact, the "essence" of strategy is making conscious choices about designing infrastructures for competing. If one's current infrastructure does not fit the needs of some segments, then one has three choices:

1. Dropping those segments in which the company cannot compete.
2. Losing market share over time to competitors catering to attractive segments.
3. Developing another infrastructure alongside the existing one.

Referring to *Figure 3*, one segment may value service, while another buys on price. The company may have to choose between the two. This will affect choices of equipment, deals with suppliers and distributors, and inventory along the supply chain. Manufacturing engineers should point out the differences and choices required. How many actually do?

## VIEWPOINT: WHAT IS A PRODUCT?

Products are the reason customers buy from you. The Wheel, however, is very quiet on the dynamics of products as determinants of enterprise infrastructure. But all products are not created equal, and the differences complicate infrastructure design. A manufacturing enterprise with a large product portfolio will likely have a mix of products at various stages of their life cycles, as shown in *Figure 2*. Some will be new, undergoing frequent design change, growing in terms of sales and high-margin contributors to profit. Older products may have stable designs, no growth and declining profitability.

A practical example involves a machine tool purchase. Often engineers use cost reduction to justify such purchases. However, flexibility could be a more valuable benefit if the tool is to make a stage 2 product. The tool may make the product cost more, but the added profit more than makes up for it.

## SOLUTION: DIVIDE AND CONQUER

A solution to these issues is a tactic for using "spheres" when designing the manufacturing enterprise. A sphere has product-market-operations dimensions and gets its name by virtue of the fact that it has three dimensions. *Figure 5* depicts the sphere concept. *Table 2* provides examples of ways an engineer can carve spheres out of a complex enterprise.

A couple of examples help explain the concept. An automotive company might create a sphere with these components:

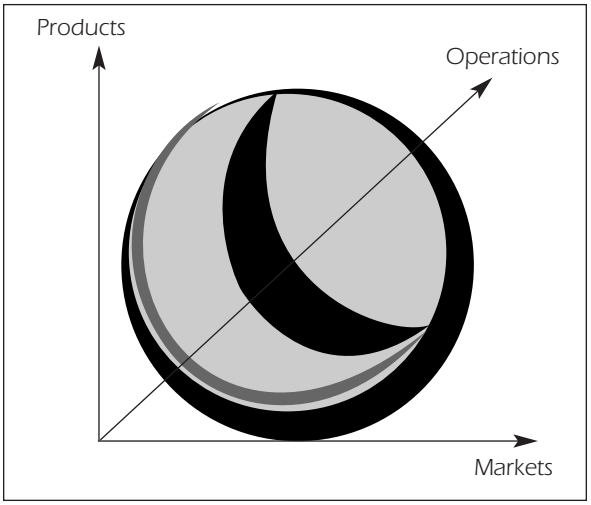



*Figure 5. Conceptual depiction of spheres.*

| Dimension | Basis for sphere | Examples |
|---|---|---|
| Markets | End-user segments<br>Regions where products are sold<br>Expectations for service, delivery | OEM/Aftermarket<br>US/Europe/Asia<br>Immediate/Delayed delivery |
| Products | Innovative/Functional<br>Manufacturing processes employed<br>Materials used | SUV/Sedans<br>Batches/Assembly line<br>Metal/Composite |
| Operations | Production facilities (plants, cells and so on)<br>Key suppliers<br>Distribution channels<br>Customer-dedicated facilities | Plant 1, 2, 3<br>Intel/other microprocessor<br>Direct/distributor/VMI<br>GM/Ford/DaimlerChrysler |

*Table 2. Basis for spheres in a manufacturing enterprise.*

1. Market—a regional market (the US).
2. Product—a product life cycle division; (new SUVs [a stage 2 product] that are expected to grow rapidly).
3. Operations—component and assembly plants that make the SUVs.

Such a sphere might adopt liberal inventory policies that would enable fast response to expected higher levels of sales. Equipment choices at component plants in terms of numbers and type would reflect the need for quick added capacity.

Another example is a single plant manufacturer of aerospace fasteners, which might define a sphere as follows:

1. Market—distributors (rather than direct sales to airframe manufacturer customers).
2. Product—high-volume standard fasteners.
3. Operations—designated manufacturing cells and customer distribution centers.

In the automotive example, the products are "innovative" high-profit SUVs (stage 2 product). The manufacturing infrastructure will assure supply to the market. The supply chain in this case would have built-in flexibility to minimize lost sales due to stock-outs. The fasteners are a functional product (stage 3), and costs are as important as availability. The manufacturer in this case could support its distributors by providing vendor-managed inventory services to end users.

This approach extends Wickham Skinner's "focused factory" to the supply chain (described by Hayes and Wheelwright [9]). The concept argues that a single factory or supply chain will not perform multiple specialized tasks well. Carving out and designing spheres to the needs of customers as advocated in the Wheel will lead to competitive success.

## LEVELS 2-3: "COLLABORATION"

Levels 2 and 3 are the "collaboration" levels. Here, the Wheel recognizes the importance of the "soft" side of the manufacturing infrastructure—People, Teamwork, and Organization. In the five SCM tasks, task 2 encompasses collaborative relationships within the enterprise; task 3 addresses those with outside partners. There are two distinct tasks because the challenges are different. Also, it has been this author's experience that achieving internal collaboration is no less challenging than external collaboration.

**The organization is only as strong as its people, organization, and culture. Today's highly competitive worldwide markets require a new approach to managing, organizing, and applying the knowledge and skills of people. [7]**

Collaboration is a "hot topic" in supply chain circles these days. Everyone wants to do it more effectively, but often do not know why or how. Discussions of collaboration are often closely tied to new software standards and products to facilitate it. This fuels a huge commercial motivation for promoting the concept. For this reason, level 3, Shared Knowledge & Systems, is closely linked to the information infrastructure that enables the sharing of knowledge around the enterprise. Level 3 is likewise linked with level 4, consisting of all the activities that make up the enterprise.

## WHAT KIND OF INFRASTRUCTURE PROJECTS ARE YOU WORKING ON?

Unlike hardware and facilities, the impact of people, organization and culture is hard for

| Level 1 Function | Level 2 Company | Level 3 Supply Chain |
|---|---|---|
| **Strategic (S)**<br>Changes basis for competition<br>Identified in strategic plan<br>New product/capability<br>Justified by market share, margins | | |
| **Non-Strategic** (N)<br>Responds to deficiency<br>Incorporates common technology<br>Justified by ROI, cash flow<br>Sponsored by a department | | |

*Figure 6. SCM improvement projects.*

the outside, or even the inside, observer to see. *Figure 6* describes some tests the manufacturing engineer can apply to his or her own company. This figure shows six categories of an improvement project. The levels along the top correspond to entities in the supply chain—a function or department, a company or business unit, or the supply chain itself.

Most improvement projects in a company likely reside at the functional level and are confined to improvements in one department. A new machine tool is such an example. A company-level change requires the involvement of more than one function. An example could be the integration of design and manufacturing processes. Level 3 is the supply chain level. These involve more than one business unit. Examples are joint product development between companies or cost-reduction initiatives between suppliers and their customers.

The vertical axis shows two types of projects and the criteria that apply. Strategic projects have the potential to change the basis of competition. They can occur at all three levels. The exhibit suggests some tests to apply to your projects. The non-strategic project, "N" type, is often a defensive move. It could be the correction of a problem or installing an information system that is gaining broad acceptance in an industry. (ERP systems in the late 1990s are an example.) Implementing these systems is a cost of doing business and adds little in the way of distinctive competitive advantage.

Most projects are level 1, non-strategic investments. As a manufacturing engineer, you can perform a self-assessment. List all projects under way in your company. Include manufacturing equipment, facilities improvement and information systems. You should worry if few are strategic and at the business unit or supply chain level.

## WHAT KIND OF STRUCTURE DO YOU HAVE?

One response to the supply chain phenomenon has been the conversion of executive titles to "supply chain" labels. For example, directors of procurement transform into "supply chain vice presidents." In a consumer-oriented business, the VP supply chain title might settle on the director of distribution. Some companies also bring their manufacturing functions into the supply chain fold; others do not. These companies should, because manufacturing is certainly part of the supply chain.

You can test your organization's structural approach to SCM. *Table 3* shows three generic approaches to organizing a manufacturing enterprise. The traditional approach is the "functional" organization. For example, if a manufacturing engineer (working on the shop floor) reports to a vice president of manufacturing (who is responsible for all of the company's products), then this is the type of organization your company has. The model corresponds to the functionally laid

| Organization type | Appropriate when: | Not appropriate when: |
|---|---|---|
| Functional | Small company, narrow product line, mature business, Stage 3, four products, useful for start-up, prototyping processes (stage 1) | Multiple products in different stages, serving different customer segments |
| Product-centric | Capital intensive production process, homogeneous customer base, wide variety of production process technologies, stage 3 products | Varied customer base, relative low-cost production technology, innovative products |
| Supply chain centric | Strategy targets attractive segments, style-driven business, heavy new product flow, stage 1 and 2 products | Too many market segments cause loss of focus, price-sensitive market |

*Table 3. Approaches to supply chain organization.*

out shop where like equipment is located in one location.

Another option is the product-centric organization. As a manufacturing engineer, your department is responsible for a product. This is the intent of cellular manufacturing where unlike machines are grouped together to reduce lot sizes and cycle time for a family of products. The automotive assembly plant, where platforms with different nameplates are produced in a single plant, embodies this model.

A supply chain organization might reflect the spheres described earlier. This case is the "factory within a factory" and could also include procurement, suppliers, warehouses, distribution centers, engineering and other functions traditionally not included with manufacturing.

## DO YOUR ACTIONS HAVE NO PURPOSE?

Christensen, Raynor and Verlinden [10] contend that earlier in the product life cycle (stages 1 and 2 in *Figure 2*), a company will likely need to maintain control of its supply chain. In the industry vernacular, it will be "vertical integrated." Manufacturing engineers will favor "make" rather than "buy" to control processes.

As the market matures and moves into stage 3, cost becomes paramount. Christensen, Raynor and Verlinden contend that companies will favor "buy" over "make." The supply chain will consist of best-in-class suppliers. It is time to go outside with a process rather than making marginal improvements to an internal one. An engineer may be persistently and unsuccessfully trying to improve processes that could be completed elsewhere, or processes for products that are better off dead.

## CAN YOUR ORGANIZATION EXECUTE?

In 1997, Stephens, Gustin and Ayers [11] described a vision of stage 3 supply chain organizations. It is still too soon to tell if this vision will be widely implemented; however, it serves as a model for governance of the "virtual enterprise."

An organization such as the one described here is also a necessary precursor to collaborative systems for sharing information. Implementing supply–chain level projects unlocks options for improvement, particularly if all the product's costs are represented by the collaborating organizations.

Multi-company supply chain collaboration can benefit by having the following in place:

1. Teams with representatives from the significant participating companies.
2. Goals for the endeavor, including the basis for competing and expectations for revenues, profits and investments.
3. A third-party "honest broker" to facilitate the effort, oversee meetings, decisions and implementation.
4. A CEO, or upper-level management representative, steering committee to lead the effort.
5. Multi-year projects to implement the strategy with participating companies funding the effort.
6. A financial model that distributes risks and rewards to guide contracting.
7. Investments in technology to facilitate needed information sharing among the partners. Partners with legacy systems will operate those if they do not interfere with supply chain operations.

Not every supply chain situation calls for all seven elements, but the manufacturing engineer should look for these elements if entering into joint supply chain improvement projects with partners. If they are absent, perhaps he or she should suggest them.

## WHERE IS THE POWER?

Supply chain organizations must recognize the power relationships that exist between companies, their suppliers and their customers. Certainly, suppliers to Detroit's "Big 3" are aware of the stringent requirements. Nor are these suppliers under any illusions that they can easily change the situation. They must do their best to comply, maintain high performance evaluations and escape Draconian requirements that go with low performance.

However, there are a host of other relationships that one or both parties can shape to their needs. The earlier "Next Generation

Manufacturing" Blue Book [5] mentioned that "teaming must be a core competency." Creativity in these "collaborations" needs to be honed to maintain and increase market share. The *Handbook of Supply Chain Management* [1] recommends a vocabulary for supply chain partner relationships. Putting the vocabulary to work is useful for reviewing partnership proposals and organizing the virtual enterprise. The methodology uses three dimensions—*purpose*, *direction* and *choice*—to characterize a partnership or virtual enterprise.

*Purpose*. This first classification is used to determine whether the partnership will create new "space" in the market. New space might be the case with an innovative product or supply chain approach. Dell did this by capturing the lead with direct sales of personal computers. The company successfully created new supply chain space at a time when personal computers were a stage 2 growth product. As the product has matured into stage 3, Dell retains its profit leadership. Contract electronic manufacturers, known widely as CEMs, have pulled off a similar move. They buy assets of large electronics companies and adapt them to serve multiple customers.

A company seeking new space should next consider whether it should partner or not. The partner must bring something to the party to make the venture work. For example, a partner may be needed to fill in a manufacturing capability that one's own company does not have. It could be cheaper to partner than to build the new capability internally. In some cases, the company may decide to go it alone.

Companies can also partner to enhance an existing supply chain. In this case, no new space is created. Consolidation in an industry is an example of partnering of this sort. It involves mergers driven by the perceived opportunities for economies of scale. Online sellers "hooking up" with brick and mortar retailers, called "clicks" and "bricks," are an example of this type of partnership. Both supply chains exist, but the combination can be more powerful than separate versions. "Clicks" provide convenient transactions. "Bricks" facilitate viewing the product before buying and returning it later if needed.

*Direction*. When considering options for partnering, the "direction" of the partnership is important. There are two basic directions—horizontal and vertical. *Figure 7* illustrates the "direction" property. The open circles show the proposed supply chain; black circles show a competitive or parallel supply chain. The figure shows two horizontal partnerships. On the right, the partnership creates space by the partnering of two organizations that serve a common customer. On the left, a horizontal partnership is formed between two companies performing similar functions in separate supply chains.

A vertical partnership is created along the same supply chain. Two partners joining within the same chain illustrate this. A retailer who concentrates its business with a preferred distributor is an example. Wal-Mart did this successfully with McKesson, a pharmaceutical distributor. Supplier reduction programs are examples of vertical partnerships developing in a number of industries.

*Choice*. The term *choice* reflects the relative power of partners. This characterization is borrowed from information systems, using terms "one" and "many" to describe relative positions of the partners. A "one" describes cases where there are few potential partners. Automotive, aerospace and government agency markets have only a few OEM buyers. These markets are oligopolies. The "many" side describes the supplier base for these compa-

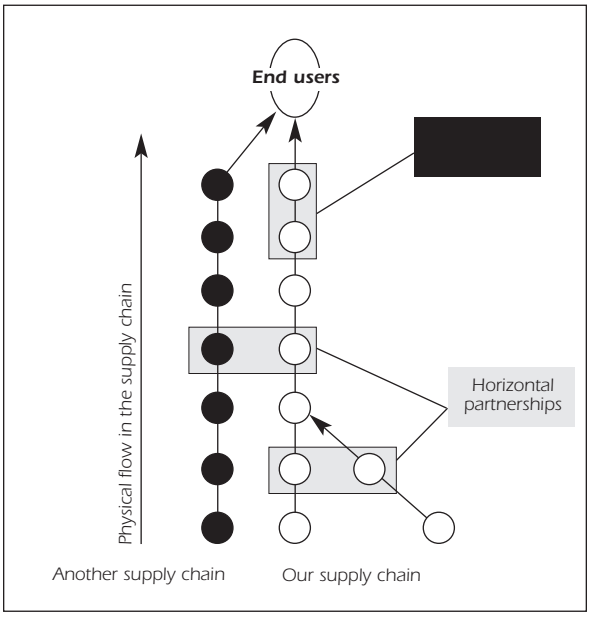



*Figure 7. Partnership directions.*

nies. Therefore, auto suppliers work in a "many-to-one" relationship.

The other end of the spectrum is represented by Microsoft's leverage over personal computers. It is an example of "one (Microsoft) to many (personal computer sellers)." In fact, recent anti-trust suits have challenged this leverage. A "many-to-many" environment indicates partners have multiple options for joining with others. Both sides of the partnership have many potential companies. This is the situation in very competitive markets.

Partnerships and mergers of equals represent a "one to one." AOL with Time Warner and Daimler with Chrysler are two examples. AOL and Time Warner attempt to combine content from Time Warner with distribution from AOL. This is new space and a vertical partnership. DaimlerChrysler is a horizontal partnership, but probably creates no new space. An example of a "many-to-many" horizontal partnership would be two distributors joining to offer wider geographic coverage or two machine shops with complementary equipment capabilities joining to pool their capabilities.

*Vocabulary and the Wheel.* Why should manufacturing engineers worry about this? The answer lies in the increasing importance of collaboration through partnerships in the enterprise infrastructure. The Wheel at level 2 refers to "People, Teamwork and Organization," which captures the need to use people knowledge and skills. The way we go about this will depend on the nature of the partnerships we have with other companies.

Unfortunately, many partnerships take form without conscious reworking of the infrastructure. By identifying these cases and characterizing them with the vocabulary, infrastructure designers can formally address the needs they bring. Also, if a company is considering a partnership, it should review the ability of its infrastructure to make the partnership successful.

## PROCESS-ENHANCING SYSTEMS

Shared knowledge and associated systems form level 3 of the Wheel. Indeed, CASA/SME has, as its mission, the sharing of ways to make enterprise integration work. This level interacts with levels 2 and 4, the processes of the enterprise. Level 3 can be viewed as "lubricating" the interface between the people, their skills and knowledge, and the processes the people must operate.

There is no end to supply chain software "solutions" available in the marketplace. Some are finding that those investments limit flexibility in adapting, as roles in the supply chain can change rapidly. They are also finding that transaction systems can effectively deal with routine transactions. Many transactions are anything but routine, and level 2 skills and knowledge are needed to get the work done.

Bensaou and Earl [12] contrasted Western and Japanese management styles in terms of what they call "mindsets" for managing information technology. The authors recount the frustration often heard in the US regarding integration of technology into the business and the tendency to chase "technology for technology's sake."

*Table 4* summarizes their research into the different mindsets. The Western mindset contrasts with the Japanese mindset on the way managers frame technology use. They were surprised that many of the problems cited in the US do not occur in Japan. The

| Issue | Western Mindset | Japanese Mindset |
|---|---|---|
| Matching IT with business needs | Align IT with business strategy | Basic way we compete drives IT investments |
| Return on investment | Capital budgeting process, ROI | Operation performance improvement |
| Technology and process improvement | Tend to adopt technology—seen as best way to improve | Use the right technology to meet a performance goal |
| Connections between IT users and specialists | Tech-savvy staff and CIOs | Rotation through technical and management roles |
| Improvement of organization performance | Design elegant system; adapt to it | Design system to use employee knowledge |

*Table 4. Mindsets for implementing information technology.*

research supports the Wheel's conception that level 3 systems and methodologies should bring level 2 know-how to the support of level 4 processes. As the discussion proceeds, this idea will be expanded.

## LEVELS 4-5: "ACTIVITY SYSTEM"

This Blue Book addresses levels 4 and 5 of the Wheel together. In reality, level 5 resources bring level 4 processes into being, so they are tightly entwined. It is up to level 5 to translate aspects of the external environment (level 6) into enterprise resources to fuel value-adding processes at level 4. This is the "outside-in" perspective. From lower levels 1-3, processes reflect their "inside-out" perspectives.

The Wheel divides level 4 into 15 processes. It is recognized that a single manufacturing enterprise need not perform all 15 internally. The "virtual enterprise" happens by delegating functions that outside specialists may perform better. Alternatively, the manufacturer can carve out market niches as "best in breed" in some narrow service or product focusing on a subset of processes.

This section describes ways to decide what form infrastructure processes should take. After all, without conscious, ongoing redesign, the infrastructure grows weak in comparison with competitors that aggressively implement change.

## ACTIVITY SYSTEMS FOR PROCESS DEFINITION

Most strategic planning approaches focus too much on finance and marketing and overlook the role of operations. These approaches relegate operations to a passive role in achieving a competitive position. "Activity systems" in the heading refers to a methodology from Michael Porter [13], a respected guru on strategic planning. Porter's activity systems approach is a way to define and design manufacturing enterprise processes. What follows is a description of the methodology.

Underlying the approach is the principle that effectively competing means making choices about how to compete. You cannot be all things to all people. Without choices, one is condemned to commoditization, and the only advantage comes from operational effectiveness. In other words, one has to cut prices and costs to keep up. There is no other reason to buy from you. Serving all masters means you will be mediocre, serving no one well. Competitors can swoop in and pick off pieces of your market.

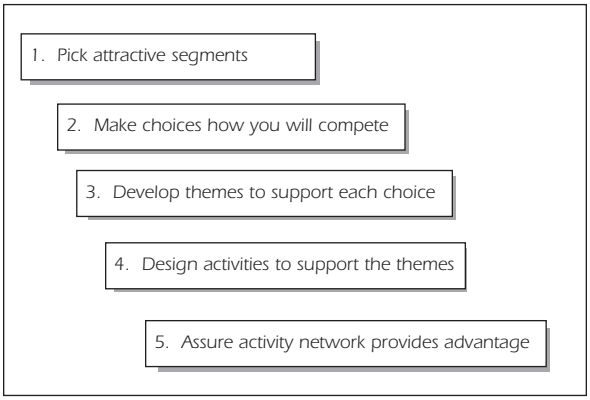



*Figure 8. Building an activity system.*

Focusing on a market will help bring prosperity. *Figure 8* shows steps in the process. Step 1 is picking out attractive segments to pursue. Once the segment is chosen, the company must make conscious choices of how it will compete; this is step 2. In step 3, each choice defines a "theme" that supports the activity system. To execute on each theme, the company must develop supporting activities in step 4. Each activity supports one or more themes. It is the linkages between activities and themes that erect barriers to competitors.

## BUILDING INFRASTRUCTURE: THE ACME CASE

A hypothetical case illustrates how to build an activity system. The company, called Acme, is a machining operation that produces fasteners for OEM airframe manufacturers, such as Boeing. Acme is a technology leader that licenses its products to competitors. This technology includes the fasteners themselves and the tooling to install them. The total cost to the OEM of installing a fastener, including labor, is much more than the cost of the fastener itself and the tooling.

In the past, customers bought directly from Acme through its sales force. The largest OEM (Boeing) still buys direct and accounts for about half the market. However, many more OEMs now buy from distributors. These

distributors provide vendor-managed inventory to the OEMs assembly lines. These arrangements reduce costs for the OEMs and enforce stringent delivery requirements on the distributors. Acme has a small share of Boeing's business because Boeing buys on price, and several licensees offer lower prices than Acme.

Acme makes fasteners to order. In a period of high demand, it has long lead times because its plant is near capacity. Acme is noted for its quality and the technical support it provides. It maintains an engineering group, a sophisticated sales force and laboratories to guide customers in fastener selection and application. However, Acme does not charge for technology-related services. Such services are a cost of maintaining a leadership position for the technology.

Users of Acme's technology often seek technical advice from Acme, then buy from a licensee. Acme's machining operations are arranged in a "functional" layout with like equipment located together. So the path through various operations in the shop is lengthy, and there are many stops.

Even in times of prosperity, Acme makes little profit. Industry competition is fierce in a cyclical business. Apparently, profitable business leaves little on the bottom line after expenses are deducted. Acme recently installed a manufacturing-oriented ERP system to control its finances and operations.

*Table 5* describes the choices Acme has in the themes that would anchor its activity system and infrastructure. In the left-hand column of *Table 5* are four "themes" and the associated choices. For example, for "production flexibility," Acme could choose to continue its inflexible approaches built for another era or adapt ways to provide short lead-time responses. This would particularly aid its position for supporting the distributor supply chain.

Should Acme take the full-service options, becoming the lowest price, lowest service provider would cost a lot in terms of good will, as well as its hard-won position as a leader. *Figure 9* shows the activity system that might result if Acme chooses the "high-end options" from *Table 5*. Notice that these choices are reflected in the four themes that anchor the activity system.

*Figure 9* shows activities that support the themes. The lines from the activity to the themes display linkages. Also, notice that activities support multiple themes. These activities, such as the level 4 processes of the Wheel, are what make the enterprise tick. Fit between the activities comes from their ability to support the themes, which are the result of conscious choices on how to compete.

*Table 6* explains how the activities (or processes) support the themes. It describes how each of the activities identified in *Figure 9* can address what Acme might view as market opportunities. With regard to the Wheel, these activities will form specifications for levels 3, 4 and 5. A danger is that, over time, the 15 processes in the Wheel have taken their own courses. They no longer support any underlying themes for competing. Companies with various departments (termed "fiefdoms") probably have this problem.

## REINVENTING THE WHEEL

As a long-time SME and CASA member, this author has not paid much attention to the Wheel, other than to observe that it

| Theme | As-Is | High-End Option | Low-End Option |
|---|---|---|---|
| Technology leadership | Engineers, labs, sales force | Continue the as-is | Drop expensive overhead functions to reduce cost |
| Production flexibility | Inflexible, long lead time | Have plenty of capacity, carry inventory, and be responsive | Focus on one customer; dedicate plant, tightly link to that customer |
| Customized services | Services designed around traditional OEM direct sale | Design specialized approaches for major segments. Compete on services. | Offer no service options. Compete on price. |
| Account profitability | Poorly managed. All products appeared profitable. | Focus on segments with highest margins. Adopt activity-based approach. | Lower costs to compete in most |

*Table 5. Acme's strategic themes.*

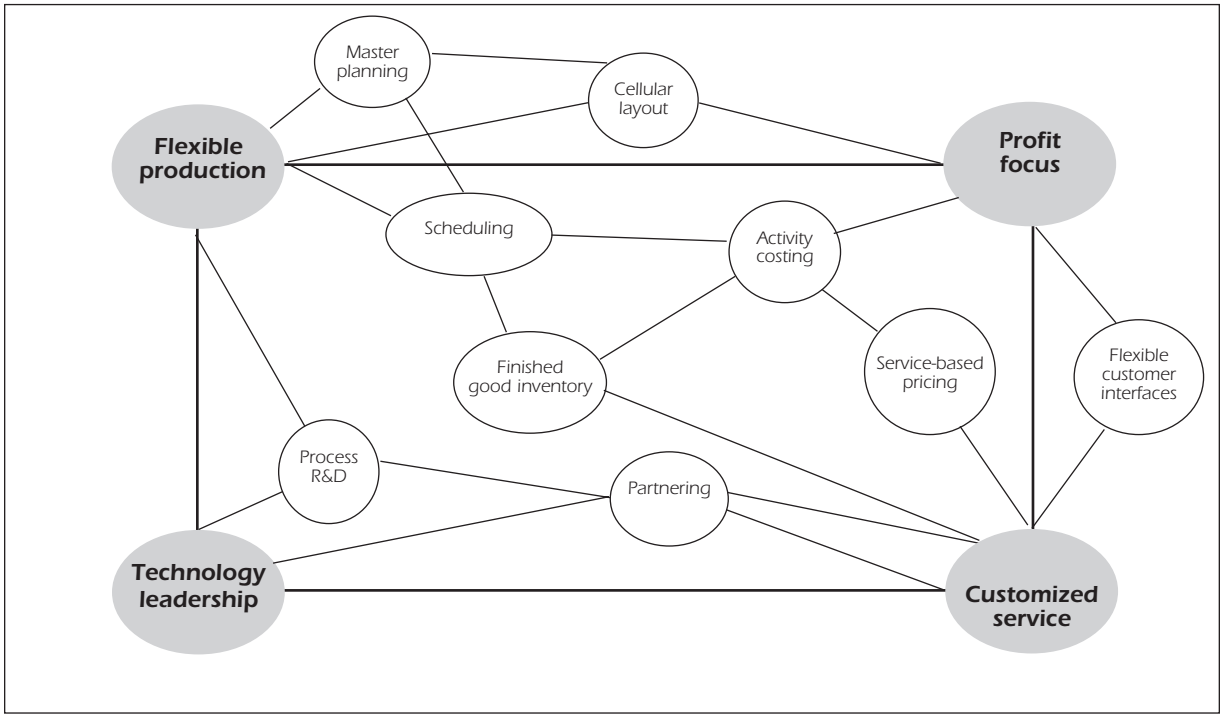



*Figure 9. Example activity system.*

| Activity/process | Contributions | Themes supported | | | |
|---|---|---|---|---|---|
| | | Flexibility | Technology | Service | Profit |
| Master planning | Develop plan for facilities, customers and products. | X | | | |
| Scheduling | New methods would improve plant utilization and create fast-response FG inventory. | X | | | |
| Cellular layout | Rearrange plant to quickly produce high–volume products. | X | | | X |
| Process R&D | Develop new product designs to lower installation cost. | X | X | X | |
| Partnering | Create alliances with others to fill in product line. | | X | X | |
| Finished goods | Establish fast response finished goods inventory. | X | | X | |
| Flexible interfaces | Implement systems to manage customer relationships. | | | X | X |
| Service-based pricing | Reflect services component in pricing. | | | X | |
| Activity-based costing | Change allocation methods to match costs with cost drivers. | | | X | X |

*Table 6. Activity support of strategic themes.*

seemed quite complex. Writing this Blue Book evoked some observations on the Wheel and its use—calling to mind the strengths and what could be construed as weaknesses. Going through the exercise has shown how versatile and useful the Wheel is as a model for modern manufacturing enterprises. What is lacking, and what has hopefully been addressed (at least partially), are the changes brought on by the need to compete through supply chains rather than as stand-alone companies.

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