Waste Not, Want Not – How Manufacturing Extension Can Improve Business Performance

Eric Oldsman
President, Nexus Associates, Inc.
68 Leonard Street, Belmont, MA 02178
Tel: 617-489-0311 Fax: 617-489-4413
Email: oldsman@nexus-associates.com

and

Chris Heye
Senior Associate, Nexus Associates, Inc.
68 Leonard Street, Belmont, MA 02178
Tel: 617-489-0311 Fax: 617-489-4413
Email: heye@nexus-associates.com

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Abstract

Manufacturing extension centers have helped small manufacturers to improve performance on the shop floor and thereby reduce costs. This article presents a case study of a metal working firm that was able to increase productivity and profits by instituting measures recommended by a field agent working for the Florida Manufacturing Technology Center (FMTC) . As a result of services provided, the company was able to boost manufacturing throughput and increase efficiencies. Using a simulation model, the article explores how small changes in manufacturing performance can result in significant cost reduction. It then discusses the consequences of alternative strategies designed to enhance the value of goods sold, rather than lower the costs of production. It concludes by arguing that manufacturing extension centers should help companies become more distinctive as well as more efficient.

Introduction

Since the early 1990's, manufacturing extension centers (MECs) in the United States have assisted thousands of small manufacturers across the country. There are now numerous well-documented stories of firms that have benefited significantly from these types of services (U.S. Department of Commerce 1997). For the most part, services have tended to focus on helping companies achieve higher levels of efficiency. Field agents, often working in conjunction with private consultants or other third-party service providers, have helped small manufacturers eliminate waste in their production systems by improving work flow, increasing machine run time, and enhancing quality. At times, reductions in costs have enabled companies to bid more aggressively for new orders and sales have subsequently risen. As discussed below, small changes in manufacturing operations can have broad consequences for firms because of the interrelated nature of manufacturing systems. Changes in one area ripple through the manufacturing plant, affecting other parts of the system.

While MECs should continue to provide efficiency-enhancing services to manufacturers, we argue in this article that assistance should be broadened to focus more on value creation. Specifically, in addition to helping firms reduce production costs by becoming more *systematic*, MECs should endeavor to help them enhance the value of their products by becoming more *distinctive* (Luria 1997). In an increasingly competitive and global marketplace, improvements in production efficiencies may be insufficient to ensure the profitable growth of small manufacturers in the United States. Producers of commodity products will be threatened constantly by lower cost manufacturers in the United States and elsewhere in the world. Manufacturers need to consider ways to escape the trap of commodity production by exploiting advantages in technology and know-how.

The next section of the article presents a brief case study of a firm that undertook a series of actions designed to increase throughput and productivity. Using a simulation model, the article explores how small changes in manufacturing performance can result in significant cost reduction. It then goes on to discuss the consequences of alternative strategies designed to enhance the value of goods sold, rather than lower the costs of production. It concludes that manufacturing extension centers should help companies become more distinctive as well as more efficient.

The Case Study

A recent case study completed by the authors as part of an evaluation of the Florida Manufacturing Technology Center (FMTC) provides a good example of the kinds of services MECs typically deliver. The study examined the nature and impacts of the services delivered by FMTC field agents to a small metal fabrication company in Florida over a recent one-year period.

The Problem

Florida Metals is a producer of large fabricated metal products such as axles, suspensions, chassis components and other large parts and assemblies for original equipment manufacturers (OEM) in the transportation sector.[1] It produces a variety of metal parts using computer numerical control (CNC) machines as well as standalone milling, drilling and welding equipment. It manufacturers over 2,500 different products.

Though historically successful, the firm had been experiencing difficulties typical of many small manufacturers. Despite an increase in sales, profits had fallen for two years. The company was having trouble getting parts out the door on time while keeping costs down to an acceptable level. Orders were piling up and costs were mounting. The company was trying to process nearly 1,000 orders on any given day and scheduling had become difficult. The shop floor was becoming cluttered with work-in-process inventory, making it difficult to locate parts, materials, tooling and related documentation.

Much of the problem revolved around excessive machine set-up times. Florida Metals' expensive CNC machines were frequently down for set-ups. Existing jobs were constantly being bumped by "hot" parts, i.e. those requiring immediate shipment. The situation was further exacerbated by small lot sizes. Running to stay in place, employees were working two shifts plus considerable overtime to meet scheduled deliveries.

FMTC assistance

The President of Florida Metals was frustrated by difficulties in getting the system under control and approached the local office of the FMTC looking for help. After a thorough assessment, the field agent recommended that the company first focus on reducing the time required for setting up machines. By reducing downtime, the company would free up existing capacity to produce the orders already on its books. With the full participation of machine operators, the company undertook a series of actions to clarify set-up instructions and organize tooling for more efficient handling. As part of this effort, the company also increased average lot sizes from roughly seven to 20, and reduced the number of orders on the floor at any one time from nearly 1,000 to 500.

The second project undertaken with the assistance of the FMTC field agents was the establishment of plant performance measures. The company instituted procedures to track how time was being spent on the shop floor and to closely monitor production efficiency. As part of this effort, the firm changed the content and format of job sheets that accompany each lot around the shop floor. Using this data, the firm is able to calculate production times and costs for each part. At the end of each week, the total time required for all parts is calculated and compared to historical averages. A chart depicting the trend in production efficiency is then posted throughout the plant, letting workers know how they are performing. In addition to this overall plant productivity measure, the company now calculates a similar measure for each employee and includes a summary in his or her weekly paycheck.

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[1] Florida Metals is a fictitious name used to protect the firm's real identity.

Benefits

There is substantial evidence that these and other services provided by the FMTC have made Florida Metals more efficient. Production has been much smoother and overtime reduced. Changes on the shop floor have had a positive impact on productivity and profitability. Based on performance data maintained by the firm, productivity across the plant has risen by roughly 30% in less than one year. In addition, the president of Florida Metals expects profits to increase significantly this year due, in large part, to the assistance the firm has received from the FMTC.

The High Cost of Waste

The case study summarized above is just one example of success stories that are becoming increasingly common throughout the United States. Other evaluations of manufacturing extension centers in other parts of the country have revealed similar benefits from such services (Oldsman and Welch 1997). Projects undertaken with the help of field agents have enabled companies to become more systematic, reducing waste and improving production efficiencies. As a direct result of services provided, many manufacturers have achieved the following:

- reorganized their plants to improve work flow and reduce the movement of materials;
- improved the organization of tooling, gauges and inventories;
- increased the percentage of time that machines are running parts;
- lowered raw material inventories and reduced buffer stocks;
- reduced scrap, rework and customer rejects; and
- reduced unnecessary labor and material requirements.

Often these efforts have entailed the development of performance measures along with formal quality assurance practices to collect necessary data, identify production problems, and determine appropriate corrective actions.

The benefits that firms derive from these efforts stem in large measure from the complex, interrelated nature of manufacturing systems. In most manufacturing operations, any single change in operations is likely to have ramifications for other elements of the system. For example, a reduction in machine set-up times will likely affect not only overall machine run time, but also work-in-process (WIP) inventories and labor requirements. However, sometimes the full consequences of changes on the shop floor are hard to estimate precisely *because* of these interrelationships. Companies may not understand these dynamics or have a means to calculate the full cost of waste. As a result, they may forego opportunities to reap considerable savings – in effect, leaving money on the shop floor.

The potential to reduce costs from various actions can be seen in the following example using a computer simulation model designed to help MEC field agents and manufacturers estimate the pay-offs of various improvement strategies.[2] The example is based on a hypothetical firm – a metal fabrication firm with $10 million in annual sales. It produces stamped metals parts with a typical piece price of $5.00. The firm has 53 employees of which 40 work on the shop floor. Most of the shop floor labor is spent on primary processing operations, though some time is allocated to secondary operations such as assembly. Last year it had a payroll of $2 million split evenly between shop and non-shop employees and purchased $5 million of raw materials and parts. Roughly another $2 million was spent on other purchased inputs, including manufacturing services, equipment leases, rent, electricity, and other miscellaneous expenditures.

Like many other manufacturers, the company is interested in lowering its costs by reducing scrap and/or by making better use of its machines. Table 1 presents the results of two alternative simulations. The first posits a decrease in scrap from three percent to one percent. The second assumes that machine run-time increases from 50% to 57.7% as a result of reducing set-up times from two hours to one hour, decreasing the number of lots that are bumped due to scheduling problems from 25% to 10%, and lowering internal wait time from 38% to 36% through better plant organization. In both cases, the simulation focuses solely on the savings that the company would realize as a result of improvements in its manufacturing performance. It does not consider the cost of implementing steps to achieve these savings.

What are the potential pay-offs of reducing scrap by two percentage points? The company would save $124,800 given no increase in demand, i.e., assuming that the firm ships exactly the same number of units to its customers. This is a significant amount for a company of this size. Gross profit margins would increase by 1.2 percentage points. While the bulk of these savings would come from a reduction in material requirements, the company would also save labor and other manufacturing costs including purchased services and electricity. Fewer resources would be devoted to parts that eventually get scrapped. As a result, labor productivity measured in terms of value-added per labor hour would increase by $2.40.

It is also important to point out that reducing scrap also frees up productivity capacity to make good parts that can be shipped to customers. If the company were able to increase orders to take advantage of this additional capacity, gross profits would rise by roughly $206,000. Given the larger volume of production, unit costs would fall even further and gross profit margins would increase by1.6 percentage points. Although inventory levels would remain roughly constant, increased sales would result in greater inventory turns. Finally, even though orders increased, the additional capacity would shorten manufacturing lead times 0.9 days.

Table 1 also shows what would happen if the company were to increase the percentage of available time that machines are actually running parts under different constraints. An increase in machine runtime is tantamount to an increase in productive capacity. The additional plant throughput would enable the company to produce the same number of units in less time, reducing

[2] SimPlant is a business planning tool developed by Nexus Associates, Inc. and the Performance Benchmarking Service of the Industrial Technology Institute (ITI) with support from the National Institute of Standards and Technology (NIST) Manufacturing Extension Partnership (MEP). The software application incorporates a simulation model applicable to a wide range of manufacturing operations. At the time the article was written in October 1997, seven manufacturing extension centers were piloting the software for use in their service delivery.

the cost of goods sold by $126,500. Here again, if the company were able to increase orders, gross profit would increase by $705,400.

Table 1. Consequences of Cost Reduction Strategies

		Lower Scrap Rate Scenario		Increase Machine Runtime Scenario	
	Base Case	**Demand Constrained**	**Capacity Constrained**	**Demand Constrained**	**Capacity Constrained**
Sales revenue	10,0000,000	0	206,185	0	1,573,425
Cost of goods sold	7,024,997	(124,849)	(1)	(126,507)	867,999
Gross profit	2,175,003	124,849	206,186	126,507	705,426
Average unit costs	4.5	(0.06)	(0.09)	(0.07)	(0.24)
Gross profit margin	21.8%	1.2%	1.6%	1.3%	3.1%
Labor productivity	50.4	2.4	2.4	7.4	8.1
Inventory turns	20.0	0.0	0.6	0.4	3.9
Lead time (days)	5.7	0.0	(0.9)	(0.1)	(1.5)

Both of these examples demonstrate the potential to increase profits by improving production efficiencies. However, as noted above, the cost of implementing necessary changes on the shop floor are not included in these calculations. Excessive scrap and machine downtime can be traced to numerous factors. For example, high scrap may be due to older machines that cannot hold required tolerances, inadequately trained or supervised machine operators, mis-specified information on job sheets, and/or the use of the wrong grade of materials. The task for the field agent is to work with the company to diagnose the root causes of identified problems and define an appropriate set of corrective actions. The cost of these improvement projects can be compared to the potential benefits of remediation using the same approach as above. This approach can be used to help ensure that companies focus on activities that are likely to yield the greatest *net* benefits.

The Path to Enhanced Value

Small manufacturers across the country will continue to benefit from efforts to reduce costs. Most small manufacturers supply components and subassemblies to larger original equipment manufacturers (OEMs). These big automotive, aerospace and electronics companies have been relentless in forcing suppliers to meet higher quality standards while simultaneously requiring lower prices. Attempts by OEM's to squeeze smaller suppliers are likely to continue – as a result, the chase for higher and higher production efficiencies is never ending. However, there are limits to this path. Since most companies essentially produce undifferentiated products, most gains in performance are passed on to customers in the form of lower prices. The challenge for small manufacturers is to keep some of the gains.

While manufacturing extension programs should continue to work with companies to reduce costs, they should also explore ways to help small manufacturers become more distinctive. Companies should continually consider what it will take to enable them to *raise* prices and maintain higher profits. They should focus on boosting productivity not just by lowering costs, but also by increasing the value placed on their products by customers. To this end, small manufacturers need to pursue strategies that yield distinct competitive advantages in the market based on new capabilities, higher product quality, and/or improved customer service.

Consider the same hypothetical metal fabrication company described above. Hiking the typical piece price from $5.00 to $5.10 – a two percent price increase – would translate into an additional $200,000 per year given the same level of orders. Efforts to enable the company to raise prices may involve a number of different actions. For example, as demonstrated in Table 1 above, increasing machine run time by roughly seven percent would shrink lead times from 5.7 to 4.2 days. This reduction could provide a competitive advantage – customers may be willing to pay a premium for shorter turnaround times.

This approach still centers on utilizing the same basic manufacturing processes and selling the same products. Further afield, the company may consider developing a capacity to manufacture its own dies and tooling, investing in new manufacturing capabilities, providing engineering assistance, and moving away from the manufacture of discrete parts to the production of subassemblies and final products. Even further afield, the company may elect to design and produce its own proprietary products. Each of these action involves adding value, allowing companies to command higher prices for its goods.

As the company adds value, productivity will rise. It is important to recognize that productivity gains can be made by increasing value-added as well as by reducing required resources (labor, materials, electricity, etc.). This fact is often ignored in the rush to cut costs to the bone.

Conclusion

The analysis is not meant to diminish the importance of current efforts by MECs around the country to help small manufacturers lower the cost of production. These efforts have clearly helped many companies improve productivity and profits, and should continue. Rather, the intention is to provide an argument for broadening the types of services that are being delivered by MECs to include more value enhancing projects. Small changes in the value of a product – as reflected in a slightly higher sales price – can have as much impact on a company's bottom-line as fairly significant reductions in cost. Moreover, because value-enhancing services are biased towards growth as opposed to cost minimization, they are likely to have a greater impact on the regional economy as a whole than efforts to minimize costs.

A greater focus on helping companies become more distinctive requires forging long-term relationships between companies and manufacturing extension centers. While cost reduction projects tend to concentrate on solving discrete problems, projects that attempt to increase value added often involve more integrated business solutions. By necessity, these types of projects are more extensive, affecting a broad range of business processes and taking longer to implement. To be successful, field staff need to have relevant industry expertise in addition to technical qualifications.

It is the authors' belief that in the long run, the ability of U.S. small manufacturers to compete in the global marketplace will be heavily dependent on their capacity to add value. Consequently, efforts by small manufacturers to enhance the distinctiveness of their products will be as important as those to improve production efficiencies. The more capable MECs are in delivering value enhancing services, the better the chances will be for the growth and prosperity small manufacturers throughout the country.

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Author Biographies

Eric Oldsman is President of Nexus Associates, Inc., Belmont, Massachusetts. Chris Heye is a Senior Associate with Nexus Associates, Inc.

Nexus Associates, Inc. is an economics and management consulting firm based in Belmont, Massachusetts. The firm specializes in performance measurement, program evaluation, market research, and economic analysis. Assignments are typically undertaken within the context of strategic planning, organizational development, and process improvement efforts. Since it was founded in 1991, the firm has established a solid reputation for high quality work that meets the needs of its clients on time and within budget.

Nexus Associates has worked with government agencies, quasi-public authorities, not-for-profit organizations, federal laboratories, universities and private corporation both in the United States and abroad. Clients have included the U.S. Department of Commerce, National Institute of Science and technology, Massachusetts Technology Collaborative, New York State Science and technology Foundation, Industrial Technology Institute, Tufts University, World Bank, Inter-American Development Bank, Mexican Government, Hong Kong Government, and General Motors.

Dr. Eric Oldsman -- the founder and president of Nexus Associates --- has more than 20 years of consulting experience. Prior to establishing the firm, he was a senior consultant at Arthur D. Little, Inc. and served as a program officer at PACT, Inc. He holds a Ph.D. in public policy from Harvard University and B.A in economics from Brown University.