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Research Policy 30 (2001) 977–992

research policy

www.elsevier.nl/locate/econbase

# US manufacturing extension partnerships: technology policy reinvented?

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**Abstract**

The US manufacturing extension partnership (MEP) is examined as an example of the new partnership paradigm in US technology policy. The MEP provides technology assistance services, particularly for small and medium-sized enterprises. Influenced by aims to reinvent government and reorient technology policy, the MEP seeks to be comprehensive, collaborative, and demand-driven. However, the MEP's partnered management style is constrained by political and industrial systems that continue to operate on traditional lines. After probing these tensions, the paper offers insights for the MEP's future development and for other technology and innovation policies that seek to emulate the MEP's partnership approach. 

*Keywords:* Manufacturing extension; Technology policy; Partnerships; United States

## 1. Introduction

In contemporary technology policy, public–private partnerships have emerged as a central organizing mechanism for promoting research and development and accelerating the diffusion of innovations. As defined by the OECD, such partnerships in the field of technology policy encompass "... any innovation-based relationship whereby public and private actors jointly contribute financial, research, human, and infrastructural resources, either directly or in kind." (Organisation for Economic Cooperation and Development, 1998, p. 8.) In the United States, as in other OECD member states, there are now numerous cooperative programs in the field of technology policy and technology transfer involving a wide range of public and private participants (Coburn and Berglund, 1995).

There is, of course, much variety in the structure and organization of technology partnerships (see, for example, the range of partnership models discussed in Etzkowitz and Leydesdorff, 1999). In some instances, private organizations take the lead in consortia that also involve universities and other public institutions; in other cases, public organizations lead technology partnerships that involve multiple public agencies, non-profits and private groups. After providing further context to the development of the partnership paradigm in the United States, this article draws on a partnership case of the second type: the US manufacturing extension partnership (MEP). The MEP is a collaborative initiative between federal and state governments that also involves non-profit organizations, academic institutions, industry groups, and a variety of public and private technology assistance and business service providers. The MEP aims to upgrade the performance and competitiveness of US industry, especially small and medium-sized manufacturing enterprises with fewer than 500 employees.

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0048-7333/01/$ – see front matter 
PII: S0048-7333(00)00168-2

On its face, the MEP's collaborative approach presents a model of "reinvented" technology policy that is comprehensive, locally-managed, and demand-driven — representing a contrast with the fragmented and "technology-push" methods of previous federal technology transfer programs. In many ways, the MEP program has been remarkably successful — a significant achievement in a policy arena with a mixed record of performance. However, as the paper discusses, many tensions are inherent in pioneering new technology policy management styles in the context of political, fiscal, industrial, and innovation systems that continue to operate on lines that are more traditional. These tensions are examined and insights are drawn both for the future development of the MEP and for other technology and innovation policies that seek to emulate the MEP's approach. Although the MEP represents a publicly-led model, the case illustrates trends and issues relevant to a broad range of public–private partnerships, particularly in highlighting the inter-organizational tensions that occur within partnership boundaries and the mission trade-offs that result.

## 2. New frameworks for partnerships in technology policy

Many writers have commented on the paradigm shifts that have occurred in US innovation and technology policies over the past five decades (for example, Tassey, 1992; Crow, 1994; Galli and Teubal, 1997). Following the end of World War II, there was an emphasis on building-up the capabilities of national labs, universities, and corporate research centers and promoting R&D for such government-oriented missions as defense, energy, space exploration, health, and agriculture. In the 1960s, a focus on technology transfer emerged, with the aim to promote greater civilian "spin-off" from mission-driven public R&D.

Now, a third shift is underway. Prompted by increased global economic competition and the end of the cold war, US technology policy is more attentive to explicit civilian commercialization goals. Perhaps even more significantly, new implementation concepts are being pursued which — eschewing traditional linear "pipeline" models of technology "push" and "pull" — are based on more complex and iterative perspectives on the technology development and diffusion process (Branscomb and Florida, 1998). In particular, new patterns of industry collaboration and commercialization are being promoted, through industry consortia, university–industry linkages, and public–private partnerships. Examples of the new policy approaches at the federal level in the United States include the development of the advanced technology partnership (ATP), the manufacturing extension partnership, the partnership for a new generation of vehicles, and the United States innovation partnership (Brody, 1996; Shapira et al., 1997).

Collaboration between laboratory researchers and potential industry users or between the public and private sectors to develop and diffuse technology is not, of course, a new idea. In the late 19th and early 20th centuries, state land grant universities throughout the United States were chartered to work with farmers through agricultural extension and with industry through engineering experiment stations (Combes, 1992). By the 1920s and 1930s, scientists in government laboratories and universities were already collaborating on joint research projects with industry — a pattern that was massively reinforced during World War II by the collaborative, large-scale government, university, and industry projects in such fields as atomic weapons, computing, and radar (Freeman and Soete, 1997). Ironically, as Freeman and Soete (1997, p. 300) go on to note, the very success of these "big science" projects buttressed the notion that public investment in basic R&D would result, linear fashion, in applications and innovations. This encouraged the build-up of basic R&D capabilities and the public sponsorship of mission-oriented research that predominated in the 1950s and 1960s.

The American strategy of "front-loading" policy attention and public resources to basic research and government missions, while leaving commercial innovation and technology diffusion to fare for themselves in the private sector, underwent increasingly critical scrutiny in the late 1970s and 1980s. During this period, Japan emerged as a fully-fledged industrial and technological power. Japan's achievement was seen, at least in part, as an outcome of public–private collaboration for the purposes of commercial innovation that was far tighter than then common in the United States. Japanese public policy had, in Morris-Suzuki's (1994) terms, promoted an effective "social network"

of innovation, where the sharing of information and the collaborative matching of resources by the public sector, research institutions and private companies significantly accelerated not only technological progress but also commercial success. US industries, including those in knowledge-intensive high technology sectors, appeared relatively disadvantaged in terms of commercializing technology, despite America's evident strength in basic science and core research. This prompted US initiatives in the 1980s to encourage the cooperative transfer of research and development from federal laboratories to industry, establish university–industry research centers, and promote industry consortia in electronics, machine tools, and other industries (Office of Technology Assessment, 1990).

Despite these initial steps, and the considerable debate that accompanied them, it was not until the 1990s that a sustained effort to develop a new policy framework for public–private technology partnerships was put into place. On assuming office in 1993, the Clinton Administration defined new principles for the federal government's role in technology policy that included promoting a business environment to support private innovation and encouraging civilian technology development and commercialization (Executive Office of the President, 1993). The administration's implementation strategies included reallocating federal funds from military to civilian research, stimulating collaborative relationships between research performers and technology users, and measures to speed the deployment of new technologies to industry. These efforts to reorient federal technology policy through emphasizing public–private partnerships, civilian goals, and technology deployment have not been without criticism. For example, strenuous charges of unnecessary "corporate welfare" were levied at Clinton's new technology policies following the election of a Republican Congress in 1994. Moreover, it is evident that attention to establishing a new technology policy paradigm was greater in the administration's first term than in its second. Besides the difficulty of working with the Republican Congress, other factors at work included the strong performance of the American economy in the mid-to-late 1990s and perceived needs to re-boost defense spending, each in their own way "bumping-down" civilian technology policy's place on the broader policy agenda. Yet, these caveats notwithstanding, it does seem that a new era in US technology policy has taken root, and that attention to public–private collaboration and civilian technology goals will continue.

In understanding how this reorientation of policy came about, there is a natural tendency to focus on the changes that have occurred at the federal level. However, there is another important strand to the story, namely the role of states in establishing new concepts and frameworks for technology policy. During periods when the federal government has been reticent to take explicit civilian technology promotion measures, states have often done so under the guise of economic development. State universities and engineering experiment stations (and their successors) have long been engaged in collaborative, pragmatic relationships with local industries. States have sought to promote economic development by establishing regional technology clusters, among the most notable being North Carolina's Research Triangle. Most recently, US states have considerably increased their investments in technology policies, including university/non-profit research centers, joint industry–university research partnerships, direct financing grants, incubators, and other programs using research and technology for economic development (Coburn and Berglund, 1995; Berglund, 1998).

By the mid-1990s, states were spending about US$ 2.7 billion of state-derived funds (i.e. excluding federal and industry funds) on research and technology programs (State Science and Technology Institute, 1998). By comparison, the FY 1998 federal budget for the US National Science Foundation (NSF) was US$ 2.5 billion (for research support). This is, of course, not an entirely appropriate comparison: NSF has a far greater emphasis on fundamental science and engineering than do the states, although at least some of the state spending is used to match or leverage NSF awards. Nonetheless, it is symbolic that total US state research and technology spending now exceeds NSF's budget.

The relevance of the states is not simply that their budgets have increased, but also that they represent a significant, although at times under-emphasized, element in the reinvention of US technology policy. In America's decentralized federal system, the states are in their own right a countervailing source of policy intervention and experimentation. For example,

from the late 1970s through to the mid-1980s, intense economic restructuring and growing international competition generated many debates in Washington about the need for new industrial and technological policies. But, for political and ideological reasons, there was little in the way of a comprehensive federal response. However, a series of states did put into place their own industrially-focused technology policies, including Pennsylvania's Ben Franklin Partnership and Ohio's Thomas Edison Program (Osborne, 1988). These state models influenced the federal technology policy measures in the landmark 1988 Omnibus Trade and Competitiveness Act (which, for the first time, designated federal agency responsibilities for *commercial* technology promotion and established the program of regional manufacturing technology transfer centers that evolved into the MEP) and also the subsequent technology policy initiatives of the Clinton administration. One of the essential elements of these state models was partnership between government, industry, and academia. Moreover, the states not only pioneered prototypes for current partnership models, but today also serve as stakeholders in many technology partnerships now being promoted by the federal government.

## 3. Rationality of technology partnerships

As just discussed, in the reorientation of US technology policy, a new emphasis is being placed on commercialization. Public–private partnerships have emerged as a principal organizational and implementing mechanism. It is appropriate to ask: why? In considering this question, it is important to distinguish between general arguments for public policy intervention in technology policy and specific rationalizations for the use of public–private partnerships as a mechanism for implementation.

In general, an active governmental role in support of science and technology is typically justified on grounds of market failure. For example, it is advanced that because of the difficulties of fully appropriating results, private firms are likely to under-invest in research and development, thereby leading to under-investment from the view of potential social returns (Tassey, 1992). Related justifications focus on the concepts of public good and strategic interest, where purely private efforts in such areas as medicine, environment, defense, or industrial competitiveness are judged unable to maximize social well-being or to meet political or community goals.

Although public sponsorship has long been seen as an appropriate response to private market shortfalls in supplying optimal or desired levels of basic research and development, it has often been assumed that private mechanisms coupled with open access to public research institutions and universities could adequately disseminate technological innovations. However, it is increasingly recognized that market failures and strategic interests also exist in the process of technology diffusion. Potential users face uncertainty, information and learning costs, and other externalities which may result in under-investment in available technologies; similarly, potential suppliers of information and assistance also face learning costs, may lack expertise, or face other organizational barriers in promoting the diffusion of potentially rewarding technologies. System-level factors, such as the lack of standardization, regulatory impediments, weaknesses in financial mechanisms, and poorly organized inter-firm relationships, may also constrain the pace of technology diffusion. In the context of rapid international flows of information and capital and increased global competition, it has also been argued that strategic national and regional efforts to maintain industrial competitiveness depend not only on innovativeness, per se, but more than ever on the diffusion, effective application, and further incremental improvement of known technologies (Office of Technology Assessment, 1990).

Where market failures or strategic interests in technology diffusion are established, a range of specific policy tools is available. Measures such as subsidies and tax breaks for individual firms, enhanced information provision, or the development of traditional functional technology transfer programs may be effective policy responses. Why then the current emphasis on partnerships? Although the justifications for public–private partnerships take on many variations, it is possible to identify three broad types of reasons.

### *3.1. Efficiency and scale (economic rationality)*

Perhaps the most common justification for promoting public–private partnerships as an implementation strategy for technology policy is one of efficiency.

Usually, there is the desire is to optimize existing programmatic investments, by reducing overlaps and leveraging of scarce resources. It is also hoped that transaction and search costs are reduced. Given the historical context where individual programs and policies exist but do not necessarily coordinate well with one another, the efficiency motivation for partnerships is also a response to "government failure." The desire to form partnerships to improve the total efficiency of public technology policies is consistent with increased concerns by both public and private sector leaders about government performance enhancement. In addition to addressing government failure, partnerships can potentially be market correcting. If firms can be brought together in consortia, the risks involved in research and development can be shared, leading to a better balance between costs and returns. Typically, this argument is applied to generic, "pre-competitive" research. Yet, it also applies to the diffusion of technologies. For example, individual small firms in a locality may inadequately invest in training employees to use new technologies, perhaps because the cost of developing a new training program is too high for any single firm to justify. All firms, facing the same cost barriers, thus under-train and suffer from inadequate skills to use new technologies. However, if these firms are organized into a consortium, the training development costs can be spread over multiple firms, thereby lowering the unit costs to affordable levels for individual firms. In this case, with partnership, all firms benefit. Often, it takes an intermediary to stimulate the organization of firms into initial partnership.

### *3.2. Enhancement of scope and learning (social rationality)*

A second reason for promoting public–private partnerships is to improve the scope and quality of action — to do things through collective processes that could not be done individually. Partnered initiatives often seek to offer combinations of services, for example by combining technology assistance, training, management, and marketing assistance in an integrated fashion to firms. This is a mix that may require expertise from multiple public and private service providers. Even more fundamentally, partnerships frequently aim to accelerate the learning and sharing of knowledge and to promote networks of information flow, technology diffusion, experimentation, and organizational innovation. Fountain (1998) highlights "shared resources, shared staff and expertise, group problem-solving, multiple sources of learning, collaborative development, and diffusion of innovation" among the benefits of inter-organizational partnerships and consortia. In this sense, partnerships aspire to serve as investments in social capital or "associational economies" to promote the processes of collective learning and innovation now seen as crucial in the formation of effective systems of innovation at national, regional, and sectoral levels (Cooke and Morgan, 1998).

### *3.3. Sustainability (political rationality)*

In the "realpolitik" of public policy, it must also be admitted that partnerships have emerged as a political response to attacks on traditional concepts and instruments of government policy. The last decade or so in the United States has been one where any discretionary governmental activity has come under great skepticism and criticism. This is certainly true of technology policy. At the federal level, political momentum by conservatives to leave technology development and diffusion to the market was strong in the 1980s and remains powerful in the 1990s. These political forces frequently suggest that government cannot effectively guide technology policy, due to inefficiency, lack of skill, bureaucracy, or political favoritism. In response, technology policy proponents have advanced partnerships as a more effective, non-traditional approach that involves business input and matching funds, market incentives and fee for service, and an emphasis on performance. It is also true that in some cases, public agencies and institutions have promoted the formation of partnerships to serve their own organizational objectives. Partnerships can be seen as way of extending leverage and influence. In other instances, agencies seek partnerships for purposes of survival.

In theory, ideal public–private partnerships are ones that concurrently promote the triple goals of economic efficiency, social learning, and political sustainability. In practice, this ideal is hard to achieve. At best, most partnerships optimize between these three goals. If pushed too far in any particular direction, performance on one or both of the other goals suffers. Thus, if partnerships are too focused on efficiency

and performance goals, then learning and innovation may be given short shrift. Yet, if too focused on social learning without efficiency outcomes, then the political system may become impatient at the lack of "visible" results and so curtail support. If political rationality results in partnerships that are mostly symbolic and which lack economic and social substance, this too is problematic, particularly in terms of economic and social opportunity costs and the credibility of public action. It might be noted, however, that political sustainability and symbolism cannot be ignored: some partnerships that have high political value can preserve themselves, even if less than fully effective in economic and social performance. Paradoxically, even if partnerships seem to demonstrate economic and social outcomes, their continuance can be uncertain if they lack appeal to political values (a problem that affected the ATP in the mid-1990s).

These contrasting rationalizations for partnerships, and the need for partnerships to navigate and negotiate between different objectives and needs, suggest that the partnership is a particularly complex category among the tools of technology policy intervention. The hyperbole of partnership promises cooperation, reciprocal benefits, and seemingly effortless leveraging of resources. The reality is not so simple: partnerships usually have costs as well as benefits and frequently have to spend time and energy to reconcile competing interests. Once new policy frameworks have been established to encourage partnerships, significant leadership and management resources then need to be invested to ensure net benefits and desired results. The kinds of issues, tensions, and management strategies that are involved in implementing partnerships in technology policy are illustrated in following sections, through the case of the US MEP.

## 4. The manufacturing extension partnership

The MEP is a network of technology assistance and service providers that aims to upgrade the performance and competitiveness of small and medium-sized manufacturers in the United States.[1] The MEP is a collaborative initiative between federal and state governments that also involves non-profit organizations, academic institutions, and industry groups. The National Institute of Standards and Technology of the US Department of Commerce is the MEP's federal sponsor.

The provision of technology and related business assistance to small and mid-size firms in the United States is not an entirely new activity. In the 1950s and 1960s, state industrial extension and technology assistance programs were established in several states, including Georgia, North Carolina, and Pennsylvania. These early programs diffused technical information and used professional engineers and other technical specialists to help local firms improve their use of technology (Shapira, 1990). Increased concerns about industrial competitiveness and regional economic development over the next two decades prompted the development of similar programs in other states. By 1990, manufacturing extension and technology transfer programs had been established in 28 states. However, of these only about one dozen states operated field service networks using industrial experienced staff able to work on-site with firms — a factor critical in being able to address specific manufacturing problems on the shop floor of small firms.

The federal government started its own direct support of industrial extension programs in the late 1980s and early 1990s. Under the auspices of the 1988 Omnibus Trade and Competitiveness Act, the National Institute of Standards and Technology set up a handful of manufacturing technology centers, working in an initial collaboration with selected states (Office of Technology Assessment, 1990; National Research Council, 1993). But the most dramatic expansion of federal sponsorship came with the Technology Reinvestment Program, first announced in 1993 and implemented in 1994 and 1995 (Advanced Research Projects Agency, 1993). Although this multi-billion dollar program was targeted towards the post-cold war conversion and restructuring of America's defense-industrial base, it did make significant funds available for the upgrading and deployment of technology in civilian industries, including small and mid-sized manufacturers. The National Institute of Standards and Technology was allocated a share of these resources to increase the number of manufacturing technology centers and to organize, through what was then the embryonic MEP, a

[1] Small and medium-sized manufacturers are defined in the US as those with fewer than 500 employees.

collaboratively-delivered set of industrial extension services to manufacturers throughout the country.

The Technology Reinvestment Program had a major impact on the structure and character of the MEP. Funding was awarded through a competitive review process and states and other applicants normally had to match one-half of proposed costs with their own or private funds. Additionally, applicants were guided to form partnerships of service providers. There was an explicit requirement that proposals for funding address a criterion entitled "Coordination and Elimination of Duplication." This criterion required the proposer to understand and link with related service providers in the service region, be consistent with existing state strategies, and not duplicate existing resources or services. Partnership proposals were judged in terms of the number, diversity, and skills of constituent service providers, geographic scope and coverage, cohesiveness, organization, and management structure (National Institute of Standards and Technology, 1994).

Boosted by the Technology Reinvestment Project and with subsequent support from the civilian budget through the US Department of Commerce, the MEP has now grown to a network of more than 70 centers in all 50 states. MEP centers are structured either as separate non-profit corporations or as part of other organizations, such as universities, stage agencies, technology centers, or economic development groups. A variety of partnership elements are fostered. The federal sponsor works with states and local centers in program management and development and in backing joint working groups, staff training, information and communications systems, and common tools. MEP's annual federal funding (about US$ 105 million for the fiscal year 2000, of which more than US$ 90 million goes to center support) is supplemented by more than US$ 130 million in state and private funds (latest estimates indicate that private sector revenues and fees contribute around US$ 70 million annually to MEP operations). In almost every case, individual centers operate with and through local networks of associated public and private service providers. Centers usually have governing or advisory boards that include local public and private-sector representatives.

Currently, about 30,000 firms are being assisted each year by the MEP through assessments, technical assistance projects, information workshops, and other services. Two-thirds of assisted companies have fewer than 100 employees. MEP centers reach and serve these firms directly through over 400 local offices and through a partnership network of more than 3100 affiliated public and private organizations that deliver or support the delivery of services to small and medium-sized manufacturers.

The most common partnership relationships are with economic development organizations and universities. About 95% of centers have relationships with these types of organizations. [2] The next most common type of organizational relationship, for two-third percent of the centers, is with community or vocational colleges and technical institutes. Almost sixty percent of centers have relationships with industry associations and small business development centers, and about one-half with private consulting companies. To a lesser extent, partner relationships are also reported with federal laboratories, larger companies, utilities and training organizations (Table 1). Although there are issues of data comparability, the number of MEP partners in 1997 was more than three times greater than the 750 affiliated organizations reported by 40 centers at the end of 1995. It suggests that MEP center affiliations with partnership organizations have grown. [3]

MEP organizational partnerships are diverse. Many MEP centers have arrangements where other service providers act as program affiliates to perform particular operating functions, such as marketing to prospective customers, or provide specialized services, for example in helping manufacturers with environmental compliance. MEP centers have also established collaborative initiatives with industry associations, large manufacturers, technology centers, and other groups through which information, training, networking, technology diffusion, or other special projects are

[2] Calculated form of reports to NIST by 68 MEP centers (June 1997), with removal of duplicative information. There are variations in how different centers define and report their affiliates. Some centers do not report information about organizations that staff informally used to provide assistance to manufacturers. In addition, data from seven mostly newer MEP centers is not included in this analysis.

[3] Further details about the characteristics and organizational forms of MEP partnerships are found in Shapira and Youtie (1998a). The balance of this section of the article draws upon this study.

Table 1
US manufacturing extension partnership: affiliated organizations[a]

| Type of organization | Percent of centers reporting affiliation |
|---|---|
| Economic development organization | 97 |
| University or 4-year college | 95 |
| Community or vocational college | 66 |
| Industry association | 59 |
| Small Business Development Center | 59 |
| Other non-profit business assistance organization | 57 |
| Consulting company | 48 |
| Federal laboratory | 38 |
| Other government agency | 38 |
| Other extension service (cooperative, industrial) | 31 |
| Large company | 31 |
| Electric power or other utility | 31 |
| Training organization | 29 |
| Other for-profit organization | 26 |
| Vendor (of equipment or software) | 10 |

[a] Source: analysis of manufacturing extension partnership center reports to the National Institute of Standards and Technology, June 1997. Based on reports from 68 centers.

targeted to small and medium-sized manufacturers in a particular locality, industry, or supply chain.

Perhaps most frequently, MEP centers use other service providers on a subcontract or referral basis. About one-quarter of MEP's technical assistance projects involve outside service providers.[4] In such cases, center staff typically conduct an assessment of a customer's needs, propose a project, and then recommend qualified outside service providers or consultants to assist in implementation. Centers tend to use other service providers in fields both outside of and within traditional MEP core competencies. Human resource projects, where most MEP centers do not have in-depth expertise, are most likely to involve outside service providers. However, the second most common area for third party projects — process improvement — is a central MEP core competency. Here, the involvement of outside partners to provide services presumably leverages the number of projects within their field of expertise that center staff can manage. Other common areas for third party projects include business systems and management, market development, and quality.

While partnerships between MEP centers and other organizations are often informal, increasingly the tendency is for these relationships to be structured in writing, through memoranda of understanding, performance agreements or binding contracts. Formal agreements are universal where money changes hands. But there is no single contractual model for the whole system; each center has considerable flexibility in organizing partnership arrangements within allowable legal, auditing and sponsor criteria. MEP centers may entirely underwrite the cost of activities or specialized services by partners, although this mode of partnership is becoming less prevalent as MEP centers face greater pressure to generate fee revenues. In other cases, MEP centers and partners share costs (at times with in-kind as well as cash contributions) or collectively obtain resources for a special project from NIST, the state or another sponsor. With the aim of generating revenues, some centers seek management fees from outside service providers who implement referred projects with MEP customers. In other instances, vendors, corporations, or large private consultants may donate cash, equipment, in-kind or pro-bono services in liaison with MEP centers.

In several senses, the MEP is an organizational hybrid. It is not a purely private partnership, as its leading players are public and non-profit entities. Yet, private service providers and, of course, private manufacturers are integrally involved. Second, the MEP is not a purely national effort, in contrast to the advanced technology partnership — a federal program that promotes national consortia of private companies, laboratories, and other institutions to develop and commercialize leading-edge technologies; nor is the MEP a purely local effort, as is the case with state technology initiatives like Pennsylvania's Ben Franklin partnership or the Georgia Research Alliance — programs that are concerned only with technology development in individual states, without regard to national impact.[5] Rather, the MEP embodies a partnership between different levels of government — with the relationships between these levels undergoing change over time. Finally, the MEP is not a purely technological initiative, in the "hard" meaning of this

[4] Analysis of 8443 technical assistance projects of 8 h or more with companies completed by 59 MEP centers in 1996 shows that outside service providers were involved in 24% of projects.

[5] For comparison with state technology initiatives and partnerships, see the program descriptions available through the State Science and Technology Institute at http://www.sti.org/.

term. Rather, considerable weight is given to issues of management, training, marketing, and strategy, as well as to technology per se.

Yet, these variations notwithstanding, the MEP certainly incorporates most of the design principles articulated in government reform proposals and advanced by advocates of new public–private technology policy partnerships (Osborne and Gaebler, 1993). First, the program seeks a cooperative relationship between the public and private sectors. The private sector is involved not just as a recipient, but also as a service partner and an advisor. Second, the program is decentralized and flexible, with individual centers able to develop strategies and program services which are appropriate to state and local conditions. Third, the MEP seeks not to duplicate existing resources. Rather than provide services directly from the federal level, MEP awards are designed to get existing service providers, whether they be consulting firms, non-profit organizations, academic institutions, public agencies or trade associations, to cooperate and coordinate in their efforts to assist local manufacturers.

## 5. Partnership outcomes and tensions

Many advantages of scale, scope, and shared learning are claimed from the MEP's efforts to promote partnership and service coordination to aid the industrial modernization of small and mid-sized manufacturers (US Department of Commerce, 1999a). These include reduced duplication, access to special skills, greater flexibility, the leveraging of public and private dollars, and improved service to clients. To what extent are these professed public and private benefits actually achieved, and at what cost?

Such questions were probed in a study of MEP service coordination conducted in two phases between 1995 and 1998. The first phase of the study examined the initial development, operation, and effects of service coordination in the MEP system (Shapira et al., 1996a). On-site cases were conducted of six MEP centers and their partnership relationships. The second phase of the study examined subsequent changes in how MEP centers coordinated services with partner organizations (Shapira and Youtie, 1998a). The design of the second phase involved revisiting four of the original case study centers (about 2 years had elapsed between the first and second rounds of case studies, allowing changes in partnership arrangements to be observed). Two new case study MEP centers were added. In both phases of the study, structured interviews were conducted with MEP staff, partner organizations, small business customers, and state sponsors. These case studies were augmented by reviews of program documents from each center and its affiliates, an analysis of partnership information from MEP's national records, interviews with national program staff, and input (in Phase I) from an expert advisory panel. [6] In summary, this research found these benefits:

1. Enhanced service partnering and coordination stimulated by the MEP has made available a wider range of expertise to firms and, in many instances, a more systematic approach to providing assistance.
2. Involving other partners has allowed MEP centers to increase flexibility and has particularly helped newly established centers to ramp-up their services fairly quickly by building on and expanding existing resources. MEP centers have been able to draw upon other well-established organizations, such as economic development organizations, to conduct marketing and outreach campaigns.
3. Resource sharing has occurred. Facilities at community colleges have been used for business training programs and for demonstrating new technologies. Experts at universities and federal labs have been involved in helping firms to resolve specific technical problems.
4. New working relationships have been forged with private consultants through whom MEP centers have been able to broker a range of

[6] The research on service coordination in the MEP system was directed by Philip Shapira and conducted with Jan Youtie, Gordon Kingsley, and Marc Cummins. The eight MEP centers and networks that were the focus of case studies were: the Chicago Manufacturing Center, the Florida Manufacturing Center, the Georgia Manufacturing Extension Partnership, the Great Lakes Manufacturing Technology Center (Cleveland, OH), the Industry Network Corporation (a multi-state franchise serving five states including New Mexico, Arizona, and Nevada), the Manufacturing Extension Partnership of Southwest Pennsylvania (Pittsburgh region), the Minnesota Manufacturing Technology Center, and the Oklahoma Alliance for Manufacturing Excellence. The cited project reports (1996, 1998a) contain full details of the research methodology, cases, and findings and are available through the Worldwide Web site of the Georgia Tech Policy Project on Industrial Modernization at http://www.cherry.gatech.edu/mod.

business-oriented services to small and mid-sized firms. Centers have also used partnerships to develop new service offerings. In affiliation with third party organizations, MEP centers have won grants to develop new tools, training, and group service programs and to extend services in critical fields, including environmentally conscious manufacturing and human resources.

5. Small and medium-sized customer firms indicated that it was preferable to deal with one organization able to offer a range of needed business services from public and private sources — as opposed to numerous single-function government programs or private vendors promoting only their own products.

So far, so good: it does seem that the emphasis on partnership has influenced how services are organized and delivered to small and mid-sized manufacturers through the MEP system. Moreover, most companies report that they take action on MEP project recommendations: one state study shows that that over two-thirds of customers act on the recommendations provided by program staff (Youtie and Shapira, 1997), while in a national MEP post-project survey almost three-quarters of customers report that interactions with MEP centers cause them to take actions they would not have done otherwise (Voytek, 2000). Companies further report that these actions lead to improvements in manufacturing processes and skills (Shapira and Youtie, 1998b). Several studies have found that MEP-prompted actions lead to cost savings, additional sales, higher profit margins, or improved productivity (see, for example, the evaluations conducted by the US General Accounting Office, 1995, and Jarmin, 1999). However, other studies report more mixed results. For instance, Luria (1997) found that Michigan MEP customers improved to a greater extent than non-customers in sales growth, employment growth, and adoption of certain process improvements and technologies. But, center customer growth in wage rates, profitability, and labor productivity were not significantly different from that of non-customers.

Overall, the weight of the evaluation evidence (particularly of studies that include non-customer controls) is that MEP projects typical have positive but mostly modest effects on companies (Shapira, 2000). To an extent, this conclusion is a reflection of the genuine difficulties that companies have in reporting quantitative effects from project interactions, particularly in terms of dollar impacts. But it may also reflect the fact that many manufacturing extension projects are of small scale and, by themselves, cannot be expected to have substantial effects. A majority of the interactions that the MEP has with companies involve less than 8 h of total staff time (a threshold below which projects are often deemed too small to evaluate). Conversely, those cases where MEP interactions have had significant strategic impacts on companies frequently involve in-depth, long-term engagements (which may extend over several years), and are often associated with internal management changes (Youtie, 1997; US Department of Commerce, 2000). Several analysts have recommended that the MEP needs to give greater attention to strategic offerings that will assist firms become more distinctive and specialized in their marketplaces, rather than offer standardized, often short-term, services that simply emphasize efficiency (Luria, 1997; Oldsman and Heye, 1998). Indeed, MEP management acknowledges that while their program has established a national network, is reaching significant numbers of firms, and has many individual success stories, it has yet to achieve hoped-for levels of center performance and customer improvement across the whole MEP system. "We have done a lot, but only touched the tip of the iceberg," notes the director of the program. [7]

Why has the MEP's achievement in rapidly realizing scale in its service delivery system been paralleled by mostly modest performance outcomes for customers? It can reasonably be argued that such outcomes come with the territory: the pragmatic adoption of improved technologies and methods by existing manufacturing firms will typically lead to incremental, rather than dramatic, results. At the same time, it is also evident that the performance outcomes experienced to date reflect, at least in part, inherent tensions in the program's partnership model. While at first glance, partnership appears to offer a "free ride" that can leverage public investment, further analysis shows that, in fact, partnership tends to be accompanied by tensions that reduce desired leveraging effects. Such tensions derive from conflicts and tradeoffs between

[7] Plenary remarks by Kevin Carr, Director, NIST Manufacturing Extension Partnership, 2000 Manufacturing Extension Partnership National Conference, 8 May 2000, Orlando, FL.

the three underlying rationalizations for partnership formation noted earlier. For example, although MEP centers have formed partnerships and, in so doing, have pursued the economic rationalization of leveraging resources, this process has both direct (i.e. MEP) and indirect (i.e. non-MEP) costs. Field interviews conducted as part of the service coordination study found that MEP programs actively engaged in service coordination incurred significant transaction costs, including the expense of identifying and qualifying outside providers, information exchange, contracting, consulting, and monitoring. Furthermore, in most instances, the other program resources "leveraged" by MEP centers were not "free" in that they had to be paid for by other public or private sources. Additionally, the inter-organizational tensions associated with partnership promotion efforts required the expenditure of significant amounts of "political" capital, for example in resolving concerns about clients being "stolen" or about one program working in another's territory. In short, some collective resources that (in theory) might have been available to re-allocate to more strategic assistance to firms were (in practice) expended internally in processes of organizational adjustment or were not truly available to be leveraged for different purposes.

Similarly, aspirations for partnerships to improve overall service quality were not so easily achieved. The case study interviews found that while the differential characteristics of program partners added new capabilities to the system, efforts to promote tighter service coordination also revealed limitations among those partners (Shapira et al., 1996a; Shapira and Youtie, 1998a). These affected how various partners performed in delivering modernization services to manufacturers. For example, economic development organizations often offered general referral services but typically could not deliver technological or longer-term project assistance to firms. Federal laboratories and university researchers possessed particular technical capabilities in specific fields, but drawing on these capabilities was hampered by asynchronous time horizons and administrative barriers within these large institutions. Small business development centers provided needed business planning capabilities, but their lack of manufacturing background posed problems in face-to-face dealings with manufacturers (see also the evaluation of MEP-Small Business Development Center partnerships in Yin et al., 1998). Private-sector consultants did have an orientation towards manufacturing needs. However, their expense rates and operational styles were often geared to large-manufacturer budgets. Finally, the involvement of community colleges promised additional institutional resources for local manufacturing extension partnerships, but these sometimes proved ephemeral as college administrators (under continual funding pressure) focus on their own priorities, rather than the MEP's.

To an extent, some of these problems could have been avoided with better selection of partners. However, the political rationality of partnerships is such that lead organizers have to work with the spectrum of organizations they find within the jurisdictions defined as eligible for funding. Moreover, it is not always apparent what the limitations of partners are until real work is underway. Of course, many of these operational issues are addressable — and can be seen as teething problems that settle down as partnerships evolve over time. Indeed, the case studies found that MEP partnerships went through successive stages, during which not only was there changes in the balance of benefits and costs but also much learning about the how partnerships could be most effectively structured and managed to accommodate developments in customer needs, technology, and policy. MEP partnerships were first formed under conditions of increased federal and matching funds, with guidance to demonstrate a high level of coordination and service partnership. Under these conditions, MEP centers entered into a wide-ranging set of service partnerships, as our analysis of MEP-affiliated organizations illustrated. However, as MEP centers subsequently operationalized their partnerships, they have better understood the strengths and weaknesses of particular affiliates. This has led to changes in arrangements. In many cases, relationships have been scaled-down or ended. In other situations, links have continued but important adjustments have been made. To take one example, to address the high cost of some private consultants, one center has negotiated reduced rate structures which take into account the fact that the center bears the marketing costs and that center referrals often generate opportunities for follow-on work (Shapira and Youtie, 1998a).

As they have gained more experience with partners and partnerships, we now see many MEP centers

undertaking a substantial restructuring of their service coordination arrangements. The outcome has been to focus on tighter links with a smaller set of the most capable partners — with the ability to adjust partner arrangements, as customer business and technological needs change. Links with more marginal partners are being reduced, usually — although not always — in an amicable manner that maintains communication and allows collaboration on an as-needed basis. This trend has been accelerated by the reduction in the federal contribution to MEP center costs — from about one-half of each center's budget in the program's early years to a planned steady-state level of one-third. As federal resources become tighter, centers have to reduce their own costs as well as generate additional revenues from customers and other sponsors. Partnerships with other service providers continue to be important. But centers have recognized that they must more exactly specify what each service provider is expected to contribute to the partnership, how partnership performance will be monitored, and under what conditions partnerships will be renewed or, if necessary, terminated.

The challenges faced by MEP affiliates in achieving more substantial performance outcomes are compounded by difficulties in designing assessment and evaluation systems that can match the differential objectives pursued by sponsors, service providers, and customers. Among the sponsors, state and federal aims in co-funding partnerships do not necessarily coincide. A principal federal interest in promoting manufacturing extension is the improvement of industrial competitiveness and productivity for the nation as a whole. States, on the other hand, are particularly concerned about what happens within their own boundaries. They seek new jobs, although in reality enhanced productivity may reduce employment in some instances, and have few qualms about supporting "their" businesses, even at the cost of jobs in another state (for example, by assisting low-wage small firms, some extension efforts may help the shift of high-wage jobs from manufacturing regions in other states — a process that may be zero-sum or worse from a national perspective, but which may be judged worthwhile from a state standpoint). Similarly, from the viewpoint of individual partner organizations and assisted firms, each represents different stakeholders and interests that may or may not consider MEP evaluative metrics as important benchmarks of performance or outcomes. Thus, community colleges may seek to boost trainee enrollments in their institutions (an own goal), rather than upgrade the internal training processes of firms (which relates to the MEP partnership goal of overall firm upgrading). This example illustrates a sense in which partners in the MEP network can also be competitive in terms of customer procurement and maximizing credit for their own programs.

Diversity in objectives is found, of course, in many policies and programs whether operated through partnerships or not. However, it is apparent that as partnerships grow, so does the multiplicity of stakeholders and differential interests, thereby adding to the complexity of what and whose objectives evaluation should measure. Moreover, it is also apparent that some organizations were added to particular MEP partnerships to bolster local political support, head off potential "turf battles" and augment outreach efforts, rather than provide distinct service delivery capabilities. Evaluative results may show that these partners contribute little on standard measures, but underestimating the role of these partners could impair a federal sponsor's ability to maintain ongoing in-state political support for inter-governmental partnership initiatives such as MEP.

A further tension arises between efforts to standardize performance metrics for MEP affiliates to promote efficiency, effectiveness, and public accountability (a desired goal for reinvented government), and the complex, non-standard, and hard-to-quantify character of customized services offered to promote innovation, networking and learning (elements of the social rationality of the partnership). Standardized evaluation metrics for manufacturing extension providers have stressed business outcomes, such as increased sales or reduced costs, and economic development impacts, particularly effects on jobs (Oldsman, 1996; Shapira et al., 1996b). Illustrative of this trend are the four performance measures emphasized by the MEP to meet the US Government Performance and Results Act: increased sales, labor and materials savings, capital investment, and inventory savings (US Department of Commerce, 1999b). However, differences in the specialized services that various partners offer present challenges to the use of such narrowly defined efficiency measures across the whole partnership. Diverse organizations are involved in MEP

programs, including universities, colleges, economic development organizations, technology centers, federal labs, utilities, and different kinds of private sector consultants. Some partners offer services that were more likely to have quantifiable effects than others. Some are more likely to produce short-term gains, whereas others promise long-run effects on an industry or regional economy. For example, partners who provide human resource and training services or help firms develop supplier linkages and inter-industry networks frequently have less tangible effects on a firm's bottom-line than organizations, which show firms how to make fast savings in energy consumption or fix a particular machine problem. The risk here is that partners whose activities have deeper long-term impacts may be unfavorably compared to service providers whose results are more readily measurable now.

In a sense, there is a tension here that goes beyond differences in partner roles and to the basic expectations ascribed to partnerships themselves. On the one hand, partnerships are promoted as innovative mechanisms, able to address structural, long-running problems and needs better than previously fragmented approaches and services. On the other hand, partnerships are also expected to efficiently and quickly produce visible results. There are undeniably possibilities for partnerships to simultaneously make progress on both of these fronts, but realistically, as we found in our cases, tensions may be apparent between what can be measured now and what is of long-term value.

A final set of tensions is found in the intergovernmental relationship between the federal government, the states, and the MEP centers. The federal-state relationship is simultaneously a collaborative effort to share resources to promote modernization objectives and a contractual arrangement between the federal government and the states for the delivery of certain services and outcomes. While the former role requires openness and information sharing, the latter tends to encourage the withholding of "bad news" by centers and requires conformity to established bureaucratic norms and regulations. On the one hand, the MEP aims for learning, flexibility, and experimentation — leading to interactions with companies that have strategic outcomes. On the other hand, the MEP is also under pressure to achieve wholesale coverage, serve large numbers of firms, and quickly produce "visible results." The former reflects the social learning rationality in the MEP's partnership design. The latter reflects the economic and political rationalizations of achieving scale and institutional survival.

There is much discussion of this tension within the MEP system (see, for example, Oldsman and Luria, 1998), with many proposals for change. However, it has been rather hard to make progress on these proposals. In earlier phases of development (roughly the period 1988 through 1994), the MEP was arguably more open to the innovation and discursive dialogue (and also the risk of failure) that characterizes the social learning pole. After a heightened concern with political sustainability (around 1995 to 1996, with the election of a Republican-led Congress), the MEP is now under pressure to emphasize economic efficiency and measurable performance. In this reality, the drive for visible results tends to get priority, leading to many MEP projects that are short-term, of limited duration, but not always of strategic import. These projects seem to produce outcomes that are adequate to secure ongoing federal political support and funding. However, as the MEP's federal investment declines to one-third, it remains to be seen whether a focus on short-term economic rationality will generate the increased state and private revenues necessary to sustain a national system. The former may require more emphasis on political sustainability, as adjustments are made to MEP partnerships to garner greater state and local political support and the funding this brings. The latter may be best served by initiating interactions and projects with companies that are more customized, long-term, and strategic, so as to generate significantly more fee revenue. This would change the service mix, shifting from large numbers of small projects to somewhat fewer larger projects, potentially excluding many of the smallest manufacturers and also regional or industry network initiatives from which it is hard to generate income. In short, it is probable that in the future the MEP will continue to grapple with how it emphasizes and meets contrasting goals and objectives, within the three-axis framework of efficiency and scale, sustainability, and scope and learning.

## 6. Conclusions

The experience of the MEP exemplifies how partnership initiatives negotiate, are stymied by,

or otherwise manage the tensions and challenges posed by new technology policies that emphasize inter-organizational and inter-sectoral collaboration. In part, the story here is of conflict between traditional and reinvented approaches to government; in part, it is also about the tensions inevitably inherent within the new models of technology partnership. The net product is to make partnerships complex mechanisms to manage well, with varied and usually not straightforward outcomes. As proponents hoped, the MEP case studies did find real benefits associated with partnered service coordination. These included avoiding the duplication of services, tapping specialized skills, spreading development costs of new tools, broader marketing to new industrial customers, improving access to particular industries and areas, flexibility in staffing and the delivery of services, improving service quality, enhancing visibility in the locality, and strengthening state and local support. At the same time, while partnership and service coordination had significant advantages, the cases also identified costs and tensions. These included increased transaction costs (including the expense of identifying service providers, information sharing, contract management, and monitoring projects), difficulties in maintaining quality across partner organizations, delays in timely service delivery, and inter-organizational tensions through unresolved conflicts over client and service territories.

With increased attention being paid to promoting public–private partnership in industrial modernization and other areas of technology policy, there should be a careful assessment of it's benefits and costs. In the MEP examples, it was found that new partnership arrangements resulted in significant advantages, but this should not lead policymakers and program managers to overlook the reality that there are expenses and tensions associated with greater coordination. Investments of resources, time, people, technology, and political capital are needed to make public-partnerships work well.

As J.M. Keynes observed more than half a century ago, "the difficulty lies, not in the new ideas, but in escaping from the old ones." Much of the high-level debate about partnerships in technology policy assumes away the real difficulties of implementing such approaches, particularly where partnerships are laid on top of existing systems and organizational arrangements. Yet, at the same time, the "grounded" case study literature on organizational partnerships — in management as well as public administration — is replete with as many stories of failure as success. Interestingly, the management literature emphasizes that the most successful business partnerships and alliances are those where there is a strategic commitment to learning (see, for example, Burgelman et al., 1996, p. 593–595). In the world of public–private partnerships, learning is also expressed as a major goal. As the MEP cases indicated, there is learning in these partnership over time, and improvements occur. However, it is apparent that other goals related to economic rationalization and political expectations constrain the commitment to learning too, leading to less than the strategic outcomes originally anticipated (no doubt, similar processes are at work in the business world too).

In this context, the extent, the identification and diffusion of "best practices" in partnership operation is a very critical element — since this process has the potential to shorten aggregate learning cycles, by transferring successful experiences, methods, and tools between partnerships and locations. Promoting the transfer of best practice is invariably not straightforward and sometimes not possible because of the particular tensions, constraints, and circumstances found in individual partnerships. Nonetheless, best practice transfer is one of the important practical steps that can be taken — with the program design lesson that mechanisms and funds for such activities should be built in when new partnership initiatives are designed. Indeed, it has been possible to identify a set of best practices that appear to influence positive outcomes from MEP partnerships (Shapira and Youtie, 1998a; Westra, 1997; Yin et al., 1998).

Recognition should also be paid to the tradeoffs that are inherent as partnership stakeholders multiply. For example, it has been suggested that the ATP should be more closely tied to states and to regional goals (Hill, 1998). The payoff is seen as a higher local profile for the ATP that might then be translated into greater support in Washington, as well as the potential to garner state and local funding matches. Yet, as the MEP case illustrates, this would also lead to a changes and conflicts in ATP goals, as state desires for local economic development rose in prominence

against national objectives for industry-wide technological commercialization.

Overall, it is to be recognized that US technology policy has progressed in substantive ways compared with a decade or so ago. The MEP surely illustrates this. Whereas the US once lagged most other industrialized economies in the scale and scope of its industrial modernization efforts, today there is a nationwide system in place that is comparable (and in several areas more innovative) than found elsewhere. The convergence of a new emphasis on civilian technology diffusion with the reorientation of governmental implementation towards decentralized public–private partnerships has paved the way for the establishment of the MEP. Such public–private partnerships by themselves do not "waive away" longstanding and broader tensions in the relationships between the public and the private, between technological innovation and diffusion, between competing organizations, and between different elements of a federal political system. But if implemented with realistic program design and effective management, they do offer a renewed framework to elucidate and address these issues, and to explore opportunities for improvement.

## Acknowledgements

Special acknowledgments are due to Jan Youtie for collaborative contributions with the author to several of the underlying research projects cited in this paper. An earlier version of the paper was presented at the Conference on Civilian Technology Policy in the United States and Europe, Atlanta, 9–10 April 1999.

## References

Advanced Research Projects Agency, 1993. FY93 Technology Reinvestment Project, Program Solicitation. US Department of Defense, Arlington, VA.

Berglund, D., 1998. State Funding for Cooperative Technology Programs. Batelle Memorial Institute, Columbus, OH.

Branscomb, L., Florida, R., 1998. Challenges to technology policy. In: Branscomb, L., Keller, J. (Eds.), Investing in Innovation: Creating a Research and Innovation Policy that Works. MIT Press, Cambridge, MA.

Brody, R., 1996. Effective Partnering: A Report to Congress on Federal Technology Partnerships. Office of Technology Policy, US Department of Commerce, Washington, DC.

Burgelman R., Maidique M., Wheelwright, S., 1996. Strategic Management of Technology and Innovation. Irwin, Chicago, IL.

Coburn, C., Berglund, D., 1995. Partnerships: A Compendium of State and Federal Cooperative Technology Programs. Batelle Memorial Institute, Columbus, OH.

Combes, R., 1992. The Origins of Industrial Extension: A Historical Case Study. Master's Thesis, School of Public Policy, Georgia Institute of Technology, Atlanta, GA.

Cooke, P., Morgan, K., 1998. The Associational Economy: Firms, Regions, and Innovation. Oxford University Press, Oxford.

Crow, M., 1994. Science and technology policy in the US: trading in the 1950 model, Science and Public Policy, August.

Etzkowitz, H., Leydesdorff, L., 1999. Symposium: the triple helix of university–industry–government relations. The Journal of Technology Transfer 24 (2/3), 111–254.

Executive Office of the President, 1993. Technology for America's Economic Growth: A New Direction to Build Economic Strength. The White House, Washington, DC, February.

Fountain, J., 1998. Social capital. In: Branscomb, L., Keller, J. (Eds.), Investing in Innovation: Creating a Research and Innovation Policy that Works. MIT Press, Cambridge, MA.

Freeman, C., Soete, L., 1997. The Economics of Industrial Innovation, 3rd Edition. MIT Press, Cambridge, MA.

Galli, R., Teubal, M., 1997. Paradigmatic shifts in national innovation systems. In: Edquist, C. (Ed.), Systems of Innovation: Technologies, Institutions, and Organizations. Pinter, London.

Hill, C., 1998. The Advanced Technology Program. In: Branscomb, L., Keller, J. (Eds.), Investing in Innovation: Creating a Research and Innovation Policy that Works. MIT Press, Cambridge, MA.

Jarmin, R., 1999. Evaluating the impact of manufacturing extension on productivity growth. Journal of Policy Analysis and Management 18 (1), 99–119.

Luria, D., 1997. Toward Lean or Rich? What Performance Benchmarking Tells us About SME Performance, and Some Implications for Extension Center Services and Mission. In Shapira, P., Youtie, J. (Eds.), Proceedings of Third Workshop on the Evaluation of Industrial Modernization Programs on Manufacturing Modernization: Learning from Evaluation Practices and Results. Georgia Institute of Technology, Atlanta, GA.

Morris-Suzuki, T., 1994. The Technological Transformation of Japan. Cambridge University Press, Cambridge, UK.

National Institute of Standards and Technology, 1994. Technology Reinvestment Project Deployment Activity Areas: Lessons Learned. In: Materials presented at workshops in Oakland, CA and Atlanta, GA, 28 March, 1994. Manufacturing Extension Partnership, Gaithersburg, MD.

National Research Council, 1993. Learning to Change: Opportunities to Improve the Performance of Smaller Manufacturers. Commission on Engineering and Technical Systems, Manufacturing Studies Board. National Academy Press, Washington, DC.

Office of Technology Assessment, 1990. Making Things Better: Competing in Manufacturing. USGPO, Washington, DC.

Oldsman, E., 1996. Does manufacturing extension matter? An evaluation of the industrial technology extension service in New York. Research Policy 25 (2), 215–232.

Oldsman, E., Heye, C., 1998. Waste not, want not — a look at the impact of manufacturing extension centers. Journal of Technology Transfer 23 (1), 37–42.

Oldsman, E., Luria, D., 1998. Integrating strategy and evaluation in the manufacturing extension partnership. In: Shapira, P., Youtie, J. (Eds.), Manufacturing Modernization: Implications of Evaluation Results for Program Improvement and Policy Development. School of Public Policy, Georgia Institute of Technology, Atlanta, GA.

Organisation for Economic Cooperation and Development, 1998. Public/private partnerships in science and technology: an overview, STI Review, p. 23.

Osborne, D., 1988. Laboratories of Democracy: A New Breed of Governor Creates Models for National Growth. Harvard Business School Press, Boston, MA.

Osborne, D., Gaebler, T., 1993. Reinventing Government: How the Entrepreneurial Spirit is Transforming the Public Sector. Plume, New York.

Shapira, P., 1990. Modern times: learning from new state initiatives in industrial extension and technology transfer. Economic Development Quarterly 4 (3), 186–202.

Shapira, P., 2000. Evaluating manufacturing extension services in the United States: experiences and insights. In: Paper presented at the US–European Workshop on Learning from Science and Technology Policy Evaluation Bad Herrenalb, Germany, 11–14 September 2000.

Shapira, P., Youtie, J., 1998a. Manufacturing Partnerships: Coordinating Industrial Modernization Services. Phase II Final Report. Georgia Institute of Technology, School of Public Policy and Economic Development Institute, Atlanta, GA.

Shapira, P., Youtie, J., 1998b. Evaluation industrial modernization: methods, results, and insights from the Georgia manufacturing extension alliance. The Journal of Technology Transfer 23 (1), 17–28.

Shapira, P., Youtie, J., Kingsley, G., Cummings, M., 1996a. Coordinating Industrial Modernization Services: Impacts and Insights from the US Manufacturing Extension Partnership. Georgia Institute of Technology, School of Public Policy and Economic Development Institute, Atlanta, GA.

Shapira, P., Youtie, J., Roessner, D., 1996b. Current practices in the evaluation of US industrial modernization programs. Research Policy 25 (2), 185–214.

Shapira, P., Kingsley, G., Youtie, J., 1997. Manufacturing partnerships: evaluation in the context of government reform. Evaluation and Program Planning 2 (1), 103–112.

State Science and Technology Institute, 1998. Survey of State Research and Development Expenditures: Fiscal Year 1995. State Science and Technology Institute, Westerville, OH.

Tassey, G., 1992. Technology Infrastructure and Competitive Position. Kluwer, Norwell, MA.

US Department of Commerce, 1999a. Solutions for Manufacturers: Manufacturing Extension Partnership. National Institute of Standards and Technology, US Department of Commerce, Gaithersburg, MD.

US Department of Commerce, 1999b. Annual Performance Plan, Fiscal Year 2000. Technology Administration, US Department of Commerce, Washington, DC.

US Department of Commerce, 2000. More Transformed Firms: Case Studies. Manufacturing Extension Partnership. National Institute of Standards and Technology, US Department of Commerce, Gaithersburg, MD.

US General Accounting Office, 1995. Manufacturing Extension Programs: Manufacturers' Views of Services, GAO/GGD-95-21-216BR. GAO, Washington, DC.

Voytek, K., 2000. Where are we and where are we headed? In: Presentation by NIST MEP Evaluation Director at 2000 Manufacturing Extension Partnership National Conference, 9 May 2000, Orlando, FL.

Westra, R., 1997. Partnership Improvement Project: Advanced Technology Centers and Manufacturing Extension Centers. Center for Occupational Research and Development, Waco, TX.

Yin, R., Merchlinksy S., Adams-Kennedy, K., 1998. Evaluation of MEP-SBDC Partnerships. Report prepared by Cosmos Corporation for the Manufacturing Extension Partnership, National Institute of Standards and Technology, Gaithersburg, MD.

Youtie, J., 1997. Toward a cross-case analysis of outcomes of exemplary engagements by MEP centers. In: Shapira, P., Youtie, J. (Eds.), Proceedings of Third Workshop on the Evaluation of Industrial Modernization Programs on Manufacturing Modernization: Learning from Evaluation Practices and Results. Georgia Institute of Technology, Atlanta, GA.

Youtie, J., Shapira, P., 1997. Tracking customer progress: a follow-up study of customers of the Georgia manufacturing extension alliance. Journal of Technology Transfer 22 (2), 43–52.