

**Toward a Model of Technical Assistance for Small Manufacturers:
The Role of Performance Technology**

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This paper addresses a historical, systemic-oriented perspective on efforts to improve the competitiveness of small-sized manufacturing firms. While it is well-recognized that the growth of small firms is vital to economic growth in the United States and that some form of external technical assistance is needed to sustain this growth, only minor attention to models or theories of technical assistance have been investigated and validated. Small firms face many barriers to competitiveness that include a wide range of needs from lack of information, to inability to implement new technology, to scarcity of resources. Among these numerous challenges, the one offering the greatest opportunity for leverage and growth is the deployment of new technology, where new technology is broadly defined to not only include machines and software, but enlightened methods for management of the enterprise. The results of the review indicate that while technical assistance efforts remain uncoordinated generally, considerable evidence suggests that regional infrastructures are supporting the increase of such outreach efforts. An examination of the approaches used in technical assistance indicates a number of salient features of performance technology, especially a systems approach to implementing new technology. How performance technology might assume a greater role in technical assistance to small manufacturers is the subject for consideration.

For the purposes of this discussion we will adopt a comparatively simple, yet conceptual definition of performance technology as “ a fundamental commitment to the identification of organizational performance problems and the development of the most appropriate solutions” (Dick and Wager, 1995, p. 35). Performance technology brings a holistic framework to the analysis of issues impacting human performance that are fundamentally interdisciplinary. These disciplines include psychology, industrial engineering, training and development, ergonomics and human factors engineering, organizational development, compensation and benefits, and learning and cognitive science.

Theoretical Framework

The theoretical framework used to review of the literature of technical assistance to small manufacturers over the past fifteen years begins with the establishing the importance for improving the competitiveness of such companies. The review is drawn from two primary fields: industrial modernization and economic development. Industrial modernization is the term usually applied to methods and resources deployed to improve the competitiveness of manufacturing companies through external or internal interventions. Economic development relates to the environmental conditions where manufacturing companies are located – the relationships to customers and suppliers, government policies and incentives, geographic

proximity to resources. The perspective for analyzing the potential relationship between small manufacturer technical assistance parameters and a performance technology framework is a summary of existing literature, results of professional networking and personal experience. A history of the technical assistance movement in the United States lays the groundwork for understanding its fundamental needs, environmental constraints, proposed solutions, and relationship to an interdisciplinary view of performance technology.

The review documents worldwide interest in the economic development of small to midsized manufacturers through free market activities, government-sponsored interventions and incentives as well as public-private partnerships. The crux of the argument for developing a conceptual framework for technical assistance begins with the understanding of the systemic issues that interfere with the economic growth of such firms. If the barriers to manufacturing modernization and resulting competitiveness are systemic, one might argue that solutions to these barriers must also be systemic.

However, this examination points out that there does not appear to be an acceptance of a common infrastructure or framework to deploy these solutions. Thus, researchers seem to agree on the type of solution and recommend various approaches to technical assistance, but there is paralysis in the implementation. The consensus solution for manufacturing modernization appears to recommend a strategy (Modernization Forum, 1993) that addresses the following types of dimensions:

- Technology
- Markets
- Work Organization
- Skills -- managerial and front-line
- Finance
- Inter-Firm Cooperation
- Advanced Business Management Practices

These dimensions encompass engineering, management, human resources and other disciplines that need integration for a systems approach to small manufacturing competitiveness issues.

This perspective leads this writer to conclude that the systems perspective and interdisciplinary approach of performance technology offers a valuable model for the implementation of solutions to the competitiveness of small firms. This requires the deployment of mechanisms for organizational change in its performance infrastructure, thus performance technology offers a “method for designing the necessary performance system to achieve new levels of performance” (Rummler, 1999, p.47).

Research Propositions

The following research propositions guided the collection of documentation for this paper:

1. Why is it important to understand the issues of competitiveness facing the growth and development of smaller-sized manufacturing firms?
2. How can the barriers to competitiveness of such firms be categorized?
3. What are the alternative sources of technical assistance to small manufacturers and how well do they function in the United States?
4. What are the major conceptual approaches to technical assistance?

5. What types of technical assistance appear to be the most successful? What may be learned of such efforts outside the United States?
6. How does technical assistance relate to performance technology? Is there a role for performance technology theory and concepts in the development of a model for technical assistance?

Perspectives of Economic Development in Manufacturing

Although the number of US manufacturing jobs has decreased over the past two decades to about 19.1 million in 1993, the sector as a whole continues to generate a disproportionate share of secondary jobs -- about 4.5 times as many as the retail sector and about three times as many as the personal and business service sector (Baker and Lee, 1992). In addition, manufacturing's contribution to US Gross Domestic Product (GDP) increased 1.5% (Bureau of Labor Statistics, 1992) in the decade of the 1980's. Also, manufacturing accounted for more than 2/3 of American export earnings in 1991 with a little over 20% of the workforce as reported in 1992 data published by the US Dept. of Commerce.

Why the interest in smaller manufacturers?

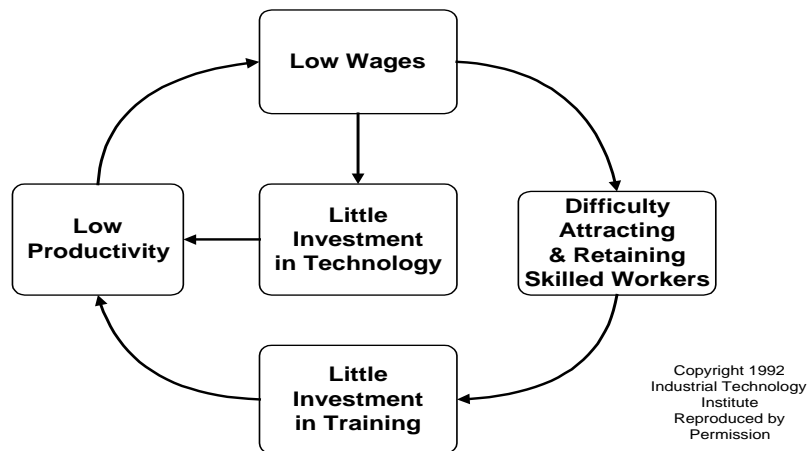
A major shift has occurred in the size of manufacturing firms since the mid-1970's. From 1980 to 1990, the number of manufacturing firms has grown from 319,000 to 378,000 and 98% of these firms employ 500 or fewer workers. Concurrently, the number of employees in firms over 1000 employees decreased by over 20%, and this has helped spur the growth of smaller firms, especially those under 100 employees. Larger manufacturing firms reduced employment by over 1.2 million workers, and smaller firms added 2.2 million workers to yield an overall employment of 12.2 million US workers, 64% of the industrial workforce (Modernization Forum, 1993). While employment is a major factor in the importance of smaller firms, a more important statistic is the amount of value-added, accounted in aggregate form across firms. In aggregate form, such firms represent up to 60% of the final goods production costs, component, subassemblies and parts (Industrial Technology Institute, 1991) that determine the cost competitiveness and quality of US products.

However, this growing role that small firms occupy in American manufacturing has not generally enhanced national economic competitiveness. While the overall productivity growth rate has slowed since 1970, it has slowed twice as fast in small firms -- from 3.4% change in value-added per work hour in 1947-67 to 1.3% in 1967-87 (Luria, 1993). The comparative drop for large firms was 4.1% to 2.9%. The gap in productivity between large and small firms has increased from a 21% difference in 1967 to 32% in 1987 (the latest data for these figures). This decline in productivity has brought with it an increasing wage gap and, therefore decreased earning power for the average worker.

An overall picture, given in Figure 1, depicts a number of the major components representing the never-ending cycle that small manufacturers typically encounter. It is derived from studies of hundreds of firms with data collected from the Performance Benchmarking service developed by Dan Luria (1993).

Figure 1

The Vicious Circle Confronting US Manufacturing



While there are a number of reasons for these differences, many industrial researchers and economists blame a low adoption rate for new technology as a primary difference. To provide three examples, approximately 40% of firms with 250 employees or less have adopted the use of computer-aided design (CAD) compared to 74% of firms with more than 500 employees (Industrial Technology Institute, 1990). Comparative figures from the same database for computer numerical machines (CNC) used for cutting and shaping metal and other materials are about 30% for small firms vs. 77% for large ones. A more dramatic difference derived from that data is in the use of machining cells (a set machines with different functions grouped to complete a process) where it is 9% for small firms and 36% for large firms.

Needs, Barriers, and Opportunities facing Small Manufacturers

There have been numerous studies conducted over the past 20 years examining the needs of smaller manufacturers (Manufacturing Studies Board, 1986; Organization for Economic Cooperation and Development (OECD), 1993; Frostbelt Automation, 1990; Shapira, 1990a) as well as compendiums of tools and methods developed specifically for assessment of the small manufacturing context (Brandenburg, 1994 and Shapira, 1993). But none is as comprehensive and has received as much consensual agreement as the study performed by the National Research Council (NRC) in 1993.

Before considering that work, it is useful to show a comparison with the results of similar studies on barriers to innovation conducted on western European companies by the OECD (1993) that showed the following rank order for firms under 500 employees and a high correlation with the NRC list: lack of capital; difficulties in predicting demand; apparent costs in developing the innovation; problem of adapting their marketing function; costs of monitoring future applications; difficulties in finding technological information; employee skills; and government regulations.

The NRC study identified five broad needs determined from reviews of the literature, focus groups with small manufacturer owners/managers, interviews with industry association executives, interviews and site visits to both small manufacturers and service providers, and data

sources provided by local government agencies. The five broad barriers to competitiveness or needs can be categorized as follows and described in more detail subsequently:

- Disproportionate impact of regulation
- Lack of Awareness
- Isolation
- Where to seek advice
- Scarcity of capital.

The first NRC identified barrier is based upon a much greater economic regulatory compliance impact requiring a larger percentage of capital investment from small firms than for larger businesses. The regulatory environment imposed by national, state, and local initiatives include issues on trade, environment, employment, work place safety, health care and liability. As a result, small manufacturers seldom have the time or the resources to keep up with all the latest regulations as well as address them in a systematic way.

The second area of need reflects the general consensus that small manufacturers are often unfamiliar with changing technology, production techniques, and business management practices. This is often brought home heavily with regard to the implementation of new technology because it is likely to require “systems methods” interfacing across different functions of a firm. The integration of these functions entails understanding issues not only with the technology, but the work skills and support structure of a company -- issues that require considerable time and energy of management.

Isolation, the third barrier, results from firms having too few opportunities to interact with similar companies facing similar issues. Suppliers do not often have the opportunity to interact with their major customers or to benefit from the membership in a cooperative supplier improvement program (like many Japanese suppliers do). Recent benchmarking efforts of one manufacturing assistance institute has shown that more than 50% of more than 500 companies surveyed believe they can be ranked among the top 15% of all such suppliers. While this result is a statistical impossibility, it illustrates the limited knowledge many companies have of their relative standing in their own industrial groups.

For owners and managers of smaller companies, it has always been difficult to locate high-quality, unbiased information, advice, and assistance. Equipment vendors cannot be relied upon to provide unbiased advice, and they have a significant portion of external contact with small company management. Generally, the company accountant or the company lawyers are the external consultants most managers trust. Yet their range of knowledge can be limited with regard to technical problems, replacing equipment or upgrading the skills of their workforce. The public sector offers a wide variety of confusing, uncoordinated, and competing services -- universities, economic development groups, community colleges, and government agencies.

The fifth of the identified barriers, scarcity of capital, means that operating capital and investment funds for modernization efforts are difficult to obtain. Regardless of the presence of manufacturing firms in a given community, is nonetheless surprising that many bankers and loan officers do not understand the manufacturing business. On the other hand, many small company managers have a difficult time putting together a solid business plan in a format the financial community can readily accept. Another more recent phenomenon, with the merger of many smaller banks, has led to centralized decision-making where the known character of small company management is no longer part of the investment equation.

Current Status: A Disconnected System

One perspective for examining how smaller manufacturers can obtain the assistance they need to become competitive is to review how free market resources interact with these firms. One source is the relationships that they have built with their major customers (which in many cases are only one customer). With the high vertical integration that exists in the US automotive and aerospace industries, customers could see it in their best interest to deploy their engineering staff to help improve productivity of their suppliers. Unfortunately in the US, there exist strong adversarial relationships between larger customers and their suppliers. Visits to suppliers by customer engineers are usually for the purpose of quality audits, but can go so far as to border on the “hell week” made notorious by the former purchasing director for General Motors, Ignatius Lopez. Not all US customer-supplier relationships follow that pattern. For example, the seven major furniture manufacturers in western Michigan have formed “work groups” comprised of customers and suppliers in order to draft joint quality standards as well as standards for electronic commerce and packaging.

Another potential major resource for smaller manufacturers is the US university system. However, the universities place greater priorities on fundamental research that is ultimately published in the public domain rather than applying current technology and methods, the results of which end up as proprietary information. Certainly, the university reward system promotes research and publications, and occasionally teaching, but there are no special incentives to assist small shops solve problems. University faculties are trusted for their integrity and objectivity, but are often criticized for their very specialized knowledge being too narrow to help the smaller company. Larger firms, on the other hand, are known to have numerous joint ventures and close working relationships with many well-known universities. The products of these ventures tend to have a narrow, state-of-the-art focus, which is the opposite of the state-of-the-practice needed to benefit smaller companies. The federal government also has shown great confidence in what universities might be able to do when they awarded two of their first three centers in their Manufacturing Extension Partnership (MEP) program (see subsequent discussion) to universities. But after more than three of the first six years funding, both programs floundered such that the fiscal responsibilities were given to non-university entities. Similar evidence can be cited in European universities where criticism of the university system runs even deeper (OECD, 1993).

A third potential source for assistance is the federal government. Historically, the federal government has maintained a fairly low level of funding prior 1988 for direct assistance to small manufacturing companies. One of the major reasons cited for this low level of funding has been the fear of the US establishing an “industrial policy”, a significant concern for a true free market economy. The major issue is that the government would pick winners and losers (by providing assistance to some companies and not others) -- a function performed historically by the free market. Two federal programs of note are the Small Business Administration, especially their Small Business Innovation Research set-asides, and the Trade Adjustment Assistance program for companies impacted by adversarial import conditions. Both offer very small amounts of dollars for assistance. However, this policy changed with the passage of the Omnibus Trade and Competitiveness Act of 1988, and its implications are discussed later.

Another potential source of private sector assistance might be the US equipment and software vendors. But these vendors are more interested in selling product, rather than making sure it is the right solution for the problem presented. One of the major headaches sold to small

manufacturers comes in the form of a technology known as MRP II (a material handling and inventory control software system). There are more trade journal articles written with a title something like: How I survived MRP II, than any corresponding to successful implementation. Furthermore, there are many vendors who won't even attempt to sell to small companies, some for what seems a logical reason -- the cost of sales is just too high. While many vendors are willing to sell to smaller companies, many private consultants and consulting firms do not. In simple terms, small companies just do not pay enough, the advice is too narrow, and they also do not have good tools to select the right consultant or vendor.

Another type of assistance from the private sector is trade associations. However, most US trade associations have their offices located in Washington, DC where their main purpose is to pursue legislative agendas. At the local level, many manufacturing groups are involved with community, education and tax issues, but rarely do they ever provide or help secure resources for substantive manufacturing assistance.

A final type of technical assistance is that of manufacturing networks, a primarily self-help system of cooperation among a group of firms. Many such networks are fostered or promoted with government cooperation, especially in Europe. Networks of small to medium-sized companies can take many forms from informal discussion groups to co-production networks. Most are comprised of economic agents, manufacturing and service firms and institutions working in complementary areas. They can be viewed as complex systems for the exchanges of information both horizontally and vertically. They bring about a synergy of available knowledge at the members' disposal helping them to accelerate the learning process.

The major types of networks can be categorized as follows (OECD, 1993):

- market networks for suppliers, customers, and partners
- production networks with subcontractors, banks, and service providers
- inter-firm networks established to build strategic interactions between suppliers and customers
- information transfer networks that operate on a non-systematic basis comprised of firms, research organizations, trade associations and training organizations.

Major characteristics of networks found through the OECD (1993) study include high personalization, informal, flexible, multi-functional, and over time become more complex and dense. Benefits cited by owner/managers for belonging to networks indicate significant influence on business practices and operations. Such benefits include (with percentage of firms indicating each benefit in parentheses):

- increase sales of current products (59%)
- assistance in obtaining subcontracts (53%)
- increase or develop export sales (51%)
- joint research and development opportunities (44%)
- obtain leverage purchase of supplies (43%)
- sharing provider services (36%).

In the US, there is a growing interest in manufacturing networks, both formal and informal (Bosworth, 1993; Hatch, 1995). Bosworth provides a general characterization of such networks according to a two-dimensional diagram showing complexity of relationships where informal associations occur at one end and co-production among firms occurs at the other.

Conceptual Foundations for Technical Assistance

In order for manufacturing in the US to remain competitive, it is generally agreed that continuing investment in new technology is required, and this investment is a critical need for smaller manufacturers (Shapira and Youtie, 1997; Swamidass, 1997; Kelley and Helper, 1997; Shapira and Rephann, 1996). What is generally less accepted is that this investment requires a concomitant investment in human resources and associated strategies. Thus, most experts have purported a systems approach to the implementation of new technology.

One quasi-government agency that has continually advocated this approach is the Manufacturing Studies Board. "Realizing the full benefits of AMT (advanced manufacturing technology) will require systematic -- not piecemeal -- change in the management of people and machines ... a critical mass of interrelated changes is required in seven areas of human resource practices: planning; plant culture; plant organization; job design; compensation and appraisal; selection, training, and education; and labor-management relations (Manufacturing Studies Board, 1986, p.2)."

Their results from 16 case studies indicated the following conclusions for supporting a successful implementation strategy for AMT (1986, p. 55):

- the planners must give high priority to address the issue of employment security
- there must be a compelling business rationale, especially if accompanied by high performance expectations
- more profitable when human resource issues are understood and addressed in the planning stage and every subsequent stage in design, approval and implementation
- more effective when management has formulated a guiding philosophy dedicated to improving the plant culture
- require an openness to learning from one's experience and that of others, especially management and union
- unprecedented efforts to communicate thoroughly to employees and their the competitive realities of the business, conditions requiring AMT and plans for implementing
- a variety of initiatives to promote positive culture for employee relations and labor relations
- employee participation in implementation activities
- early assignment to the project
- broad training that begins before assignment to the project
- systematic, periodic evaluation of the effectiveness of AMT.

A number of different solutions for the dilemmas and needs of smaller manufacturers may be proposed. These solutions might take the form of methodologies, economic development policies, theories of technology deployment, and various other implementation strategies. In Europe, the OECD (1993) proposed the following type of activities:

- technological advisors and network brokers for technology transfer capturing state-of-the-practice and communicating it companies within a certain region
- technological centers for technology transfer and training
- incubators for first 3 years of start up of a new business
- scientific and technological parks as catalysts for industrial expansion, experimentation and shared costs among firms within the region

Many of the issues related to solutions are addressed more often in European literature, particularly Great Britain, than in the US. Two examples of this are the writings of Hendry, et.al. (1994) and the edited book of Towill and Cherrington (1993) from their detailed case studies of

small manufacturing firms in Britain. Towill and Cherrington present a balanced model to a systems approach to AMT deployment found across a study of 30 firms. More successful companies balanced the manufacturing system design with work force concerns and include attention to three cultures deemed critical for AMT investment: the investment culture, the project culture and the operational culture. With regard to overall strategy, Hendry and associates identify three strategies for protecting assets and sustaining growth during the formative years of a new company. These are, they claim the three key criteria for a resource-based theory of competitive advantage: durability, transferability and replicability.

Hendry and his colleagues also demonstrate that formal systems for learning by either blue collar or white-collar workers are quite limited and depend upon relationships cultivated with bosses or union leaders and to some extent on their co-workers and team members. Whether or not this provides a sufficient basis for developing up-to-date and appropriate skills probably fall short of what is required. In this same context, they also note that small firm managers seem to follow “free agent “ careers, a principle having considerable impact on small firm learning and the maintenance of unique or core competencies.

This systems view of context, technology, people and organization has rarely been addressed in US studies recounting the actions of small manufacturers.

Given the need of small manufacturers to implement more advanced technology in order to remain competitive, some approaches to this implementation have been proposed that contain many elements of performance technology. Foremost among these approaches is HI-TOP (High Integration of People, Organization, and Technology) developed by Majchrzak, et. al., (1991), which proposed to eliminate the independent, asynchronous planning generally found in the deployment of new advanced manufacturing technology. The goals of this analysis are threefold:

- indicate what people and organizational capabilities are needed for a given technology plan
 - identify if the appropriate people and organizational capabilities are likely to be in place in the organization, and
 - suggest technology plan, organization, and people changes if needed capabilities are missing.
- The result is that surprises are reduced and needed changes to technology, organization and people are identified in time to be smoothly implemented. While this approach not only makes sense conceptually, and it has been validated and proven in organizations like Digital Equipment Corporation and Hewlett-Packard, it has yet to show viability with smaller manufacturers. The reason for this lack of adoption is the significant resources it requires to complete all processes of data gathering, collection, analysis, and synthesis for planning and replanning.

Sleezer (1991) presents another promising approach to the analysis of small manufacturing company needs. Her model and analysis tools were validated in the small manufacturing context, but have yet to be widely applied. Her approach is a hierarchical analysis beginning with an organizational analysis, then to work behavior analysis and finally to individual capability analysis. The well-developed tools allow the user to effectively translate training needs assessment theory to practice. However, since her approach depends upon locating “training” solutions to identified problems, it does not address the broader needs that technology deployment generally requires.

Another example for an approach to technical assistance that includes substantial attention to the deployment of new technology in manufacturing is given by Beal (1994). Its application is fairly narrow in that the process focuses on how new technology should be launched in a manufacturing setting. However, the implementation timeline is quite long starting

at initial systems requirements before the machine is ordered, through the process of building and testing machine components, to the actual launch of “job one” on the shop floor. His model is based on taking the best practice concepts for transfer of training given by Broad and Newstrom (1992) with the change management concepts of Rummler and Brache (1990) and translating them to this specific application. The result has been a niche business he has created in working with smaller machine tool builders in order to build customer (machine purchaser) requirements into the training and organizational elements *before, during and after* the construction process. This process is in stark contrast to the accepted manufacturing approach that tags training only to shop floor appearance of the new machine.

History of Technical Assistance in the United States

The closest analogy to technical assistance currently characterized as industrial extension or outreach is the US Department of Agriculture’s Extension Service. In cooperation with land-grant universities and state and local governments, there are approximately 9,600 full time county extension agents that disseminate new information, demonstrate new techniques, and offer technical assistance. As a technology transfer mechanism they are regarded as a huge success to their customer, the American farmer, in the 20th century.

Prior to 1988, there was no US national program for manufacturing assistance similar to that for agriculture. Instead there were a wide variety of state, local and privately sponsored programs performing some version of technical assistance, primarily for smaller manufacturers. There have been a number of reasons stated for the lack of national effort, but primary among them was an unwillingness for the US to have an “industrial policy”. Such a policy many argue (Osborne, 1990) would have the government picking winners and losers and would be the antithesis to a free market economy. Some of the state-sponsored industrial extension programs have had long and considerable success. Although North Carolina has been cited as providing the first program in 1955 (Shapira, 1990a), it was the program begun by Georgia in 1960 that has been held as a model for longevity and consistent state support. The Georgia program exists today in expanded form with a set of statewide offices and a technology center located on the campus of Georgia Institute of Technology. In the mid-1960’s, the Pennsylvania Technical Assistance Program (PENTAP) was initiated and expanded later into the programs known as the Ben Franklin Centers and subsequently to its current form as Pennsylvania Industrial Resource Centers. Since these programs were modeled after the agricultural services, they consisted primarily of professional engineers in regional field offices and helped local firms solve technical problems and increase their use of technology. In the late 1970’s and throughout the next decade, there were numerous other programs initiated notably in Maryland, Massachusetts, Michigan, New York and Ohio.

These programs as a whole required significant state expenditures so that they were and are at the whim of state governors and legislators. The Michigan program known as the Michigan Modernization Service, begun under a Republican governor in 1985 and fostered by the succeeding Democratic governor was hailed as important model for other programs to follow (Osborne, 1988). Its unique characteristics were to add a strong research and development component, as in the agricultural extension model, to support the structure as well as using both an engineer and a training specialist to provide improvement and modernization

recommendations. Nonetheless, when a different Republican governor was elected in 1990, it was one of the first programs he eliminated from his budget.

Because these efforts were focused on the deployment of technology, some modest support on a competitive basis was provided by the US Dept. of Commerce through a program known as STEP (State Technology Extension Program). However, 1988 turned out to be a watershed year for these efforts when Congress passed the Omnibus Trade and Competitiveness Act. Along with revamping the old National Bureau of Standards into the National Institute for Standards and Technology (NIST) within the Dept. of Commerce, significant federal monies were designated to expand these programs. The overall plan was to establish a network of technology centers throughout the US to provide technical assistance to all types of small and medium-sized manufacturers. These centers, called Manufacturing Technology Centers, were designated to serve particular geographic regions, and each major operational hub was funded initially at \$6 million a year for the first six years of operation. State and private contributions or revenues matched all dollars. Following the use of Defense “downsizing” monies (known as the Technology Reinvestment Project or TRP) in 1992, other levels and types of funding arrangements were developed to include greater industry cost-sharing, foundation funds, and specialized state appropriations.

As of this writing, the program is now known as the Manufacturing Extension Partnership (MEP), and there exist 75 major centers and 350 satellite offices throughout the US, with at least one satellite operation in every state. MEP centers are designated to provide outreach services to firms with less than 500 employees. Under its new charter, NIST is charged with assisting industry improve technology development, process modernization, product quality and reliability, cost effectiveness, and commercialization. It is also authorized to provide technical assistance to state and local industrial extension programs and serve as link form those programs to other federally sponsored technology services. Notably absent from these efforts, however, are directives regarding a “systems deployment” of new technology incorporating organizational environment and people issues.

The MEP program recognized this shortcoming and established an alliance with the US Dept. of Labor to channel modest funding for a Workforce Working Group (Brandenburg, Shrader, and Wood, 1992; Great Lakes Manufacturing Technology Center, 1993). What occurs with the integration of technology and human resources supportive infrastructure within MEP is more dependent on center management than on federal policy. That is, many centers view the systems integration issue as a matter of best practice; other centers stick to their technology “roots” so that customer solutions always have an “engineering flavor”.

The service program established in Massachusetts was one of the more recently funded endeavors of MEP. It is notable because of the upfront dollars committed (\$30 million for the first five years) and in its attention to planning cooperatively with its customer base. One outcome of their planning process was a “futures conference” (Bay State Skills Corp., 1992). Through a three-day analysis with industry participation, the following needs were defined:

- the high cost of employment (insurance, health care, workers compensation)
- the credit crunch (and lack of investment capital)
- supplier relationships / quality issues
- availability of education and training
- regulatory issues (cost of doing business)
- response to defense cuts

- lack of a state industrial policy / coherent action to assist business.

This list is important for a couple of reasons. First, it indicates the complex nature of the issues faced by smaller manufacturers any one of which could have significant impact on the resource-constrained small company. Second, any solution addressing more than one would require a systems approach to planning and implementation. Furthermore, it argues that the solution should be in the form of a public-private partnership.

Following further discussion and prioritization, the following types of services were recommended for their new MEP center: qualified, experienced staffing; funding assistance; business strategy and planning assistance; research; technical assistance; workforce training; training of government / technical assistance providers; global market information; regulatory assistance; quality / benchmarking information; and a team approach.

MEP is not the only source of federal dollars for extension-like services. The US Department of Defense has long recognized the concept that US competitiveness in the defense business depends on the capabilities of a strong industrial base. Two examples of this support are relevant here. The first is the sponsorship of public-private joint research ventures such as the National Center for Manufacturing Sciences (NCMS). NCMS conducts its work on a project basis by obtaining both federal and private company sponsorships of selected efforts. The companies and the government share in the results, but because of the sensitivity of intellectual property, many of their findings are not available in public literature. One such project of NCMS is very visible, and that is the Manufacturing Education and Application Centers (MAEC). MAECs are “teaching factories” somewhat modeled after the Kohsetshushi centers in Japan (Shapira, 1990b) and the Fraunhofers in Germany. One example of these centers is the Textile Clothing Technology Center in Cary, North Carolina, a joint venture among the textile and clothing manufacturers.

What is fundamentally different for the MAECs as opposed to MEP is their systems commitment to the development and deployment of new technology. People issues for education and training as well as management issues are integrated at each center. NCMS provides coordination and support for the MAECs to share lessons learned across the centers. Although designed to serve the small and medium-sized manufacturers, the MAECs have little or no outreach capability and do not have a consistent source of funding.

It is also worthwhile to point out that there exist about 16 fully operational teaching factories in the US not necessarily associated with NCMS, nor exclusively devoted to smaller manufacturers. Six are attached to community colleges; five are at universities; three are sponsored by the US Dept. of Defense, and two are industry-sponsored. A couple of examples are Cayuhoga Community College in Cleveland and the Milwaukee Area Technical College.

Another type of work supported by the US Dept. of Defense was a project to establish a regional center for technical assistance in a geographic area heavily populated with small defense contractors (suppliers). The Program of Regional Improvement Services for Small Manufacturers (1993) or PRISSM augmented the existing services provided by the Institute for Advanced Manufacturing Sciences (IAMS) in Cincinnati, Ohio. IAMS was one of the manufacturing extension centers designated as part of Ohio’s state effort known as the Edison Centers Program of which there are nine centers throughout the state. The PRISSM project was designed and developed with the full cooperation of General Electric Aircraft Engines, the major customer for many of these suppliers. Its purpose was to not only test and validate a methodology for improving the competitiveness of the small firms, but to initiate the development of a permanent

infrastructure of supporting organizations in the region, select and train the field agents, experiment with the methodology to create marketing success stories, and position IAMS to be a full partner in training the national movement of extension centers. PRISSM was another example where the US Air Force, in this case, recognized the validity of integrating organizational, regional and people issues into the effective improvement of small manufacturers.

Conclusions and Recommendations

One conclusion that may be drawn from the preceding review is that the barriers and solutions to increased competitiveness to small manufacturing firms are more broad-based than just the appropriate application of engineering knowledge and skills. The types of recommended solutions include the interdisciplinary approach understanding how to integrate the technology, the organization, and the people to the establishment of regional supportive infrastructures. Another conclusion is to recognize that many concepts of performance technology have been applied to the domain of manufacturing technical assistance. Most of the approaches cited have not consciously utilized performance technology principles and only a very few performance technology professionals been involved in their design or implementation. Nonetheless, the need for performance technology principles in integrating the technical, organizational and workforce issues has been clearly demonstrated. At a minimum, a systems approach to deploy new technology in small manufacturing firms has shown growing acceptance, but not widespread adoption, in the marketplace.

Given that the business of technical assistance to small manufacturers is in its relative infancy, there are no readily known paths to applying the tenets of performance technology to this marketplace. Because there exists a decentralized system in the US where no one organization has the franchise on this market, a best entry point is the regional third party or intermediary organization. Such organizations exist in various forms and most are of the membership variety, sometimes as a separate organization and sometimes linked to other organizations. A good source to understand the functioning of such organizations is given by Flynn and Forrant (1995).

From a conceptual perspective, these intermediary organizations provide a social infrastructure for the modernization process where the central theme is companies learning from each other. Among the benefits they provide are:

- helping firms to become more flexible, problem-solving enterprises
- facilitating the thinking through strategic issues in a non-defensive atmosphere
- providing valuable service to firms where the private sector is either unavailable or unwilling.

These organizations are often actively working to forge new relationships among firms and related economic and workforce development agencies at the regional level. Certainly an MEP center qualifies as one of these intermediary organizations. It would be a rare MEP center indeed that has all the capabilities to serve customer needs in their region. A good source for the nearest center can be found on the NIST World Wide Web homepage.

A second nearby source is a local community college, especially the business services or customized training unit. Most states have funds that target small manufacturers as an economic development strategy, which are generally delivered through community colleges. While many opportunities focus on training per se, there is a growing recognition for a wider involvement

from organizational development and management specialists especially for medium-sized companies who do not have that internal capability.

A third source, possibly more difficult to locate, are organizations, generally membership-based, who serve a special or local clientele such as a group of unionized auto suppliers, an agency providing services to an industrial park, or a business owner's association in a subsection of an urban area. Most can be located through a county economic development office or a local chamber of commerce.

Contribution of this Research to HRD

Given the preceding discussion and history, what does this mean for performance technology in particular and HRD in general? First, because manufacturing technical assistance in the US is a recent but expanding field, there exist significant opportunities to investigating and learning of best practices that have generalizable findings. Economic development efforts that involve "brownfield" redevelopments in distressed urban areas, the creation of business incubators to spur the development of high technology products and services, and the construction of industrial parks are three types of initiative that are commonly formulated. In these cases, as well as for the existing manufacturing technology centers, opportunities exist for theoretical contributions from research studies, application studies leading to tool development and testing, consulting activities, and commercial sales and product development. From the previous discussion, it can be determined that well-informed performance technologists have many tools, methods and approaches that are relevant to the needs of small manufacturer.

It is obvious to this writer that HRD has a significant role to play to understanding and improving the methods by which technical assistance can be formulated and delivered effectively and efficiently. Such research and demonstration efforts will be fundamentally interdisciplinary, thus forcing integration across fields where academic cooperation is still rare. It can argued, however, that the resulting findings will have an impact not only on the field for HRD, but on the economic prosperity of US manufacturing businesses, employees and their communities.

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