Manufacturing Technology Centers : Public Policies to Enhance Competitive Performance Among Small Manufacturers in the United States

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Abstract

This thesis analyzes public policies to enhance competitive performance among small manufacturers in the United States, particularly the Manufacturing Technology Centers Program developed by the National Institute of Standards and Technology (NIST) since the "*Omnibus and Competitiveness Act*" of 1988.

The study reflects the resurgence of small and medium-sized enterprises (SMEs) and their very significant role in the American economy. It is pleaded that this evolution relies on two fundamental trends : the downsizing of large manufacturing firms and the advantage of small companies for innovation. However, data and surveys show evidence that SMEs' response to a rapidly changing technological environment is lagging, which can be seen as one strong rationale for public assistance.

The main types of existing public policies are thus identified : the benefits of state industrial extension services are stressed and Small Business Administration's programs are described. Nevertheless, most public assistance focuses either on financial services or on R&D promotion. It is shown that very few actions are undertaken toward manufacturing issues.

Established after 1988, the Manufacturing Technology Centers (MTCs) Program tries to fill in this gap. However it is not clear that MTCs add unique features to the array of public assistance toward SMEs. A particular emphasis is then given to the comparison of the relative merits of two alternative strategies for MTCs. First, the "in-house" model is a more hierarchical and centralized example, internalizing a lot of services. Second, the "broker" model is based on network actions. It refers to and saturates all existing private or public existing regional organizations.

It is argued that the "broker model" could bring more opportunities for small firms. Since it is based on an economic coalition of regional players, this "intermediary organization" could also be less sensitive to changes in political leadership. It is more integrated in the regional economy, more flexible and less expensive to operate. Finally it fulfils its original task of coordination between public efforts toward SMEs.

The fundamental conclusion drawn from the practices of MTCs is that more leverage could be achieved through networking actions. Although an enormous potential exists to enhance SMEs' performance, the MTC Program seems to need new directions and rethinking at the national level.

Written in a cross-cultural perspective, the final part of the thesis uses the American perspective to provide some recommendations on the French policies toward SMEs. The idea of networks between firms and decentralized actions is promoted.

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I have also received valuable advice from several personalities in the Boston area, like David Birch, who initiated the interest for small businesses at the begining of the 1980's. Visiting scholars at MIT and professors from the MIT faculty gave me their deep understanding of the small enterprises' issues.

I wish to acknowledge my thesis advisor, Professor J. Nicholas Ziegler, who gave me extremely helpful support and guidance for my work and research. Thanks also to his MIT course "*Governments, Markets and International Competition*", he gave me very interesting insights into international management issues involving institutional, economic and political patterns.

Professor Richard de Neufville guided me throughout my year at MIT. I thank him for having accepted me in the "Technology and Policy Program" that he is chairing. This experience will be extremly enriching for me.

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CONTENTS

CHAPTER 1
INTRODUCTION

I BACKGROUND

In the past two decades, most industrialized countries have either experienced the resurgence of small and mid-sized enterprises (SMEs) or they have at least recognized the importance of SMEs for the vitality of their economy. In each country, a complex array of institutional, political, cultural and economic forces are at stake. These driving factors determine in some way the role of SMEs in a nation's economy as well as the degree of public interest and success in shaping "industrial policies" toward SMEs.

In the United States, the competitiveness of the economy and the potential of small businesses for influencing it is a growing concern that has been reflected in recent debates during the last decade. Among the most prominent figures in this debate are Michael Porter,[1] Annalee Saxenian,[2] Bennet Harrison, Charles Sabel and Michael Piore,[3] and Robert Reich, the current US Secretary of Labor.

One pole in these debates is represented by Michael Porter. In the "diamond" framework that he has developed to represent the determinants of national advantage, Michael Porter emphasizes the importance of industry competition, which appears to him to be the relevant level of discussion. However, Porter's views do not provide much detail about the firm's dynamic of growth over time or the rationale for firms to cluster. The geographical scope is mainly focused on the nation state. Porter does not investigate regional -like

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[1]PORTER, Michael, "*Competitive Advantage of Nations*", NY : Free Press, 1990.
[2]SAXENIAN, Annalee, "*Regional advantage : Silicon Valley and the Route 128*", Harvard University Press, 215p., 1994.
[3]SABEL, Charles and PIORE, Michael, "*The Second Industrial Divide*", New York : Basic Books, 1984.

Italian industrial districts for instance- or supranational levels of industry competition. The government plays only a very indirect role in the "diamond" of determinants ; it is simply viewed as an influencer -either positively or negatively- of the national "diamond".

Annalee Saxenian presents also a limited sense of what government or public agencies can do. She rather highlights cultural factors such as dense social networks, porous boundaries among firms or open labor markets, which help explain patterns of "entrepreneurship" and regional clustering of firms. Her main analysis deals with the comparison of cultural patterns between Route 128 around Boston and Silicon Valley in California, which is characterized by a decentralized industrial system.

Along with Annalee Saxenian, Michael Piore and Charles Sabel place their primary emphasis on local networks of firms, rather than government intervention. According to their analysis, these industrial clusters provide adjustment capacity for firms and potential for growth and innovation. The view of government held by these authors needs to be extrapolated from the idea of industrial districts, where constructive networks are built upon joint support and resource sharing between small firms. Annalee Saxenian argues that "regional policies should be designed to catalyze and coordinate, rather than directly manage, collaboration among the many actors that populate a regional economy."[4] This perspective suggests that government can -as catalyst or broker- ensure that the ingredients come together in the right mix in order to favor networks between local economic actors.

Like Piore, Sabel and Saxenian, Bennett Harrison is also interested in local dynamics. However, he should be placed on the other side of the spectrum since he supports a larger involvement of the government in the local economy. He believes that public policies can play an active role in enhancing the development of small enterprises. He sees for instance the role of the government as an active partner with the private sector to strengthen the economic growth. In order to shape and to expand local industrial policies, this kind of intervention leads to more hierarchical relationships between firms, laboratories and public agencies.

[4]SAXENIAN Annalee, "Lessons from the Silicon Valley", *Technology Review*, May 1994.

This end of the spectrum can also be occupied by Robert Reich,[5] who believes strongly in an industrial policy for the United States. But he even recommends a more hierarchical role for the government. Robert Reich pointed out in 1983 that :

> The only way to transform our present industrial policy from a "do-it-yourself" hodge-podge - heavily weighted toward subsidizing service industries sheltered from international trade and maintaining aging segments of our older industries- into a form for positive economic change is by centralizing its administration and enhancing its visibility.[6]

According to Robert Reich, the United States was already moving toward the institutionalization of a more centralized and strategic industrial policy, as an inevitable response to the long-term decline of American competitiveness in world markets. This kind of "topdown" policy was, however, more common in countries where the State plays a strong role, such as Japan[7] or France.

The different positions can be summarized in the following scheme (see figure 1 below), where two major parameters are involved : first the structure of the public agency (central versus peripheral), and second, the nature of the industrial linkages that are promoted by public actors (hierarchical versus networking action).

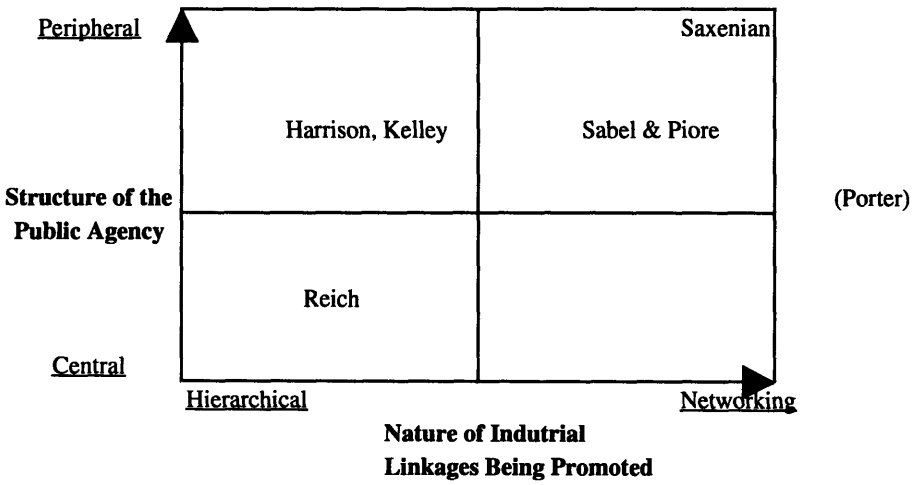

Figure 1 : Mechanisms of Public Intervention Toward Small and Mid-Sized Enterprises

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[5]See MAGAZINER, Ira C. & REICH Robert B., "*Minding America's Business, The Decline and Rise of the American Economy*", Harcourt Brace Jovanovich, Publishers, 1982, or REICH, Robert B., "An Industrial Policy of the Right", *The Public Interest*, Number 73, Fall 1983.
[6]REICH, Robert B., "An Industrial Policy of the Right", *The Public Interest*, Number 73, Fall 1983.
[7]See "*MITI and the Japanese Miracle : the Growth of Industrial Policy , 1925-1975*" by Johnson, Chalmers A., Charles E. Tuttle Co., 1986, 393p.

The "structure of the public agency" suggests how public policies can be implemented and integrated into the local industrial profile of the region. It reveals also government's ability to reach a large and diverse community of small enterprises. On the other axis, the "nature of the industrial linkages" undertaken by public agencies reflects the indirect or direct role that the government is willing to play in the economy : a more direct role is usually played by a hierarchical form of intervention, whereas other policies -such as a broker-type policy- will focus on promoting networks and collective actions among firms. One can also relate this scheme to what Kelley and Arora[8] present as models for public interventions : institutional builder or service providers.

The debate that I will try to enlighten with examples throughout my thesis is the tension between a central and hierarchical type of public assistance on one hand and a peripheral, networking type of public policy on the other hand. Many features can be used to watch the role of public organizations : the involvement of private firms, their degree of satisfaction, the flexibility of public actors and their ability to evolve over time with new market conditions or new technologies, the dynamism of innovation flows between public and private organizations, etc. The example of the Manufacturing Extension Partnership Program (United States Department of Commerce) will be used as the main illustration and finally as an opportunity for me to take a position in the debate.

My own argument suggests that the regional levels and local issues are predominant. States have clearly been the leaders in establishing innovative ideas during the last decade. Since the local context is so strong, subordinate governmental jurisdictions should lead the different industrial extension services provided to small enterprises. However, there is an opportunity for federal programs that can operate in a decentralized fashion. They need to be well adapted to their industrial region as well as to the existing public or private assistance providers. Moreover, I argue that one of the best way to promote the powerful idea of networks among firms is to run these programs as a "broker". When public organizations operate this way, they can reach a high level of efficiency and they can create an intense flow of information and of innovation among local industries and economic resources.

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[8]KELLEY, Maryellen R. and ARORA Ashish, *"Service Provider or Institution Builder ? An Assessment of the Role of Industrial Modernization Programs in U.S. Technology Policy"*, MIT Industrial Performance Center, Working Paper 95-004WP, March 1995.

II. SCOPE OF THE STUDY

The study analyzes a number of public policies elaborated in the United States in order to enhance the technological development of small manufacturers. The thesis does not examine all existing public programs, but focuses primarily on the policies that have been recently developed by NIST (National Institute of Standards and Technology) under the Manufacturing Extension Partnership Program. The thesis also seeks to make a cross-cultural study between France and the United States in the area of public intervention for small manufacturers.

III. APPROACH

My research has been divided into two main phases. The first phase consisted in an extensive literature review on public assistance to small manufacturers in the United States. This literature review served as a reference point for my applied investigations of public agencies during the second phase.

In order to have a more realistic view on these programs, I conducted a series of visits to governmental or state agencies. Interviews were held in the Small Business Administration (SBA) in Washington, in the National Aerospace Agency (NASA, Washington) and at the National Institute of Standards and Technology (NIST) in Gaithersburg (Maryland). Three Manufacturing Extension Partnerships (MEP) have been visited : New-York MEP (Troy, NY state), the Southeast Manufacturing Technology Center (SMTC in Columbia, SC), and the Massachusetts MEP (Bay State Skill Corporation in Boston, MA).

The main limitation of my research concerned the time available to meet a large number of private firms. As a result, the feedback on public efforts that might have been obtained from small entrepreneurs is limited.

IV. THESIS OUTLINE

Chapter Two presents a general framework for understanding the U.S. small manufacturers and their role in the nation as well as the various issues that are at stake.

Cultural differences and important factors such as venture capital or labor environment are quickly reviewed. Opportunities for small manufacturers in the US economy are examined.

Chapter Three describes the diversity of federal and state efforts to assist small manufacturers in their modernization process. The main programs within the different states, the Small Business Administration, and NIST are introduced. I have tried to distinguish the main features of each approach. The purpose of this chapter is to prepare the reader to recognize the particularity of the Manufacturing Extension Partnership Program (established by NIST after 1988) and the place that it has among other existing mechanisms of public interventions.

Chapter Four focuses on the Manufacturing Extension Partnership Program (previously called the Manufacturing Technology Centers Program) itself. It summarizes and enlightens some of the characteristics of this program. Centers can be seen as "intermediary organizations" between the state and federal levels.

Chapter Five examines two different types of models for Manufacturing Extension Centers. First the "in-house" model, which implies more planning and coordinating, is identified. The second model that I will analyze is the "broker" model, where Centers act as a catalyst to fill in the existing regional framework of actors and to take full advantage of networking among firms.

Chapter Six is a cross-cultural examination of France and the United States. I will try to relate this analysis to the frameworks envisioned in the precedent chapters and we will see how the somehow more "interventionist" and "centralized" approach in France can be contrasted by the American one.

Chapter Seven concludes this paper on the development of public policies to enhance competitive performance among small manufacturers.

CHAPTER 2
U.S. SMALL MANUFACTURERS' FRAMEWORK

I. INTRODUCTION

In 1992, there were over 21.3 million businesses filling tax returns in the United States. At the same time, there were 5.7 million businesses with employees. To underline the importance of small businesses, one can think that only 14,000 of these businesses employ more than 500 workers and are considered large businesses.

In its 1993 report,[9] the Small Business Administration (SBA) points out that small businesses have assumed increasing importance in the US economy in conjunction with a fundamental structural shift toward employment in services. The SBA underlines that the service industry continues to show signs of consolidation into larger entities : this trend to larger scale operations in trade and services is not unlike the trend to large scale manufacturing 75 years ago. On the other side, employment in manufacturing has been shrinking, in part because of

[9]US SMALL BUSINESS ADMINISTRATION, "*The State of Small Business : A Report of the President, 1993*", United States Government Printing Office, Washington, 1993.

more efficient production technology and increased labor productivity : the percentage of the workforce engaged in manufacturing in 1992 was less than half what it was in 1950.

In this chapter, I will first analyse some of the features of US small manufacturers. Then I will discuss some factors of the economic environment that could provide competitive advantages to US small manufacturers.

II. SMALL MANUFACTURERS IN THE US ECONOMY

II.1 THE RECENT EVOLUTION OF U.S. MANUFACTURING

There is a paradox in the figures of U.S. manufacturing industries. For the past 40 years manufacturing has accounted for 20 to 22.5%[10] of the US GNP. In 1991, manufacturers contributed more than 67% of American export earnings. Thus manufacturing goods still constitute an enormous strength of the nation's economy. On the other hand, the US manufacturing sector has suffered traumatic changes over the past 20 years, despite recent positive signs of growth. Manufacturing employment fell from a peak of 21.1 million in 1979 (resp. 23.4% of the total labor force) to just 17.8 million (resp. 16.2%) in 1993. Put another way, a staggering 15.4% of all US manufacturing jobs have been lost. Of equal significance, total compensation -including wages and benefits- rose just 1.4% between 1979 and 1993 in the manufacturing sector.[11] One of the most important indicators, the growth in manufacturing productivity, shows also an interesting pattern : between 1960 and 1972, the manufacturing productivity, defined as the value added per hour of work, grew at an average annual rate of 2.6%,[12] whereas it expanded at a rate of 2% in the last twenty years. US manufacturing industries have been deeply affected by the evolution of international competitiveness and by the globalization of the economy.

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[10]All data provided here come from NATIONAL RESEARCH COUNCIL, Committee to assess barriers and opportunities to improve manufacturing at small and medium-sized companies, Manufacturing Studies Board, Commission on Engineering and Technical Systems, "*Learning to Change : Opportunities to Improve the Performance of Smaller Manufacturers*", National Academy Press, Washington, D.C., 1993, 136p., p. 7.

[11]FRANKS, Bob, MEEHAN, Marty, "A Bipartisan Strategy for US. Manufacturing", *Issues in Science and Technology*, Winter 1994-1995, p. 50. In fact, average hourly wages -adjusted for inflation- declined 9.6% during the two decades following their 1973 peak.

[12]i.e. only two-thirds of the rate of Japan.

One trend in the manufacturing industries is nevertheless to be understood. It suggests that large-scale, mass-production systems are now being edged out by more specialized and flexible forms of "lean,"[13] or "agile" manufacturing. As consumer tastes have increasingly favoured customized goods and services, the old industrial giants are being replaced by networks of small, innovative, flexible production units. Flexible specialisation is being pursued both by independent small firms and by the decentralization of large enterprises. This evolution shows that -in their response to global competition- large firms are concentrating on their core business elements. Other operations such as parts production, sub-assembly, transportation or maintenance are subcontracted out to smaller and less costly suppliers.

II.2 SMALL VERSUS LARGE MANUFACTURERS

The number of manufacturing establishments in the US grew from 319,000 in 1980 to nearly 374,000 in 1990. Small and medium-sized enterprises (SMEs) comprise the bulk of these manufacturing establishments (98%). SMEs are vital links in the value-added chain that supplies large manufacturers and provide approximately 40% of manufacturing employment. They represent as much as 60% of final goods production costs,[14] and therefore determine to a significant extent the competitiveness of American industry. Small businesses are seen as a catalyst for innovation : it has been estimated that small firms produce about 2.4 times as many innovations per employee as large firms. Since the mid-1970s, there has been a steady increase in the total number of small and medium-sized industrial firms, typically defined as those with fewer than 500 employees. The number of establishments with over 250 employees decreased.

	Employment Size of Firm								
	Total	1-4	5-9	10-19	<20	20-99	100-499	<500	500+
Number of firms (1990)	327036	124543	60470	53158	238171	67301	16870	322342	4694
% Chge in Firms (1989-90)	0.89	2.66	1.19	0.07	1.7	-0.9	-2.21	0.93	-1.76
% Chge Employment (89-90)	-1.87	3.31	1.19	0.02	0.89	-1.27	-2.6	-1.45	-2.13

Table 1 : Firms and Employment by Firm Size in the Manufacturing Industry, 1989-1990
Source : US Small Business Administration, "*The State of Small Business : a Report of the President, 1993*", United States Government Printing Office, Washington, 1993.

[13]See for instance : WOMACK James P., JONES Daniel T., ROOS Daniel, "*The Machine that Changed the World : the Story of Lean Production*", New York : Rawson Associates, 1990.
[14]"*Learning to Change : Opportunities to Improve the Performance of Smaller Manufacturers*", National Academy Press, Washington, D.C., 1993, 136p., p. 7.

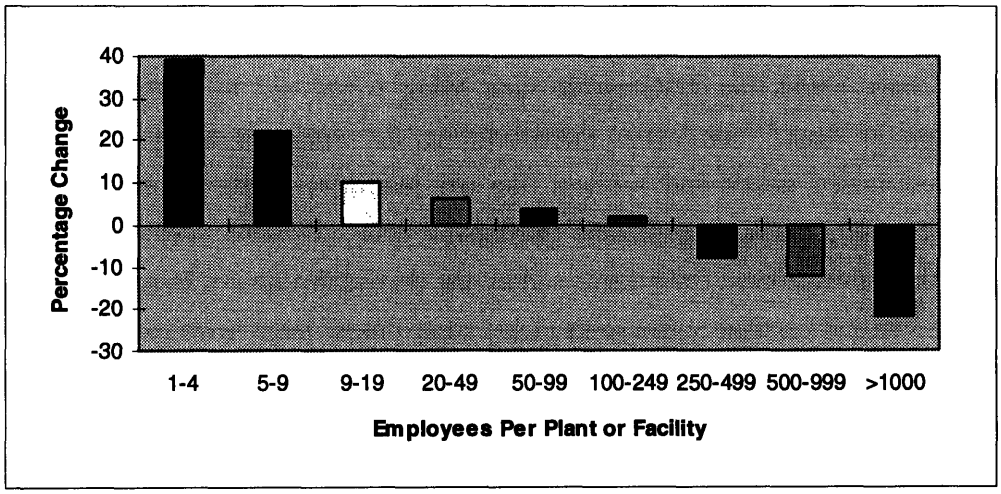

Figure 2 : Percentage change in the number of manufacturing establishments of different sizes, 1980-1990.

Source : US NATIONAL RESEARCH COUNCIL, Committee to assess barriers and opportunities to improve manufacturing at small and medium-sized companies, Manufacturing Studies Board, Commission on Engineering and Technical Systems, "*Learning to Change : Opportunities to Improve the Performance of Smaller Manufacturers*", National Academy Press, Washington, D.C., 1993.

The number of employees and the change in employment in small and medium-sized firms support the same conclusions. The average employment in US manufacturing enterprises has declined from about 75 workers in 1977 to under 64 in 1986. Nevertheless, despite increased employment in small plants, the United States has a much smaller proportion of employment and value-added in enterprises with less than 500 employees than does Japan (63% in 1983) and some European countries (France : 53% in 1989, Germany : 40% in 1983).

However, since the early 1970s the value-added per employee among large plants -those with 500 or more employees- has been growing 50% faster than those with 20-499 workers. A recent survey found that among manufacturers with 500 or more employees, 93.7% reported use of at least one advanced manufacturing technology, compared with only 60.9% for those with under 100 employees.

The data shown in figure 2 suggest evidence that SMEs response to a rapidly changing environment is lagging.

Technology	United States		Japan	
	50-499	>500	1-299	>300
NC/CNC	39.6%	69.8%	57.4%	79.4%
CAD/CAE	36.3%	82.6%	39.1%	75.2%
Automated Inspection	10.5%	44.3%	30.1%	66.7%
Machining Cells	9.1%	35.9%	39.4%	67.4%
Robots Pick and Place	5.5%	43.3%	22.6%	62.2%
Robots Other	3.9%	35.0%	8.3%	41.1%

Table 2 : Percent of Firms Using Technology, by Employment Size.
Source : United States Census Bureau, 1987.

II.3 GEOGRAPHIC DISTRIBUTION

Although manufacturing is found throughout the United States, there are important geographic concentrations : the 12 largest concentrations account for 70% of all US manufacturing establishments. The American economy -indeed the world economy- is made up of a series of regional economies, each of which radiates out from a city or network of cities. Each regional economy is unique.

A single industry can have major importance in more than one geographic region. States cannot deal with problems affecting entire industries because industries cross state lines. These patterns of industry location suggest the limits of state actions to assist manufacturing modernization and the potential benefits of a national perspective involving "intermediary organizations" between the federal and the state level.

As we will see in chapter 3, there is an opportunity to develop federal policies toward small manufacturers. The idea of a national network of public assistance has however to be carefully managed and planned to take into account the diversity of industries and its geographic distribution.

III. CULTURAL DIFFERENCES

My research work is written in a cross-cultural perspective between France and the United States. Therefore, I would like to address quickly here below (section III and IV) some of the national issues that I find the most critical for the development of small businesses in the United States.

III.1 THE PERCEPTION OF PUBLIC ORGANIZATIONS

Since most of the American relationships between business and government are a matter of "perception", I think that it is important to point out how the US government is commonly viewed. As a result of the enormous new regulatory apparatus that was erected throughout the 1960s and '70s, the government is mainly associated with its regulatory role, which most often carries a negative image. American businessmen feel it is not appropriate for the government to play a "development role" and to identify particular technologies or to "pick winners or losers", since it has neither the knowledge nor the market sense to spot in advance. Therefore, one can say that in the life of most American small businesses, the government has never been seen in positive terms. People simply do not trust it to do something intelligent. Adversarial terms have long characterized government-business relationships in the United States. This statement implies that it is particularly difficult to set up new public policies, to modify old ones - especially in the area of "industrial policies"-, or to generate a national commitment for them. We will see in the final section of this thesis what kind of resistance various programs encounter with the new Republican Congress elected in November 1994.

However my belief is that this perception could change in the future, since competitive advantage of nations clearly implies a positive contribution of government's actions. In the era of international competition, the "cow-boy culture" of early Americans can no longer be sustainable alone : positive partnership should be created among all actors of the economy.

One should however underline that only few small manufacturers are seeking government assistance when they have to turn around difficulties. Federal or state assistance simply do not enter in the day-to-day operations of most American small businesses. Therefore the analysis developed here cannot illuminate the strengths or weaknesses of the entire small-firm sector in the United States, because it only focuses on a very particular question, which seems to account for very little in the American economy.

II. 2 AMERICAN ENTREPRENEURSHIP

This country has always prized an entrepreneurial capitalism that grows from the bottom up, not the top down. According to George Bush, it is "a prosperity that begins on Main Street and extends to Wall Street -not the other way around." Michael Porter underlines that "invention and entrepreneurship are at the heart of national advantage."[15] To ilustrate this point, most people view high failure rates in small businesses as positive signs, because it means that the market selects the fittest firms. When there is the highest jobs' turnover, one can often find the greatest economic growth. It is possible to describe that as "microdestability", which produces some kind of "aggregate stability."

An important issue associated with small businesses regards health and pension benefits. In order to attract and retain productive workers, small businesses need to be able to afford to provide the benefits that will give their employees economic security.

IV. AMERICAN CHARACTERISTICS

IV.1 VENTURE-CAPITAL SUPPORT

Venture-capital support is of primary importance for small manufacturers. This statement is particularly true for the case of start-up or very innovative companies. There is however a certain scarcity of capital for production's investment or for mature industries which want to modernize.

In addition, I must mention that the existence of a stock market (NASDAQ) is of course crucial for start-up companies, when they want to raise capital or make financial movements. Such developments should occur in Europe with the creation of a "second market," but financial investors do not yet seem to be prepared to take as much opportunities in small firms as American investors do. This whole idea of financing should be further developed in order to fully understand one of the strongest advantage of American small businesses.

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[15]PORTER, Michael, "*Competitive Advantage of Nations*", NY : Free Press, 1990, p. 125.

IV.2 LABOR ENVIRONMENT

The second strong competitive advantage is linked to the flexibility of the labor market. Hiring and firing procedures are less costly than in Europe. The American regime of liberal market for entry or exit may be one strong explanation for the strength and the importance of small entrepreneurial companies This point needs also to be deepened in order to draw interesting conclusions.

The labor market in the United States has still significant negative aspects too. It has indeed shaped the respective approaches SMEs have on workforce training and work organization. In a mutually reinforcing downward cycle, the general weakness of training makes many small firms reluctant to invest in such "education" objectives because they fear that once they have increased their skills, their workers will leave to obtain higher wages elsewhere. The labor environment allows some firms to "bid-down" wages and working conditions, which is also known as the "low road" strategy of industrial competitiveness.

VI. OPPORTUNITIES FOR SMALL MANUFACTURERS

VI.1 WHEN INNOVATION IS THE KEY FOR GROWTH

According to the Small Business Administration,[16] jobs over the September 1991 to September 1992 period increased by 177,700 in small-business-dominated industries, helping to offset a 400,000-job decline in industries dominated by large businesses. Even during this slow-growth period, this increase in employment provides further evidence of small businesses' flexibility in adapting to market conditions while continuing to offer new products and services that meet consumers' needs.

However, the enthusiasm for small businesses must be tempered a little bit, and some pattern must at least be understood. The economist David Birch gives us a good insight into this discussion.[17] In the American business "menagerie" that he envisioned, there are mice, gazelles, and elephants. The 1950s was the period of the elephants, the giant industrial

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[16]US SMALL BUSINESS ADMINISTRATION, "*The State of Small Business : a Report of the President, 1993*", United States Government Printing Office, Washington, 1993, p. 12.

[17]PEARLSTEIN, Steven, "Leap Years for the "Gazelles", In the Job Jungle, Mid-Sized Firms Overtaking Business "Elephants" and "Mices"", *The Washington Post*, March 7, 1993.

corporations. By the 1980s, Birch argues, it was the mice -the small businesses with 20 or fewer employees- that were ascendant. They generated many of the 16 million net new private-sector jobs in the US economy, while the lumbering elephants were shedding 4 million jobs. But during the 1990s, it will be the gazelles that dominate the landscape : the mid-sized firms that are big enough to have the technology and sophistication necessary to compete, but still small enough to respond quickly to changing markets. He calculated that a mere 500,000 companies -or about 8% of the total number of US firms- are now generating three quarters of all the new jobs in the country, with mid-sized companies (with annual sales from $5 million to $150 million) representing a disproportionate share.

Birch points out that the economic and moral superiority of small business appeals to the populist instincts of all Americans. However, much of the mythology surrounding small business job creation is just that -mythology- based on misunderstandings and outdated assumptions. Many of the jobs were rather short-lived, and were likely to be the result of a new starting up rather than an existing company adding to its payroll. "It is not new firms that will be the major source of growth in the '90s," said David Birch, "it is growing firms."[18] Therefore one can see in positive terms all the efforts that are developed to enhance the modernization and technological development of existing mid-sized firms. The difference between the gazelles and the mice is not merely size, but also outlook and sophistication :

> Owners of the gazelles are interested not in maintaining their personal income, but growing the business to national and international sales. They are more sophisticated as managers. And they are immersed in technology -not creating it, necessarily, but applying it in all phases of their operations.[19]

When one raises the question of innovation, there is an interesting distinction to be made between high-tech and mature industries : this point will be discussed further in chapter 4. What I wanted to point out here is that innovation and technological change is crucial for the prosperity of a manufacturing firm, whatever its size is.

VI.2 BARRIERS TO OVERCOME

Many of these small manufacturers, however, are operating far below their potential. Five fundamental barriers to manufacturing performance improvements in smaller firms have been identified[20] :

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[18] Ibid.
[19] Ibid.

- disproportionate impact of regulation : the regulatory environment creates a disproportionate burden for smaller firms,
- lack of awareness : smaller manufacturers are often unfamiliar with changing technology, production techniques,
- isolation : smaller manufacturers are generally isolated and have too few opportunities for interaction with other companies in similar situations,
- difficulty to seek advice : it is difficult for owners and managers of smaller companies to find high-quality, unbiased information, advice, and assistance,
- scarcity of capital : operating capital and investment funds for modernization are difficult for small and medium-sized manufacturing firms to obtain.

An interesting study[21] showed that firms associated with the defense industry appear to have overcome the modernization constraints more successfully than other non-defense firms. The authors attribute these differences to the strength of the support network in defense manufacturing.

VI.3. THE CONTEXT OF PUBLIC ASSISTANCE

One important role for the government is the inclusion of small firms in its procurement policies. A United States government study examined a sample of high-technology and fast growing companies and found that almost half received at least 50% of their revenues from the government during their first year of existence.[22] However, large cut-backs in defense expenditures are going to generate big troubles within small firms in the military sector. This evolution forces the government -either at federal or at state level- to react and to propose some kind of intervention to promote economic development. It is worthwhile to keep this remark in mind in order to understand the context of the late 1980's.

As pointed out by David Birch, there are a lot of defenders of the old mythology of small businesses creating most of the nation's jobs. Therefore, in the hope of creating jobs -and attracting votes-, politicians have proposed to small businesses a lot of tax breaks and of exemptions from regulations. For example, the later debate dealt with the possible exemption of contribution to health insurance. However, Bennett Harrison emphasizes that:

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[20]NATIONAL RESEARCH COUNCIL, Committee to assess barriers and opportunities to improve manufacturing at small and medium-sized companies, Manufacturing Studies Board, Commission on Engineering and Technical Systems, "*Learning to Change : Opportunities to improve the Performance of Smaller Manufacturers*", National Academy Press, Washington, D.C., 1993, 136pp., p. 7.

[21]KELLEY, M.H., and WATKINS T.A., "*The Defense Industrial Network : a Legacy of the Cold War*", Carnegie Mellon, 1992.

[22]US Small Business Administration, 1980.

> Large corporations clearly have been downsizing but their shrinkingage amounts to a lopping off of the tip of an iceberg, not a complete meltdown. Even more significant, big firms have been changing shape in a Darwinian evolution prompted by global competition. Companies [...] are forming networks and alliances with other entities [...]. The result is a new industrial symbiosis that helps all parties in these networks thrive.[23]

According to Bennett Harrison, wasteful and meaningless tax breaks have to be scrapped in order to target more narrow and specific approaches. As we will see, recent state experience has demonstrated that government also has an important role to play -as catalyst, broker, partner with the private sector- in ensuring that the ingredients of growth come together in the right mix. Industrial technology policies can also be principally justified by the need to shape and reinforce the contribution of non-market institutions and actors to the technology diffusion process.

Since the mid 1980s, American policymakers have been worried about the slowness of US SMEs in adopting and fully using new manufacturing techniques and technologies and the resulting adverse effects on industrial competitiveness, domestic supply chains, regional economies, and the stability of high-wage manufacturing jobs. One can say that the underlying rationale for bolstering the public technological infrastructure for SMEs has combined considerations for industrial competitiveness with those of employment and local economic development.

Maintaining the US position will naturally require continued improvements in manufacturing productivity. It is difficult to assess the right positioning of small manufacturers in the economy and therefore to successfully address their needs. Technological innovation can clearly play a critical role in enhancing productivity, but implementing change requires more than research. Faster and more effective ways must be found to move research findings from the laboratories to practical application in the production line. As we will see further, the Clinton administration has proposed a substantial increase in federal funding for industrial assistance activities. The next chapter will show that public assistance can have very different forms. I will try also to analyse and to discuss some of the strengths or weaknesses of the current public policies in enhancing the competitive performance among small manufacturers.

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[23]HARRISON, Bennett, "Small-Business myths and realities", *US News and World Report*, November 14, 1994, p.110.

CHAPTER 3
THE DIVERSITY OF FEDERAL AND STATE EFFORTS

I. INTRODUCTION AND EVOLUTION IN THE PAST DECADE

Over the course of the last decade, steady, modest, incremental policy change has crafted a new mode of public-private cooperation. According to George Heaton, a "new paradigm"[24] in technology development has emerged. Two main reasons are associated with this : first, the major economic problems arising from international competition that the United States faced, and second, the economy's increasing dependence on technological progress. I would like to review quickly below the initiatives that took place in the area of technology policy during the last decade[25] :

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[24]HEATON, George R. Jr., "Commercial Technology Development : a New Paradigm of Public-Private Cooperation", *Business in the Contemporary World*, Autumn 1989.

[25]One of the very first program, the "State Technical Services Program" (STSP) had been established in 1965 to fund cooperative projects involving state agencies, universities, and private firms which were designed to promote the adoption of advanced technologies. STSP however was revoked in 1969.

- 1979 : a "*Domestic Policy Review*" (DPR) of policies affecting technological innovation,
- 1980 : the "*Stevenson-Wydler Technology Innovation Act*", which first expressed the necessary national commitment to support commercial technology and to develop a network of Centers for Industrial Technology,
- 1981 : the "*Tax Reform Act*" : a five-year tax credit of 25% in order to increase R&D spending,
- 1982 : the "Bayh-Dole Patent Act" to extent to small businesses the commercialization of government-sponsored research,
- 1982 : the "*Small Business Innovation Development Act*" to strengthen small entrepreneurial ventures,
- 1985 : the NSF (National Science Foundation) gave the first grants to "*Engineering Research Centers*", a new institution for cooperative technology development,
- 1986 : the "*Federal Technology Transfer Act*" to strengthen the system of technology transfer of 1980 (it mandated the use of cooperative agreements between federal labs and private firms),
- 1986 : passage of the "*Tax reform Act*", which again favored R&D tax credit,
- 1988 : large-scale government funding began to flow to "*generic industrial R&D*" such as Sematech (Semiconductor industry) which is one component of an overall DOD program entitled the "*Defense Industrial Base*",
- 1988 : passage of the "*Trade and Competitiveness Act*", which is the first substantial effort to establish an explicit civilian technology policy.

The experimentation with new programs as well as the considerable diversity of federal, state and local efforts to provide assistance to small businesses is one major characteristic of the American system. The General Accounting Office[26] identified 24 federally sponsored government programs that primarily provide management and technical assistance to business. These programs offer a variety of services to business, including assistance in areas such as accounting, developing business plans, proposal and bid preparation, marketing, worker training, and assistance in implementing improved manufacturing technology. There is not a coordinated national system of programs. Instead, there are "pieces of a system scattered about different agencies of government, both at the state and federal levels and in the private sector."[27] It represents an extraordinary coordination problem at the state, the sector and the national level. One can say that the pattern of industrial technology assistance in the United States is more fragmented and less developed than in Japan and in several European countries. There is

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[26]GENERAL ACCOUNTING OFFICE, "*US Government Aid to Business : Federal Programs that Provide Management and Technical Assistance*", Fact Sheet for the Honorable Joseph I. Lieberman and the Honorable Donald W. Riegle, United States Senate, October 1994, 9pp.

[27]KELLEY, Maryellen R., ARORA, Ashish, *"Towards a National System of Industrial Modernization Services : Program Design and Evaluation Issues"*, a Report to the Manufacturing Extensions Partnership Program of the National Institute of Standards and Technology, U.S. Department of Commerce, H. John Heinz III School of Public Policy and Management, Carnegie Mellon University, Pittsburgh, Pennsylvania, 109 p., May 1994.

also often too much emphasis on "upstrem" research or on sophisticated technologies which smaller firms cannot absorb.

In terms of federal efforts alone, the Small Business Administration (SBA) and the Department of Commerce (DOC) have the largest number of management and technical assistance programs. Other programs are conducted by the Departments of Defense (DOD), of Energy (DOE), of Labor (DOL), of Transportation and the Treasury. The majority of the programs to assist businesses are targeted to small businesses. Funding levels vary widely, ranging from a high of $71 million for SBA's Small Business Development Centers to a low of $1.5 million for DOL's Micro-enterprise Grant Program.

One can be concerned by the fact that, even at the federal level, there is no particular federal office that tracks or coordinates all the various programs proposed by different government agencies. For the most part, initiatives have become overlapping uncoordinated programs. Moreover, the programs often compete for funds to support assistance efforts. I think that the most important policy goal should be to emphasize on the simplification and the restructuring of all these various efforts. Higher levels of efficiency could thus be reached. My belief is that the small business community would certainly benefit from such a clarification. Even the political sphere could be more easily educated and therefore a broader political support could be achieved.

I will first describe some aspects of the state industrial extension programs. As we will see, states have lead the modernization efforts during the last decade and their policies were used as guidance for most other public agencies, especially for the new programs set up by the National Institute of Standards and Technology (NIST). My own argument suggests that the state level and local issues are key elements to understand the whole array of public assistance toward small and mid-sized enterprises. Then I will analyze what can be the role of the Small Business Administration at the federal level. Finally, other federal agencies and in particular the new NIST's missions will be presented.

II. STATE INDUSTRIAL MODERNIZATION PROGRAMS

Traditionally, most economic development efforts have concentrated on recruiting large firms ("smokestack chasing") or aiding new start-up businesses. However, since the beginning of the 1980's, state governments have been leaders in establishing industrial

assistance programs. Even in a country ideologically disposed to "laissez-faire", the practical reality is that there are too many businesses and jobs involved in small firms to "give-up" to the market without intervention. State and local policy makers have formulated an array of programs to promote SMEs as part of an overall economic stabilization and local development strategies.

During the 1980s, there has been little leadership from the federal level, since the Reagan and Bush administrations adopted a "hands-off" approach to all kinds of applied industrial and technology policies. The America's decentralized framework has reinforced the initiative of states. Programs were begun by Texas in 1948, North Carolina in 1955, Georgia in 1960 or Pennsylvania in 1965. These efforts were modelled after the long established and very successful US cooperative extension service in agriculture (since 1910) and used professional engineers based in regional offices.

II.1 INDUSTRIAL MODERNIZATION SERVICES

Industrial modernization services can be grouped into five basic type of activities[28] :

- information services (9%) : range from technical assistance phone lines to data-base access,
- assessment and planning consultation (43%) : industry-level investigations or consultancy arrangements by field agents with individual companies,
- technology demonstration and development : adaptation and experimentation of new technologies to the needs of particular industries) (11%),
- education and training (29%) (based at community colleges or state universities),
- financial assistance[29] (9%).

Technical assistance does not exist frequently among state industrial extension services : only 13 state programs were using field agents to work on-site with firms to solve technical problems. In fact, when small manufacturers are asked about their main requests for assistance, technology-related problems appear in rank 6. The most important issues deal with financial assistance, business plans, etc.

Industrial modernization programs have rather focused their services on specific sectors or industries: Textiles (7% of the programs), Machining (10% of the programs), Metal-

[28]Ibid.

[29]The Economic Stabilization Trust (EST), developed in Massachusetts, provides capital loans and guarantees to viable, high-value added firms. The loans are typically used to leverage other financing. Since its inception, the EST has provided $66.7 million with $10.2 million in loan funds.

working (17%), Electronics (10%) or General Manufacturing (10%) Industries are particularly targeted. Federal and state governments are a major source of funding for the typical Industrial Modernization Program (IMP) : non-government sources[30] and state government funding each account for about 40% of the budget, while federal funding accounts for the remaining 20%. An average operating budget for an IMP was $4.2 million in 1992.[31] One study showed that states spent more than $550 million on technology programs in 1988[32] : 48% came from state funding, 23% from federal funding and the remainder from universities or grants.[33] But, according to Philip Shapira,[34] almost 70% of this money went to advanced technology research centers and to research grants, spending that generally does not help existing small manufacturers. Programs that focused on technology transfer and management, rather than technology development, received less state funding : a total of $57 million in 1988.

The instruments used by the states include also the state provision of venture capital, state "incubators" for small business which provide technical and managerial assistance for new start-ups and export promotion through state-sponsored advertising and business representation abroad. Pennsylvania for instance has 30 incubators, more than any other state. These instruments are often combined with traditional approaches such as industrial parks or training education. I think that the incubators play a very positive role for new companies : they are much more than a simple subsidy, in cash or in kind. However, there is still a lack of assistance to acquire financing to upgrade technology. This is particularly important, since one of the most important obstacles to manufacturing modernization is the lack of financing.

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[30]In the case of IMPs, membership fees are most often based on annual gross sales.

[31]Most Industrial Modernization Programs are using pay-for-service fees : the average cost per manufacturing client is around $2600. Programs that provide intensive assessments, field service employing one or more professional engineers, and assistance extending to many days of service have much higher costs, ranging from about $5,000 to $20,000 (See Philip Shapira : "*Modernizing Manufacturing : New Policies to Build Industrial Extension Services*", Economic Policy Institute, 1990, 64p).

[32]Minnesota Governor's Office of Science and Technology, 1988.

[33]Oversight Hearing on the SBA's FY 1994 budget, *Committee on Small Business*, US Senate, 103^{d} Congress, 1st session, 1993.

[34]SHAPIRA, Philip, "*Modernizing Manufacturing : New Policies to Build Industrial Extension Services*", Economic Policy Institute, 1990, 64p.

II.2 THE CATEGORIES OF INDUSTRIAL MODERNIZATION PROGRAMS

Industrial Extension Programs can be grouped into four categories.[35] First, the "Technology Broker Programs" disseminate technical information to firms and make referrals to other sources of assistance. These programs handle a high volume of requests, allocating to each a small amount of time (usually less than one day) : PENNTAP (Pennsylvania Technical Assistance Program, $900,000 of funding) for instance deal with 850 private firms each year and 450 other organizations. OTTO (Ohio Technology Transfer Organization) has a network of 34 agents based at community colleges in the state : it received $1.6 million (1988) from the state and it handled nearly 4300 requests in 1988 from 3000 companies. Nearly half of the requests involved management and business questions.

The second type is the "University-based field office programs" : these programs, which have closer links with faculty, tend to focus on problem-solving to help companies overcome specific difficulties. The largest university-based field program is run by the Georgia Institute of Technology with its network of 12 regional offices and 26 field staff. In FY 1988, it provided 960 firm-specific assists with a $2.5 million budget. Firms are provided with two to five days of assistance.

The third type is the "Technology Centers" and "state-sponsored consulting services." These programs frequently employ consultants and promote technological modernization. Fee for service or cost sharing is more common. An illustration is the Michigan Modernization Service (MMS) housed at the Industrial Technology Institute in Ann Arbor. Firms, mainly metalworking companies, receive up to six days of free assistance : sophisticated diagnostic process through on-site visits, technology and training recommendations or market analysis. MMS served 130 clients in FY 1988 with a state budget of $2.8 million.

The last and emerging category of state programs is the "Manufacturing Networks" : in several states, efforts are made to build regional networks of firms which can cooperate on technology diffusion, training, design, finance and marketing. This is of course influenced by the industrial districts of Northern Italy. A series of quasi-public service centers sustain

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[35]Ibid.

these networks, sponsored by local and regional governments. Two pilot networking projects have been established in North Carolina and in Arkansas.

The most famous state programs are the Pennsylvania Technical Assistance Program, the Benjamin Franklin[36] in Pennsylvania, the Ohio Edison's Program[37] and other initiatives in Massachusetts (Massachusetts Industrial Services Program), New-York, Michigan, Maryland (Technology Extension Services : TES), Virginia, etc. By the beginning of the 1990s, 42 industrial modernization programs in 28 states had been established.[38] Some programs have tried to stimulate the formation of networks, industry associations or councils of firms. In each case, the network of companies has been formed by the assistance of a "broker" agent, supported by state funds. Groups of firms that organize around a specific shared service (demonstration facilities for instance) or network providing external economies represent the most common forms of networks.

Even the best state programs are unable to help more than a few hundred firms per year. The 42 programs identified by the National Governors' Association served a total of 17,500 clients in 1990 (i.e. less than 5% of the total US small manufacturers). According to the analysis made by Maryellen Kelley,[39] "the generic approach of most industrial extension programs will not prove to be an effective means of technology transfer to industry, in the long run". The main contribution to industrial modernization seems to occur when activities bring groups of firms together rather than through programs that provide individualized consulting services. As a group, public efforts attract a much greater share of private sector resources to support their activities.

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[36]In the program's fourth year of operation (1988), private corporations matched $26.45 million in challenge grants with roughly $20 million in cash and $48 million in equipment, laboratories and staff time. Another $40 million came from other sources, including the universities, the federal government and foundations. Firms receiving grants attracted $61.4 million in private venture capital during the program's first four years of operations.

[37]Edison's manufacturing modernization activities (established in 1984) are provided through 8 technology centers : these are laboratories that focus engineering resources on making incremental improvements to existing products and processes.

[38]US NATIONAL GOVERNORS' ASSOCIATION, "*Increasing the Competitiveness of America's Manufacturers : a Review of State Industrial Extension Programs*", Washington, D.C., 1991.

[39]KELLEY, Maryellen R., ARORA, Ashish, *"Towards a National System of Industrial Modernization Services : Program Design and Evaluation Issues"*, a Report to the Manufacturing Extensions Partnership Program of the National Institute of Standards and Technology, U.S. Department of Commerce, H. John Heinz III School of Public Policy and Management, Carnegie Mellon University, Pittsburgh, Pennsylvania, 109 p., May 1994.

> While the majority of IMPs can be thought of as "supply side" interventions, initiatives that explicitly consider customer-supplier relations may strengthen the incentives of small and medium-sized supplier firms to introduce process technology improvements.

Bringing firms together and serving concentrations of companies from particular sectors can therefore better stimulate the "demand" side (i.e. the small manufacturers demand).

II.3 THE RELATIVE IMPORTANCE OF THE STATE LEVEL

I think that the state level is the key to the introduction into the American system of public policies and to the understanding of the efforts toward SMEs. The important issue of the federal role can now be better understood in the light of state actions. As pointed out by David Osborne,[40] the governmental unit that most closely matches the regional economy is the state :

> If in a rush of enthusiasm for American "competitiveness" we simply round up the best state programs and legislate them into federal law, without a careful sorting of the apropriate level for each form of intervention, the results will be inevitably disapointing.

Hence the design of most microeconomic programs should, ideally, be specific to one region. However, the states have resource problems. Because state governments are competing with one another for industry, there are severe pressures to keep taxes low, which makes it difficult for states to come up with the necessary funding. According to David Osborne, "these realities suggest a relatively simple rule of thumb : when the appropriate model differs from one region to another, programs should be run by the states. The federal role should be to provide funds."[41] The federal government can also play a critical role in creating incentives for states to act. I will emphasize these points when the Manufacturing Extension Partnership Program will be presented in chapters 4 and 5.

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[40]OSBORNE, David, *""Laboratories for Democracy""*, Harvard Business Press, 314 p., 1988, p. 283.
[41]Ibid., p. 285.

III. SMALL BUSINESS ADMINISTRATION[42]'S PROGRAMS

The federal government supports roughly half of all research and development undertaken in the United States, and upwards 75 percent of basic research. However, according to the private non-governmental Council on Competitiveness, the United States spent in 1988 as little as 0.8% of the total federal government budget in R&D ($63 billion in 1989) on industrial development and this is mostly for product rather than process technology. These numbers are to be compared to 4.8% in Japan and 14.5% in Germany.

The SBA defines a small business as "one which is independently owned and is not dominant in its field." In the manufacturing industry, a small business eligible for SBA aid must have fewer than a maximum of 500 to 1500 employees and greater than 51% US ownership.

The Small Business Administration is actively involved in the promotion of minority businesses and not specifically focused on manufacturing industries. Over the past decade several interesting programs have been established. I will first review three main components of the SBA's action toward small businesses. Then I will discuss some characteristics of this intervention. I will use these programs as a background and a contrast to the analysis developed in chapters 4 and 5.

III.1 SMALL BUSINESS LOAN GUARANTEE PROGRAM

The most important role of the Small Business Administration is the "loan guarantee program," which covers low interest loans for many business purposes. It guarantees generaly between 70% and 90% of the loan value, up to $750,000. During 1991-1992, bank loans guaranteed by the Small Business Administration increased substantially. Between October 1991 and September 1992, the total number and volume of guaranteed business loans increased to 18,853 and $4.5 billion from 18,285 and $3.7 billion in fiscal

[42]The Small Business Administration was founded in 1953, and is currently employing 3500 people (1500 in Washington). One hundred offices are distributed throughout the United States. Twenty-two million "small businesses" are identified in the country. The SBA uses also the Service Corps of Retired Executives which is a 13,000-member volunteer program.

year 1991.[43] The SBA has developed a myriad of loans programs : pollution control loans, small business energy and conservation loans, contract loans, and even a Secondary Market Program for business loans guaranteed by the SBA, etc. In terms of international trade, the SBA has developed loans to exporters, which increased from $42 million in 1990 to $123 million in 1991 and $195 million during the first three quarters of 1992.

Another program (developed since 1958) proposes financial assistance to small firms : this is the "Small Business Investment Company" (SBIC) program. The legislation created a new $250 million program designed to provide equity-type financing to small businesses with high growth potential. The SBA licenses private venture-capital firms that independtly make their own investment decisions and supplements their capital with U.S. government-guaranteed debt or securities. SBICs are able to make equity investments in small firms wanting to develop and market their ideas.

III.2 SMALL BUSINESS DEVELOPMENT CENTERS

These Centers are aiming at providing very basic technical knowledge, routine advice and management assistance to Small Businesses. Training programs and workshops are also included. When needed, they can direct companies to the various SBA's programs of assistance. Fifty-seven SBDCs exist currently throughtout the United States with 900 service locations. As we will see further, the interesting aspect of SBDCs is that they could be combined with new manufacturing programs developed by the National Institute of Standards and Technology (NIST). The SBA has indeed a great ability and experience in reaching companies on a daily basis, and this should be used by NIST programs to offer complementary services in technical and financial areas. For instance, the Michigan SBDC network had 26 locations in 1988 with 90 full-time employees. Its FY 1988 operating budget ($4.9 million) included $2 million from the SBA, $1 million from the state of Michigan, $750,000 from the academic sector, $485,000 from the private sector and $600,000 from local governmental agencies.

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[43]US SMALL BUSINESS ADMINISTRATION, "*The State of Small Business : a Report of the President, 1993*", United States Government Printing Office, Washington, 1993, p. 272. The share of the SBA was $3.3 billion in 1991 and $3.87 billion in 1992.

III.3 SMALL BUSINESS INNOVATION RESEARCH (SBIR)[44] PROGRAM

The Small Business Innovation Development Act of 1982 requires federal agencies with large extramural R&D budgets ($100 million or more) to allocate a certain percentage (1.25% in 1982, the objective being 2.5% in 1997) of these funds to small R&D firms. Eleven federal agencies[45] participate in the program : each manages its own program.

SBIR projects are directed toward small businesses interested in high-tech R&D[46] contracting for the federal government. The program is designed to stimulate technological innovation, promote the R&D efforts and make greater use of small businesses in meeting national innovation needs. SBIR legislation requires three phases. The first phase awards funds for feasibility studies and innovative ideas, usually of less than $50,000. Successful projects enter a second phase lasting two years, with up to $500,000 in funding. The third phase generally involves the use of nonfederal funds for commercial application. Since its inception, over $3.2 billion and 24,902 awards[47] (between 1983 and 1992) in federal R&D funding hasve been allocated to small businesses. There was 2,475 awards in FY 1992 for $508.4 million. The average recipient of SBIR awards is a ten-year old company with thirty-five employees. Of these participants, 24% had received subsequent outside funding, which amounted for twice the dollar amount of the SBIR awards.[48]

III.4 CHARACTERISTICS AND DISCUSSION

SBA's programs have tried to promote the growth of small businesses through various programs. However, most of these programs are purely financial assistance and are not directed specifically toward small manufacturers. The loan guarantee is a very "classical" tool of intervention. It is indeed considered as a subsidy within the European Union. When the theme of the technological development of SMEs becomes of central importance (SBIR for example), the SBA provides financial awards but does not investigate the

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[44]This type of action could be linked with ANVAR's programs in France.

[45]Five of them -DOD, NASA, HHS, DOE and NSF- provide over 90% of SBIR funds.

[46]Thys type of R&D program can somehow be compared with ANVAR actions in France, although mechanisms of attribution and partnerships with public agencies are very different.

[47]Projects related to electronics and materials accounted for $1.9 billion during the ten year period.

[48]Price Waterhouse, "*Survey of Small High-tech Business Shows Federal SBIR Awards Spurring Job Growth, Commercial Sales*", Washington D.C., : Small Business High Technology Institute, April 1985.

technological capabilities of the firm. Competitive performance or production capabilities of the firms are not reviewed. Again, this type of awards is very "classical", and could be ranked among the undesirable "picking winners" policies. Although the basis of the SBIR relies on a competitive selection, it can hardly be exempt of arbitrary choices.

In addition to that, I think that SBIR program responds more or less to the needs of federal agencies. But one cannot say that the market is the driving force : it is rather a "government-push" policy, with a stimulation of the "supply" side (i.e. the federal R&D). This does not necessarily fulfil the needs and the demand of small manufacturers. This kind of policy relies on the belief that technology generated to meet the needs of federal agencies will simply spin-off into commercial use. One can suspect that there might be sometimes an inherent incompatibility between the R&D needs of public actors and of private firms. The SBIR program helps "channel Federal research funding to innovative small firms."[49] It has been created because the results of basic research, performed thanks to the sunk investment in federal laboratories and universities, do not readily find their way to the market place without the use of an intermediary mechanism. Many small manufacturers however have not utilized it because of its academic, scientific-oriented proposal process.

Finally, the SBIR program is an upstream action, reaching high-tech firms ; it does not allow the broad and downstream up-grading of manufacturing firms with new techniques. These are also single and isolated projects and do not favor the creation of networks between firms. One should notice that federal financial support to smaller firms comes mostly in the form of new business start-up assistance. There is much less support for manufacturing process improvement. According to the SBA, only 34%[50] of phase II SBIR projects are commercialized ten years after the end of phase II, which is a pretty low rate of success. I wonder to which extent the relatively poor manufacturing capabilities of SMEs are responsible for this rate. Enhancing the technical capabilities of firms could help them going successfully through the production process.[51] One can however notice that

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[49]US SMALL BUSINESS ADMINISTRATION, "*The State of Small Business : a Report of the President, 1993*", United States Government Printing Office, Washington, 1993, p.4.

[50]12% of phase II awardees achieve commercialization 4 years after the company has received its phase II awards, 23% after 6 years and 34% after 10 years. See Oversight Hearing on the SBIR program, Committee on Small Business, 102d Congress, March 31, 1992.

[51]As pointed out by James Utterback in his book "*Mastering the Dynamics of Innovation*", the innovation can often be modeled by two phases : the first one, which is focused on product innovation, and the second one, which deals with process innovation. Small firms have a relative competitive advantage in the first

the SBA is using existing money in all of its project : the chances of passing through the investigations of the new majority in Congress can thus be greater.

IV. OTHER PUBLIC EFFORTS

IV.1 DEPARTMENT OF DEFENSE

As we have previously seen, spending cuts in Defense budget will affect many small manufacturers. The Department of Defense remains in fact the largest source of contracting dollars, accounting for 68.1% of the contract dollars awarded to small businesses in 1991.[52] Since the end of the last decade, there has been a growing support for the conversion of defense suppliers to civilian technologies and markets. The DOD has developed management and technical assistance (financial and personnel management, marketing, proposal development, loans and capital investment) to defense subcontractors for a total of $45 million in FY 1994.[53]

One of the major development in this area is the creation of the Technology Reinvestment Project (TRP) in 1993, under the Clinton administration. The TRP combines the mission of maintaining and developing the advanced defense technology base with those of assisting the transition defense suppliers and technologies to civilian markets and stimulating the production of competitive commercial products. The budget was $471 million for 1993. In its comparison of modernization practices between United States and Japan, Philip Shapira points out :

> The use of TRP as the main funding vehicle for manufacturing modernization clearly reflected political compromises, first, in eluding budget deficit problems by using Defense dollars rather than new civilian-side funds and, second, by cloaking the program with a national Defense mission to avoid the appearance of "industrial policy.[54]

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stage, where imaginative ideas are required. However, the innovation in the manufacturing process requires longer experience and more capital resources, which are mainly found within large firms.

[52]US SMALL BUSINESS ADMINISTRATION, "*The State of Small Business : a Report of the President, 1993*", United States Government Printing Office, Washington, 1993, p. 13.

[53]US GENERAL ACCOUNTING OFFICE, "*US Government Aid to Business : Federal Programs that Provide Management and Technical Assistance*", Fact Sheet for the Honorable Joseph I. Lieberman and the Honorable Donald W. Riegle, United States Senate, October 1994, 9pp.

[54]SHAPIRA, Philip, "*Modernizing Small Manufacturers in the United States and Japan : Public Technology Infrastructures and Strategies*", to be published in M. Teubal et al (editors) "Technological Infrastructure Policy (TIP) : an International Perspective".

The Technology Reinvestment Project did not define specific mechanisms and national directions for Defense conversion. This program has thus been severely cut by the new majority in Congress for FY 1995 : . We will see in chapter 6 that this evolution should have some negative implications for the latest Manufacturing Technology Centers that have been founded under TRP appropriations.

NASA has also established technology transfer programs. This action is developed around seven Regional Technology Transfer Centers. They work more or less as data resource centers. William Rader, Director of the Arkansas Center for Technology Transfer, pointed out that :

> I personnaly scan the National Technical Information Services monthly reports and the NASA Tech Briefs published monthly, and find it to be a rare event that these research reports are of value to any business in this state.[55]

This statement shows that the "push" from federal laboratories does not work very efficiently to enhance competitive performance of small manufacturers. NASA did not develop efficient industrial extension services. According to the sucess of its results in R&D or high-technologies, the National Aeronautics and Space Agency should rather focus on "technology commercialization," and develop high-level skills around this process.

IV.2 OTHER AGENCIES

The Department of Labor (DOL)[56] and the Department of Energy (DOE)[57] have undertaken various actions concerning the "industrial competitiveness" of the nation. However, none of these is specifically targeted toward small manufacturers. It is moreover difficult to argue that these departments can justify an interesting and efficient involvement in the industrial competitiveness issue. The conclusions drawn by the Galvin Commission (February 1995) on the DOE converge to underline that industrial competitiveness is not one priority mission of the DOE.

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[55]Oversight Hearing on the SBA's FY 1994 budget, *Committee on Small Business*, US Senate, 103d Congress, 1st session, 1993.

[56]DOL has developed "micro-enterprise" grants : this provide funds to states for business-related training and support ($1.5 million in 1994).

[57]DOE has established the "Small Business Initiative, which provides technical information, up to 80 hours of consultation services, or access to specialized facilities for the evaluation of new processes or equipment ($8 million in 1994).

Finally, it could be noticed that trade associations of small businesses could help their member firms improve technology. However, American trade associations tend to be reactive rather than "pro-active", responding to government actions or dealing with business regulation issues.

This quick review of federal actions toward SMEs shows that there is very little coordination of policies at the federal level. Although the diversity of actors can have positive consequences, it needs to be better managed. As we will see in the next section, NIST was assigned the task of coordinating all the various efforts toward small manufacturers. The next two chapters of the thesis will also try to shed light on how successful NIST has been in this particular mission.

V. NIST NEW MISSIONS

Over the past decade, there has been an expansion of public and public-private technological infrastructure initiatives and programs to help small firms with industrial development and technology deployment in the United States. But, until recently, most of these industrial modernization activities were initiated at the sub-national level, by state governments, universities, colleges or non-profit local organizations.

In this domain, the federal government's role began to change with the passage of the "*Omnibus Trade and Competitiveness Act*"[58] by a Democrat Congress in 1988. Recognizing that there was a problem of industrial competitiveness in the United States, the Act gave an explicit mandate to a civilian agency, the National Institute of Standards and Technology (NIST, former National Bureau of Standards) within the US Department of Commerce to promote manufacturing technology deployment. Compared to the previous focus on public efforts in R&D, this legislation provided for the first time a new direction for a diffusion-oriented technology policy in the United States. President Clinton has called upon the Commerce Department to become the "technology agency" in the United States.

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[58]The Act declared that "the highest priority of the US government [should be] to pursue a broad array of domestic and international policies ... to guarantee the continued vitality of the technological, industrial and agricultural base of the United States."

NIST was given control of four new major programs : the Regional Centers for the Transfer of Manufacturing Technology (Manufacturing Technology Centers Program, renamed Manufacturing Extension Parthnership Program in 1993), the Industrial Extension Services Program, the Advanced Technology Program and the Clearinghouse for State and Local Initiatives on Productivity. I will review below the two major directions undertaken by NIST to fulfil its new missions.

V.1 ATP (ADVANCED TECHNOLOGY PROGRAM)

Created by Congress in 1990, the ATP is overseen by NIST and provides competitive matching grants[59] to companies working on "precompetitive" or "generic" technology. The different projects that were granted involve high-risk and high pay-off research. They are driven by the industry since selection criteria are dominated by technical concerns but also by business plans and potential commercialization. "Market failures" in this area of uncertainty is the main reason for government intervention through ATP, which FY94 funding was $200 million and FY95 request to Congress $451 million.

According to the US Department of Commerce, during the first three years of the program, over 48% of all ATP grants and 24% of the funding went to business with less than 500 employees. In addition, 30% of the grants and 50% of the funding was awarded to joint ventures, many of which included small businesses. In the debate about "industrial policies", one should clearly recognize this type of mechanism as a "picking winners and losers" (either technologies or firms) policy. It is thus not surprising that the Republican majority has cut back the FY95 budget.

V.2 MEP (MANUFACTURING EXTENSION PARTNERSHIP PROGRAM)

The Omnibus Trade and Competitiveness Act of 1988 also authorized NIST to establish the Manufacturing Technology Centers (MTC, its new name is Manufacturing Extension

[59]Up to 50% of the R&D costs. Individual companies may receive up to $3 million over 3 years. Most often, consortia of firms are funded. Electronics (35%), Manufacturing (18%), Biotechnologies (15%), Computers (16%), Materials (11%) are the main areas.

Partnership : MEP) Program. There were three and then seven regional centers[60] established under the original MTC program. The goal of the MTC program is to help the nation's small- and medium-sized manufacturers upgrade their technological performance and competitiveness. The Centers are selected from competing proposals submitted by prospective sponsoring organizations. Under the original legislation, the selected Centers are expected to be financially independent after the first six years of funding by NIST on a matching basis.

There are now some 44 Manufacturing Extension Centers sponsored by NIST operating in the United States. Only eleven of these are large centers with annual federal contribution comparable to the original MTCs (i.e., $3 million or more annually). Although NIST was given a substantial mandate, its budget for the program was extremely small : $16-17 million at first. The MEP Program was funded at $122 million for fiscal year 1995, which is still not substantial at all for the scale of the American economy. Usually, one large Manufacturing Technology Center has an operating budget of $6 million and is responsible for an area of 8000 small manufacturers. Centers are usually organized into one regional center and several Manufacturing Outreach Centers (MOCs), which visit firms through field agents. One MOC is typically funded at a level of $1 million, with 1000 manufacturers in its area. The MEP program is governed by the principle of "matching funds" with state and private organizations funds, and clients' fees. For example, SMTC (Southeast MTC in South-Carolina) has the following financial sources : $2 million from NIST, $2 million from the state and $3.7 million from private sector.

Whereas the SBIR program deals with high technologies development through R&D efforts, the interesting point about the MEP Program is that it aims at enhancing competitive performance among small manufacturers through its focus on manufacturing techniques. Moreover the emphasis is most often on existing and commercially available technologies. I will analyse in details the MEP program in the next two chapters. The MEP program carries indeed new strategies of services and interesting features which are strongly related to its structure as "intermediary organization" between different institutional levels.

[60]These centers were located in the following states : New York, Ohio, and South Carolina, then California, Kansas, Michigan, and Minnesota.

CHAPTER 4
THE MANUFACTURING TECHNOLOGY CENTERS PROGRAM : A NEW TECHNOLOGY POLICY ?

I. INTRODUCTION

The Congress directed NIST to create the Manufacturing Technology Centers (MTCs) program in the "Omnibus Trade and Competitiveness Act" of 1988 (U.S. Congress, 1988). The purpose of this program is to speed the transfer of advanced manufacturing technologies to US industry, particularly small and medium-sized manufacturers, by establishing regional technology transfer centers.

During the election campaign and shortly after taking office, the Clinton administration has published plans in 1992 to raise significantly the contribution of the federal government in industrial extension efforts, in part by greatly expanding the MTC program. President Clinton has proposed the creation of a national network of Manufacturing Extension Centers :

> To enhance the use and access to technology, we will : create a national network of manufacturing extension centers. [...] Federal funds (to be matched by state and local

governments) will support and build on existing state, local, and university programs, with the goal of creating a nation-wide network of extension centers.[61]

It is interesting to underline that the proposal for a national network of centers is very similar to the existing equivalent technology centers in Japan[62] : Clinton's advisers were clearly aware of the Japanese programs toward SMEs. As a result of the last competition, which concluded in October 1994, there are now 44 centers located in 32 states. The second phase of the program (started in 1993) showed a dramatic growth of federal assistance, supported largely by funding from the Defense conversion initiative (TRP, see chapter 3). The idea of a national network has however to be handled carefully. As pointed out by various reports, the geographic distribution of manufacturers vary a lot across the country. Most manufacturers are to be founded along definite corridors and within specific areas or "industrial pockets". Therefore, a uniform network of MTCs would be cost-inefficient since MTCs need to be particularly well adapted to their regional environment.

It is important to point out that NIST programs are an experiment to discover what role government can play working in partnership with the business community. In contrast with other countries, it is still a new idea in the United States to have the government working with the industry to shape the economic growth. However, one can regret that no comprehensive assessment of existing state Industrial Extension Programs has been done by NIST before the introduction of the MEP services. We will see also that there is a strong lack of national directions given by NIST to operate these centers.

Before entering into more details, let us remark that since the MEP Program is still in its experimental phase, very few quantitative data can be obtained about its impact within the SMEs. The purpose of the study is more to underline specific qualitative ideas that seem to be interesting or that raise new questions or features. In addition, only a very small number of American small manufacturers have been assisted through the MEP program : in the year ending in June 1994, the first seven Manufacturing Technology Centers had carried out only 2885 (less than 1% of US SMEs) technology assistance projects and formal assessments.

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[61]President Clinton and Vice-President Gore, "*Technology for America's Economic Growth, A New Direction to Build Economic Strength*", February 22, 1993

[62]In total, there are 170 centers in Japan, at least one in each of Japan's 47 prefectures, employing 6900 people, including 5300 engineers and technical personnel.

II. "MATURE" VERSUS "HIGH-TECH" INDUSTRIES

One should point out that the MTC program is mainly directed toward existing manufacturing facilities. "Start-up" companies are not commonly included as clients of the MTCs and high-technologies are rarely implemented. I will review why public assistance is rarely assisting with success high-tech firms or start-up companies. I will also try to analyze what are the rationales for helping mature industries instead of high-tech firms.

II.1 START-UP FIRMS AND HIGH-TECHNOLOGIES

One could suggest that the main focus of public efforts should be high-tech promising firms rather than mature industries that have a lower growth potential. Following the arguments of Michael Porter,[63] one could argue that the MTCs' program focuses however on "generalized factors" of production, since most mature industries are assisted through the implementation of existing -state of the market- techniques. As various reports have underlined, the program has shown its failure in its original objective of transferring advanced technologies. It is surprising for instance that most MTCs do not consider biotechnologies in their portfolio of activities, and concentrate rather on metal-working companies. "Advanced" or "specialized" factors of production, such as state-of-the-art technologies, provide more decisive and sustainable bases for competitive advantage than "generalized" factors.

As pointed out by Michael Porter, only the private sector role can create specialized factor advantage in most industries :

> Government investments in factor creation usually concentrate on more basic and generalized factors. For example, investments in basic research, while important in seeding possibilities for commercial innovation, will not lead to competitive advantage unless transmitted to and further developed by industry. Government efforts to create advanced and specialized factors often fail unless they are closely coupled to industry, because government entities are notoriously slow or unable to identify new fields or the specialized needs of particular industries.[64]

Since they fail in enhancing a competitive advantage based on specialized factors such as advanced technologies, the MTCs program reinforces Michael Porter's argument against possible public efforts. On the other hand however, I think that MTCs can be particularly

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[63]PORTER, Michael, *Competitive Advantage of Nations*, NY : Free Press, 1990, p. 78.
[64]Ibid., p. 81.

flexible and rapid in their response to the needs of the small manufacturers (see discussion in section chapter III.3). Although the first six years of the program have not been absolutely convincing, there is a tremendous potential for action and partnerships with small manufacturers.

In her book "*Regional advantage*", Annalee Saxenian underlines that the success story of the Silicon Valley does not depend on public policies. The Silicon Valley relies heavily on young companies or on start-up firms created by market forces in the semiconductor industry. She underlines that national efforts to promote particular technologies are not a convincing agenda. There is indeed a widespread failure of efforts around the world to "grow the next Silicon Valley" by focusing solely on "free flows of capital, labor, and technology."[65] She points out that "regions are best served by policies that help companies to learn and respond quickly to changing conditions", and that "regional policies should be designed to catalyze and coordinate, rather than directly manage, collaboration among the many actors that populate a regional economy."[66]

II.2 THE RATIONALE FOR ASSISTING MATURE INDUSTRIES

Economists, such as Gregory Tassey (NIST), view the MTC program as a "diversification" in the federal portfolio of assistance to industry. Not only fast-growing companies, but also existing firms are to be assisted. In addition to the positive "diversification" effect, the modernization of the mature industries, which constitute the broad base of U.S. manufacturers, provide a better supply chain to the economy. Robert Reich made in 1983 the following statement :

> Only as high technologies are embedded within the products and processes of our older industries -thereby rendering them more competitive internationally- can we expect to generate more jobs with higher real incomes.[67]

Although the government cannot neutrally pick up high-specialized winners or losers in an emerging and fast-growing industry, it can enhance competitive performance among a broad basis of SMEs.

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[65]Annalee Saxenian, "Lessons from the Silicon Valley", *Technology Review*, May 1994.
[66]Ibid.
[67]REICH, Robert B., "An Industrial Policy of the Right", *The Public Interest*, Number 73, Fall 1983.

One can think of the industrial modernization process as a two-stages dynamic. The first one could be viewed as a "market-stage," where market forces select winners and losers, as well as new technologies in very specific and advanced areas. In the second stage, mature industries incorporate proven, state-of-the market technologies. During the first stage, the role of public efforts should aim at creating the best capital, labor and regulatory environment for entrepreneurship. In the second stage, the role of public organizations can be a more active one : promoting the diffusion of the former "advanced technologies."

One historical trade-off exists among basic-science research and applied technologies. An interesting study[68] performed by the US department of commerce showed the economic impact of advanced manufacturing technologies. The Census Bureau conducted an important survey (called the SMT for "Survey of Manufacturing Technology") of US manufacturing firms, which relates technological change to economic growth and employment. The data (see table 4 below) show that plants that use more advanced technologies outperform other firms in four important ways : they are more productive, they are less likely to close, they increase employment more rapidly and they pay higher wages than comparable firms. Although these results might be intuitive and obvious, the survey provide quantitative data that could have some influence on policy-makers.

		Technology Use			
		Lowest			Highest
Plant Size		1	2	3	4
Smallest	1	55.2	67.6	79.6	218.3
	2	3.8	15.6	29.4	54
	3	-12.5	3.6	9.3	35.9
	4	-27.3	-8.3	-3.3	10.3
Largest	5	-14.5	-26.3	-18.9	-2

Table 3 : Employment Growth (percent change in employment) at Manufacturing Plants, 19882-1987 : Plants Grouped by Size and Technology Use

Percent change in employment. Based on a sample of 8800 manufacturing plants that were in existence over the period 1982-1988 : Plants are segregated by initital size and by the number of advanced technologies used in 1988.

Source : US Department of Commerce, "*Technology, Economic Growth and Employment : New Research form the Department of Commerce*", Economics and Statistics Administration, Office of the Chief Economist, December 1994, p. 10.

[68]US Department of Commerce, "*Technology, Economic Growth and Employment : New Research form the Department of Commerce*," Economics and Statistics Administration, Office of the Chief Economist, December 1994, 18p.

Number of Technologies Used	Contribution to Growth in Employment	Change in Failure Rate
1 to 2	6.2	-13.4
3 to 5	8.7	-7.9
6 to 7	11.8	-18.3
8 and over	14.4	-22.6

Table 4 : Impact of Advanced Technology on Employment Growth in, and Survival Rates of, Manufacturing Plants : 1987-1991
(Deviation in percent : relative to plants that used no advanced technologies)

Source : US Department of Commerce, "*Technology, Economic Growth and Employment : New Research form the Department of Commerce*", Economics and Statistics Administration, Office of the Chief Economist, December 1994, p. 10.

Moreover, as shown above, manufacturing technology adoption allows small plants to grow rapidly, whereas it allows large plants to avoid shrinking. These results suggest that the investment in technological development is critical for the nation's economy. Technological change is one of the central driving forces in the competition process. The impact of manufacturing development is of prime importance for small firms. The primary factor for growth and success is innovation.

Although it is too early to evaluate the impact of the program among the SMEs community, we can suggest that public intervention has a role to play within this type of "mature" manufacturers. Though, public efforts can regenerate a competitive advantage for mature industries, whereas market forces and "invisible hand" are able to do that among high-tech start-up firms.

Finally, it should be noticed that some economists consider MTCs as "infratechnologies," which increase the efficiency with which technology-based economic activity is conducted. These technology supports can potentially act collectively as a "leveraging agent," and technology-based infrastructure is coming to be viewed as an essential element for the creation of a national competitive advantage.

III. ORGANIZATION AND STAFF OF MTCs

III.1 OPERATING BUDGET

The centers should initially be supported by federal and state funds, but federal funding should decline in the fourth year and fall to zero in year six.[69] The pay-for-service basis is a good tool to reflect the willingness and the commitment of the firm. However, if centers become too dependent on fees, they loose their public specificity. Therefore the cut-back in the budget should deeply affect the nature of the federal efforts through the MEP program.

III.2 STAFF AT MTCs

The staffing of MTCs can be questionable. Most of the staff is composed of retired manufacturing engineers or people who have left a private company at the "critical" age of 50-55 (with a few exceptions in the two original MTCs that I visited : SMTC and NYMEP). The experience in industry is an indisputable positive aspect because the program credibility relies on having staff with extensive experience in private industry. But I think that the high average age has to be balanced in order to insure an appropriate "dynamism." Perhaps a distinction can be drawn in that sense between the manager of the MEC, which should be rather young or at least extremly dynamic. This point has however to be deeply tempered by the fact that it relies on only two visits that I did.

In addition, it is worthwhile to notice that specialized and experienced engineers within each MOC tend to provide specialized services in their own domain : a quality insurance specialist will be inclined to assess a firm under this unique angle, whereas an industrial engineer will prone a reorganization of the plant's lay-out. As we will see in chapter 5, my belief is that the most appropriate staff people for MTCs should consist in excellent generalists that are able to identify problems and to refer to a specialist private organization for problem-solving.

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[69]NIST provides funding for six years, with maximum funding of $1.5 million, $3 million, $3 million, $2.4 million, $1.8 million, $1.2 million.

IV. SERVICES PROVIDED BY MTCs

The technologies are usually grouped into six broad categories : computer assisted design, flexible manufacturing, automated materials handling, automated sensors, computer networks, and computer control. As pointed out in the General Accounting Office (GAO) analysis,[70] advanced manufacturing equipment are very expensive, and a better use of existing equipment is promoted as a first stage.

As previously mentioned, technology is nevertheless not the main purpose in the requests for assistance. A survey of the first seven MTCs showed that of the top twenty services offered, technology was ranked number 6. The strongest demand goes to human development, financial and business plans. According to Bill Ranson[71], small manufacturers come to SMTC because they have a "business" question : an opportunity for a new market, an increase in market share, or the development of a new product. MTCs should develop skills to handle these business questions rather than trying to "impose" responses through manufacturing techniques. Useful partnerships with SBDCs, SBICs or with the banking community could be developed.

The main strategic directions for services are : quality improvement, multimedia networking, environmental services and supplier development. These services rely on a short front-end assessment made by field agents. An example of this has been developed under the "Quickview assessment" in NYMEP. Although NIST planned that MTCs would be consulting oriented, there is also a strong need for education services : workshops, managers' training, awareness seminars, demonstration facilities,etc. The investment in worker training and upgrading skills and talents is seen by many small manufacturers as an extremely risky venture : they are afraid they will lose the investment made in training workers because high paying jobs can be taken away by larger companies. When technology is not adopted at the same rate in different countries, it is not only from an economic standpoint but also from an education standpoint. "Teaching factories" are in this respect an increasingly popular concept among the various approaches to industrial

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[70]US GENERAL ACCOUNTING OFFICE, "*Technology Transfer : Federal Efforts to Enhance the Competitiveness of Small Manufacturers*", Report to the Ranking Minority Member, Committee on Small Business, U.S. Senate, November 1991, 45pp.

[71]Bill Ranson is the Director of Advanced Technology at University of South-Carolina - Southeast Manufacturing Technology Center.

modernization. We will see in the next chapter however that it can have serious limitations.

The Southeast MTC (South Carolina) can be used as an illustration : during its first 30 months, the SMTC contacted 308 SMEs and initiated 207 projects with clients. It has conducted 405 on-site assessments of manufacturers' operations to identofy problems and to match clients with service providers. It has also conducted 114 workshops, seminars and forums.

An interesting study produced by NEXUS, Inc.,[72] suggest that the type and quality of assistance that MECs provide to clients is legitimate : 65% and more of the clients estimated that MEC was the "only or better source" to offer or provide informal assistance and trouble-shooting at little or no cost, to perform cost-effective assessment of operations and discussion of potential work and to present unbiased information.

Thinking of the services leads to a necessary reorganization of the MEP program, since small firms have to be considered from a whole standpoint and with connections to several partners. I will go into this discussion in the next chapter.

V. BUILDING AN ECONOMIC NETWORK OF ACTORS

In the selection and in the awards process, potential MECs have to show how they will be integrated in the regional network of public assistance toward small manufacturers. According to the legislation, NIST is authorized to provide technical assistance to state and local industrial extension programs (IMPs) and to serve as a link between these programs an other federal technology services. One of the main advantage of the MTC relies on the fact that it can be a neutral partner in the network : it should have little link with companies, suppliers of equipment or private consulting firms.

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[72]NEXUS ASSOCIATES, Inc., "*Manufacturing Extension Centers and Private Consultants : Collaboration or Competition ?*", Prepared for the Modernization Forum, US Department of Commerce, January 11, 1995.

V.1 INDUSTRIAL PROFILE OF REGIONS

As pointed out in chapter 2, the clusters of manufacturing establishments tend to have particular industrial specializations. The technical assistance however does not make any strong difference according to particular industries. Each MTC can be viewed as an intermediary organization : thus, it is an "experiment" in how to integrate federal efforts in manufacturing assistance with existing private and public -manily state-assistance resources to meet the demand of very diverse local manufacturing communities.

However, one difficulty arises because it is extremely difficulty to assess SMEs' needs. There has been no comprehensive assessment of the existing technological capabilities of small manufacturers. Similarly, there is little comprehensive understanding of the sources of competitive advantage and disadvantage of small and medium-sized manufacturers. Industry types, concentrations of private consulting firms, production costs, availability of venture capital, etc. should be taken into consideration before setting a particular type of Center.

It is worthwhile to notice that the expectations and missions for the MTCs appear to have evolved toward a much broader set of initiatives than was originally perceived. The MTCs differ primarily in the emphasis each places on the roles of technical center and field assistance service. We will see in the next chapter that two kinds of "model" for MTCs can be distinguished in accordance to these two type of missions, and we will try to evaluate the perspectives of each one.

V.2 INDUSTRIAL ASSISTANCE NETWORK

According to Kelley and Arora,[73] "the variations among sectors and countries in the nature of inter-firm relationships and the accessibility of non-market institutions holds the key to explaining the differences in the rate and extent of the diffusion of new manufacturing technologies." It is believed that there is for instance a strong accepted practice of sharing technical know-how among Japanese firms.

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[73]KELLEY, Maryellen R. and ARORA Ashish, "*Service-Provider or Institution-Builder ? An Assessment of the Role of Industrial Modernization Programs in U.S. Technology Policy*", MIT Industrial Performance Center, Working Paper 95-004WP, March 1995.

The existing network of regional actors is usually quiet well developed in industrial areas. For instance, the SMTC has developed 25 partnerships with existing organizations in South-Carolina and in North-Carolina. NYMEP has housed one or two representatives from the local SBDC in order to associate technical with financial expertise : this SBA staff can now focus on small manufacturers instead of small businesses in general. This is actually a partnership between 4 actors : the State University of New York, which administers the program, the Small Business Administration, and NYMEP (New York State Science and Technology Foundation and NIST). Of course situations depend on regions and are for instance very diverse between rural Oklahoma and New-York City : in the former case, public efforts should integrate a lot of services, whereas in the latter case, public organizations should refer to existing and outstanding private firms.

As pointed out by Maryellen Kelley,[74] "in sectors where sources of innovation external to the firm are particularly important, networks comprised of other enterprises and non-market institutions ordinarily play key roles in the transfer of technology." Since the trend of the economy seems to go to more outsourcing, public agencies should recognize this essential element and concentrate their efforts in the promotion of networks.

V.3 INVOLVING LARGE FIRMS

Involving large firms in the industrial modernization process of their suppliers is also one goal of the MEP program. Large manufacturing firms can provide powerful incentives for the adoption of new technologies by their smaller suppliers. This link seems also to refer to the research conducted by Eric von Hippel[75] on the "functionally distributed innovation process." The SMTC for instance has involved two large companies in its operations : IBM and DEC. However, the industry match of these companies goes through "in-kind" donations, and one can suspect that the incentives for the large firms are likely to have commercial objectives. Once a demonstration has been performed on a particular equipment, chance of buying the equipment of the same brand are greater. Therefore one can regret that there is not true commitment among large firms for improving the suppliers

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[74]KELLEY, Maryellen R. and ARORA Ashish, "*Service-Provider or Institution-Builder ? An Assessment of the Role of Industrial Modernization Programs in U.S. Technology Policy*", MIT Industrial Performance Center, Working Paper 95-004WP, March 1995.
[75]VON HIPPEL, Eric, "*The Sources of Innovation*" Oxford University Press, 1988.

chain. This way of enhancing competitive performance among small suppliers should be explored further.

I think that the difficulty to involve large firms is related to the classic "arms-length" relationships that large customers have with their subordinate suppliers. In the United States, smaller firms operate in an atmosphere of great uncertainty. One can suggest that the short-term character of supplier-customer links is one "cultural" parameter that can induce greater difficulties for the modernization process of small manufacturers.

As it has been previously mentioned, one of the objective of MTCs is to create networks between firms as well as between public agencies within each region. This aspect suggests a comparison with the existing industrial districts in Italy, where consortia of small firms are built. The most successful Italian consortia aim at promoting exports and at securing financial guarantees. The important difference between Italy and the United States is that a strong legislative framework and financial support have been created in Italy in order to promote the development of consortia. In the area of technological innovation however, consortia might be more difficult to build, since companies are certainly less willing to share information.

CHAPTER 5
POLICY ANALYSIS OF MTCs' PRACTICES

I. INTRODUCTION

MTCs can be viewed as an effort to integrate federal programs in manufacturing assistance with existing private and public assistance resources to meet the demand of very diverse local manufacturing communities. In the words of Charles Sabel, this program can be described as "experimental federalism."[76] The question is thus the following : "how to regroup regional institutions to raise their chances for improving firm competitive performance ?"

The MTCs that I will analyze and compare here are SMTC (Southeast Manufacturing Technology Center, based in Columbia, South-Carolina), NYMEP (New-York

[76]SABEL, Charles F., "*Discussing Evaluation in a World of Discursive Standards : Assessing Manufacturing Technology Centers*", Paper prepared for the workshop : Manufacturing Modernization : Evaluation Practices, Methods, and Results, Atlanta, Georgia, September 18-20, 1994, Forthcoming in a special issue of Research Policy, 1995, 35p.

Manufacturing Extension Partnership, based in Troy, NY). I may also make references to GLMTC (Great Lakes MTC, Cleveland, Ohio) and MMEP (Massachusetts MEP, Boston, MA).

The purpose of chapter 5 is to compare different practices of MTCs and to recommend some policy choices. Defining the agency and organizational form through which resources can be best targeted toward industrial modernization remain indeed difficult. This task should however be conducted by NIST. Some efforts to define a national technology policy or models to implement MTCs would be more than welcomed. A related issue is that of federal-state relationships and the level of government or "intermediary organization" which should be given the responsibilities for industrial modernization. In addition, the existing level of multi-agency fragmentation within the federal government and the differences between states still make it hard to achieve coordination, consistency and commitment.

II. FUNDING POLICY

In the original legislation, the MTCs should be self-sufficient after 6 years. However, since this goal seems difficult to achieve, some perspectives of evolution will be necessary.

Most MTCs run on a fee-for-service basis. Although firms pay for the assistance provided, the cost is 30% to 50% lower than in the private sector, which allows small firms to afford these services more easily. However I have found that no cost-sensitivity analysis has been performed. It seems nevertheless important to anticipate what the reaction of small manufacturers could be if fees are going to be substantially increased. How many potential clients would be scared away ? This determination is essential for the financial evolution of MTCs. And one cannot be sure of the result of this sensitivity analysis, since the number of clients actually increased when fees instead of free services were introduced. Some international comparisons might also be helpful : Japanese Technology Centers for instance serve as free or almost free resources for small firms but, according to Philip Shapira,[77] they seem to experience difficulties at keeping the pace of the leading edge of technological changes.

[77]SHAPIRA, Philip, "*Modernizing Small Manufacturers in the United States and Japan : Public Technology Infrastructures and Strategies*", to be published in M. Teubal et al (editors) "Technological Infrastructure Policy (TIP) : an International Perspective".

Some people even suggest that private for-profit organizations could perform the same tasks as MTCs. I have the impression that MTCs are today in a very ambiguous financial situation : on one hand they perform tasks that are similar to private services -the main difference being their low fare-, and on the other hand they need to increase the price they tag on their services in order to survive. As previously mentioned, I think that the operating revenues (through the fees) are not well understoodand managed : for example at NYMEP fees are neither clear nor established in advance but they vary according to different parameters : the size of the company, its financial situation at the time of the project, etc.

The funding issue is interesting because it reflects the ambiguity of the MEP program : when MTCs engage themselves in technical services, they somehow run in parallel of the private sector or of other public organizations in the state, and they need substantial funding that political officials will increasingly be unwilling to provide. The structure of the budget is really odd : it is an hybrid of state, federal money, and operating revenues. None of these funds can be predicted with certainty one year in advance, which makes the tasks very difficult. With federal funding there is a pressure for greater federal control that is not desirable from the state standpoint. I think that new financial linkages based on increased autonomy have to be found between local and federal representatives. Federal money should only be a leveraging agent.

In fact a lot of states experience budget restrictions. The natural reaction is then to eliminate the latest programs, like the MEP for which states provide substantial matching funding. The NYMEP Center was in this situation at the time I visited it. As we will see further, one of the best way to avoid the downsizing of the MEP program relies on the capacity of the Centers to be well integrated in the regional network of public actors. The national commitment to the modernization strategy is nevertheless essential to insure a decent continuity in the actions undertaken.

One can also suggest that some kind of reallocation be provided between different states. NIST funding could be mainly directed to the states that are unable to provide the matching funds. It is plausible that richest states could indeed fund and run the program by themselves.

III. THE RESTRUCTURING OPPORTUNITY

The main issue to address is the following : how successful have been MTCs to create a coherent system and not just increasing the number of industrial assistance ? I will try to show that the answer to this question favors what can be called the "broker" model. As I pointed out in chapter 3, the main feature of the public assistance toward small manufacturers is the diversity of actors involved in a large number of programs. However this diversity reflects some kind of overlapping and also some confusion. As authorized by the legislation, the main role of MTCs should be a coordination one.

In the competition process to select new Manufacturing Extension Centers, there is a great emphasis on the way the new MEC will fit into existing public organizations. However, I think that this point is paradoxal and not well scrutinized. When strong state industrial capabilities are already in place, chances of overlap and proliferation without coherence are indeed bigger. Much more caution should be taken to set up a new MEC. American administrations recognize that both decentralization and coherence are highly valuable, but these two objectives are not always easy to achieve.

It is dangerous to oversimplify the innovation process that can occur within small manufacturing firms. Federal policy makers have in mind that federal-sponsored research can be transferred directly to the private secto. MTCs' original goal was to transfer advanced technologies from NIST laboratories. But this old type of "pipeline model" is no longer realistic. Instead of choosing the right technologies and "feeding" the US small manufacturers with them, public actors should enhance however their role as catalyst (of the "demand" side, i.e. SMEs' side) or as facilitator of changes. The efficiency of an MTC would therefore rely on its capabilities for managing different programs and bringing outsourcing organizations together. This last aspect should be ranked with a high priority in the evaluation process of Manufacturing Technology Centers, but it is not really considered.

Most often, MTCs missions can be seen as technical assistance at low fare, i.e. subsidies without technical added-value. Private sector firms could do the same job, although a higher price would not be necessarily affordable for small manufacturers. Moreover, it appears that technical capabilities already exist in the states, through universities, technical colleges or federal laboratories. The "only" lack is the expertise to put these capabilities

together and to manage them efficiently. MTCs should focus on providing these needed organizational skills.

For example, it has been noticed that financial questions arise frequently among SMEs. SMTC and NYMEP then started to develop a partnership with people from the local Small Business Development Center (SBDC). This strategy for MTCs could also go further in facilitating better understanding and stronger relationships between the banking community and small manufacturers.

I think that the main purpose of the MEP program should be to promote the reorganization of existing mechanisms of industrial assistance. The most efficient mission could be a restructuring of the existing network of regional industrial services and a rethinking of the appropriate balance as well as the appropriate means of assistance in the areas of human capital, financial capital and technology. Clearly, the most legitimate level of assistance toward SMEs is the state level. There is a strong tradition of state and local autonomy and such localization is a desirable feature for industrial extension services. Creating a MTC should introduce a new perspective of public efforts : more technically oriented and only focused on small manufacturers. The coordination role should be emphasized, without adding any extra technical facilities or staff. One of the best way to avoid building federal program on top of state ones would be through the adoption of "broker" types centers. With the high degree of fragmentation within organizations and with a low level of budget, MTCs should learn how to saturate the existing regional facilities and concentrate their efforts on clarification and simplification of the different programs.

It is interesting to look at the differences between New-York state and South-Carolina. In New-York state, twelve programs[78] existed before the creation of the Northeast Manufacturing Technology Center. Although political leadership might deeply influence the programs, I believe that Manufacturing Extension Centers could better survive any change in political legislature if they increase their ability to use, coordinate and saturate

[78]Industrial Technology Programs (Regional Technology Development Organization Program, Industrial Technology Extension Service, Industrial Effectiveness Program, New York Photonics Development Corporation, etc.), Corporate Finance and Development Programs (Corporation for Innovation Development Program, Ventureline, etc.), University-Industry Programs (Centers for Advanced Technology Program, R&D Grants Program, State Industry University Cooperative Research Centers, etc.), High Tech Global New York (Long Island High Technology Incubator, etc.).

the state facilities and programs.[79] Federal resources should be used mainly in terms of flow of funding to the states. The impression of something added from the federal level can be perceived as very negative : MTCs should be only the architecture. I think that it is the most efficient way to built a political coalition between regional actors. The Northeast MTC has somehow failed in its reorientation and restructuring of the state programs - perhaps because the state services were already strong, already well adapted to their environment and well implanted. It seems to be one industrial program among twelve others, without its specificity and its leveraging power. The consequence is that the NYMEP program has became somehow "marginal" and its existence is at stake. In this perspective, the role of the SMTC has been easier : since no state industrial extension program pre-existed, the implementation of the MTC allowed a better coalition between actors. I would like to point out here that historical development of state programs should be seriously taken into account before the introduction of a new federal-sponsored center. By contrast to the common idea, the most friendly environment is perhaps not where strong state industrial services have previously grown.

An interesting feature has been developed in South Carolina by EDI (Enterprise Development Inc.)[80] : this non-profit organization creates non-profit agencies with particular missions (an environment task for instance) and provides initial support through grants. However, after a while, these newly created organizations should be able to run by themselves. One can suggest that such spin-off mechanism should be applied for MTCs. The federal money could be used as an initial input to restructure state industrial services. Once the new orientation is achieved, then an independent and self-sustainaible (or even a for-profit one) agency could run the program.

A decentralized type of assistance does not mean inconsistency. Autonomy does not necessarily prohibit the existence of national purposes. By contrast, I think that a nation-wide network of "broker" Centers should provide the necessary coherence in the technological up-grading of SMEs, since it would be the best suited strategy for technology diffusion, which should be the "strongest" denominator between public efforts.

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[79]Kelley and Arora have shown that "indsutrial extension services providing individualized consultations to SMEs were more dependent on governmental sources of funds than other types of programs. See KELLEY, Maryellen R. and ARORA Ashish, "*Service Provider or Institution Builder ? An Assessment of the Role of Industrial Modernization Programs in U.S. Technology Policy*", MIT Industrial Performance Center, Working Paper 95-004WP, March 1995.

[80]EDI is the managing force for SMTC. It has been spread out of SC Department of Commerce in order to bring in federal and private funds and to work in a more "creative" environment.

IV. EVALUATION

The question of evaluating the impact of public assistance toward small manufacturers is extremely difficult. It might be endless and results in an "academic fiction". For example, one typical problem is the impossibility to compare both situations (with and without public efforts) on the same basis for each firm : it is never possible to calculate precisely what would have happened in the absence of assistance. It is very difficult to link technology transfer actions to common measures of increases in market share, sales or profits, which can be due to other internal or external influences on the firm. In addition to that, firms that have been assisted are likely to overestimate the impact of assistance on company evolution. Thus there are inherent ambiguities within any business performance measures. Conventional indicators (reduction in scrap, employment, sales increase, etc.) or cost-benefit analysis that have been used show sometimes almost inconsistent results.

One should mention that MTCs have developed tools of assessment. Although imperfect, any measure of their impact on SMEs is indeed crucial for their evolution. SMTC for example uses primarily sales increases and quality improvement (reduced scrap). Thus, calculations show incredible "returns"[81] such as $28 for $1 in federal money (SMTC, 1st quarter 1994)! However, such calculation does not take into account matching funds from the state and the firm's investment. This type of evaluation is organized at SMTC around the "Competitiveness review", which lists 140 questions in order to rank each activity[82] of the company and the improvements that have been made. Most often evaluation focuses on case studies. Although it can be somehow biased by the personal (un)satisfaction of the client, it provides good qualitative data.

The approach that I have followed is to focus on qualitative and new ideas that each type of intervention can suggest. Again, the main question to address is the following : does this program add something new to the existing system of public assistance ?

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[81]The concept of "return on investment" is quite irrelevant here, since two different types of money -the public and the private one- are at stake and cannot be evaluated on the same basis.
[82]Five areas are distinguished : management, technology, quality, cost and delivery.

V. "BROKER" VERSUS "IN-HOUSE" MODEL

V.1 DESCRIPTION

Among the 44 Manufacturing Extension Centers, many categories can be distinguished.[83] Maryellen Kelley and Ashish Arora underline that :

> The one-on-one industrial extension service model where the state agency is the source of expertise is not the only approach. Institution building approaches emphasize inter-firm learning, in which government serves as the catalyst for bringing technology developers together with potential users and for providing closer linkages between organizations that are technology leaders and those that tend to be followers. [...] Institution-building strategies can be expected to have a greater impact on leveraging private sector resources than public agencies that attempt to provide a substitute source of expertise as direct service providers for these absent institutions.[84]

According to the visits that I have made and to the information that I got from various MTCs, I will rather focus on two types of models. The first one is built on a lot of "in-house" facilities, whereas the second one relies more heavily on outside participation and can be called "broker" model. Within MECs, one strong distinction exists between the Manufacturing Outreach Centers (MOCs) and the direct technical services. For example, in NYMEP, ten MOCs are located throughout New-York state, and the headquarters in Troy houses some demonstration facilities. In the case of the "broker" model, the MEC links companies to existing resources (such as technical colleges, universities or other state organizations) and serves as the "steward" of the network. The MEC is the facilitator or the manager of all resources that contribute to the technical solution. In the following sections, I will try to determine what is the best suited mode for each particular industrial system. I will also underline that different kind of policies result from each approach.

V.2 FLEXIBILITY

Since there is no "typical small manufacturer", MTCs need to be extremely flexible to adapt to each new situation or each technology and to changes in the demand conditions

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[83]David Osborne (see his article "State Technology Programs : A preliminary analysis of lessons learned", *The Council of State Policy and Planning Agencies*, 1989) classified state industrial programs into four categories : passive (information through database), broker (outsourcing), active (visits) and comprehensive programs.

[84]KELLEY, Maryellen R. and ARORA Ashish, "*Service-Provider or Institution-Builder ? An Assessment of the Role of Industrial Modernization Programs in U.S. Technology Policy*", MIT Industrial Performance Center, Working Paper 95-004WP, March 1995.

of small manufacturers. The SMTC outsources 50% of its activity to third-party consultants, while using technical colleges, universities, staff people from SMTC or national laboratories the rest of the time (mainly when the request is for off-the-shelf technology). The philosophy is to incorporate new programs when needed and to internalize state-of-the market technologies. The "broker" model is more efficient in that sense, because it allows to direct the firms to several specialized organizations, where diverse and changing technical problems can be solved The concept of "third sector", such as technical colleges or private consultants, is powerful because it entitles greater flexibility and autonomy than allowed in purely governmental operations. I do not believe that a non-market institution can serve as the only source of expertise for industrial modernization since market signals and private sector incentives are excellent ways to promote expertise. A public organization can however be used as a central node between these institutions.

Although not applied to the study of MTCs, this kind of distinction has been very nicely enligthened by Kelley and Arora.[85] They analyze first the "service-provider model", where the service to individual firms is the main goal of the center, which considers itself as a source of expertise. This requires that field staff develop and keep current a high level of expertise in various technical areas, which I think is almost impossible. The second model relies on the "institution-builder approach," which focuses on creating and strenthening private sector technology transfer institutions. This second model is preferred since it leverages private-sector capabilities, which are most likely to be state-of-the-art and cost-efficient.

Several reports have pointed out that "soft" activities in such areas as training, information access, referrals, networking and associations among firms and laboratories are in many cases more important than "hard" assistance in helping firms to introduce new machine technologies. I think that the "broker" model is well-adapted to handle such needs.

In a certain sense, the federal government has to learn how to work like large corporations, in sub-contracting specialized missions and coordinating actors. It is worthwhile to notice that industry changes lead away from vertical integration as a principle of industrial organization and toward systems of collaborative manufacturing

[85]Ibid.

operations. Annalee Saxenian[86] underlines that the industry structure is one strong difference between Route 128 and Silicon Valley :

> Silicon Valley has a regional network-based industrial system that promotes collective learning and flexible adjustments among specialist producers of complex and related technologies. The region's dense social networks and open labor markets encourage experimentation and entrepreneurship. [...] The functional boundaries within firms are porous in a network system. The Route 128 region, in contrast, is dominated by a small number of integrated corporations.

Her argument favors the open structure of Silicon Valley to explain its success. A decentralized network-based system is organized to adapt continuously to fast-changing markets and technologies. I strongly believe that this kind of principle should apply also to public organizations that are service providers to the industry.

V.3 OPERATING COSTS

A Center with a lot of "in-house" facilities is much more expensive to operate. When MTCs want to develop a lot of "in-house" facilities, they rely most often on private vendors which offer their machines for demonstration purposes. In this way, one cannot say that MTCs are neutral, because they only display the machines that particular vendors give them. If a particular Center want to be completely "objective" and up-to-date, it needs to buy by itself a much larger array of equipment. Following an ideal "in-house" model would therefore be substantially expensive. Moreover, this kind of demonstration facilities is obsolete as soon as they have been set up and trade-shows can almost fulfill the same task. A "minifactory" or demonstration facilities entail heavy expenses and full-time operators as well as maintenance personel. On the upper side of the "in-house" model, custom tailoring services and facilities for individual firms tend to be very expensive. The lower side would be to offer generic services, which are however often unattractive to firms with specific needs. I think that the "broker" model would be less sensitive to budget restrictions since it has lower operating costs.

According to SMTC officials, if the SMTC started over today, they would partner 100% of their activity with existing resources within the state. They would not employ a single sales person nor any staff for technical deliveries. This type of outsourcing is obviously

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[86]SAXENIAN, Annalee, *""Regional Advantage : Silicon Valley and the Route 128""*, Harvard University Press, 215p., 1994.

less costly and takes benefit from the chain of state or local organizations that can provide assistance. It is better integrated within the state and its goal is to saturate the existing regional network.

V. 4 MTCs VERSUS PRIVATE CONSULTANTS

An important question to address is the relationship between Manufacturing Extension Centers and private consulting firms. Some opponents of the MTC program see indeed the Centers as public organizations competing with the private consulting sector.

However, as shown in an analysis of Nexus Associates Inc.,[87] the analysis suggests that rather than competing with private consultants, MECs help small manufacturers use consultant more effectively :

> MECs provide assistance that enhances the relationship between manufacturers and private consultants. Such MEC assistance includes help in front-end needs assessment, identification and selection of an appropriate consultant, and management of the ongoing client-consultant relationship.[88]

The results of the survey that NEXUS[89], Inc. completed suggest that MECs do not compete directly with private consultants : only 7% of small manufacturers indicated that MECs simply offer the same set of services available through private consultants. One interesting conclusion is that MEC clients that use consultants are more likely to plan important changes to their operation compared to similar manufacturers that have not participated in MEC programs. With the short assessment provided by MECs, companies are in a better position to identify the nature of assistance they need and to define a scope of work for private consultants. Thanks to an established network of private consultants, MECs help clients identify the right kind of private consultants to address particular questions. When limited to a short assessment, MEC services encourage greater openness to change, enabling companies to benefit more from outside assistance. According to the

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[87]NEXUS ASSOCIATES, Inc., "*Manufacturing Extension Centers and Private Consultants : Collaboration or Competition ?*", Prepared for the Modernization Forum, US Department of Commerce, January 11, 1995.

[88]Ibid., p. 1.

[89]The survey was performed in 1994 within 750 MECs' clients and 800 other non-clients small manufacturers. Sample were defined to ensure a compplete distribution of industries and of geographic areas.

study conducted by NEXUS, even consultants involved with the MEP program state that MECs are beneficial to their business.

One should also notice that some MECs provide companies with matching funds to offset some of the costs of hiring consultants : these is the case with the NYMEP, and also with the Upper Midwest Manufacturing Technology Center (UMMTC) based in Minnesota. The UMMTC relies on outside assistance for all projects : while private consultants account for 50% or so of projects, the Center also refers clients to experts at technical colleges, universities, and other organizations for assistance.

If we go forward, we can suspect that the chance of competing with private consultants is greater when the MTC has a lot of "in-house" expertise. This point will be even more emphasized when MTCs will have to raise their fees at the end of the first six year of federal funding. Technical experts will be proposed by the MTC at a lower cost and will therefore erode the ability of small consultants to stay in the business. Moreover, I wonder in which way public experts can be as efficient as private one to follow on technical improvements that exist on the market. Therefore I think that even this point goes in favor of a broker model, where the public actor would elaborate a network of qualified private consultants. Through local relationships and contacts made by field agents, the MECs can remain a qualified source of informal assistance, unbiased information and cost-effective short assessments of operations.

V.5 OVERALL EFFICIENCY WITH NETWORKS

Although each Center has to find its own way, I would like to place a greater attention on the role of MTCs to enhance the formation of networks between firms and also networks between organizations which deal with SMEs. The United States General Accounting Office points out that :

> The committee also believed that NIST should give substantial weight to the integration of an MTC into an overall economic development plan and broad industrial interest.[90]

[90]US GENERAL ACCOUNTING OFFICE, "*Technology Transfer : Federal Efforts to Enhance the Competitiveness of Small Manufacturers*", Report to the Ranking Minority Member, Committee on Small Business, U.S. Senate, November 1991, 45pp.

These two types of networks -private firms anc public agencies- should not be separate but intertwined. I would call such MTC an "active broker" model, i.e. a model where the Center plays a networking role through active MOCs contacts. The task of MOCs is to keep the first contact and visit to the client, which seems indeed to be crucial. By building networks between regional agencies, one can increase the opportunities for small firms to interact.

I think that the public funding should be used for two purposes : first to support a sophisticated and well-trained staff. Secondly I think that public funding should be used for cost-sharing of private resources. Since private actors are more alert than public organizations to react to changes in technologies and in markets, MECs should make a better use of existing private resources, instead of delivering services by their own without a clear sense of their value (which is reflected by the fluctuating fee policies on MECs' services). Each State would run the Center. It could participate for the staff (mainly through existing IMPs) and to a certain extent to the cost-sharing, whereas the federal level would only be implicated in the funding of projects and devolve management to states. It is neither desirable nor efficient for the federal government to be in the "retail business of overseeing large numbers of local industrial modernization programs."[91] By adopting such configurations, one can suspect that MECs could better survive political changes at the national level, the only possible effect on the program being the number of projects affected by changes in the federal financial contribution.

The broker model can go further by leveraging networks. It is well adapted to regions with a diverse mix of industries. A 1991 review identified some 50 industrial networks in 14 states, involving over 1500 small firms. Once the network is up and running, it is possible that modernization and technology issues can become part of the network's agenda. The broker model allows a potential combination between networking and individual approaches through MOCs (Manufacturing Outreach Centers). One strong argument in favor of networking is that it more readily allows broader issues of inter-firm collaboration and public-private relationships to be addressed. In this context, one can guess that the technology transfer will be more "technology push" or "market-driven" than "government-pull."

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[91]SHAPIRA, Philip, "*Modernizing Small Manufacturers in the United States and Japan : Public Technology Infrastructures and Strategies*", to be published in M. Teubal et al (editors) "Technological Infrastructure Policy (TIP) : an International Perspective".

It is very often stated that what does influence the ability of a firm to make economic use of new technology is the flow of information to which the firm is exposed through relations to suppliers, customers, trade associations, etc. Annalee Saxenian[92] points out that the velocity of information in the Silicon Valley is particularly high. Therefore, the main issue to be addressed by a public organization is : what is the most efficient structure to achieve this goal on "information flow" and "information sharing" ? To meet and discuss common concerns and problems were recognized by small manufacturers among the most valuable services that a neutral party, such as a MTC, could provide.

> Examples of MTC services that workshop attendees noted as potentially very useful include activities that facilitate better networking among companies, such as forums, workshops, [...] and brokering or matching appropriate private sector providers with smaller clients.[93]

Kelley and Brooks (1991) have shown that when small enterprises are involved in inter-firm learning activities, they adopt new processes and new technologies at a higher rate than small firms that lack these connections. I think that a "light structure" with various ramifications between different institutions can enhance this flow of information between parties better than a heavy and rigid center, which would be more likely to rely on its internal capacities. These "soft" services were noted repeatedly as some of the most useful and important contributions that could be made by the MTCs. In this area of services, MTCs do not compete with private sector services and they fulfill a mission that can only be attributed to public organizations. These activities have a great leverage and could increase the scope and impact of the MTCs efforts.

Public efforts can also develop private network brokers. Some people believe also that private "service bureaus" could take place and offer similar services to SMEs.

This kind of model is of course not unique and should be adapted to the region where it is inserted. The broker model is for instance subject to the capabilities of the technical colleges or universities in the region. When the local industrial system does not provide any facilities or consulting firms, MTCs should internalize more activities and offer a larger panel of services. Moreover such organization could turn to spin-off private

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[92]SAXENIAN, Annalee, *""Regional advantage : Silicon Valley and the Route 128""*, Harvard University Press, 215p., 1994.

[93]US NATIONAL RESEARCH COUNCIL, Committee to assess barriers and opportunities to improve manufacturing at small and medium-sized companies, Manufacturing Studies Board, Commission on Engineering and Technical Systems, "*Learning to Change : Opportunities to Improve the Performance of Smaller Manufacturers*", National Academy Press, Washington, D.C., 1993, 136pp., p. 79.

organizations after a certain period of time and compensate a poor local network of private consulting firms. Thus, the "in-house" model should not be rejected as a whole, although it looks less optimal from my point of view. A larger study could analyze in more details the adequation of each model with particular type of industry mix or regions.

I think finally that there might be some "personal" issues around the concept of MTCs. It is quite obvious that each MTC manager will be more attracted with the creation of a large panel of "in-house" services. Conducting a Center of many field engineers and technical specialists seems to be much more powerful than being director of a "broker" center, which looks more like an empty shell. There is therefore a natural inflation toward a larger MTC offering more services. It requires a lot of wisdom as well as excellent personal relationships with the local community to be the head of a "broker" center.

VI. POLITICAL EVOLUTION OF THE MEP PROGRAM

In his 1983 paper,[94] Robert Reich has somehow anticipated most of the developments and features of the "industrial policy" debate in the United States. He underlines that :

> Industrial policy has become something of a political Rorschah test. The term somehow summons each person's fondest hopes or direst fears. [...] The central question with which we must deal concerns not the economic wisdom of industrial policy but its political form.

According to Robert Reich, "our industrial policy lies buried, and the choices it embodies are never clearly posed." The recent evolution of the US Congress raises serious doubts about the continuation of the federal efforts, whereas partnerships with small manufacturers are particularly dependent on long-term perspectives.

With the change in leadership, Congress has committed to a significant reduction in federal spending and will carefully scrutinize all federal programs, including the NIST MEP, which is viewed as "technology welfare." The shift in power changed the leadership and membership of key committees in the House and in the Senate. Rep. Robert Walker (R-PA) now chairs the House Science Committee, which has jurisdiction over the authorization of the MEP program, and Rep. Robert Livingston (R-SD) chairs the House Appropriations Committee, which sets funding levels for the program.

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[94]REICH, Robert B., "An Industrial Policy of the Right", *The Public Interest*, Number 73, Fall 1983.

The House Appropriations Subcommittee on Commerce/Justice voted on February 23, 1995 to rescind $26.5 million of the $90 million FY95 appropriation for the NIST MEP program. However, the $90 million FY95 appropriation for MEP was $30 million above the $60 million requested in the President FY95 budget. If passed as expected, the cut will slow MEP growth without killing for 1995 the momentum of the program. Any changes to the 1995 budget must first win the approval of both the House and the Senate and then be signed into law by President Clinton or passed over his veto.

In its FY96 budget, the administration remains faithful to its investments in technology. Regarding technology partnerships, the budget proposes a 14% increase in the ATP (from $431 million in FY95 to $491 million in FY96), a 62% in the MEP (from $91 million to $147 million). Funding should support 90 MEP centers, and a 14% increase in the TRP (Technology Reinvestment Project from $443 million to $500 million). However, there is a significant probability that the Technology Subcommittee of House Science Committee may fail to authorize any appropriation for the MEP in FY96.

Some MTCs (SMTC for instance) are already looking for additional money through smaller program grants, and do not count too much on NIST grants. Although fee income can discipline the programs, a stable and sufficient core of public support is needed.

There has always been a balance between basic science research and applied technologies in the US policy on Science and Technology. One can also see this distinction as the difference between "breakthrough" and "incremental innovation" strategies. In the immediate post-war period, this trade-off was in favor of sciences until the mid 1980's, when came the need for commercialization of all the military advanced projects. But the support and efforts for technology has never been anologous. This type of "industrial policy" based on technology development is still a politically-sensitive concept in the United States. Although NIST influence might grow, there is still no leading institution in the technology area like the NSF (National Science Foundation) for example. Now one can perhaps observe a shift back to sciences and pure research.

As previously illustrated, the concept and practice of industrial modernization for small firms has progressed rapidly in recent years. However the recent evolution of Congress debates suggests that this type of technology policy has not yet gathered enough political and business support. I suspect that the MEP program might be cut before it has reached an adequate coverage. The short-term horizon of administration and Congress (caused by

budget and electoral cycles) as well as the absence of national commitment represent a big tension with the essentially long-term aspects of industrial modernization. The recent difficulties of the MEP program reflects deeply-rooted visions and institutional patterns of the American economy.

VII. CONCLUSION

The example of U.S. public efforts toward small manufacturers provides several insights into public policies in the area of Science and Technology. The MEP program aims at filling one gap in the domain of manufacturing techniques. In assisting small manufacturers, the U.S. system seems to emphasize the virtue of a multiplicity of approaches in confronting an inherently unpredictable technical environment. However, one can be deeply concerned by the fact that a chaotic assistance emerges sometimes at the local level. One must also remember that state governments have been leaders in establishing industrial assistance programs : they should therefore be deeply involved in the coordination of actions with a substantial financial support from the federal government. From my perspective, the best way that NIST efforts can be fully rewarded is through the "broker" model for the Manufacturing Technology Centers.

CHAPTER 6
POLICY "RECOMMENDATIONS" FOR FRANCE

I.INTRODUCTION

In this last chapter, I will first present briefly the major players whose objective is to enhance competitive performance of small manufacturers in France. Then, I would like to highlight the main interesting features of the American policies in order to draw some "recommendations" for the French industrial system toward small manufacturers. Some positive aspects can indeed be drawn from state-of-the art- organizations or from "best practices." This kind of exercise is a difficult and perilous task, and one can suspect that some societal pre-conditions or arrangements are required within each nation. However, I think that some qualitative features are well worth noticing.

II. BRIEF OVERVIEW OF FRANCE'S POLICIES

There were approximately 36,000 small manufacturers[95] in France in 1991, representing 53% of the total manufacturing workforce, 41% of the manufacturing output, and 25% of the exports. In the past years, there has been a slight increase in the number of employees in the small manufacturing firms.

[95]This number does not take into consideration Food, Energy and Construction industries. Under the French definition, "small manufacturers" have between 10 and 499 employees. The corresponding population of small manufacturers is approximately 140,000 (i.e. 4 times the French number) in the United States.

Different public actors try to promote small manufacturers and to enhance their competitive performance. The two main public organizations are the ANVAR[96] and the DARPMI[97], which constitutes one division of the Ministry of Industry. In terms of economic development, other players involve the chambers of commerce or the "conseils régionaux." ANVAR has the task of promoting and financing innovation, and facilitating technological transfers and partnerships. Its budget represents 1.5 billion FF : rougly 2,500 grants and loans to innovation or technology transfer projects. This agency is operating with a staff of 365 people at headquarters and in 24 regional offices.

The DARPMI is also operating through its 24 territorial offices housed in the DRIRE[98]. Whereas ANVAR is more focused on technological innovation, the DARPMI emphasized the technical up-grading of manufacturing facilities. With a staff of 300 professionals, this action is undertaken under four main directions : "conversion or modernization funds" (40% of the total budget), assistance to "immaterial investment" (25%) (consulting, hiring professional managers, etc.), and two technological programs centered around new materials (electronics) and CAD-CAM-CAE (all issues related to computer usage) (25%). "Collective actions" represent the remaining 10%. In terms of budget, France's assistance toward SME is very substantial : roughly 6500 projects were undertaken in 1993, with a total budget of FF1.3 billion.[99] In comparison, the US federal efforts seem incredibly small and are at their "experimental" stage.

The trend toward more responsibility at the regional level has been encouraged by the laws on decentralisation introduced in 1982 and 1983, which increased the tasks and the resources available to local governments relative to those of central government. On the other hand however, one has to remind that France is a State with strong administrative capacities. Thus, although regional entities provide matching funds through 5 years "Contrat de Plan," the directions for the industrial modernization system are given at the national level. It is the DARPMI that runs these programs under centralized mechanisms and frameworks. We can say that the industrial assistance system provides an interesting example of "deconcentration" -and not "decentralization"- of the State. Nevertheless it is

[96]"Agence Nationale de la Valorisation de la Recherche." Created in 1979, this is a public agency run as an independent concern.
[97]"Direction de l'Action Régionale et de la Petite et Moyenne Industrie."
[98]"Direction Régionale de l'Industrie, de la Recherche et de l'Environment."
[99]The funding came from the French Government (62%), Regions (16%), EU (18%), others (4%).

worthwhile to underline that there is a strong program stability, a long time horizon and a national commitment that the United States sometimes lack.

III. MAIN IDEAS FROM THE US PERSPECTIVE

III.1 FINANCIAL ISSUES

Raising capital is a difficult task for small manufacturers anywhere but especially in France, where the relationships between financial institutions and SMEs should be deepen at the local level. SBICs can be viewed as an interesting example of a vital partnership between government and the private financial sector. It is one partial response to the need of financing for growth, modernization or expansion, and it illustrates the concept of government leverage. "Incubators" in various states are also places where partnerships in the area of high-technology are favored. The principle of matching funds for NIST MTCs is also one example of the catalyst role that can be played by the federal government to attract state or private funds.[100]

Venture-capital and second-market (such as NASDAQ) issues have been briefly mentionned in chapter 2. An enormous potential exists here to facilitate the access of capital for small manufacturers.

III.2 FLEXIBILITY

Although I have never "practiced" French approaches toward SMEs, I have the impression that public institutions rely too often on a standardized, "generic" package of services. What I like in the MTC Program is the flexibility of the design, which enables the interactions between various institutions to evolve over time. Charles Sabel describes the "continuous incorporation of local learning into the redesign of national institutions,"[101]

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[100]This is already done on a very broad basis in the 5 years contract ("Contrat de Plan") between the national government, regional entities ("Conseils Régionaux") and some European matching funds (FEDER).

[101]SABEL, Charles F., "*Discussing Evaluation in a World of Discursive Standards : Assessing Manufacturing Technology Centers*", Paper prepared for the workshop : Manufacturing Modernization : Evaluation Practices, Methods, and Results, Atlanta, Georgia, September 18-20, 1994, Forthcoming in a special issue of Research Policy, 1995, 35p.

which can lead to superior performance. The need to remain flexible, to fund experiments, and to adapt accordingly is a guiding principle in the United States. Although it seems unrealistic to go as far as the creation of "non-for-profit" organizations like in the United States, the creation of public structures between governmental agencies, universities, laboratories and industry associations could be promoted. They would rely on a "decentralization" principle and they would be run under local leadership.

The variety of approaches in the United States is far greater and there is a high degree of program decentralization and diversity. There is a strong willingness to go beyond specific technical problems and to pursue broader views on firms activities such as the combination of technological upgrade with business development plans.

The other attractive idea is that the MTC program is not specifically a "grant" program. It also tries to involve all the interested parties : federal and state levels as well as the private sector.

A strong characteristic of the American economy is the vitality of innovation that can be seen in the best US technology start-up companies. This country has emphasized the emergence of high-technologies rather than the support for conversion of old industries. Perhaps the gap between innovation and technology assistance policies should not be too large.

III.3 PRIVATE SECTOR INVOLVEMENT

The local industry leadership and collaboration is a promising feature of the American industrial extension system. The participation of private entrepreneurs in the board of public organizations is very important in this respect. This allows programs to be driven by local companies and their objectives. For instance the Midwest Manufacturing Technology Centers (MMTC, Ann Arbor, MI) has set up industry councils for the two industries that are the largest employers in the state : private sector representatives are thus able to shape the MMTC actions. MMTC has also targeted the automobile industry for its sectoral approach to industrial modernization. A council made up of leading industry representatives now meets regularly with MMTC staff in order to identify areas of improvement and common industry standards for supplier certification. This enables both public and private actors to be better aware of the efficiency and of the adaptation of the

established programs. In the evaluation of the programs, getting the feedback from the SMEs community is a strong preoccupation, although this is not to say that this type of issue is always well-addressed. In addition, the involvement of private firms can make a better promotion of the public efforts in the business community. One can see such participation as a very strong stimulation of the "demand side" in the modernization process of SMEs.

There is a great emphasis in the United States on the role of the private sector. The soul of the US system can be summarized in the following statement :

> The technology the private sector uses is largely created by private firms, only supplemented by "spin-off" from federal agency mission-driven technology.[102]

This nation tries to promote the cooperation among sectors : this increases policy civility and also holds the potential to be more efficient. Public initiatives should rely on market investment criteria and market signals instead of bureaucratic decisions. Therefore business and government should really be co-funders in most projects.

I believe that the catalytic action of public organizations is very important : clubs around MIT in the route 128 or information sharing networks in the Silicon Valley account for a great deal in the success of these clusters. One should not undermine the "strength of weak ties,"[103] as mentionned by Granovetter. These mechanisms can be enhanced by "collective actions" undertaken by public agencies. For instance, MTCs realized that they need to provide less assistance to individual manufacturers and give greater emphasis to identifying and addressing technical problems common to large numbers of manufacturers. The widespread use of Internet and electronic database -for resources tailored to the entrepreneur's need- are very powerful tools for these kind of actions.

I would like to underline that the "institutionalization" issues are of particular importance either in France or in the United States. It is worthwhile to refer to MITI interventions in Japan : MITI does not intervene as directly in the Japanese economy as does the Department of Defense in the US or the Ministry of Industry in France. Decisions are made consensually through ongoing conversations between companies, industry

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[102]Branscomb, Lewis, "The National Technology Policy Debate", *Empowering Technology : Implementing a U.S. Strategy*, MIT Press, Cambridge 1993.
[103]Granovetter, Mark, "The strength of weak ties", *American Journal of Sociology*, Vol. 78, No6, pp. 1360-1380.

associations and government analysts. The participation of each stakeholder in the decision-making process is said to be very different. In France, the interaction between private firms and civil servants occurs too often in one -topdown- way.

CHAPTER 7
CONCLUSION

Small and medium-sized enterprises are key players in the American economy, as long as they are able to up-grade their manufacturing capabilities and maintain a competitive advantage. We have seen that a large diversity of public efforts is focused on the following objective : trying to enhance competitive performance among SMEs. However, public policies are neither very well coordinated nor always targeted to the needs of small firms.

As an intermediary organization between federal and state levels, the Manufacturing Extension Partnership Program carries very promising features, compared with "traditional" approaches. The first six years of the program have shown that two main directions emerge among Manufacturing Technology Centers : the "in-house" model at one end of the spectrum and the "broker" model at the other end. The "broker" model seems to be based on an economic coalition of players at the regional level, whereas the "in-house" model relies more on a political coalition -at the federal as well as at the state level- to support its operations.

It is argued that this "in-house" type of technical assistance does not add something really new to the existing system of state industrial extension services. Moreover it somehow violates deeply-rooted ideologies of American business as well as of political community : providing and therefore choosing technologies is a certain form of biased "picking winners or losers" industrial policy. It is also more likely that regional communities could desert this program after the initial period of federal financial support, since it does not show particularly original characteristics or performance -except its federal funding-.

It is believed that MTCs operating as "brokers" would not be as constantly in doubt as to long-term survival like MTCs operating under the other model. They should be indeed more integrated in the economic activity. Since they operate on a network basis, they should open new strategies for firms. They will not tend to be in direct competition with small consulting companies. They would also be more "demand" (i.e. the demand of the SMEs' community) than "supply of services" oriented.

MTCs see their action as designed to bridge the "technology gap between sources of current technology and the small and mid-sized companies that need it."[104] However, this "intermediary organization" should not add another heavy structure between SMEs and technologies. In order to gain full advantage of the enormous potential among SMEs, NIST needs to devote ongoing attention to the adaptation of MTCs to their local community.

According to the literature discussion presented in the introduction, the Manufacturing Technology Centers Program gives an excellent illustration of the necessary move to decentralized networking kind of public organization that has been recognized as more efficient. This is again summarized in the figure 3 below.

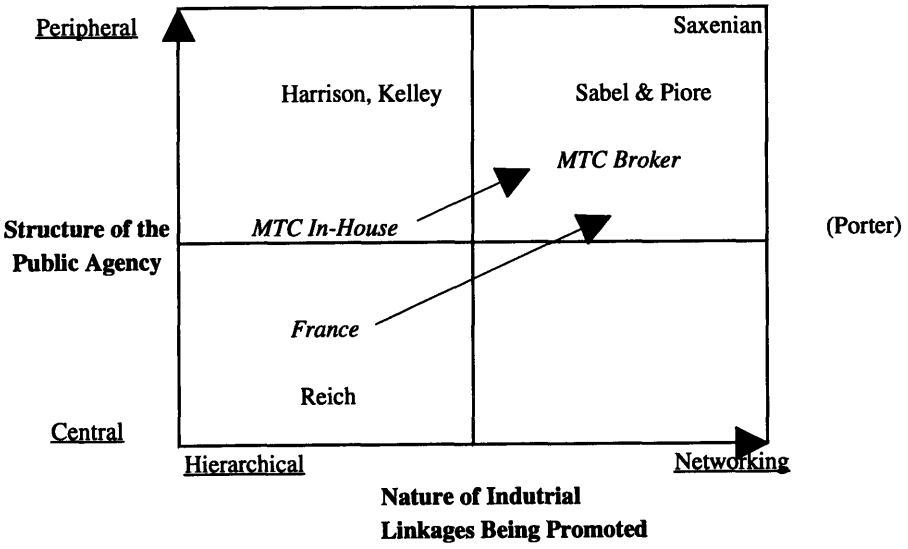

Figure 3 : Mechanisms of Public Intervention Toward Small and Mid-Sized Manufacturers.

[104]Great Lakes Manufacturing Technology Center, *Annual report*, 1993.

APPENDIX
INFORMATION ON VISITS & CONTACTS

Among all organizations, I selected two "older" Manufacturing Technology Centers (NYMEP and SMTC) and one more recent Manufacturing Extension Center (MAMEP, Boston). I received documents from GLMTC (Great Lakes MTC), MMTC (Midwest MTC) and MAMTC (MidAmerica MTC). The organizations that I visited and some of the people that I have interviewed are identified below with a star-symbol*.

I also conducted interviews in the Small Business Administration (Washington), in NASA (Washington) and at NIST (Gaithersburg, MD) in January 1995.

Massachusetts Institute of Technology

Pr. Maryellen Kelley*	Visiting Assoc. Professor of Technology Policy Dept. Political Sce & Industrial Performance Center.
Pr. Michael Piore*	MIT, Professor of Economics
Pr. Charles Sabel	MIT, Professor of Political Science
Pr; J. Nicholas Ziegler*	Assistant Professor of Management MIT Sloan School of Management, Thesis Advisor

MISCELLANEOUS

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NEXUS Associates, Inc.*	68 Leonard Street, Belmont, MA 02178 (tel : 617 489 0311)

NATIONAL AEROSPACE AGENCY (NASA)

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Office of Procurement* Washington DC 20546	James Pesnell* (Procurement Policy Analyst) tel : 202 358 0484 (fax : 202 358 3081)

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

US Department of Commerce, NIST Gaithersburg, MD 20899-0001	Standard, tel : 301 975 2000
Gregory Tassey*	Senior Economist
Connie Chang*	Policy Analyst, Advanced Technology Program
Kevin Carr	Director, MEP Program, tel : 301 975 3593
David Cranmer*	Assistant Director Policy Planning, MEP

MANUFACTURING TECHNOLOGY CENTERS (NIST / states)

1989 MTCs

NYS Science & Technology Foundation 99 Washington Avenue, Suite 1730 Albany, NY 12210	tel : 518 276 6751 tel : 518 276 2905
NY Manufacturing Extension Partnership* Rensselaer Technology Park 385 Jordan road Troy, NY 12180	tel : 518 283 1010 Director : Ms. Judith Gustinis Jeffrey Shacket*, Asste Program Administrator Evaluation Gerald L. Yarter*, Technical Progr. Administr.
Southeast MTC* PO Box 1149 Columbia, SC 29202-1149	tel : 803 252 6976 Director : Bel Cross*
Great Lakes MTC Prospect Park Building, 4600 Prospect Avenue Cleveland, Ohio 44103-4314	tel : 216 432 5322 (Standard : 5300) Director : Dr. George Sutherland

1991 MTCs

Midwest MTC Industrial Technology Institute 2901 Hubbard road Ann Arbor, MI 48106	tel : 800 292 4484 Director : Mr. John Cartier
Mid America MTC 10561 Barkley, Suite 602 Overland Park, KS 66212	tel : 913 649 4333
California MTC 13430 Hawthorne Blvd Hawthorne, CA 90250	tel : 310 355 3060 Contact : Ms. Joan Carvell
Upper-Midwest MTC Minnesota Technology, Inc., 111 Third Avenue South, Suite 400 Minneapolis, MN 55401	tel : 612 388 7722 Contact : Ms. Dianne Bilderback
Massachusetts MEP* Bay State Skills Corp. 101 Summer St. Boston, MA 02110	Ms Jan Pounds*, Director

SMALL BUSINESS ADMINISTRATION

Office of International Trade*	Giordano A. Chiaruttini* (tel : 202 205 6720) Deputy Director (fax : 202 205 7272)
Small Business Innovation Research*	Dick Schane*, Director
Unisphere* (International Ventures Network)	Paul Allen* (tel : 202 296 3558)

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