UNCERTAINTY and the SEAMLESS SUPPLY CHAIN

By Steve Geary, Paul Childerhouse, and Denis Towill

The "seamless supply chain" sounds like the business management version of Utopia: a perfect flow of information and materials facilitated by all supply chain partners thinking and acting as one. Yet research conducted by the University of Cardiff in Wales suggests that the seamless supply chain is not just a theoretical concept but, rather, a realizable goal. This supply chain nirvana, however, can only be reached by reducing sources of uncertainty throughout the extended supply chain.

"We sail within a vast sphere, ever drifting in uncertainty, driven from end to end. When we think to attach ourselves to any point and to fasten to it, it wavers and leaves us; and if we follow it, it eludes our grasp, slips past us, and vanishes forever. Nothing stays for us."

—Blaise Pascal (1623-1662), French scientist, philosopher

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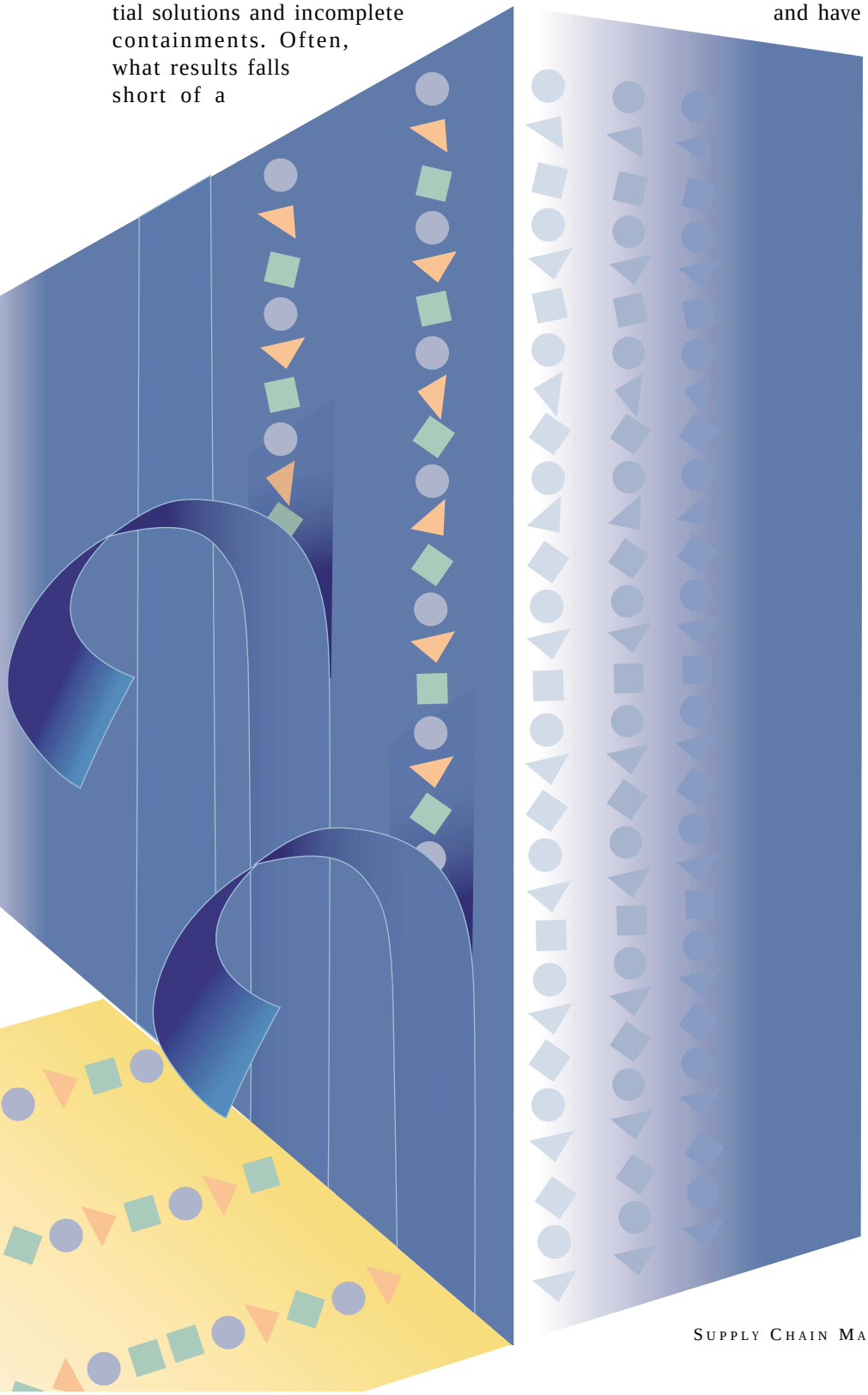
Uncertainty rules the supply chain. Sales deviate from forecast. Components are damaged in transit. Fabrication yields fail to meet plan. Shipments are held up in customs. In truth, schedule execution is just a roll of the dice.

Supply chain professionals spend their days reacting to uncertainty, to managing the consequences of the unknown. Because supply chain performance is inherently unpredictable and chaotic, supply chain practitioners often must seek safety mechanisms to protect against disruption. Today, the typical supply chain professional expends significant effort to expedite orders, check order status at frequent intervals, deploy inventory

"just-in-case," pad leadtimes, or find other creative ways to buffer themselves against disruptive events. All of these costly activities are the direct result of uncertainty caused by a lack of visibility and clear two-way communication among all participants in the supply chain. On the rare occasions when there is time to reflect on this uncertainty, these professionals only have time to construct partial solutions and incomplete containments. Often, what results falls short of a structured plan to improve performance.



In a world where economic markets are incredibly volatile, however, it is imperative that we understand the true implications of uncertainty in the supply chain. Researchers at the Logistics Systems Dynamics Group (LSDG), Cardiff Business School, Cardiff University in Wales have explored the issue of uncertainty in automotive industry supply chains and have established a relationship between best-in-class supply chain practices and levels of supply chain uncertainty. Exploration of the LSDG results and of related research indicates a relationship among uncertainty reduction, best-in-class operating practice, integration, extended visibility across the supply chain, and business success. To combat uncertainty and improve performance, companies therefore need to work toward enabling what we call the seamless supply chain. The seamless supply chain is an idealized concept of perfect information flow and perfect material flow, facilitated by all supply chain players thinking and acting as one. Yet, although it is an idealized concept, the seamless supply chain is not beyond reach in reality. In fact, there is a well-trodden path in that direction that relies on best practices and extended visibility. Supply chain leaders who follow this path will be rewarded with improved business performance.

Supply Chain Integration: The Evolution

Historically, there have always been supply chain leaders. Although absolute performance levels have consistently improved over time, every era has had organizations that distinguished themselves from the population at large. For example, in 1574 the Venice *arsenalotti*, or master ship builders, were capable of delivering a warship every 24 hours. In 1851, just-in-time (JIT) methods were successfully applied on a large scale during the construction of the Crystal Palace in London.[1] Over the course of six months, prefabricated components were transported from Birmingham to London on time with very little waste. A century later during World War II, manufacturers set up very effective supply chains to produce fighter aircraft, ships, and land vehicles. These highly efficient supply chains achieved order-of-magnitude improvements in throughput and cycle

time during just a few short years.

Despite this impressive history of supply chain management, good practice is still far from the norm. For example, Joseph Andraski, vice president of a leading American food products supplier, estimates that in the retail sector, only about 7 percent—at most 10 percent—of supply chains are operating effectively. (And this is a vertical that many companies use as a performance benchmark.) Likewise, Jack Burbidge, a consultant and academic, surmises that only 10 percent of all manufacturers are adopting smooth material flow principles in their production and delivery channels.[2]

In a world where economic markets are incredibly volatile, it is imperative that we understand the true implications of uncertainty in the supply chain.

According to The Performance Measurement Group (PMG), a supply chain benchmarking subsidiary of consultancy PRTM, a well-organized company can generally execute successfully at the 90+ percent level.[3] While this means that any one of a set of 10 scheduled events is highly likely to have a favorable outcome, simple probability calculations also indicate that there is only a 35 percent chance that all 10 will successfully happen. Simple mathematics demonstrate a disturbing likelihood: An organization facing a very simple scenario that requires the coordination of only 10 independent events will most likely fail to deliver two times out of three. Because no one can predict which of the 10 scheduled events will fail to be executed, a supply chain professional must be prepared for any of the 10 to fail. Uncertainty prevails.

This unsatisfactory situation exists despite new developments in technology and supply chain best practice that, when utilized effectively, can enable improved supply chain performance. We have powerful technology, which includes the Internet, advanced visibility solutions, sophisticated planning technologies, electronic data interchange, and emerging XML-based communication, as well as incredible raw computing power. We also have proven practices in the areas of flexible manufacturing, automated warehousing, and rapid logistics. Finally, for years, thought leadership has been consolidating around the following closely related best practices:[4]

- **Simplicity.** The adoption of solutions that have already been proven, such as inventory reduction, simplified processes and products, flexibility, and commitment to continuous and incremental improvement.
- **Smooth Material Flow.** The progressive achievement of tasks along the value stream so that a product proceeds from design to launch, from order to delivery, and from raw materials to a finished product in the hands of the customer with no stoppages, scrap, or backflows.
- **Value Stream Management.** The effective management of specific activities required to design, order, and provide a specific product. Value stream management also makes sure that products move, in a more effective fashion, from concept to launch, from order to delivery, and from sourcing of raw materials to delivery to the customer.
- **Lean Thinking.** A philosophy that seeks to shorten the time between customer order and product delivery by eliminating sources of waste and delay. Lean is "a way of thinking" for adapting to change and continuous improvement. It provides a structure and a philosophy that ensures that tasks are performed and value-added activities are linked in the most effective way possible.

All of these concepts focus on the same guiding supply chain principles: reduce friction, eliminate waste, and drive velocity through the supply chain. If they are deployed across the extended supply chain, they will drive the enterprise toward establishing a true seamless supply chain.

For many of today's supply chain practitioners, these four concepts may seem "old hat." Yet Andraski, Burbidge, and PMG still see significant room for improvement in supply chain performance. This implies that it is the selection and deployment of these tools—not the creation of the tools themselves—that might be preventing organizations from reaping the benefits. It is, therefore, imperative to understand the major obstacles to achieving a seamless supply chain. We need to understand where we are today in terms of supply chain practice. Are our supply chains really this bad? And if so, what steps have been taken by leading organizations as they have strived to achieve a seamless supply chain?

LSDG's Research on the Auto Industry

To answer these questions, Cardiff University's Logistics Systems Dynamic Group performed a detailed audit of 32 European value streams in the automotive industry. The term "value stream" became popular following publication of the book *The Machine That Changed the World* a decade ago by researchers at the Massachusetts Institute of Technology. A value stream focuses specifically on a product or group of products. A supply chain, then, can be thought of as a bundle of value streams. The majority of the companies in the audit were located in the United Kingdom and were in the automotive component and subassembly sector servicing both European and Japanese carmakers. Several provided an opportunity to study multiple supply chain value streams within the same business. By taking this close look at the auto industry, LSDG hoped to determine the present operational state of European supply chains and likely future operating scenarios. The team members also wanted to design a road map describing how value streams can move toward those future scenarios.

Much of LSDG's work grew out of its already existing expertise in material and information flow and previous work

done by other research groups on the automotive industry. *The Machine That Changed the World,* for example, explores the evolution of the supply chain in the automotive industry and traces the development of lean manufacturing as a discipline.[5] This book describes the steps necessary to achieve the seamless supply chain in the automotive industry. There is no doubt that *The Machine That Changed the World* has been successful in sounding a wake-up call in support of lean thinking. For example, because of the book, we now know that the typical automobile mass production system has two weeks of parts inventory, yields 130 assembly defects per 100 cars, and consumes 31 labor hours to assemble a car. In contrast, a world-class lean automobile mass producer only holds *two hours* of parts inventory, has only 45 defects per 100 cars, and requires just 19 hours to make a car.[6]

Supply Chain Uncertainty

As LSDG's work progressed, researchers began to look at their findings within the context of supply chain uncertainty. Addressing the problem in this light is a logical extension of previous work done in simplicity, smooth material flow, value stream management, and lean thinking, given that the ultimate goal of each of these best practices is to reduce uncertainty in the supply chain.

Supply chain uncertainty can be classified into four general types: process, supply, demand, and control.

- **Process uncertainty.** Process uncertainty affects an organization's internal ability to meet a production delivery target. The amount of process uncertainty can be established by understanding each work process's yield ratios and leadtime estimates for operations. Also, if the particular product delivery process is competing against other value streams for resources, then the interaction between these must be studied and codified.
- **Supply uncertainty.** Supply uncertainty results from poorly performing suppliers' not meeting an organization's requirements and thereby handicapping value-added processes. It can be evaluated by looking at supplier delivery performance, time series of orders placed or call-offs and deliveries from customers, actual leadtimes, supplier quality reports, and raw material stock time series.
- **Demand uncertainty.** Demand uncertainty can be thought of as the difference between the actual end-marketplace demand and the orders placed with an organization by its customers. Demand uncertainty can also be quantified by measuring how well companies meet customer demand. For example, poor on-time delivery or fill rates are often a result of demand uncertainty, though this is not always the case. If a customer suddenly places a weekly order that is twice the typical order size, it may be the result of a shift in underlying demand or it may just be that the customer has modified safety stocks or ordering rules.
- **Control uncertainty.** Control uncertainty is associated with information flow and the way an organization transforms customer orders into production targets and supplier raw material requests. The level of control uncertainty can be determined by comparing customer requirements, supplier requests to deliver, and production targets over the same time periods. Control uncertainty is driven by the algorithms and control systems that are used to transfer the customer orders into production targets and supplier raw material requests. In a pure demand-pull environment, the linkage between supply and demand is clear and control uncertainty is eliminated. However, companies typically use order batching and lot sizing, which obscures the linkage between demands placed and true requirements.

Each of these uncertainties creates a drag on operational performance. However, supply chain professionals often are so busy dealing with the fallout from uncertainty (such as stock-outs, missed shipments, and oversupply) that they do not have time to attack the root cause of the problem. The issue has been complicated even further over the course of the last decade by the movement away from the vertically integrated supply chain. Now, rather than confronting the uncertainty generated just by activities within the operational domain of a single organization, we must manage uncertainty across a host of supply chain participants. Outsourcing, the virtual organization, and modular manufacturing all contribute to supply chain uncertainty issues. All of this makes it more important now than ever before to understand the relationship between supply chain performance and uncertainty.

Supply Chain Practice Today: Where Are We Now?

To evaluate the level of uncertainty in the value streams that they were studying, LSDG researchers developed performance indicators for uncertainty within a structured survey format. Under the LSDG index, an uncertainty index of one indicates a low level of supply chain uncertainty, and the highest index of four correlates to supply chains facing high uncertainty. The uncertainty level is considered to be low when the value stream delivers to the marketplace what has been ordered, on time, at the right quality and quantity, and with little waste. It is the target that all supply chains strive to achieve. High uncertainty results from this target's being disrupted by such factors as a customer-induced bullwhip effect; unpredictable value-added processes; poor vendor performance; and the control system using stale, noisy, or incomplete data. Under these conditions, supply chains exhibit somewhat chaotic and reactive behavior and unpredictable performance.

The LSDG audit team members used this scale of one to four to codify each of the value streams that they studied. Their judgment was based on a wide variety of inputs acquired during the audit. These inputs typically included process maps, productivity data, schedules, time series, activity sampling, company accounts, and feedback from structured interviews. Analysts also had to complete extremely focused checklists on the existence or absence of specific

phenomena and operating conditions that are associated with uncertainty.

The results of the audit are shown in Exhibit 1. The pie chart classifies the supply chain value streams according to their uncertainty scores. About 10 percent of the value streams studied received an overall uncertainty index of four. These value streams demonstrated minimal control over their own processes and had not successfully applied material flow and lean thinking concepts to their operations. Another 45 percent had an uncertainty index of three. They were in various stages of implementing lean thinking concepts and had already reduced some of the uncertainty in their value stream. Approximately 35 percent had reduced their uncertainty levels even further to an index of two and engaged in supply chain practices that went significantly beyond internal integration. Finally, 10 percent of the organizations in the audit can be regarded as rapidly approaching the seamless supply chain. They have an uncertainty level of one and, at this point, can be regarded as examples of world-class performers.

The *bad news* is that the Cardiff LSDG audits confirm Andraski's pessimistic characterization of current supply chain operations. Only 10 percent of the participants are demonstrating best-in-class behavior and experiencing low uncertainty scores. The *good news* is that an additional 35 percent of the value streams sampled are making progress toward the seamless supply chain. This means that nearly half the sample has at least some practices worth emulating. So although our survey confirms the Andraski/Burbidge "snapshots," we do see that industrial practice is heading in the right direction.

The research on industrial practice has also demonstrated that there is a substantial payoff from successful applications of lean thinking, smooth material flow, and other best practices to specific business processes. Exhibit 2 shows some typical results recorded by a first-tier automotive supplier servicing both original equipment manufacturers (OEMs) and the after-market spares market. The results were measured by the host companies and audited by LSDG. These results shows substantial improvements. As the supplier moves closer to the goal of the seamless supply chain, it becomes more in tune with both its customers and the marketplace, providing competitive advantages to participants across the entire chain.

EXHIBIT 1

Supply Chain Characteristics Displayed by Value Streams in LSDG Audit

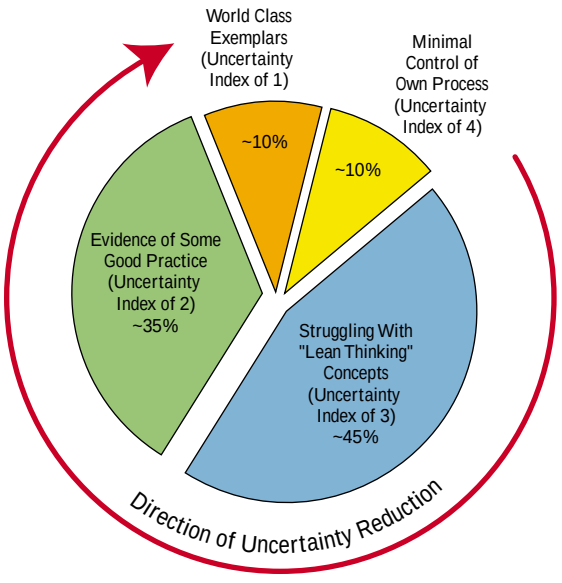


EXHIBIT 2

Typical Performance Improvements Obtained via Smooth Material Flow

PERFORMANCE METRIC	OBSERVED	BENEFIT
Leadtime	Down	7 to 1
Set-up Time	Down	3 to 1
Production Runs/Annum	Up	4 to 1
Rejects/Million Parts	Down	2.5 to 1
Overdue Orders	Down	4 to 1
Annual Sales	Up	by 1/3
Return on Investment	Up	by 1/3

This heightened proximity to the customer reinforces the movement toward integration beyond the four walls and visibility across the extended supply chain. This increased integration, in turn, leads to lowered uncertainty and improved performance. Thus, the seamless supply chain becomes a self-fulfilling prophecy: Lower uncertainty leads to tighter integration, which reduces uncertainty further, and the cycle continues.

Stages of Supply Chain Maturity and Uncertainty

The four divisions established by LSDG (minimal control, some application of lean thinking and material flow, evidence of good practices, and world class exemplars) correspond to similar frameworks developed by other research groups. In particular, the group found that its results could be easily superimposed onto a powerful reference framework developed by KPMG's Graham Stevens that outlines a sequence for moving from poor supply chain performance toward the seamless supply chain. As such, the Stevens Reference Framework can be used to assess a supply chain's evolution and maturity level. It also provides a logical and widely accepted structure for defining and managing change programs.[7]

The Stevens Reference Framework divides supply chain evolution into four levels:

- **Level One (Baseline).** Companies engage in reactive short-term planning and "fire fighting." They have large pools of inventory and are vulnerable to market changes.
- **Level Two (Functional Integration).** The emphasis is still on cost, not performance. Companies focus inward on goods and are reactive toward their customers. There are some internal trade-offs.

■ **Level Three (Internal Integration).** All work processes are integrated and the planning process reaches from the customer back to the supplier. Electronic data interchange is widely used. The organization is still reacting to the customer.

■ **Level Four (External Integration).** The supply chain forms an extended enterprise. The organization has achieved integration with all suppliers and synchronized material flows. The focus is on the customer.

Each level of the Stevens Framework can be seen as comparable to the four levels identified by LSDG. At level four in the Stevens model, for example, full supply chain integration is achieved by extending the scope of management outside the company to embrace the suppliers and customers. Inherently, it embodies a change of orientation away from product to customer. A high level of integration with the customer organization is involved in order to understand the products, culture, market, and organization. It also involves integration back down the supply chain to include all supplier partners. The stated aims of full integration are thus seen to be entirely consistent with the establishment of our concept of the seamless supply chain.

The four levels created by LSDG also correspond to "The Supply Chain Maturity Model" developed by the consulting firm PRTM and its benchmarking subsidiary, PMG. Their framework uses four levels (functional focus, internal integration, external integration, and cross-enterprise collaboration) but with slightly different definitions.[8] The Supply Chain Maturity Model essentially combines the Stevens Framework's "baseline" and "functional" categories. However it adds a higher level, cross-enterprise collaboration stage. In this stage, customers and suppliers work strategically to define a mutually beneficial strategy and set real-time performance targets. IT and e-business solutions now automate the integration of business processes across these enterprises.

PMG based its model on research that focused primarily on high-tech supply chains. This research explored the current maturity level within the supply chain. In general, PMG has found that while "internal integration" is the dominant stage of operational capability across most dimensions of the supply chain, the market leaders within various industries are already moving into "external integration." This corresponds to LSDG's findings for the automotive industry's value streams.

PMG has also correlated a company's operational performance with its stage of supply chain maturity. Companies that exhibit significant external integration, and in some cases cross-enterprise collaboration, on average have better performance in on-time delivery to request, upside production flexibility, and total supply chain management costs. Most importantly, the PMG research highlights the business value in achieving the seamless supply chain. Mature companies—those truly concerned with visibility beyond the four walls—have significantly higher gross margins, earnings before interest and taxes, and sales growth rates. These measures are often four times higher than those for transitional companies still grappling with the issue of uncertainty and disintegration.

Identifying a Well-Trodden Path for Effective Change

Having classified the current state of supply chain performance, LSDG wanted to provide companies with a map for reducing uncertainty and improving supply chain performance. Superimposing results from the group's uncertainty research onto the Stevens Framework, as show in Exhibit 3, provides a good starting point. Here the uncertainty index for each level is further broken down into the four types of uncertainty (process, supply, control, and demand). The level of uncertainty is represented by a circle, with a large circle (or a four) indicating the greatest amount of uncertainty and a small circle (or a one) indicating the least amount of uncertainty. As the exhibit shows, more highly evolved supply chains in the external integration stage deal with less uncertainty. Subsequently, a reduction in certain types of uncertainty will cause an increase in supply chain integration.

Once a company has determined its stage of supply chain integration and what type of uncertainty it needs to reduce, it should look for the causes of that uncertainty. In the course of their fieldwork, LSDG researchers developed a list of some of the typical supply chain problems that create each of the four types of uncertainty. They then noted the effects these problems caused in the supply chain. Exhibit 4 on the following page lists some representative examples of the problems that companies must address to reduce uncertainty, increase supply chain integration and maturity, and improve overall performance levels.

For once a company has identified its supply chain level, its goal should be to move to the next level of integration.

EXHIBIT 3

How LSDG Uncertainty Levels Relate to Graham Stevens' Supply Chain Reference Framework

Stage of Supply Chain Integration	Summary of Associated Supply Chain Characteristics	Relative Uncertainty Quantities			
		Process	Supply	Control	Demand
1. Baseline	Reactive short-term planning. Fire fighting. Large pools of inventory. Vulnerability to market changes.	4	4	4	4
2. Functional Integration	Emphasis still on cost, not performance. Focus inward and on goods. Reactive toward customer. Some internal trade-offs.	2	4	3	4
3. Internal Integration	All work processes integrated. Planning reaches from customer back to supplier. EDI widely used. Still reacting to customer.	1	2	2	4
4. External Integration	Integration of all suppliers. Focus on customer. Synchronized material flows. SC covers extended enterprise.	1	1	1	1

This can be accomplished by developing reengineering programs that address the problems that are causing high levels of uncertainty. For example, moving from the baseline level to the functional integration level requires reducing process and control uncertainty. A company may accomplish this by implementing such things as process performance measures, proactive maintenance, more frequent materials resource planning (MRP) runs, and better stock auditing. This process of supply chain reengineering continues until external integration and best-in-class status is reached. The result is the "well-trodden path" of Exhibit 5.

The "well-trodden path" lays out the steps that a typical company would take in improving its supply chain operations. Without a doubt, addressing process uncertainty should be the first step because a company's own processes are the most visible and accessible areas to influence. The next step is to reduce supplier-induced uncertainty, as this is the second easiest area to influence. Demand uncertainty is reduced in the final stages, as it requires a change of focus with the integration of customers. Control uncertainty will be improved as a result of the overall comprehensive change program as better-quality information leads to the use of better and more robust algorithms.

Many successful companies have followed the well-trodden path, resulting in significant improvements to their supply chain. For example, one organization executed a series of improvement programs aimed at taking it from Stevens level two to Stevens level four operations. The particular programs overlapped in time and activity, and covered just-in-time procurement and customer integration. It should be noted that in having originally reached level two, the organization was already a lean thinking exemplar. The organization is now close to "exemplar" status at the much higher level four. This improvement was coupled with an important increase in bottom-line performance, demonstrated by a 10-percent increase in profit margin.

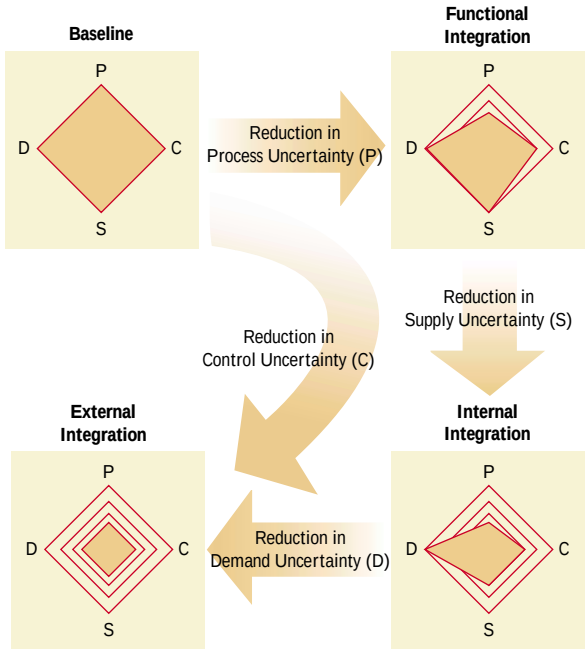
EXHIBIT 4

Typical Problems Associated With Types of Supply Chain Uncertainty

Uncertainty Source Affected	Cause of Uncertainty: Particular Weaknesses Observed in Real-world Value Streams	Effect of Uncertainty: Type of Supply Chain Disruption				
		Data Masking	Data Shortfall	Data Errors	Excess Delays	Excess Variances
Process Side	• No measures of process performance		•			
	• Reactive rather than proactive maintenance					•
	• Random shop floor layout				•	•
	• Interference between value streams				•	•
Supply Side	• Short notification of changes to supplier requirements			•		•
	• Excessive supplier delivery leadtime				•	
	• Adversarial supplier relationships	•		•		
	• No vendor measures of performance		•			
Demand Side	• No customer stock visibility		•			
	• Adversarial customer relationships	•				
	• Large, infrequent deliveries to customer				•	
	• Continuous product modifications causing high levels of obsolescence					•
Control Side	• Poor stock auditing		•			
	• No synchronization and poor visibility among adjacent processes	•		•		•
	• Incorrect supplier leadtimes in MRP logic			•		
	• Infrequent MRP runs			•	•	

EXHIBIT 5

The Well-Trodden Path: Removing Uncertainties in a Particular Pattern Enables Supply Chain Effectiveness



The Payoff of the Seamless Supply Chain

We have seen examples of specific payoffs associated with highly integrated seamless supply chains, but, as with most applied research, the true bottom-line financial impact is only inferred. In Exhibit 6, then, we explore the financial implications of uncertainty reduction and highlight areas of opportunity that will be of interest to the supply chain practitioner.[9] The benefits associated with uncertainty reduction are in many cases context sensitive, dependent on the nature of the industry and the particular supply chain under review. However, at a strategic level, we can identify some logical areas of impact.

The table in Exhibit 6 lists a sample communications or supply visibility initiative that will help reduce each type of uncertainty. Increased visibility is always the key to reducing supply chain uncertainty. This in turn will remove operational drag, improve performance, decrease cost, and increase market share and profitability.

From an internal perspective, reducing uncertainty and establishing a seamless supply chain lead to better asset uti-

lization and lower costs. Buffer inventories may be reduced, which will improve inventory turns and cash-to-cash cycle time. In turn, this leads to lower operating costs including the holding, obsolescence, and operating costs associated with the maintenance of inventory levels. From an external perspective, uncertainty reduction and the seamless supply chain lead to improved business prospects. A company that has predictable supply chain performance can more reliably serve the customer. This generally leads to higher market share, reduced costs, and higher profitability.

EXHIBIT 6

Financial Opportunities of Reducing Supply Chain Uncertainty

Type of Uncertainty	Sample Communication Initiative	Some Associated Financial Opportunities			
		Inventory	Cost	Market Share	Profitability
Supply Uncertainty	Real-time visibility into supplier schedules and inventories allows for commitments based on fact.	Reduced buffer inventories, which reduces investment in inventory.	Lower holding costs, warehousing costs, expediting (freight and human) costs.	Adding supplier availability into the decision-making process allows companies to take advantage of opportunistic sales opportunities based on actual component availability.	Real-time visibility removes friction from the supply chain, reducing total supply chain management costs and improving margins.
Demand Uncertainty	Real-time visibility into channel inventories allows for management of demand fluctuations, market opportunities, and channel obsolescence.	Reduced buffer inventories, which reduces investment in inventory.	Lower holding costs, warehousing costs, expediting (freight and human) costs.	Balanced inventory deployment in response to actual channel behavior creates incremental sales.	Real-time visibility removes friction from the supply chain, reducing total supply chain management costs.
Control Uncertainty	Reconciliation of demand patterns between forecast regenerations allows for the proactive management of schedules, suppliers, and inventories.	Pipeline management reduces cash-to-cash cycle time.	Better stability leads to lower operating costs.	Lost sales due to stockouts mitigated.	Better return on assets (ROA).
Process Uncertainty	Capture of order cycle time information (from requisition generation, through sales order creation and shipment, to receipt) allows for management of order fulfillment leadtimes.	Tighter execution based on predictable cycle times reduces investment in inventory.	Reliable execution against schedule avoids noncompliance penalties.	Management of order life cycle processes leads to more reliable performance, allowing incremental market share growth.	Incremental sales (market share) based on more reliable commitments lead to high margin drop-through.

The Seamless Supply Chain Is Good Business

Best-in-class performance remains an elusive goal for most supply chains, despite a wealth of knowledge and documented best practices and technologies. Uncertainty remains endemic and best practices adoption is spotty, despite research that indicates that the seamless supply chain is not just a theoretical construct but also a reality that can be achieved.

We have seen that the adoption of best practices leads to a reduction in supply chain uncertainty and that less uncertainty results in a more integrated supply chain, extending beyond the four walls of the enterprise. Most importantly, we have seen that the seamless supply chain is highly effective, with documented and dramatic performance improvements. Additionally, we can identify a tremendous number of business performance opportunities, in cost, asset utilization, market share, and profitability—all linked to the achievement of a seamless supply chain. Finally, we have identified proven practices and philosophies, all geared toward designing a change program to integrate the supply chain beyond the four walls and eliminate supply chain uncertainty. Realistic and achievable change programs can be implemented to deliver visibility across the extended supply chain. The seamless supply chain is not an abstract goal: It is real, it is achievable, and it is good business.

Footnotes

[1] Wilkinson, P., *The Shock of the Old ~ a Guide to British Buildings*, Channel 4 Books, London, 2000.

[2] Burbidge, J.L., "Five Golden Rules to Avoid Bankruptcy," *Production Engineer*, Vol. 62, No. 10, 1983, pp. 13-14.

[3] Zonnenberg, J.P. and S. Geary, "What It Means to Be Best in Class," *Supply Chain Management Review*, July/August 2000, p. 47.

[4] The following four bullet points are adapted from J.P. Womack and D.T. Jones, *Lean Thinking ~ Banish Waste and Wealth in Your Corporation*, Simon and Schuster: New York, 1996.

[5] Womack, J.; D.T. Jones; and D. Roos, *The Machine That Changed the World*, Rawson Associates, New York, 1990.

[6] Naim, M.M., "The Book That Changed the World", *IEE Manufacturing Engineer*, Vol. 76, No. 1, 1997, pp. 13-16.

[7] Stevens, G., "Integrating the Supply Chain," *International Journal of Physical Distribution and Material Management*, Vol. 19, No. 8, 1989, pp. 3-8.

[8] Gailius, S. and B. Moncrieff, *Supply Chain Management Signals of Performance*, Vol. 2, No. 6, 2001.

[9] Geary, S., "A Lesson from Cool Hand Luke: The International Supply Chain Demands Special Collaboration," *World Trade Magazine*, August 2001.