

White Paper

Improving Supply Chain Resilience with Network Centric Manufacturing

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Executive Summary

The recent economic crisis has made it impossible to ignore the high costs of disruptions on manufacturing supply chains: they threaten the productivity, profitability, and reputation of every organization in the enterprise. In one recent study, 58% of manufacturing sector respondents had experienced increased disruption and 73% were concerned about disruptions in the coming year.¹

In recent decades, the industry has adopted strategies for improving quality, productivity, and cost control, but we've overlooked the need to improve supply chain resilience—the ability to adapt and thrive in the face of disruption. The emerging Network Centric Manufacturing (NCM) model offers a solution.

In the NCM manufacturing enterprise, hierarchical, static supply chains are replaced with flexible yet highly coordinated dynamic supplier networks that can maintain performance amidst internal or external change. NCM addresses a critical paradox of static manufacturing supply chains—the rigidity that is intended to mitigate risk and support cost control can actually introduce greater risk by limiting the flexibility required to control costs in continually changing environments.

Manufacturing has changed, and now manufacturing supply chain management practices must catch up. This paper will describe the basic concepts of the NCM model and how it can be used to improve resilience across the entire manufacturing enterprise.

Is your manufacturing supply chain resilient?

It can be difficult to pinpoint the source of a problem after a disruption throws your manufacturing supply chain off course. An examination of the following issues will start you on the right path to improve resilience.

>> Can you identify all the suppliers in your key supply chains? If you don't know who your suppliers' suppliers are, you can't effectively manage the chain or mitigate risk.

>> Do you have communications with suppliers at all tiers? The lack of direct two-way contact with all tiers impacts your ability to receive advance warning of problems.

>> How long would it take to reconfigure key supply chains? Companies without workable contingency plans aren't prepared to handle adversity or to capitalize on opportunity.

>> How do you currently mitigate supply chain risk? If the only answer is carrying inventory, there is considerable opportunity for improvement.

Introduction

The recent economic crisis has shown us the downfalls of hierarchical manufacturing supply chain structures built on inflexible and disconnected value chains. Previously hidden costs, inefficiencies, and risks became painfully obvious as budgets shrunk, orders disappeared and credit lines evaporated.

We've learned that disruptions at any point in traditional, rigid supply chains can trigger a ripple effect that reaches the bottom line of each participating organization. Although the recent financial crisis represents an extreme disruption, managing the impact of unanticipated changes is an everyday problem for manufacturing supply chains.

Without the ability to quickly shift gears when these disruptions occur, businesses lack resilience—"the ability of a system to return to its original state or move to a new, more desirable state after being disturbed?" To gain resilience, we must rethink the way that we assemble and coordinate manufacturing supply chains. Both upstream and downstream, organizations in the manufacturing supply chain need communication and coordination strategies that protect their profit margins and reputations from unexpected changes.

It's Time for a New Model: Network Centric Manufacturing

Network Centric Manufacturing (NCM) is a supply chain management approach that leverages the rapid assembly and seamless coordination of dynamic supplier networks to accelerate production, reduce costs, and mitigate risks. It delivers resilience by providing the flexibility to adapt in the face of unexpected change.

NCM is most easily understood by tracing the evolution of manufacturing supply chains. From the earliest days of

mass production through as recently as 40 years ago, most of the effort to manufacture a product took place "within four walls" of a single company. A company could more directly control its own business performance by effectively managing its own work efforts. Collaboration occurred more naturally as those involved could physically assemble around a set of specifications. Management coordinated people and processes with a common master schedule that clearly defined expectations on production sequences and delivery dates. And when problems surfaced, management was on hand to witness and correct them before production and profitability suffered. For the most part, each manufacturer was the master of its own resilience amidst internal and external disruptions.

The movement towards geographically distributed manufacturing supply chains starting in the 1970s was adopted as a means of reducing manufacturing costs by focusing on core competencies and offloading other tasks onto external suppliers. The procurement function—with the primary goal of cost control—became the *de facto* manager of supplier selection. As a result, rigidly composed supply chains became the norm.

As these chains have expanded to include more suppliers and stretch across the globe, they naturally grew in complexity. Today, organizations in the manufacturing enterprise may be operating in different time zones, using different software systems—even speaking in different languages. New technologies address some of the challenges of communicating and coordinating, but they alone have not replicated the cost control and risk management capabilities available in the earliest days of mass production.

NCM acknowledges that the complex, geographically distributed manufacturing supply chain model will continue, but it

reduces the inefficiencies that undermine its performance and ability to withstand disruptions. NCM addresses a critical paradox of static manufacturing supply chains—the rigidity that is intended to mitigate risk and support cost control can actually introduce greater risk by limiting the flexibility required to control costs in continually changing environments.

How NCM Differs from Traditional Supply Chains

NCM requires new strategies and tactics in three core areas: manufacturing supply chain composition; tools and processes; and culture. (See Figure 1).

▪ Composition

At NCM’s foundation is the dynamic supplier network—a framework that enables the customized composition of supply chains based on real-time demands. Unlike the rigid chains that require a degree of predictability in manufacturing supply chains today, the dynamic supplier network delivers value by providing a framework for efficiently adding or swapping out suppliers as needed. With this flexibility, the coordinating organization can rapidly assemble a chain that has both the capabilities and capacity to keep pace with changing demands. This flexibility benefits every organization in the manufacturing enterprise in two critical ways: it provides a means of managing production in unpredictable environments; and it helps mitigate risks associated with a traditional static supplier base.

▪ Tools & Processes

The capability to dynamically assemble and adjust the supply chain requires new tools and processes for communicating, coordinating and collaborating. Today’s manufacturing supply chain management tools and processes function in silos, typically providing a view only into the

workings of a company and its immediate suppliers. This functionality gap makes it difficult or impossible to understand the sources (or impacts) of disruptions at other tiers in the chain. NCM tools and processes provide new capabilities for companies at all tiers to effectively coordinate and communicate, regardless of disparate systems and processes. Thus, all organizations within the distributed enterprise can work together towards common goals such as delivery deadline, quality or cost control. These next-generation tools and processes are designed to bridge the gaps that currently exist between buyers and suppliers, providing improved communication, greater visibility upstream and downstream, and a framework for more collaborative activities at all tiers.

▪ Culture

The change in composition and the introduction of new tools and processes create opportunities to change buyer-seller relationships in ways that can benefit both parties. However, the culture of the manufacturing enterprise must include several attributes so all contributors can

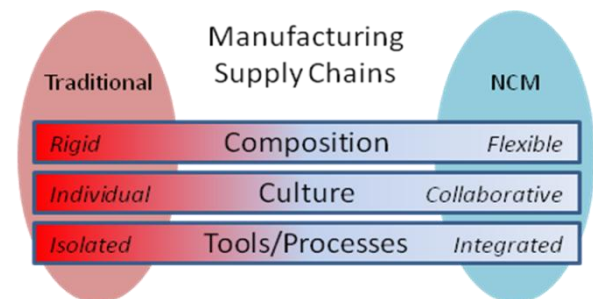


Figure 1

take advantage of these opportunities. At the top of the list is executive sponsorship—the commitment that will drive changes in both the formal and informal culture across the enterprise. The culture must also encourage the sharing of mutually beneficial information more openly, development of

agreements based on common outcomes and incentives for effective collaboration through contractual agreements and performance metrics. As this collaborative culture is embraced, buyers and sellers can not only strengthen the enterprise's resiliency but also open new conduits for product innovation, smarter design, faster problem resolution and greater competitive advantage.

Using NCM to Improve Supply Chain Resilience

We can easily identify the symptoms of a manufacturing supply chain that's crippled by disruptions, but how can we manage and measure improvements in resilience? We believe that the Supply Chain Council's Supply Chain Operations Reference (SCOR®) Model provides a good framework for understanding the following characteristics of a resilient manufacturing enterprise.

Reliability: Delivering the correct product to the correct place at the correct time in the correct condition.

Responsiveness: The speed at which the supply chain provides product to the customer.

Agility: The ability of the supply chain to respond to marketplace changes.

In our discussion, resilience results from *a combination* of these three performance criteria in response to changes happening within the supply network or in its global marketplace. A focus on improving all three metrics can provide a risk mitigation framework that improves resilience. NCM can support companies in their efforts to deliver product as promised, while also equipping them with the tools to see trouble ahead.

Although supply chain management professionals are already familiar with methods for improving reliability, responsiveness and agility from a logistics

perspective, NCM approaches are designed to deliver on all three needs for manufacturing supply chains. Each approach has a strategy, solution and culture component as described at the end of this paper in "Building Resilience with Network Centric Manufacturing." The sections below include some examples of how NCM can offer changes

Improving Reliability

The SCOR model defines reliability as delivering the correct product to the correct place at the correct time. In this performance measurement, the stakes are high for every organization in the manufacturing supply chain. Failure to meet any single criteria—product, place, or time—can result in immediate revenue losses, as well as enduring damage to the organization's reputation.

Investigations have shown that the root cause of these problems often stems from vague, incomplete, or unclear product specifications. In these cases, advanced technical data packages (A-TDPs) have proven to be a valuable NCM-based tool for improving reliability. These files provide suppliers with information such as a 2-D drawing, 3-D model, process maps and CAM data with G-Code. By providing specific, proven manufacturing processes to be followed and a more complete description of the product requirements, both buyers and sellers can mitigate the risks of delivering an incorrect or late product.

Improving Responsiveness

Responsiveness—following the SCOR definition of the speed at which the supply chain provides product to the customer—is important to all manufacturing supply chains, but it is particularly critical and risky for manufacturing enterprises that operate with unpredictable sags and surges in demand. Using NCM, organizations can

mitigate some risks associated with fluctuating customer demands by building a more flexible, diverse supplier network that can respond to demand changes more quickly. That strategy begins with tools and processes that reduce the amount of non-recurring engineering in the process and facilitate supplier interaction across disparate software tools.

Here, too, A-TDPs provide value by reducing the suppliers' time, cost and risk associated with determining how to make the product. In a recent pilot study sponsored by our organization, the buyer provided suppliers with an A-TDP and used a Web-based information-sharing system to give suppliers access to data regardless of their native software systems. The study simultaneously yielded several results. First, the buyer received quotes more quickly because the supplemental information provided suppliers with a more complete picture of the project requirements. Suppliers reduced the total hours required to prepare an RFQ response by an average of 53 percent.

Furthermore, the buyer found that including the A-TDP encouraged a greater number of qualified suppliers to respond to the RFP. The A-TDP removed the typical barriers to quote submission, giving the customer the opportunity to expand their production capacity in spite of a demanding schedule by distributing the project among a number of qualified suppliers.

Improving Agility

To improve agility, manufacturing must focus on two key efforts: identifying qualified suppliers that can contribute to manufacturing supply chains on an as-needed basis; and anticipating when additions or swaps of suppliers will be required.

Typically, manufacturing processes—such as specific machines or processes—are not specified by the customer but rather determined by suppliers that respond to an

RFQ. The supplier's non-recurring engineering (to determine how to make the part) will likely elongate the sourcing cycle each time a new supplier is needed. By including manufacturing process details in an A-TDP, a buyer can quickly screen out suppliers that do not have the desired capabilities and focus on establishing contracts and relationships with suppliers that are best prepared for the job. These organizations became part of the buyer's dynamic supplier network, on the ready to deliver as needed.

As noted above, agility is also supported by an understanding of when an addition or swap out of qualified suppliers is needed. Dynamic supplier networks, which sit at the foundation of the NCM approach, provide an agility advantage over rigid supply chains by enabling rapid changes in response to internal or external disruptions.

Other NCM-based resources can support agility improvements. NASA and the Department of Defense (DoD) are currently developing a tool that integrates a robust database of suppliers and their capabilities with a mapping system that tracks external problems that could impact supplier availability. In the event of a hurricane, for example, the supply chain coordinator would be able to anticipate which suppliers are likely to be affected and immediately identify suppliers out of harm's way that could provide replacement capacity.

What's Driving NCM?

Although NCM is still an early-stage strategy, industry and government are issuing clear signals of movement towards the new model. Executives from Lockheed Martin Aeronautics Company, General Motors, Pratt & Whitney and others cite the following business imperatives as drivers.³

>> **Developing a business model** that includes global delivery and sustainment to satisfy critical customer requirements.

>> **Planning manufacturing production** in anticipation of future product innovations, dynamic global market demands, evolving complexity, and unknown long-term business requirements.

>> **Managing enterprise-wide risk** by introducing the agility that allows the supply chain to be easily reconfigured with minimal disruption or cost.

Sustainment issues are driving pilot projects at the Department of Defense and NASA as they search for new approaches to obtaining critical parts for planes, vehicles, and weapons with longer-than-expected lifecycles and volatile demand. Several military and government agencies are finding that they can only meet these requirements by adopting tools to facilitate more rapid sourcing and production processes and identifying new suppliers that can participate in dynamic supplier networks.

Projects in both sectors are already proving to deliver value to their organizations. Manufacturers that act now to explore their NCM potential, test new approaches, and adopt changes will enjoy a significant competitive advantage.

Getting Started

Unlike other supply chain management overhauls, organizations can find ways to adopt the NCM mindset and prepare for NCM adoption without significant capital investments into new technology platforms or production processes. Much of the effort for enabling dynamic supplier networks lies with the organizations that are creating the connecting standards and technologies.

However, there are several activities that buyers and sellers can take now to prepare for NCM-based projects in the near future.

Improve procurement practices. Buyers should begin by reviewing and adjusting their procurement policies and practices to facilitate the move to dynamic supplier networks. For instance, expanding procurement packages to include manufacturing process data can provide significant results, as demonstrated in our pilot studies. Buyers also should strip out all unnecessary process steps for negotiating and executing contracts. Further, they should revise contract requirements to require visibility into all tiers of the supplier network.

Shift strategy to “Supplier Base Management.” Many companies base their immediate supplier selection on just purchase price with little regard for understanding the roles, positions or contributions of their suppliers’ suppliers. To harness the potential of NCM, companies need new strategies that extend to the entire supply chain. The approach of “Supplier Base Management” calls for actively managing both major and minor suppliers, scouting for new suppliers with the desired capabilities or traits and managing the transition of suppliers into and out of the supply chain.⁴ This approach helps organizations adjust more quickly to demand fluctuations and supply chain disruptions. More importantly, it helps ensure that when companies adjust their priorities and strategies, the entire supply chain will flex with them. Companies that shift to this strategy not only improve efficiencies, they also gain a greater competitive edge.

Create a collaborative environment. Collaboration is the key to success in tomorrow’s dynamic supplier networks. Effective enterprise-wide collaboration begins “at home.” Leadership must take steps to develop a collaborative culture within their own organization.

Create cross-functional problem-solving teams so employees are better able to share ideas, solve problems and communicate with others in different roles. Then, begin including suppliers at multiple levels where possible to extend the team's understanding of external processes and needs. Ingrain these behaviors with clearly defined metrics and accountability in individual and departmental performance reviews.

Conclusion

Ten years ago, no one could have predicted the impact on manufacturing from two wars, a category five hurricane or a financial system meltdown. Yet each of these events has caused significant constraints and disruptions that have been felt throughout manufacturing supply chains across nearly all vertical markets. Although we can't begin to predict what the next ten years hold, we can certainly make sure that our distributed manufacturing enterprises are better prepared.

The emergence of network centric manufacturing provides both buyers and sellers with the means to react and adjust before the damage becomes overwhelming. The NCM solutions emerging today can deliver valuable benefits and position your company for a more resilient future.

¹ "Supply Chain Resilience," Business Continuity Institute, August 2009

² Christopher, M and H. Peck. (2004). Building the Resilient Supply Chain. *International Journal of Logistics Management*, Vol. 15, No. 2, pp 1-13

³ DSN Innovations, NACFAM, and the Tennenbaum Institute, Georgia Institute of Technology. (2009). White Paper of the Network Centric Manufacturing Forum: Going Network Centric Delivers Results.

⁴ Melnyk, Steven A., M. Bixby Cooper, Stanley E. Griffis, John R. Macdonald and Cheryl L.M. Phillips. (2010). Supplier Base Management: A New Competitive Edge. *Supply Chain Management Review*, July/August, pp 35-41

Building Resilience with NCM

A Solutions Guide from DSN Innovations

Network Centric Manufacturing (NCM) is a supply chain management approach that leverages the rapid assembly and seamless coordination of dynamic supplier networks to accelerate production, reduce costs, and mitigate risks. The strategies, solutions, and culture of NCM enable adaptation in the face of unexpected change to help distributing manufacturing supply chains become more resilient. By moving towards an NCM framework, buyers and sellers across the distributed supply chain can improve their agility, reliability, and responsiveness—and uphold their reputation and financial performance in the face of internal or external disruption.

Building Resilience with Network Centric Manufacturing		
RELIABILITY:		
NCM Strategies	NCM Solutions	NCM Culture
<p>Design critical elements of supply chain so there is an appropriate level of redundancy in both manufacturing capabilities and/or key suppliers' infrastructure (i.e., power grid, transportation modes, etc.)</p> <p>Design non-critical elements of supply chain so that past performance (i.e., quality, delivery, etc.) is weighted more heavily than price.</p> <p>Increase ability to monitor supplier health and provide advance warnings where possible. (Note that this must extend to impacts from natural disasters, financial crises, conflict and so on.)</p>	<p>Automatic documentation and validation of technical requirements integrated into a single tool to better drive compliance.</p> <p>Supply chain visibility showing raw materials, work in process, and the transportation of product throughout the entire distributed manufacturing enterprise, providing an early warning of problems before it's too late to resolve them.</p> <p>Collaboration platform that allows supply chain participants to view and collaborate around current and complete technical data at all tiers in the supply chain without requiring the participants to have the originating software, facilitating faster problem resolution.</p> <p>Advanced technical data packages (A-TDPs) that provide specific and proven manufacturing processes to be followed.</p> <p>Robust engineering change management tools that communicate changes immediately throughout the entire supply chain.</p>	<p>Engineering team is more collaborative, working with suppliers at all levels to resolve problems before they impact production or quality.</p> <p>Procurement team member training and compensation are tied to desired supply chain success metrics, such as percentage of perfect orders.</p> <p>Acquisition policies or strategies are structured to drive proper design of supply chain.</p>

RESPONSIVENESS:

NCM Strategies	NCM Solutions	NCM Culture
<p>Design supply chain so that all supplier tiers are connected and easily able to share information, such as specifications, forecasting, scheduling, etc.</p> <p>Pre-qualify back-up suppliers of critical components, even to point of agreement of terms and conditions.</p>	<p>Robust database of suppliers that includes multiple layers of capabilities. (Machines, processes, ability to collaborate, ability to innovate, etc.)</p> <p>Sourcing tools that streamline the sourcing process, making it easier to solicit more suppliers with less effort while protecting intellectual property.</p> <p>Standards, such as ISO 10303, that facilitate the exchange and management of product manufacturing information.</p> <p>Smart machine integration tools that improve the ability to produce a first part correctly without unscheduled delays, reducing cycle time.</p> <p>A-TDPs that reduce or eliminate non-recurring engineering time in the sourcing process and shorten production ramp-up.</p>	<p>Willingness to share accurate and timely demand forecasting throughout supply chain.</p> <p>Decisions throughout the supply chain are made more quickly, weighing risk and cost against speed and customer satisfaction.</p> <p>Procurement team member training and compensation are tied to desired supply chain success metrics, such as reduction of time between order and delivery.</p> <p>Acquisition policies and strategies are structured to drive proper design of supply chain.</p>

AGILITY:

NCM Strategies	NCM Solutions	NCM Culture
<p>Design supply chains for critical components so that orders are distributed across multiple suppliers, increasing aggregate available capacity.</p> <p>Increase ability to monitor supplier health at all tiers and provide advance warnings where possible.</p> <p>Prepare sourcing contingency plans and establish proactive triggers for supply chain changes.</p>	<p>Tools that streamline the sourcing process, making it easier to solicit more suppliers with less effort while protecting intellectual property.</p> <p>“Available capacity” matchmaking capabilities that allow suppliers to anonymously post available capacity for given manufacturing processes.</p> <p>Supplier risk assessment tools that not only monitor financial viability but also track potential impacts from natural disasters, union negotiations, geopolitical conflicts, etc.</p> <p>Robust database of suppliers that includes multiple layers of capabilities. (Machines, processes, ability to collaborate, ability to innovate, etc.)</p> <p>A-TDPs that reduce or eliminate non-recurring engineering time in the sourcing process and shorten production ramp-up.</p>	<p>A greater focus on total cost ownership rather than just purchase price, facilitating supply chain design for agility.</p> <p>Willingness to share accurate and timely demand forecasting throughout supply chain.</p> <p>Procurement team member training and compensation are tied to desired supply chain success metrics, such as sourcing cycle time, ability for supply chain to support increased demand, and so on.</p> <p>Acquisition policies and strategies are structured to drive proper design of supply chain.</p>