

STRATEGIC SUPPLY CHAIN MAPPING APPROACHES

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Visualizing, tracking, and managing supply chains all become more complicated as firms pursue outsourcing strategies and as firms' supply and delivery systems become increasingly global. The authors suggest that not only is there a need to visualize the supply chain, there needs to be a well-established process for building the map so that knowledge is easily transferable and exchangeable among managers and organizations as appropriate. Further, the map should link to the strategic planning process of the firm to facilitate evaluation of supply chain membership and structure. Before an effective supply chain mapping process can be developed, it is important to understand the nature of maps, the importance of supply chain mapping, the role of supply chain mapping in strategy, and characteristics of supply chain maps. The latter will be the focus of this paper.

In a more general vein, physical mapping conventions have achieved broad agreement, although changes are incorporated from time to time. The meaning of narrow black lines, wider black lines, red lines, and double red lines are generally recognized as ways of representing different kinds of roads, regardless of continent. The railroad symbol is similarly universally recognizable. In another context, the red circle with a line through it for signage was adopted a few decades ago as the international symbol for prohibited actions. These conventions make it possible for foreign visitors to read maps and know basic traffic requirements. Universal symbols for restrooms provide an additional example of conventions. Most are easily recognizable even to those who do not read the local language.

A major purpose of this article is to call attention to the fact that there is not yet a universal set of mapping conventions to represent a supply chain and to launch a discussion of the alternative approaches possible. Progress on depicting supply chains may hasten a convergence in definition of what a supply chain is. There have been prior conventions proposed for various related purposes, as will be described later but not for the strategic supply chain mapping purposes envisioned here. Additionally, a framework of map attributes will help in understanding the profusion of map styles and offer a jumping-off point for the conventions debate.

Cisco, currently the world's largest supplier of routers for the Internet, grew rapidly during the 1990s. To be able to supply the demand, Cisco's supply chain strategy focused on outsourcing and leveraging assets (Anonymous – *Purchasing* 1999). The firm owns few of the manufacturing facilities. Instead, it relies heavily on contract manufacturers for assembly and sometimes testing of products prior to shipment to customers. Distributors of electronic components are responsible for maintaining component inventories at the assembly locations. The Cisco and Dell practices of minimizing asset ownership have rightly or wrongly become models for other firms in the computer industry that have traditionally owned larger fractions of their manufacturing infrastructure. Managing a virtual supply chain is critical for these models to succeed and these efforts would be assisted by visualization approaches such as mapping. A map from the consumer back through suppliers could encourage forecasting based on consumer behavior rather than network manager behavior.

What is a supply chain? The current definitions cover multiple functions or processes across multiple firms and call for an integrated approach that adds value for stakeholders (Lambert, Cooper, and Pagh 1998; Mentzer et al. 2001). But how can a firm know who is or should be part of its supply chain or of whose supply chain it is a part? How many tiers out should the firm manage and for what purpose? Which specific suppliers or customers should be included? Further, how can a firm decide when it is appropriate to redesign its supply chain? The authors have visited a number of firms who all do some form of mapping, yet with different end uses in mind.

The paper first defines what a map is, since there are nearly as many definitions of maps as there are types, styles, and uses of maps. Next the compelling reasons for a firm to produce a strategic supply chain map are examined. After examining a number of maps in the literature, it is clear there are few or no conventions for mapping supply chains. Supply chain mapping is further distinguished from process mapping or network design. Characteristics of a good map are described based on review of the cartography, logistics, and supply chain literatures. The risks of producing a supply chain map are examined since putting potentially sensitive data out for broad viewing has internal and external risks. A clear link from map building to firm and supply chain strategy development is proposed. Finally, future research is recommended to develop mapping approaches and conventions for use in supply chain management.

WHAT IS A MAP?

There are a number of definitions of a map. "A map is a spatial representation of the environment. By 'representation,' we mean something that stands for the environment that it portrays, and is both a likeness and a simplified model" (Muehrcke and Muehrcke 1992). The key to this definition, for our purposes, is that the map is a stand-in for the actual environment. Strategic supply chain maps might simplify the spatial relationships to a great extent, but the essence of the environment must be captured. "As is the case with other graphic constructions, maps employ a form of visual language to communicate items of information" (Rouleau 1993, p. 66). Perhaps one of the most poetic descriptions of maps comes from Denis Wood (1992, p. 4). "And this, essentially, is what maps give us, reality, reality that exceeds our vision, our reach, our span of days, a *reality* we achieve no other way."

While a strategic supply chain map must have immediacy, the goal is to exceed our individual reach and exceed our individual vision. The essence of strategy is the communication and implementation of the firm's vision.

The appearance of maps can vary significantly from application to application and across disciplines. For example, an electrical diagram is easily recognizable. One can determine current flow direction and volume, source of current, and impedance. A geographic information system (GIS) map is tied to a database. Maps provided on demand by services such as *mapquest.com* are good examples of using GIS to turn an address into a map with directions. GIS is also used in commercial transportation (Campbell, Labelle, and Langevin 2001). The map displayed can vary depending on the variables selected for view, such as population density, income, soil type, or dominant vegetation (e.g., Foust and Botts 1993, p. 115).

COMPELLING REASONS TO MAP

Why should a firm create a strategic supply chain map? A strategic supply chain map is useful for several reasons. A well executed map can enhance the strategic planning process, ease distribution of key information, facilitate supply chain redesign or modification, clarify channel dynamics, provide a common perspective, enhance communications, enable monitoring of supply chain strategy, and provide a basis for supply chain analysis. Many people tend to think and learn in pictures and feel that "a picture is worth a thousand words." Thus, a map can be quite helpful in understanding a firm's supply chain, for evaluating the current supply chain, and for contemplating realignment of a supply chain.

- A compelling reason to construct a map is to link corporate strategy to supply chain strategy. A well-constructed supply chain map with the right information, easily displayed and understood, should enhance the environmental scanning process of strategic planning. The key to building a good map for strategic purposes would be to mesh the map-building process with the strategic planning process in a seamless manner.
- A map is needed to catalog and distribute key information for survival in a dynamic environment. A good map can alert planners to possible constraints in the system. There are examples of companies that found a critical component or a raw material supplier that was in danger of going out of business (Fine 1998), was the only supplier of a critical component (Cooper, Lambert, and Pagh 1997), or dumped toxic waste improperly (Fine 1998). Quickly identifying sole or critical suppliers more than one tier up can suggest further investigation and monitoring for supply chain bottlenecks. While the map will not identify problems, it should direct the focus of the managers.
- A strategic supply chain map will offer a basis for supply chain redesign or modification. The map can be descriptive, "what is," or it can be prescriptive, "what can be." The map helps to visualize the supply chain and identify areas for further analysis or show obvious inefficiencies not as easily visible by examining only a small segment of the supply chain. For example,

potentially inefficient out-and-back shipments as components are assembled will show on the map as multiple lines. A component may be shipped to a subcontractor for finishing work before being returned to the final assembly location. If the distance is large in time or space, this could be a real source for savings. Overlaps and duplication should become more apparent through visualization. With a good map, rationalizing the supply chain becomes easier. A firm can also consider outsourcing functions or activities, creating a “lead logistics provider” or “4PL” to manage several activities which have been outsourced, or to look for synergies across product lines.

- Current channel dynamics can be displayed in a supply chain map. Issues such as relative size, power, competitive positioning, and future importance could all be included. For example, the relative importance of channel members can be assessed and displayed by different sized symbols or varying the thickness of lines connecting the symbols.
- The process of building the strategic supply chain map, in itself, will help define the perspective of the supply chain integration effort. The choice of what to represent and from what viewpoint can have a profound effect on supply chain strategy. For example, will alternative suppliers, not currently utilized, be included? Will competitors’ supply chains that overlap the mapping firm’s supply chain be made explicit (Lambert, Cooper, and Pagh 1998)?
- Both the process of developing the map and the process of disseminating the map should lead to a common understanding of the supply chain. This common understanding would include what was deemed important to managing or monitoring the chain, as well as what the supply chain structure is or will be.
- Certainly a map provides a communication tool to reach across firms, functions, and corporate units. A supply chain map that communicates across organizational divides must be carefully constructed such that the interpreted message is the intended message. The communication should be consistent across functions, processes, and firms.
- A supply chain map should facilitate monitoring of supply chain integration progress. If a map of the initial status and a map of the proposed structure are developed and disseminated, then the data contained in the maps can help evaluate the progress at various points along the way to the supply chain redesign goal.
- New individuals or firms can be oriented to their role in the supply chain. New players, both transient and new participants, can be educated quickly.
- Finally, a well-documented supply chain mapping approach can lead to an improved supply chain management procedure. In any continuous improvement environment, the need for consistent and documented processes is a key for incremental improvement. While radical changes that provide quantum improvements are critical, incremental improvements will continue to be important. Mapping can be important in providing guidance in the quantum changes in the supply chain, but there should also be incremental improvements in the mapping procedure itself.

The above offer compelling reasons to map. The map gives the manager the framework of the interrelationships but, on purpose, does not give the detail to manage a supply chain. It offers cues. There is no way to include enough information in a supply chain map to manage a supply chain and still have the map useful for strategic purposes. The analogy would be that planning a vacation strictly on the basis of a map would be unwise, as would planning a vacation without using a map.

THE NEED FOR A SUPPLY CHAIN MAPPING CONVENTION

In some other disciplines there are clear conventions for depicting reality in symbols as well as for arranging the symbols. Take, for example, the well-defined rules for electronic schematic diagrams. These offer a ready understanding of the circuit for any trained individual, regardless of their firm, language, country, etc. Since 1906, the International Electrotechnical Commission (2001) has set the standards for representing many characteristics of electrotechnical systems, such as camera, lighting, and computer control symbols.

Programming flow charts, computer schematics, and cartographic conventions make excellent use of common conventions. Data processing is a good example of the tensions between the need for creativity and the communication advantages of diagramming conventions. Data modeling uses strict rules for diagramming to facilitate communication, documentation, and understanding (Elmasri and Navathi 2000; Kendall and Kendall 1995). "When systems analysts attempt to understand the information requirements of users, they must be able to conceptualize how data moves through the organization, the processes or transformation that the data undergoes, and what the outputs are" (Kendall and Kendall 1995, p. 229). However, "Although this text focuses on the most widely used approach in practice, there will be times when the analyst recognizes that the organization could benefit from the use of an alternative approach" (Kendall and Kendall 1995, p. 19).

Cartography offers a number of broad insights into the choice of conventions and the challenges facing a mapmaker. One concept from cartography is generalization, which refers to the amount of information contained in the map and the area depicted. "Generalization denotes a process by which 'the presence of phenomena or events in a referent state are essentially reduced and/or modified in terms of their size, shape, and numbers within [the] map space'" (Balodis 1988, p.71). The end product of this generalization process is "a derived data set with less complex and usually more desirable properties than those of the original data set" (Joao 1998, p.1). One can have an electronic map of the world and then be able to adjust the level of generalization by zooming in to a specific part of it and look at species living there, water pollution levels, and population, depending on the interest of the viewer.

"A mental map is organizing all the relevant bits of information into some kind of structure" (Wood 1992, p. 15). A mental map might not look like a physical map for routing or dispatching vehicles but is "a neurological activity underwriting this kind of decision that is clearly related to the way we use paper maps to make decisions" (Wood 1992, p. 15). Thus, managers may have mental maps of portions of the supply chain which can be drawn upon to build a paper map. Additional learning can

occur as this information is shared with other managers and the broader picture of the entire supply chain emerges. However, how people draw and interpret maps depends on their point of view. For example, how desirable different parts of the country are to live in may be influenced by where one has lived (Meuhrcke and Meuhrcke 1992, p. 8).

One categorization of maps from the study of geography is user, thematic, and generic maps (Shea 1991). For a traditional map, these three focuses would translate into a survey map of a building site, a soil type map, and a road map, respectively. In terms of specificity of generalization, thematic maps are less generalized than generic maps and user maps are least generalized. A survey map of a specific building site has the lowest level of generalization. Supply chain maps can be generic examples for theory building or user for a specific chain by naming members of the chain. User maps have been suggested for specific business problems. (See Figures 1 and 2.) Value Stream Mapping, developed by the Lean Institute (Womack and Jones 1996), emphasizes mapping the flow of materials on the production floor. The Supply Chain Council (2001) has developed the SCOR model for improving the buy-make-deliver operations of a firm and has been extending it beyond a single firm's boundaries. The model's emphasis is on operational issues. Business Process Re-engineering (Hammer and Champy 1993) has focused on the process level. Fine suggests three different kinds of maps. One should include organizations (e.g., focal firm, casting supplier, clay supplier), another would include technologies (e.g., engine valve, lifters, clay chemistry), and a third would include capabilities (e.g., JIT delivery, chemical process control, assembly plant management, supply chain management). These types of user maps have a low degree of generalization, are very detailed, and have a narrowly defined set of information specific to a situation.

FIGURE 1

USER MAP: LEAN MANUFACTURING MAP

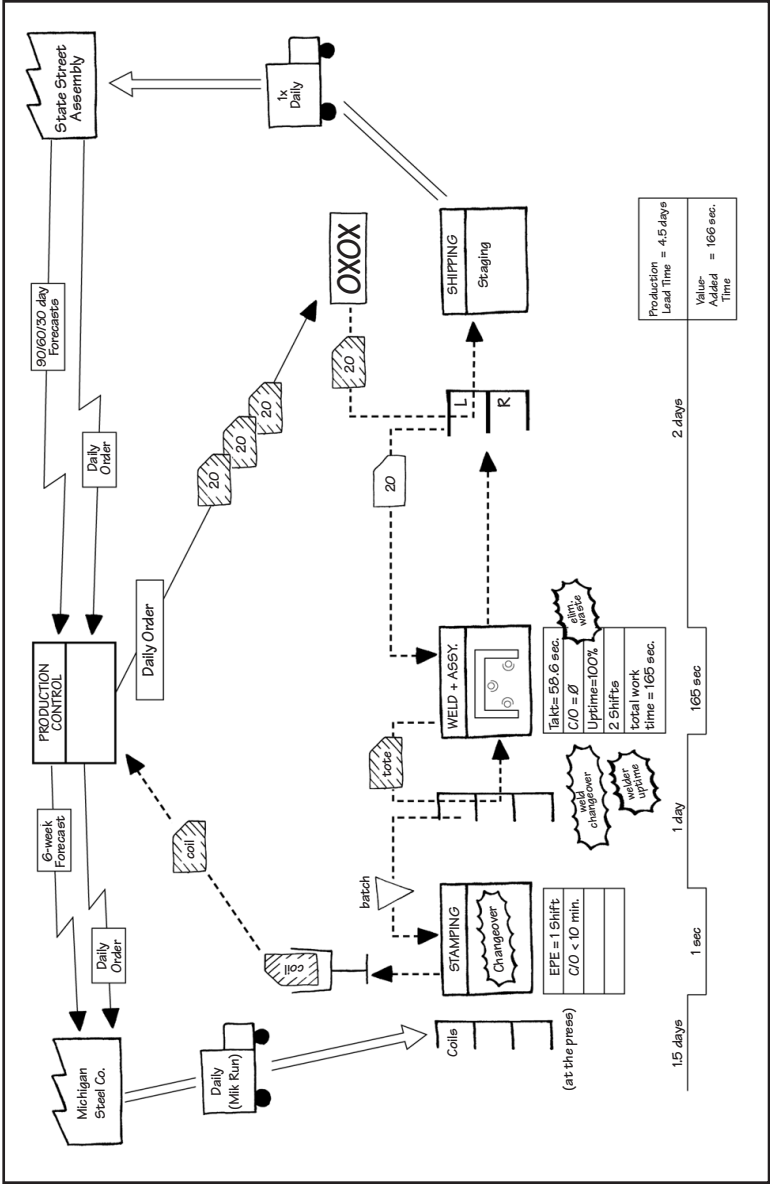
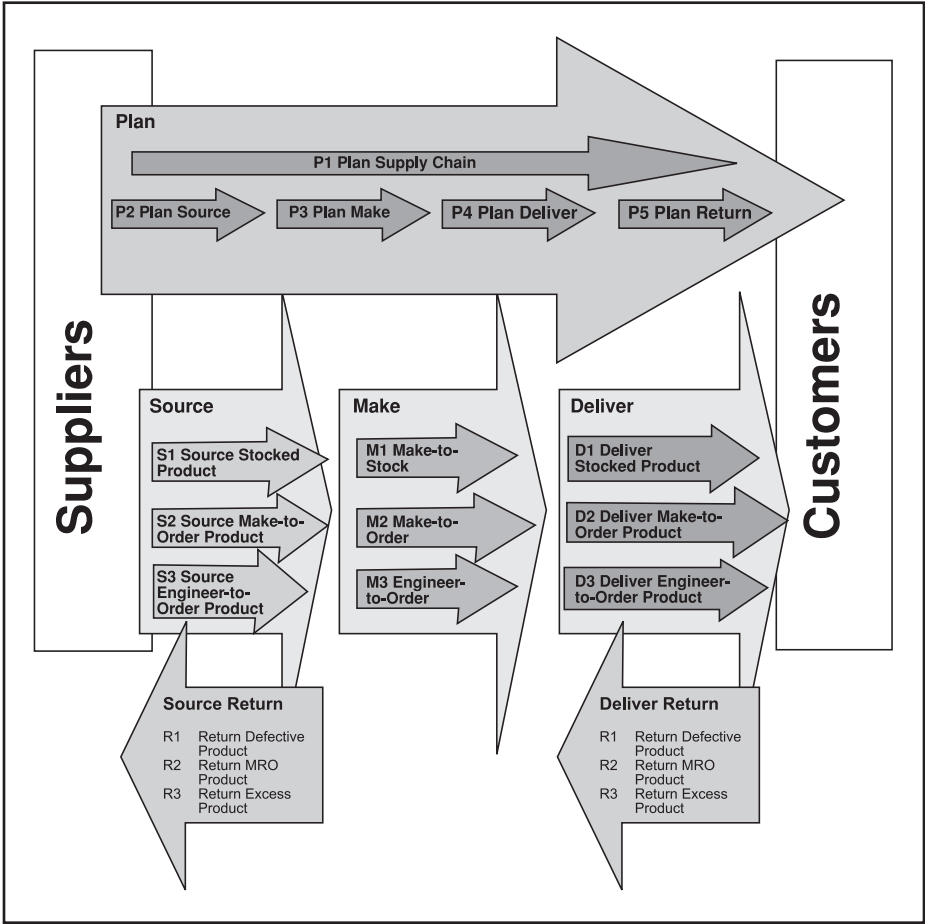


FIGURE 2
USER MAP: SCOR VERSION 5.0 MODEL



Supply Chain Council 2001, p. 9.

There is a need for a procedure for mapping the key portions of the supply chain for strategic purposes. A strategic supply chain map would be more generalized than the above approach. Overall, the lack of consensus supports the need for supply chain mapping conventions.

**DISTINGUISHING STRATEGIC SUPPLY CHAIN MAPPING
FROM PROCESS MAPPING**

Three main distinctions are made between strategic supply chain mapping and process mapping: orientation, level of detail, and purpose. See Table 1.

TABLE 1

**DISTINGUISHING STRATEGIC SUPPLY CHAIN MAPPING
AND PROCESS MAPPING**

	Supply Chain Mapping	Process Mapping
Orientation	External	Internal (typically)
Level of Detail	Low to moderate	High
Purpose	Strategic	Tactical

Orientation

The orientation of the mapping project can be defined as the focus of the mapping procedure. Strategic supply chain mapping focuses on how goods, information, and money flow in both the upstream and downstream directions and through a firm. All processes may be included. “A business can be viewed as a collection of interconnected processes” (Schroeder 2000, p. 109). Process flow-chart analysis (Schroeder 2000, p. 111) includes describing the existing system by means of flowcharts and efficiency measurements and developing an improved process design. Process mapping generally directs its attention to a single operation or system within a company. At times a supplier or customer may appear in the map, but the attention is not typically on the entire chain but rather process mapping that often does not go beyond the firm level. The SCOR model, however, offers a good example of a process mapping approach which is focused on moving the analysis beyond the firm’s borders (The Supply Chain Council 2001).

Level of Detail

A second distinguishing feature is the level of detail that is represented in the map. Strategic supply chain mapping emphasizes high-level measures such as volume, cost, or lead-time. Supply chain management takes an overall perspective of how processes work together between companies. Additionally, supply chain mapping may exclude non-critical entities to keep the map even simpler (Lambert, Cooper, and Pagh 1998). Process mapping tends to break down a process into activities and steps. Every step includes information to characterize the system being mapped. This information may not be readily available and has to be determined through extensive mapping sessions.

Purpose

The third major distinction is the overall purpose for creating the map. Process mapping is typically tactical rather than strategic. Strategic supply chain mapping occurs in conjunction with the creation of a supply chain strategy or to ensure that the current supply chain conforms to the strategy already in existence. Supply chain mapping is used either to help create a supply chain that conforms to a strategy, or as a check to make sure the current chain is set up properly to fulfill that strategy. The origin of a process map typically comes from the recognition of a problem area and an attempt to improve operating efficiency. The goal is to make changes in the current operations of the firm. Efforts are usually isolated to one process or function at a time.

CHARACTERISTICS OF A “GOOD” MAP

Maps have been powerful tools for centuries because they allow us to see a world that is too large and too complex to be seen directly. The representational nature of maps, however, is often ignored – what we see when looking at a map is not the world, but an abstract representation that we find convenient to use in place of the world. A map’s effectiveness is a consequence of the selectivity with which it represents a system. A good map is interpretable, recognizable, and in an easy-to-disseminate format.

A *supply chain map* is a representation of the linkages and members of a supply chain along with some information about the overall nature of the entire map. A *strategic supply chain map* is distinguished by its direct tie-in to corporate strategy. This type of map can be either an integral part of the strategic planning process or a tool for implementing the supply chain strategy. Supply chain maps come in a number of shapes and styles. The focus could be on a particular use or user, on a theme such as a type of value added, or generic, covering all aspects of supply chain structure. The maps can depict organizations, flows, facilities, and/or processes.

The supply chain map may be linked to, or built directly from a database, or it can be built by hand. Supply chain maps may or may not depict geographical relationships. Individual organizations may be named or grouped. Maps may include multiple business processes in their visual display, or not. There are a number of supply chain processes that could be included in a map (Lambert and Cooper 2000).

A good map would have standardized icons. These icons could come from academics, trade associations, and other sources. Conventions such as color-coding or symbol-coding business processes linked between organizations would also be helpful. Just as an interstate highway is recognizable on any highway map, the specific meaning of a link drawn in a strategic supply chain map should be easily grasped. The creators of Value Stream Mapping and Process Mapping have suggested conventions for their mapping procedures at the plant and process levels. Some of these are drawn from engineering, electrical, and computer flow-charting conventions. However, there is not a convergence on the specific symbols for process mapping. Some look like computer flow charts but many are eclectic in their choice of symbols and presentations (van der Aalst, Desel, and Oberweis 1998).

The mapping process should include a plan for dissemination. Maps could be Internet friendly for e-mail or web distribution, or they could be traditional paper documents. Internet dissemination

has a specific set of advantages and disadvantages. The potential savings in time and materials for a web distribution could be offset by a loss of control of access to the sensitive information. However, there are many security issues to be resolved regardless of the medium chosen.

While the above represents ideal characteristics, the actual number of potential mapping approaches is large. In the next section, some of the major attributes every supply chain map has are identified.

SUPPLY CHAIN MAP ATTRIBUTES

Table 2 offers a structured set of supply chain map attributes grouped into geometric, perspective, and implementation issues. Figures 3-14 contain the examples listed in the right column of Table 2. Geometry embodies aspects of generalization, particularly aggregation issues, and the shape of the map of supply chain members. Perspective addresses the focus and the scope of the map. The distinctions among user, thematic, and generic maps are captured under perspective. Implementation issues include information density and database linkage to make the map useful for managing the supply chain. It is important to understand each of these three categories as managers, industry groups, and academics develop supply chain mapping protocols and processes. Any given approach will not likely cover the full spectrum of potential supply chain maps. For example, a mapping approach can be developed which would be appropriate for focal-firm oriented maps but may not work with an industry perspective. When developing a mapping approach, understanding the targeted domain of supply chain map geometries, perspectives, and implementation issues is important.

TABLE 2

SUPPLY CHAIN MAP ATTRIBUTES

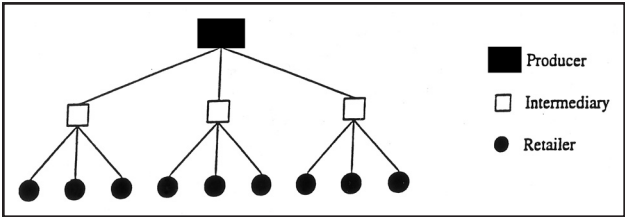
Attributes	Definition/Meaning	Distinguished by	Refer to
Geometry			
Tiers	The number of sequential business units performing transactions leading to the final consumer.		
• Direction	Direction is the coverage up or down the channel of distribution.	Supplier-Oriented Customer-Oriented Both Industry Cyclical	Customer-Oriented: Figure 3 Both: Figure 4
• Length	Length is the number of levels in each direction.	_# of Tiers Up _# of Tiers Down	0/2: Figure 3 4/4: Figure 4
Aggregation (Width)	Aggregation is the degree of specificity within a tier.	High (one box per tier) Med (types of firms at each level identified) Low (some firms are named at each level)	High: Figure 5 Medium: Figure 6
Spatial	A map is geographically representative.	Yes/No	Yes: Figure 7

TABLE 2 (CONT.)
SUPPLY CHAIN MAP ATTRIBUTES

Attributes	Definition/Meaning	Distinguished by	Refer to
Perspective			
Focal Point	A map takes a firm-centric view or an industry-centric view.	Firm Industry	Firm: Figure 4 Industry: Figure 8
Scope	This is the scope of the perspective.		
• Product Breadth	This is the breadth of product coverage included in the map.	SBU-wide Product category Product Component	SBU: Figure 9 Product: Figure 10
• Supply Chain Perspective	The supply chain includes key processes beyond logistics. (Refer to SCM definition.)	Yes/No	Yes: Figure 11
• Process View Depth	The depth of the process view is the extent to which the map incorporates a complete set of key business processes.	# of Key Business Processes Represented	High: Figure 11 Low: Figure 8
• Cycle View	Includes return channels and other feedback loops.	Yes/No	Yes: Figure 12
Implementation Issues			
Information Density	Density is the amount of information integrated into the visual display.	High to Low	High: Figure 13 Low: Figure 14
Live Link to Database	The map is linked to preexisting corporate or supply chain database(s).	Yes/No	Yes: Figure 13
Delivery Mode	The delivery mode is how the map is made available to the users.	Paper, Electronic, Web	

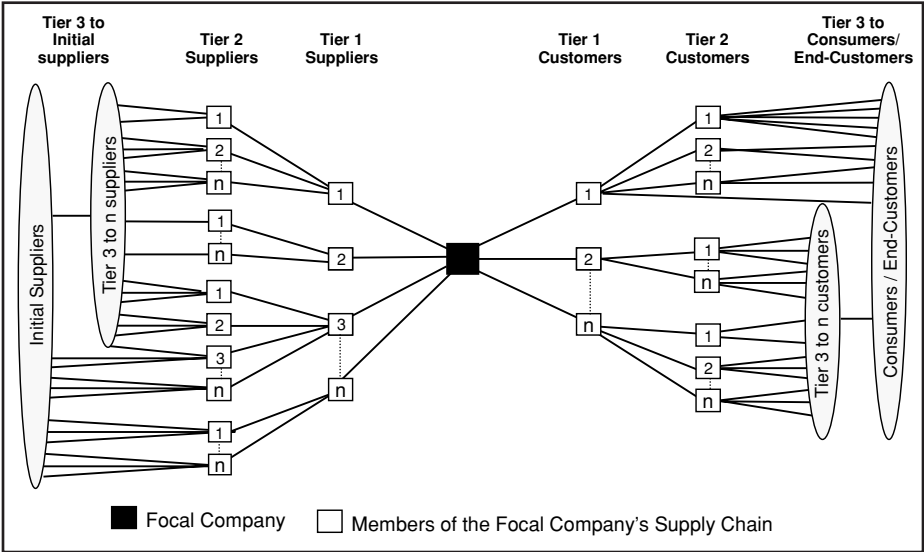
FIGURE 3

GOODS AND INFORMATION DISTRIBUTION HIERARCHY



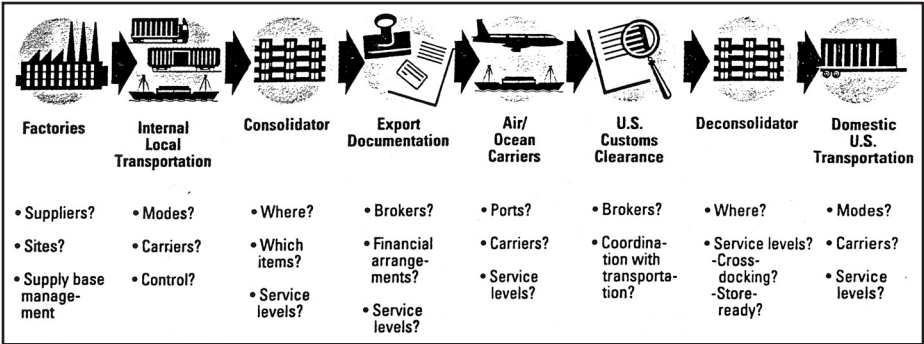
Lewis and Talalayevsky 1997, p. 148.

FIGURE 4
SUPPLY CHAIN NETWORK STRUCTURE



Lambert, Cooper, and Pagh 1998, p. 3.

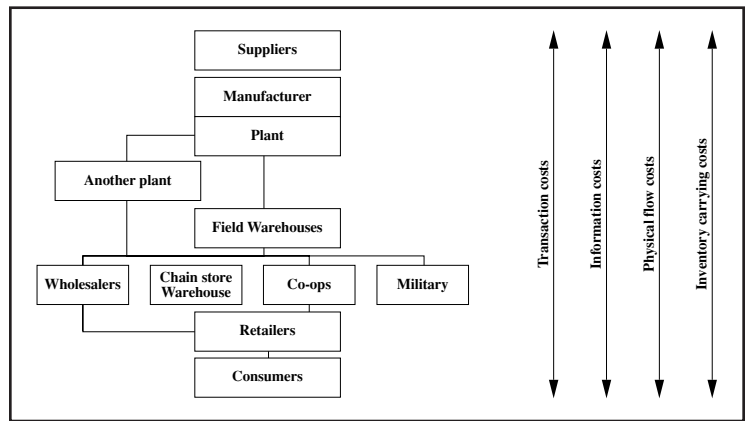
FIGURE 5
KEY ELEMENTS IN ASIAN SUPPLY CHAIN



Zubrod 1998, p. 14.

FIGURE 6

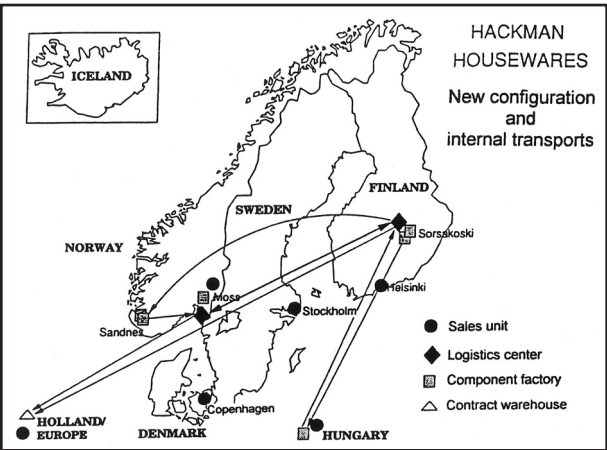
PROCESS AND ACTIVITY COSTS SPANNING THE SUPPLY CHAIN



La Londe and Pohlen 1996, p. 5.

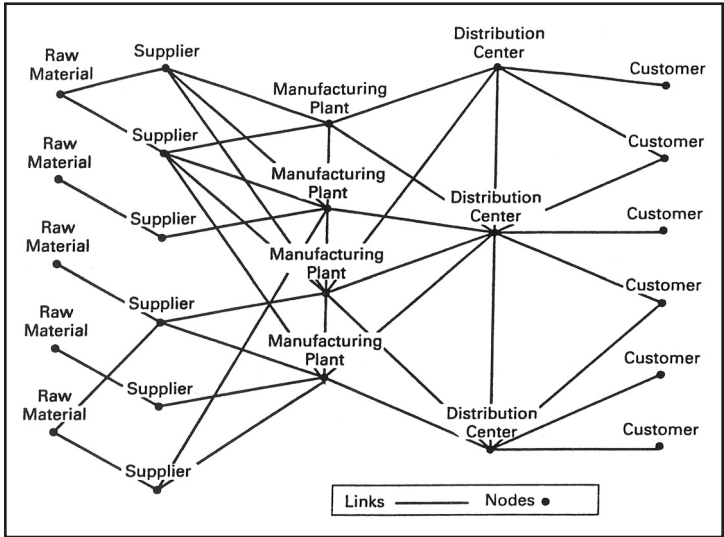
FIGURE 7

HACKMAN HOUSEWARES, NEW CONFIGURATION



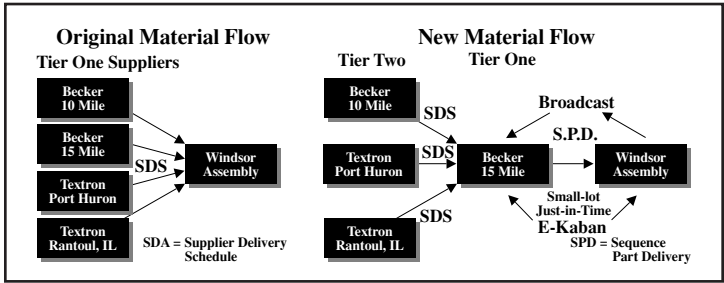
Juga 1995, p. 78.

FIGURE 8
THE “NETWORK” NATURE OF SUPPLY CHAINS



Mariotti 1999, p. 72.

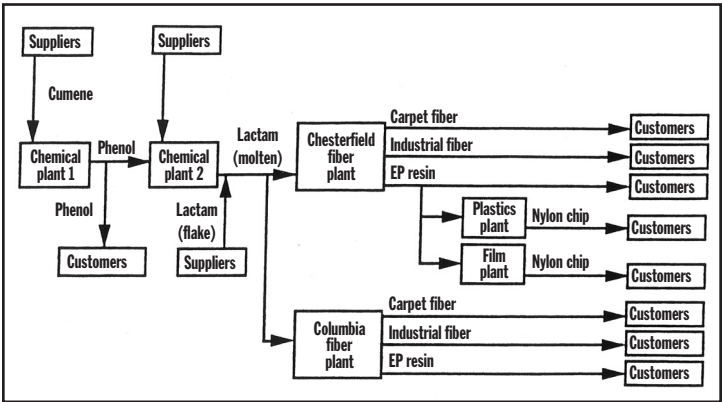
FIGURE 9
THE WINDSOR OPERATION: BEFORE AND AFTER



Stallkamp 1998, p. 21.

FIGURE 10

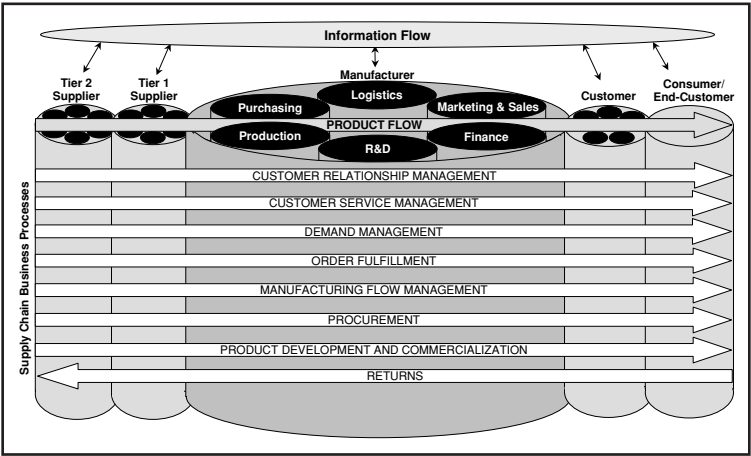
ALLIEDSIGNAL POLYMERS: NYLON VALUE CHAIN INSIDE ASP



Fine 1998, p. 113

FIGURE 11

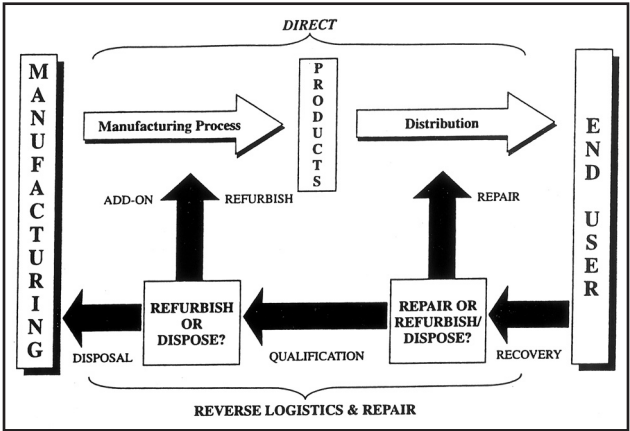
SUPPLY CHAIN MANAGEMENT: INTEGRATING AND MANAGING BUSINESS PROCESSES ACROSS THE SUPPLY CHAIN



Lambert, Cooper, and Pagh 1998, p. 2.

FIGURE 12

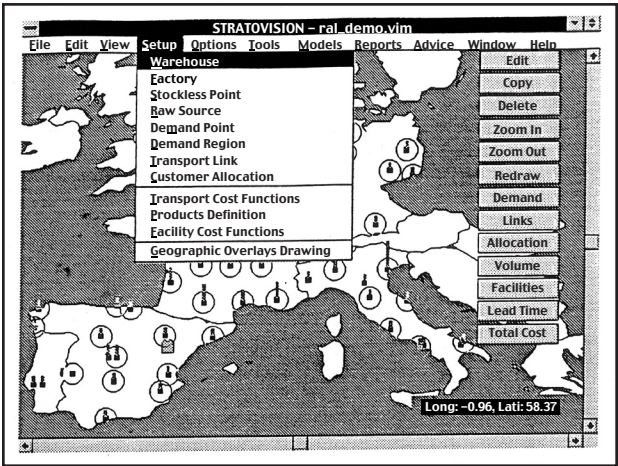
DIRECT AND REVERSE LOGISTICS AND REPAIR SERVICES CYCLE



Blumberg 1999, p. 142.

FIGURE 13

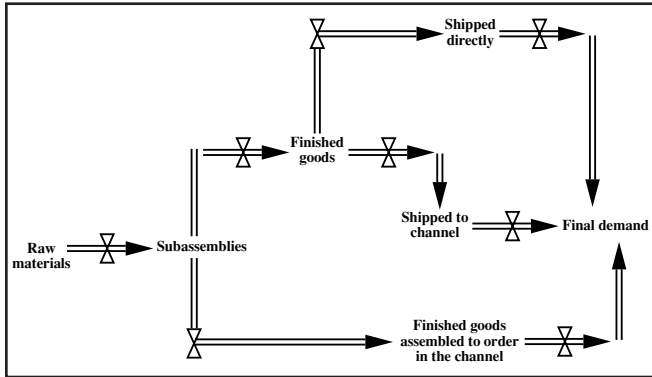
STRATOVISION SETUP MENU OPTIONS



Guedes, Saw, and Waller 1995, p. 46.

FIGURE 14

STANDARD PC-INDUSTRY SUPPLY CHAIN



Fine 1998, p. 75.

Geometry

Geometry includes the number of tiers, the degree of aggregation, and the inclusion of explicit spatial relationships. The number of tiers can be described by direction and length. The *direction* can be up the channel (Supplier-Oriented) from the focal firm, down the channel toward the final consumer (Customer-Oriented), or both. As used here, *length* is the distance out from the focal firm. The length is the number of tiers in either direction from the focal firm, not including the focal firm, e.g., 3/2 would indicate three tiers up and two tiers down from, but not including, the focal firm. An industry-centric view, with no focal firm, would include the longest span in the diagram with no slash. The length of a cyclical diagram, including recycling, is the longest span before becoming recursive. Other definitions of length are possible but may lose their descriptive nature for a firm-centric supply chain map. Figure 3 is a “Customer-Oriented” 0/2 example. Figure 4 is in “Both” directions and 4/4 but potentially an n/n depiction of a supply chain.

The geometric width of a supply chain map is a measure of the aggregation within a tier. The supply chain literature uses both linear and tree-style maps. A single box for an entire set of organizations at a given tier would represent a high degree of aggregation such as Figure 5. Figure 6 shows a medium level of aggregation below the field warehouse, indicating wholesalers, chain stores, co-ops, and military. None of these have specific store names associated with them. A low degree of aggregation would name and depict at least some specific organizations at a given tier level, for example, listing small retailers as one box along with Wal-Mart and Target as separate boxes.

The degree of generalization is analogous to the scale of a traditional map. For a strategic approach, the degree of generalization should not be too low. A map with a high degree of generalization has been used by a leading foodservice organization with tens of thousands of restaurants worldwide. The firm receives its products from suppliers, many of whom are strategic partners. From the beginning, the firm has taken an approach of closely managing the relationships with their key suppliers. The managers coordinate multiple tiers up the channel as well as connect to the end consumer. Understanding a broader perspective of the supply chain helps the firm to be competitive and innovative. With an appropriate map, the firm has proprietary information organized to help analyze its supply chain and to evaluate its performance. The more generalized approach allows for viewing of many tiers in the supply chain in a meaningful way.

However, a cement company used a tree approach and captured more detail at each tier, yet left the degree of generalization high. One of the world's largest cement manufacturers employed a mapping process in one of its international divisions to assess the current supply chain and contemplate revisions to it. The authors observed the current supply chain being mapped in preparation for examining whether the structure should be changed to better meet market requirements. In the above case, a map of at least a portion of the supply chain was created by management for analyzing and potentially reorganizing its supply chains.

Spatial maps would include explicit geographic representation. While cartographers might insist that a true map has spatial relationships depicted, for a supply chain map this information could be present or absent. This information could be represented either superimposed on a geographic map or through proportional distances on a diagram. Figure 7 is clearly a geographic map.

Perspective

Perspective is another means of characterizing supply chain maps. Focal point and scope are used to describe the view depicted by the supply chain map. A supply chain map can take a perspective from a focal firm, or a perspective that includes a competitive set of firms. Thus, firm-centric and industry-centric views are both possible as focal points. Figure 4 is firm specific while Figure 8 is industry-specific.

Scope includes product breadth, supply chain perspective, process view depth, and cycle view. The supply chain becomes more complicated when moving from mapping only a specific component of a product up through the SBU level. Including a whole company with diverse divisions would produce a very complex supply chain map, although it might be helpful to identify common suppliers and customers. A good map will clarify the *breadth* of products encompassed. Figure 9 is at a plant making different car and van models within one SBU. Figure 10 is for a specific product.

Some maps labeled as supply chain maps appear more restricted in their viewpoint than many definitions of supply chain management imply. In particular, the Council of Logistics Management defines logistics as a subset of the supply chain (CLM 2001). The *supply chain perspective* attribute is a simple yes/no assessment regarding the broader view of supply chain management under-

lying the map. Figure 11 shows both tiers and processes. The next attribute, *process view depth*, captures the number of key business processes included in the map. Figures 11 and 12 indicate high and low levels of process depth view, respectively.

Supply chain maps can depict flows of physical goods or can be *cyclic* in nature. A flow map would follow raw materials through to final consumers, for instance. A cyclic map might follow the delivery of a service or the procedures for returns, recalls, and recycling efforts, such as Figure 12.

Implementation Issues

Implementation issues indicate how the map will provide information and will be disseminated. Information density is the amount of information integrated into the visual display. The choice of information to display for each link and each node will differentiate a supply chain map from a strategic supply chain map. A link would likely be a movement, a flow, or a process, and a node would be an organization, a value added process location, or an SBU. Conventions are needed that specify whether information is most logically related to a node or a link, as well as a clear set of potential variables to incorporate. Maps with only link information or only node information are possible. Figure 13 indicates high information density within the map while Figure 14 contains little information.

If the map is dynamically linked to a database then it can be redrawn easily as conditions change, or displayed differently depending on user needs as depicted in Figure 13. In order to get high information density without getting bogged down in an endless search for input data, a strategic supply chain map could have a direct link to one or more databases already available within the supply chain.

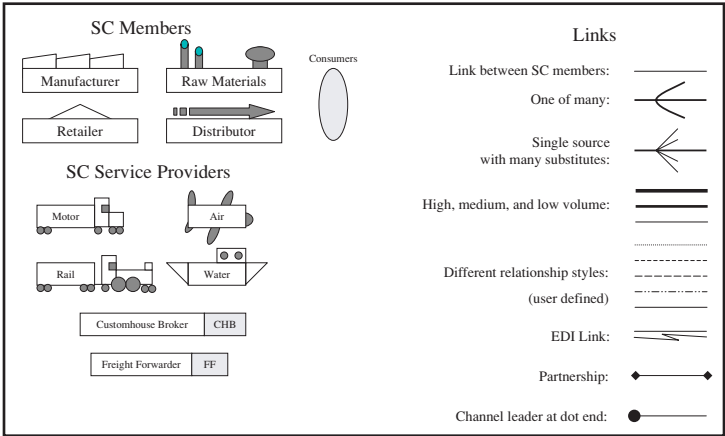
A relatively new concept in cartography is the idea of a geographic information system (GIS) that can directly drive the electronic production of updated maps (Longley and Clarke 1995, pp. 3-8). The database connection allows individual users to access unique maps according to their needs. A supply chain map, which can similarly be driven from a database, would allow customization for various users, e.g., different channel members or different organizational units.

There are a number of delivery modes possible for a strategic supply chain map. Paper is traditional, widely accepted, and not platform dependent. However, it is not flexible and can be more expensive to disseminate and update. An electronic delivery mode allows for constant updates. Electronic dissemination could range from e-mailing a simple map file to forwarding an interactive program that allows custom viewing. As a special case of electronic delivery, the web offers additional convenience, immediacy, and customization, but has attendant security concerns.

What would a set of mapping conventions look like? Figure 15 offers a set of conventions loosely derived from the lean manufacturing model (Rother and Shook 1999). The set of conventions is by no means complete. For instance, process information is not included but would likely be important in most supply chain mapping exercises. The role of size, color, shares, pies, etc., is not specified yet offers more dimensions of visual communications.

FIGURE 15

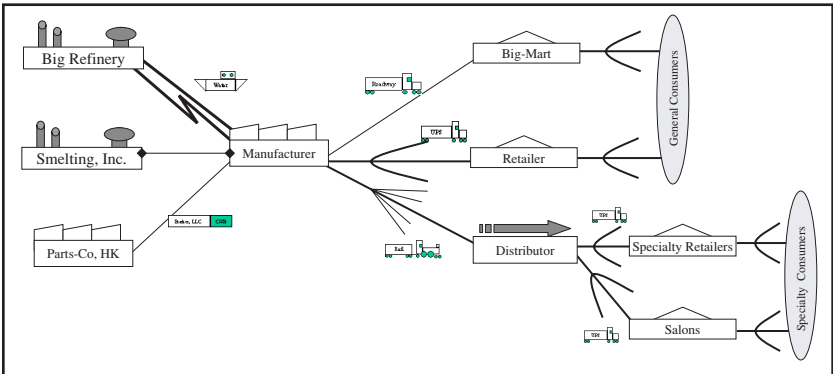
SAMPLE SUPPLY CHAIN MAPPING CONVENTIONS



The sample map in Figure 16 is one example from the many possibilities represented in Table 2. This supply chain representation: 1) depicts both directions, two tiers down and one up, 2) has a high level of aggregation, 3) is not spatial, 4) chooses a manufacturing firm focal perspective, 5) is not clear from visual inspection as to the product breadth, 6) may or may not take a supply chain perspective, 7) shows no process depth, 8) does not show a cyclic view, 9) is low in information density, 10) may or may not be database linked, and 11) is delivered by paper. The map maker and user should both understand information within the attributes included as well as the limits due to the attributes excluded.

FIGURE 16

SAMPLE MAP OF A HYPOTHETICAL SUPPLY CHAIN



The hypothetical scenario of the chain depicted could be a hair products company that has a partnership with the smelter, for the cans, and EDI links with the big refinery for some of the chemical components. There are four channels to two market segments. Different logistics service providers are depicted as well. Not shown are any strategic information boxes which could enumerate specific data about links and nodes. A strategically valuable map would include more specifics and be tailored to the specific competitive environment.

A good strategic supply chain map should be easy to build and use, comprehensive yet not overly detailed, strategic in focus, intuitive in use of visuals, effective in building alternatives, and well integrated into the strategic planning process. Nothing in this wish list definitively directs the choices outlined in the above paragraphs. Not every possible combination from Table 2 would qualify as a *strategic* supply chain map.

RISKS OF MAPPING

Some compelling reasons to produce a strategic supply chain map have been outlined. However, there are some concerns that firms must address before publishing such a map, either internally or externally. These risks include giving away competitive information, changing the chain dynamics, getting lost in too many details, and providing an ineffective perspective for management use.

Firms must be careful about providing more data than channel partners or firms need for their contributions to the supply chain, inadvertently giving away competitive information. Selecting the material to publish with the map will be critical here. Giving away component prices that competitors can view should clearly be avoided. On the other hand, brand share data and movement data down the channel are often easily accessible through individual retail information systems or through data collection firms, such as Information Resources, Inc. However, brand share data concerning suppliers, which is not as easily known, can cause channel conflict. Including retail share data in a distributed map, while sensitive, may not be a critical risk. The same data in an environment without the alternative data sources could be very detrimental.

A second concern is inadvertently changing the channel dynamics. Just seeing how a firm fits into the big picture can change the perception by channel members of their roles and relative importance, as the Hawthorne effect suggests. As a road map clearly differentiates city size and road size, a supply chain map that displays similar characteristics may be of concern to both the firm publishing the map and the other channel members. On a positive note, it can let competing suppliers or customers know where they stand in terms of importance to the firm. This relative standing could be generally known but perhaps not the specific ratio of volume of business, for example. It can make suppliers or customers more motivated to increase or hold on to market share.

Even if the map starts by using only a few pieces of information from a database, the tendency can be to continually add one more item that could help increase understanding from a tactical perspective. The purpose of the map is strategic and should stay as such. It is not a network model to be rerun for next week's or next month's production and distribution schedule. The detail provided

by the map must be continually managed to avoid otherwise inevitable expansion of data contained in or linked to the map.

A fourth issue, which follows from the previous three, is to carefully analyze what defines the map. What is the scope of the map? What variables should be used to construct the map? Which variables should be omitted? Are there a set of key elements that should be present in any strategic supply chain map, and a set of optional, situation-specific elements?

Answering the questions about what style of map will be used helps to define a perspective. Choosing a perspective without considering the inherent limitations on resulting supply chain strategies is a subtle risk. There may be things that are hidden based on the chosen perspective. For example, by omitting additional tiers, competitors, etc., potential supply chain strategy redesign options are obscured. A perspective that is too global or too detailed could make other options opaque.

LINK TO STRATEGY

The purpose of the mapping issues addressed here is to assist with strategic decisions regarding supply chain configuration and performance. Therefore, a key consideration is how the map will be used in conjunction with the firm's strategic planning and supply chain strategic planning (Kaplan and Norton 2000). There are different approaches to integrating supply chain mapping with strategic planning. One approach is to integrate mapping into the strategic planning process. Another is to perform them separately. Mapping could be a central part of the environmental scan. The "what is" map is constructed or consulted during this phase of planning as part of performance evaluation. If the firm starts with a clean sheet for considering what the corporation should be in the future, then the map construction may follow after the corporate strategy is determined and the supply chain approach is decided.

Once a prescriptive map is produced, it is useful as a basis for examining performance of the supply chain as long as the appropriate measures are part of a database underlying the map. The strategic intent is compared with the map to assess whether the current supply chain can achieve the desired goals. A continual evaluation of the supply chain's structure should occur as the current business environment becomes more global and more web-based. The planning and evaluation process cycles thereafter. The current supply chain is evaluated and, as a result of the strategic planning process, may be reconfigured.

SUMMARY AND FUTURE RESEARCH DIRECTIONS

This paper has suggested a need in the supply chain literature for a mapping convention or set of mapping conventions that will help executives to instantly recognize the kind of map being considered and some knowledge of the database underlying the map. The definition of supply chain management has evolved into one that spans functions or processes within firms and across firms from raw materials to the end consumer. This can be a very complex, even endless, map if it truly includes all customers and suppliers at all tiers. To be useful, boundaries must be set for drawing particular maps.

We have suggested a definition of a supply chain map that indicates boundary setting and a strategic view. Compelling reasons to create a map were suggested. The need for a supply chain mapping convention has been demonstrated. These conventions are necessary for instant recognition of the type of map and the purpose of the map, yet they permit customization by the user.

The role of a strategic supply chain map is to enhance strategic planning within a firm and across firms, as well as across processes and functions. This clearly distinguishes it from process mapping which is more tactical, usually within firm, and focused on one process at a time. Research is required to identify the interaction of the strategic level of mapping and the more tactical levels. Are the strategy tools merely more concise summaries of the detail-oriented, tactical maps or are entirely separate styles and processes needed?

The characteristics of a map have been grouped by geometry, perspective, and implementation issues. Other considerations include providing strategic information about each node and link included as well as the acceptance of a standardized set of icons and symbols for drawing the map so it is as interpretable as a road map. The need for conventions should not supercede the need for creativity in building and depicting strategy. There is a role for professional organizations in coordinating the development of a set of mapping conventions. A dialog should be started and prior efforts respected.

The risks of mapping include questions of access and the amount of detail provided. The results of not carefully considering the consequences of these risks include losing competitive information, creating more competition or strife within the chain, bogging down in detail, and not generating a map that is useful for strategic management decisions. Research into the uses and misuses, as well as the value and costs of building strategic maps would be valuable.

A strategic supply chain map is linked to strategic planning for the firm and for the supply chain. The map is a tool to help visualize the supply chain as it is and as it can be. Maps may be constructed as part of the planning process during the environmental scanning phase or they can be constructed as a result of a change in strategic direction. Research into the implications of integrating the mapping process into the strategic planning framework is in order. Should the environmental scan start with a supply chain map? How would this interact with strategic planning models, such as Porter's five forces model (Porter 1980)?

Based on the review of the literature and discussions with managers, we call for the development of a managerial mapping procedure. There should be specific procedures for developing and modifying a strategic supply chain map. A description of who should be involved in the process is important. Different management levels and responsibilities should be included to make sure different perspectives are included. A clear understanding of the purpose of the map, its boundaries, and the benefits must be outlined. Finally, there should be a methodology to strategically determine future supply chain configuration and the progression from what the current structure is to what a redesigned supply chain should be.

There needs to be research focused on the process for building the map so that it is useful for strategic planning purposes. It is not necessarily a spatial map but it could be a conceptual map or a diagram. The map should capture multiple levels of the supply chain, cover more than logistics and manufacturing functions, and should be information rich without reaching information overload.

Supply chain mapping is strategic and different from process mapping or network mapping. With the right approach, a strategic supply chain map should offer major advantages in building innovative, current, effective supply chains offering sustainable competitive advantages. There are compelling reasons to map. Related to each of these is a risk to the firm. More work is needed to make the mapping process and the uses of maps more powerful.

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