Educating for Technology Transfer

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The federal government's role in promoting information dissemination, science and technology, and education has its origins in the Constitution: the first amendment guarantees freedom of speech and press; article I, section 8, authorizes the federal government to grant intellectual property rights: and article I, section 8, paragraph 7, permits the government to build postal roads. [1] The federal government used the postal provisions to subsidize the distribution of news in the late 1700s. [2] After the Civil War, the federal government played a major role in the development of libraries and the American public

Just as the government helped American farmers adjust to the industrial revolution, so, today, many call on it to better prepare American businesses to compete in a knowledge-based global economy.

[1] The American attitude toward information dissemination differed radically from that in Europe w here the ruling monarchs regarded it with considerable alarm. However, building a nation required the establishment of communication l inks, the development of a unified market, the forging of a common culture, and the bu i lding of a democratic polity. The w idespread flow of information was considered essential to accomplish these tasks.

[2] See Richard B. Kielbowicz, "'New slathering by Printers' Exchanges Before the Telegraph," *Journalism History*, vol. 9, summer 1982, pp. 42-48, and Samuel Kernell, "The Early Nationalization of Political News in America," *Studies in American Political Development (New* Haven, CT Yale University Press, 1986), pp. 255-278.

[3] In the United States. libraries have always been regarded as popular educational institutions. Like the public schools, they derived their support from the public education and reform movements that developed after the Civil War. Traveling libraries were founded to bring news and reading materials to rural areas where book deposit stations were set up in grange ha] ls, neighborhood stores, fire stations, and women clubs. In ci - ties, libraries were established not only to provide access to books, but also—like the settlement houses—to provide a haven and adult education programs for a growing number of working class immigrants. These libraries developed rapidly during the post-Civ II War period, and c\ en continued to thrive in the depression years. See V. H. Mathews, *Libraries for Today and Tomorrow* (Garden City. NY: Hippocrene Books, 1976).

school system.[4] Toward the turn of the century, "t became more active in promoting science and technology, especially through the university sys-(em.[5]

These overriding values helped to structure the federal government's response to the agricultural crisis that followed the Civil War and the challenges posed by industrialization.[6] To help farmers adjust to the structural changes in the economy, the government began to develop and transfer modem technology to agriculture.[7] Working through the Department of Agriculture, the federal government established four complementary programs:

1. land grant colleges;
2. support of agricultural research at agricultural experiment stations;
3. making basic information on farm and home problems available to people through extension services: and
4. providing vocational training on agricultural problems, home economics, and industrial subjects.

Just as the government helped American farmers adjust to the industrial revolution, so, today, many call on it to better prepare American businesses to compete in a knowledge-based global economy.[8] Drawing on the success of the government past experience, there are a number of options that might be pursued today.

OPTION A: Expand the Program for Extension Services

Federal extension services have a long history in the United States, dating to 1914 with the passage of the Smith-Lever Act.[9] This act, inspired in part by the Country Life Commission, focused on agriculture and the problems of rural areas. It authorized partial federal funding for a nationwide extension program modeled after private, state, and

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[4] The American commitment to public schooling" grew in the wake of the Civil War. This commitment was so intense that it gave rise to a national crusade to establish public schools. Concerned about the problems of reconstruction in the South, the influx of Catholic immigrants, and the advent of industrialization in the North, Americans saw pub] ic schooling as a way of preserving the social, economic, and political order. See Rush Welter, *Popular Education and Democratic Thought in America (New* York, NY: Columbia University Press, 1962); and David Tyack and El izabeth Hanson, "Confl ict and Consensus in American Public Education," *America's Schools: Public and Private, Daedalus*, summer 1981.

[5] See Edward Shils, "The Order of Learning in the United States from 1865- 1920: The Ascendance of the Universities," *Miner\ 'a,* vol. 18, No. 2, summer 1978.

[6] As Wayne Rasmussen has described it: "The revolution generated by the Civil War catapulted the nation's farmers not only into a new era of mechanization but also into a world of complex social and economic forces that were too volatile and powerful for individual farmers to confront by themselves. It seemed that the appearance of more complex and productive tools intended to guarantee the farmer's survival had made that survival more complex." Wayne D. Rasmussen and Paul S. Stone, "Toward a Third Agricultural Revolution," in Don F. Hadwiger and Ross B. Talbot (eds.), *Food Policy and Farm Programs,* Proceedings of the Academy of Political Science (New York, NY: The Academy of Political Science, 1982), p. 179.

[7] The idea that knowledge could i$_{mprove}$ agriculture was first put forward by agricultural societies composed Of well-to-do gentlemen farmers, farm journalists, and some educators. Such citizen advocacy was bolstered by public agencies and private agricultural interests that acted in mutually supportive ways. These public agencies included the U.S. Department of Agriculture and the land-grant colleges. The private interests Included general farm organizations as well as commodity groups. Wayne D. Rasmussen, *Taking the University to the Peep/e: Seventy-Five Years o/ Cooperative Extension* (Ames, 1A: Iowa State University Press, 1989), pp. 8-22. See also David E. Hamilton, "Building the Associative State: The Department of Agriculture and American State-B uilding," *Agricultural History, vol. 64,* pp. 209-218.

[8] See, for a discussion, U.S. Congress, Office of Technology Assessment, *Making Things Better: Competing in Manufacturing*, OTA-ITE-443 (Washington, DC: U.S. Government Printing Office, February 1990). See also, Joe Janmesurak, "priority #1: Fix Industrial Infrastructure," *Appliance Manufacturer*, vol. 40, No. 10, October 1992, p. 92.

[9] Among extension services, for example, were Deaman Knapp's "demonstration farms," on which farmers could learn by watching and doing, and 'movable schools' such as George Washington Carver's Tuskegee mule-driven wagons full of new seeds, farm machinery, and dairy equipment, as well as boys' and girls' clubs through which it was hoped parents could be educated. See Hadwiger and Talbot, op. cit., footnote 6.

local efforts that provided education and information to rural communities.

Building on these ongoing efforts, the Cooperative Extension Service (CES) brought together a wide range of players and encouraged cooperation among them. The U.S. Department of Agriculture (USDA) and the land-grant agricultural colleges were charged with management of the program, while the costs were shared by the states, counties, and county organizations of innovative farmers, called farm bureaus. In addition, partnerships were established between university extension and experiment stations, and between county extension agencies and county farm bureaus. [10] Later on, extension people helped to start other farm organizations called commodity organizations. The experiment stations also formed links with the farm bureau and with the commodity groups so they could better understand the research needs of producers. Leadership for this public-private network was recruited from graduates of the agricultural colleges. Within a few decades, this elaborate network of players had achieved its goal of farm modernization. The quality of farm life had also been improved through access to home economics and farmer information services. [11]

Industrial extension, like agriculture extension. originated at the state level.] [2]However, it did not receive national focus until 1989 when Congress established three Manufacturing Technology Centers (MTCs)[13] and a State Technology Extension Program (STEP) [14] to be administered by the Department of Commerce's National Institute of Standards and Technology (NIST). [15] Today there are seven MTCs located throughout the United

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[10]The county agencies organized the farm bureaus, which in turn formed state and national farm organizations, thereafter becoming the Extension Service's link with political supporters as well as farmers.

[11]At present, the Cooperative Extension Service (CES) provides education, information, and technology transfer on numerous topics relevant to fanning and agriculture generally. The scope extends to many topics that are germane to rural development. CES has the advantage of many extensive state and county networks of land-grant colleges, extension agents, and field experiment stations to disseminate information and education. CES has interpreted its statutory mandate as extending to the general health of rural America, and has now developed its own rural development strategy in coordination with the U.S. Department of Agriculture and government-wide rural revitalization initiatives. See OTA, *Rural America at the Crossroads: Networking for the Future*, OTA-CIT-471 (Washington, DC U.S. Government Printing Office, April 1991), and Robert E. Chapman. Marianne K. ('lark. and Eric Dobson, "Technology-Based Economic Development A Study of State and Federal Technical Extension Services," National Institute of Standards and Technology, Special Publication #786, June 1990, p. 7.

[12]One of the largest of these efforts is the Industrial Extension Service established in 1956 at Georgia Institute of Technology)". Only in 1964 did the federal government become involved on a very limited basis, disseminating technical information to manufacturers through programs operated by individual states. Other programs were run independently of universities through state development agencies. See Chine R. Simons, "Industrial Extension and Innovation," in Lewis M. Branscomb (cd.), *Empowering Technology: Implementing a U.S. .! rategy* (Cambridge, MA The MIT Press, 1993), pp. 171-172.

[13]Today these include: 1) the Northeast Manufacturing Technology Center, located in Troy, NY; 2) the Southeast Manufacturing Technology Center in Columbia, SC; 3) the Great Lakes Manufacturing Technology Center in Cleveland, OH; 4) the Midwest Manufacturing Technology Center in Ann Arbor, MI; 5) the Mid-America Manufacturing Technology Center in Overland Park, KS; 6) the California Manufacturing Technology Center in Torrance, CA; and 7) the Upper Midwest Manufacturing Technology Center in Minneapolis, MN. U.S. Department of Commerce, Technology Administration, National Institute of Standards and Technology, "Helping Manufacturers Build a Technological Advantage," March 1993.

[14]The State Technology Extension Program (STEP) helps states to develop industrial extension programs and a modern infrastructure to serve the needs of small and medium-sized businesses. It also funds planning grants for states, and follows up with support for implementation. In addition, the STEP program develops tools that state programs can use to provide client services.

[15]The manufacturing technology centers were established under the Omnibus Trade and Competitiveness Act of 1988. As described by Simons, "Congressional interest in implementing a federal technology policy during the Bush administration resulted in several small programs under the Department of Commerce. or-w of these, the Manufacturing Technology Centers (MTC) program, is based on the premise that smaller manufacturers are the foundation of (1. S. industry. The designers of the MTC program defined the technological improvement of the smaller manufacturers a\ a necessary precursor to the resurgence of U. S, manufacturing " S imons, "Industrial Extension and Innovation," in Branscomb, op. cit., footnote I 2, p. 167,

States. Their task is to enhance productivity and technology performance in U.S. manufacturing through the transfer of manufacturing technologies and techniques. However, each employs a somewhat different approach to meet its own area's special needs. For example, the Midwest MTC, located at the Industrial Technology Institute in Michigan, has a strong industry focus, reflecting the presence of the automobile industry. The Southeast Manufacturing Technology Center, which is situated on the campus of the University of South Carolina, caters more to the needs of small, rural manufacturers. [16]

Although modeled after the CES, the industrial extension program does not have comparable federal funding. In 1992, for example, the CES was budgeted at $1 billion, $400 million of which was provided by the federal government. In contrast, industrial extension was budgeted at $80 million, with the federal government providing only $17 million.[17] Thus, it is not surprising that the CES has 3,140 offices located throughout the country, whereas industrial extension has offices in only 20 states.[18]

Federal funding might increase in the future, however, given the growing popularity and bipartisan support for technology transfer programs.[19] This support was most recently confirmed in March 1993 when the Advanced Research Projects Agency (ARPA) announced the Technology Reinvestment Program (TRP), which will receive $472 million of reprogrammed fiscal year 1993 Department of Defense (DOD) funds .20 The MTC program is now incorporated in the TRP and budgeted at $87 million.[21]

Despite their limited resources, the MTCs have received considerable praise for their accomplishments during their first 4 years.[22] Using a variety of outreach mechanisms, they have provided support to more than 6,500 small manufacturers, who claim to have received $250 million in added benefits.[23] Among the many programs they provide are individual project engineering, [raining courses, demonstrations, and assistance in selecting and using software and equipment. Some MTCs have also conpiled large databases of computer-aided design and computer-aided manufacturing software, which can be run for business c1ients using MTC hardware. A number of demonstration facilities display how automated machining processes-such as automated metalworking equipment, robotics, and state-of-the-art

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[16]National Institute of Standards and Technology, "A Collection of Successful Interactions Between the MTCs and Client Firms," U S. Department of Commerce, Technology Administration, NIST SP 848, March 1993.

[17]Most federal funding is used to support the MTC program, administered through NIST. Jim Treece, "Observing Production," *Production*, October 1993, p. 32. As noted by Gene Simons". .compared to similar programs in other countries, such as Japan's program funded at $500 million per year, the U.S. federal role was quite small." In Branscomb, op. cit., footnote 12, p. 170.

[18]Ibid.

[19]As Simons points out: "The Bush Administration's position on technology for industrial policy appeared to shift in 1992, when the Undersecretary for Technology, Robert White, issued the Technology Administration's 'Strategic View.' This report proposed expanding the MTC program to 30 large centers and 100 small centers over the next 8 years. Bipartisan support developed when Governor Clinton promised in his platform to expand the MTC program to 170 ""n~iirkcl driven" centers and to provide support for improving state extension operations. In October 1992, Senator Bingaman proposed in the Department of Defense budget revisions to spend $540 million in fiscal year 1993 on state and federal initiatives." I bid., p. 169.

[20]For a description of this program, see ch. 5.

[21]If passed, the National Competitiveness Act (HR 5757/S4) would provide an additional $150 million to the Department of Commerce in support of NIST extension services. The amount targeted for 1996-97 is $500 million.

[22]Marianne K. Clark and Eric N. Dobson, "'Increasing the Competitiveness of America's Manufacturers A Review of State Industrial Extension Programs," Center for Policy Research, National Governors' Association, Washington, DC, 1991

[23]Ibid.

coordinate-measuring machines-can be used. Two of the centers have mobile demonstration facilities[24] (see box 6-1).

With additional funding, MTCs will be able to expand their in-house capabilities; they will also be better able to link up with, and leverage the expertise of, other federal, state, local, and private sector organizations that are involved in similar activities.[25] Recent legislative proposals would facilitate this kind of interaction because the concept of extension is now much more broadly defined.[26] This would allow for greater sharing of resources and expertise. This kind of cross-fertilization proved critical for agricultural extension, and it will be a major factor in assuring the success of industrial extension.[27]

New types of nonprofit and professional organizations are already emerging to fill this need. The Modernization Forum, for example, generates interactions among the MTCs and refers them to other experts and organizations with relevant interests and needs.[28] Similarly, the National Center for Manufacturing Sciences, which promotes technology adoption through "teaching factories," hopes to partner with the MTCs, providing services as needed on a nationwide basis. [29]

Much of this interorganizational, interagency cooperation could occur electronically, online. This could greatly reduce the costs of providing extension services. The expenses entailed in establishing such a network would be small because many agencies are already investing in networking. A networked extension program might also facilitate the dissemination and integration of agency research, allowing it to be more rapidly diffused and effectively employed in the exten-

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[24]Ibid., pp. I -3.

[25]For a discussion of one such plan, see U.S. Department of Commerce, Technology Administration, National Institute of Standards and Technology, "Manufacturing Extension Partnership," summer 1993.

[26]As Simons pints out: "For example, the DOD authorization bill defines manufacturing extension as any 'public or private nonprofit program for the improvement of the quality, productivity, and performance of small manufacturing firms.' And the proposed National Competitiveness Act includes federal, state, and local agencies as well as universities, schools, laboratories, small business development centers, professional society programs, and industrial organization, as qualifying outreach centers. . . .

As this broad range suggests, industrial extension within the federal lexicon now refers not (rely to the more traditional concept of agents making in-plant visits as consultants and trouble shooters, but also institutions such as community and technical colleges and worker training Institutes to which manufacturing firms could send their employees. Hundreds of these institutions are already operating across the country, and with federal backing, could be the nucleus of the expanded national network of industrial extension. " In Branscomb, op. cit., footnote 12.

[27]As described by Clark and Dobson, with reference to agriculture extension services" "The development of linkages to other service providers and sources of technical expertise is critical to success. Although the programs differ in terms of how narrowly or broadly defined their services, all indicated the need to work with and provide access to other service providers. Extension programs often refer firms to SBA-supported Small Business De\ elopment Centers for help with marketing or management, to community colleges for training. and to universities for research and development." Op. cit., footnote 22.

[28]The Modernization Forum was established by the MTC directors to support their collaborative projects and learning and to give them a common voice in working with others.

[29]Ibid. The National Center for Manufacturing Science (NC MS) is a membership research and development consortium that serves both large and small firms in a broad range of Industries. Its only mandate is to aid U.S. member firms to become internationally competitive in manufacturing. Under its 50 I (c)(3) status, NCMS must make its research results reasonably a\ ail able to the public. Member firms define research projects and develop the research. Member firms also have first call on research results. Member firms will be 1 icensed to use the technology developed at lower fees than nonmember firms in order to offset their in-kind par-t icipation in the research process and their membership fees that help to fund the research.

BOX 6-1: NIST's MTCs Respond to the Needs of Small Manufacturers

Rapid changes in manufacturing and Information technologies and business practices have left many small manufacturers struggling to keep up Without the cushions of large capital and human resources, they are frequently left to make do with shoestring budgets and seat-of-the-pants decisionmaking The NIST Manufacturing Technology Centers (MTCs) are responding to specific business needs with a variety of assistance services such as Implementing total quality standards, pooling demand for expensive resources, and helping small businesses grow

For example, to help suppliers meet competitive demands for higher quality, the MTCs are working with client firms to register and qualify for the new European IS0-9000 standards [1] Manufacturing Development, Inc (MDI), of Cheney, Kansas, a small company with 25 employees and $1 5 million in annual sales, worked with the Mld-America Manufacturing Technology Center (MAMTC) to Implement the D1-9000 quality standard [2] An MAMTC field engineer and the company's president and vice-president together arranged for incorporation of statistical process control (SPC) techniques Training for all employees was arranged through classes taught by an MAMTC quality coordinator and the cost of training was offset through a Kansas Industrial Retraining (KIR) grant provided by the Kansas Department of Commerce and coordinated through the MAMTC Through this effort MDI was approved as a D1-9000 supplier, and subsequently realized savings of $132,000 for the year

Currently, thousands of Industrial sales in Europe, compared with a few hundred in the United States. are registered under ISO 9000, which is predicted to become a de facto prerequisite for doing business in Europe In Troy, NY, the Northeast Manufacturing Technology Center (NEMTC) established a pilot ISO 9000 registration program which Includes seminars, workshops, onsite visits to manufacturing facilities, and step-by-step training modules In 10 sessions over the course of a year, client firms, in collaboration with each other and the Quality Systems Resource Facility (QSRF) at NEMTC, prepare for the third-party registration audit This pilot program is anticipated to serve as a model for other MTCs

Another small business need that MTCs help provide is access to expensive specialized equipment or services that small businesses can only afford on a fee-per-use basis Frequently, as was the case for Fortitech, Inc of Schenectady, NY, this is for experimenting with or consulting for new computer systems Fortitech is a business that blends minerals, vitamins, and other food additives After rapidly growing from its Incorporation in 1986 to 1992, its turnaround time Increased to longer than a month Fortitech's chemists were spending too much time doing hand calculations for the blends and could not attend to analysis of the final products After consulting with NEMTC for several weeks, Fortitech computerized most of its chemists' practices using off-the-shelf database programs that run on personal computers In addition, Fortitech found further ways to improve their process by networking the computers with the analysis equipment and feeding the analysis Information into the newly established enterprise-wide recordkeeping system And the databases have contributed to inventory control. Most importantly, the turnaround time dropped to 2 weeks and Fortitech's founder estimates that the system has saved the company several million dollars that would have resulted from lost business

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[1] 'While the ISO 9000/Q90 series is only a minimum set of requirements for a quality management system, itprovides the foundation for total quality management Organizations that do not meet the requirements of ISO 9000/Q90 are unlikely to be able to meet more comprehensive requirements such as GMs Targets for Excellence' or Fords 01 program ""'ACollectlonof Successful Interactions Between the MTCs and Client Firms, " NIST SP 848, U S Department of Commerce, March 1993, p 5

[2] Boeing, one of MDIs customers, is requiring its vendors to be approved as D 1-9000 (Advanced Quality Systems) suppliers by 1996 Ibid p 24

SOURCE 'A Collection of Successful Interactions Between the MTCs and Client Firms, " NIST SP 848. U S Department of Commerce March 1993

sion process. However, to develop such a program it would be necessary to establish an organizational mechanism for synthesizing and packaging the information to be delivered.[30]

A prototype electronic network for manufacturing extension service providers, TECnet, has already been funded through the Technology Reinvestment Program. This network links NIST's MTCs, state technology extension projects, federal technology sources, and other technology reinvestment projects. TECnet will facilitate communication and collaboration among industrial extension services providers, their client firms, national laboratories, and other government programs. It will be accessible through the Internet and employ a state-of-the-art graphical user interface incorporating electronic mail. public and private electronic conferences, business software applications, databases, remittance services, directory services, context-sensitive help, security and access control, file transfer capability, and gateways to other information sources. In addi(ion, a wide variety of business-related information services will be made available to the MTCs and their clients free of charge[31] (see table 6-1).

TABLE 6–1: Information Services, Databases, and Conferences on TECnet

Databases and information	Public conferences
Computer-aided design (CAD) file transfer	Business news briefs from United Press International
CAD selection tool	CAD software support conference
CAD utility software	Database software support conference
Chemical safety data	IBM- PC support conference
Commerce Business Daily	Newsletter on manufacturing networks
Directory of Business & Financial Assistance	Spreadsheet software support conference
Federal procurement leads	**Private Conferences for NIST MTCs**
Federal Register	Defense conversion
Internet mail	Defining CAD terminology
ISO 9000 reference materials	Human resources group
Military Specifications Index	Director's conference
MTC and NIST service briefs	Field agents' conference
NASA technology transfer Information	National Staff Conference planning group
Quick View assessment tool	
U S Library of Congress database	
Used Industrial equipment directory	
Virus protection software	

SOURCE ProductIon Technology Inc Arlington VA unpublished paper, 1993

[30] As noted by NIST "The Federal government has a variety of approaches to serving the needs of small-and medium-sized manufacturers, incorporating centers and programs with in the National Aeronautics and Space Admin istration (NASA), DOD, the Department of Energy (DOE), USDA, the Department of Labor (DOL), the Small Business Administration (SBA), and a number of other departments and agencies. For the target set of manufacturers. this threatens to present a confusing diversity of services from which it is difficult for these companies to choose. These programs will continue to represent a major portion of the resources which the Federal go\ ernment applies for this purpose." NIST, op. cit., footnote 25.

[31] TECnet is being developed at Tufts University in collaboration with Production Technology, Inc., and the Microelectronics and Computer Technology Corp. (MCC)

More recently, TECnet—in conjunction with EINet,[32] Production Technology, Inc. (PTI),[33] and some of the national R&D labs—has proposed an even more elaborate prototype network under the auspices of the Manufacturing Outreach System to Achieve International Competitiveness (MOSAIC) program.[34] This network would link the MTCs and TECnet into a national information network providing access to one another; to their small- and medium-sized business clients; to the national laboratories and other technology sources; to electronic commerce networks; and to the defense sector. Given the positive externalities that are associated with networking, the benefits of such a network should be considerable. How much value might be added becomes clear when one considers the full range of networked services being offered throughout the country that can be linked to this network in support of electronic commerce (see box 6-2).

No matter how extensive electronic networks are, however, they cannot meet all extension needs. Many types of manufacturing equipment are immobile, requiring the development of demonstration centers that can replicate the factory floor. Moreover, successful technology transfer requires much more than technology; it also requires organizational and social change. To bring these kinds of changes about, onsite visits are critical.[35] Extension agency staff members will not only have to be expert and up to date in their knowledge of manufacturing technology; they will also need to understand, and be able to mediate, the relationship between technology and organizational change.

Even with increased funding and electronic interconnection, providing industrial extension to meet business needs in a knowledge-based global economy will be an extremely difficult task. In the United States, there are 360,000 manufacturing companies that have less than 500 employees. They represent a broad range of industries with distinct activities, production methods, and products. Given limited resources, they need to set priorities in meeting their diverse needs. Care will be needed to assure that some groups and some types of businesses are not pitted against one another. Questions will also arise with respect to how and on what basis services are to be made available. If, as is now the case, services are intended to be self-supporting and provided on a fee basis, firms with few resources may be excluded, regardless of their prospects for success.[36]

Labor has had very little role in industrial extension. At present, the only formal connection between labor and the MTCs is through the recently established Office of the American Workplace (OAW) in the Department of Labor. This agency is charged with developing concrete initiatives for promoting innovative workplace practices and cooperative labor-management practices. To this end, OAW is working with the MTCs, as well as

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[32]EINet is a business network being developed by MCC.

[33]PTI is the technical and management support agent for the Navy's Best Manufacturing Practices programs and the DOD Manufacturing Science and Technology Program.

[34]"Manufacturing Outreach System To Achieve International Competitiveness: A Proposal for Extension Enabling Services Under the Defense Dual-Use Assistance Extension Program," Production Technology, Inc., Arlington, VA, unpublished paper, 1993. The name has recently been changed from MOSAIC to MEPnet (Manufacturing Extension Partnership Network).

[35]Clark and Dobson, op. cit., footnote 22, p. 88.

[36]As described by Clark and Dobson: "As programs become more successful and visible, it is likely that there will be a greater demand for services. Thus, there will be a greater need to screen clients and target resources. States may want to target assistance to firms with the greatest potential for economic growth or to [hose industries thought to be of critical importance to the state's future economic health. Efforts arc underway to develop tools to assess a firm's competitive position." Ibid., pp. 88-89.

BOX 6-2: A Sampling of Statewide and Regional Network Programs

Aeronet Electronic sharing of mechanical specification and process information to drive flexible manufacturing cells for metal fabrication in the aerospace Industry

MADE Manufacturing Automation and Design Engineering program to develop both enabling and application technology sponsored by Advanced Research Projects Agency (ARPA)

AMTEX Electronically connecting textile supply chains from retail back through manufacturers to raw material suppliers

AUTO-NET An agile manufacturing pilot demonstration of the benefits of networking, electronic commerce, and distributed team management in the auto supplier chain

TEXAS ONE The Texas Open Network Enterprise is sponsored by the Texas Department of Commerce to provide a statewide communication network for manufacturers and technical assistance providers

Alaska University of Alaska Small Business Development Center's Alaska Technology Transfer Assistance Center wiII provide network access to their client firms

OTNET The State of Ohio, in coordination with its Edison Program and the Great Lakes Manufacturing Technology Center proposes to establish the Ohio Technology Network (OTNET), a statewide network of technology deployment agencies to support small and medium-sized companies

Rensselaer Polytechnic Institute/Northeast MTC (RPI/NEMTC) RPI/NEMTC wiII use the network to link suppliers provide access to Quickview—a business assessment tool—and train extension providers

New York Public Library The NY Public Library wiII provide manufacturers with access to a number of library-held databases

Michigan State University (MSU) Technology Transfer Network (TTN) MSU TTN IS a statewide communication network for technical assistance providers and small businesses in Michigan

California ACORN ACORN proposes to build a full-scale prototype of a National Information Infrastructure for engineering and agile manufacturing

New Hampshire Manufacturing Extension Program New Hampshire Department of Postsecondary Technical Education and New Hampshire Governor's Technology Partnership are creating a statewide electronic network to deploy available technologies to small and medium-sized manufacturing enterprises

Best North America Best North America is a commercial network providing access to a database of publicly and privately generated technical articles

New Jersey Institute of Technology This Institute wiII provide mail, database, and scheduling services via an electronic network to five Manufacturing Outreach Centers in New Jersey

Kansas/Sprint Kansas/Sprint wiII provide capability to transfer computer aided design files and conduct video training programs

Teltech Teltech wiII provide assistance to service providers in accessing federal and commercial technical Information

NTTC National Technology Transfer Center wlll facilitate and provide access to federal technology for small manufacturers assist in identifyng dual-use technology, assist defense-dependent firms with diversification and provide customized access to procurement opportunities

Oak Ridge Associated Universities (ORAU)/Oak Ridge National Laboratory (ORNL)/Production Technology, Inc ORAU/ORNL/JPTI will develop a training course for universities based on the Navy's Best Manufacturing Practices Program and the Program Managers Workstation developed by DOD

SOURCE ProductIon Technology Inc Arlington, VA, unpublished paper 1993

state and local offices, to develop ways in which firms can integrate innovative work systems and human resource practices with new technologies and production methods .37

The lack of direct input of labor groups into extension could be a serious mistake. Excluding labor from the extension process will not only affect workers and their quality of life; it may also limit the benefits to be gained by business from industrial extension. If businesses are to benefit from new modes of production, organizational as well as technological restructuring will be required. Changes in job content and skill levels, as well as in work patterns and authority structures, will also be necessary.[38] For this kind of workplace redesign to succeed, workers must be active participants.

One way of providing for greater worker representation would be to recognize labor as a constituent of the MTCs in its own right. Organized labor or some other agreed-upon worker representative might be included on any policy committee that directs the work of an MTC. To the extent that labor representatives have the appropriate abilities for design, assessment, and outreach, the MTCs might solicit their input and advice as they do from their client firms. MTCs could also encourage the concept of participatory design by offering both management and workers' assistance and training on group process methods, problem-solving, and best practices in this area.[39]

Organized labor could also serve as a target of outreach efforts by MTCs as well as a part of their process. Unions might be encouraged to contact MTCs with questions about new technologies and modem manufacturing methods. In turn, local and regional AFL-CIO bodies might be used to link firms represented by affiliates, encouraging them to participate in the work of the MTCs. In this event, MTC staff would need to maintain contact with appropriate union bodies to explain MTC's work, make information about the MTCs available, and solicit union support in contacting employers.

Bringing labor representation into the MTC process may not be welcomed by all. Many of the businesses that are likely to use MTC resources are small businesses that have had few dealings with organized labor. They may view labor participation as a disruptive element, if not an intrusion into their affairs. Business may not be fully aware of the potential benefits that can result from such interaction. Often when businesses have decided to partner with labor they have done so not on the basis of principle, but rather for the sake of survival.@ For this option to be viable, therefore, greater efforts will be needed to demonstrate the advantages that can be gained by all.

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[37]U S Department of Labor, "industrial Extension/Technology Integration," *American Workplace, vol. 2, No. 2,* March 1994, p. 2. This office was established in the fall of 1993. According to Martin Manley, its director, the OAW has three top priorities. These are to: 1) build a clearinghouse to help companies and employees learn from the experience of America's most successful companies; 2) develop partnerships with business and labor organizations to identify and promote high-performance work practices, employee ownership, and new roles for labor unions; and 3) promote the use of new measurements of workplace practices to allow investors, managers, and board members to better determine the economic impact of high performance work practices. See U.S. Department of Labor, '-Martin Manley Confirmed as Assistant Secretary for the American Workplace," *American Workplace,* vol. *2, No. 1,* January 1994.

[38]See Barry Mac, and H iroaki Izumi, "'Organizational Change, Design, and Work Innovation: A Meta Analysis of 13 I North American Field Studies—1 96 I -199 1," in R. Woodman and W. Pasmore (eds.), *Research in Organizational Change and Development* (JAI Press, forthcoming).

[39]The gains from these kinds of activities can be significant. One study that analyzed the use of computer-controlled technology in over 1,000" sites found that production time decreased considerably when shopfloor workers wrote their own control programs. See, for a description, Maryellen Kelley, "'productivity y and Information Technology," working paper 92-2, School of Urban and Public Affairs, Carnegie-Mellon University, January 1992.

[40]For an overview of the type of labor-management issues that need to be overcome, as well as some of the benefits of working them through, see Proceedings, *Conference on the Future of the American Workplace*, Department of Labor and Department of Commerce, Chicago, IL, July 25-26, 1993. As was emphasized throughout the conference, businesses often resisted change, except when their survival was at stake.

OPTION B: Promote the Dissemination of Business-Related Information

To assist American businesses in a knowledge-based global economy, the government might also promote the dissemination of business-related information. This is not a new role for government. Because of the critical role that information plays in economic transactions, the government has also acted to ensure its widespread and equitable distribution.[41] Taking advantage Of the advanced communication and information technologies that are available today. the government will be able to provide more information, which will be better packaged to meet business needs; delivering this information electronically can also serve to promote networking and electronic commerce.[42] A number of such efforts are already underway.

The Small Business Administration (SBA), for example, has developed a national bulletin board (SBA On-line) that provides free information about the SBA loan programs, financial management services, government procurement services, publications, and training.[43] This system allows users to download information that can then be processed and incorporated into spreadsheets at the desktop. Within the next year, small businesses will also be able to access the network from persona] computers in Business Information Centers to be established in each of the agency's 10 regions. These PCs, equipped with databases of their own, can be used to develop business plans, do financial planning, and conduct cost-benefit analyses. Eventually, these centers will provide gateways to other bulletin boards as well as government and commercial databases. If capacity permits, E-mail services will also be available. allowing businesses to contact SBA counselors or members of its service corporation of retired executives.

The benefits of this kind of effort can far exceed the costs. The SBA On-Line system, for example, cost less than $50,000 to establish. It is comprised of a PC, 20 modems, and telephone lines fed by two 800 circuits provided free to the government by Sprint. The SBA centers will also receive donations of hardware and software from vendors such as Microsoft Corp., Lotus Development Corp., Apple Computer, Inc., and Sony Corp. of America.[44]

The Department of Commerce also provides online information through BISNIS, a network that helps companies identify business opportunities in the newly independent states of the former Soviet Union. This network offers information about upcoming trade missions, potential customers and partners, sources of financing, trade and investment laws, market research, advertising opportunities, and the status of trade and investment treaties. The network was inspired by the recent Commerce Department report, "Obstacles to Trade and Investment in the Newly Independent States of the Former Soviet Union." Funding is provided by the U.S. Agency for International De-

~ I Before the telegraph, newspapers provided the basic means of obtaining business-related news. Newspapers devoted between 75 to 90 percent of their space to hrsinc~s-related topics, and they provided the fastest and cheapest way of gathering information. To promote the dissemination of news, the government permitted the postage-free exchange of newspapers among printers. Long before the advent of press associations, editors obtained nonlocal in formation by culling out-of-town newspapers, their so-called exchanges. I n an arrangement that today's journalists might find foreign and offensive, the government, in essence, operated the nation's news-gathering services. These printers' exchanges furnished most nonlocal news throughout the first half of the 19th century. See Richard B. K ielbowicz, "The Press, Post Office, and the Flow of News in the Early Republic," *Journal of the Early Republic*, vol. 3, fall 1983, pp. 255-280; and Richard B. Kielbowicz, "Modernization, Communication Policy, and the Geopolitics of News, 1820- 1860," *Critical Studies in Mass Communications*, vol. 3, March 1986, pp. 21-35

[42] For a discussion of the issues involved in electronic dissemination of federal information, see OTA, *Informing the Nation: Federal Information Dissemination in an Electronic Age*, OTA-CIT-396 (Washington, DC: U.S. Government Printing Office, October 1988).

[43] See G. Anthes, "Feds Set Up BBS for Small Businesses," *Computerworld*, Oct. 26, I 992.

[44] Ibid.

velopment. The Export-Import Bank of the United States and the Overseas Private Investment Corp. are also involved.[45]

The Internet is also a source of government-provided business information.[46] The Economic Bulletin Board (EBB), for example, is a "one-stop source of current economic information." It houses 2,000 information files provided by federal agencies such as the Federal Reserve Board, the Bureau of Labor Statistics, the U.S. Census, and the Treasury Department. Included in these files are current business statistics, economic indicators, employment statistics, energy statistics, foreign trade data, monetary statistics, price and productivity statistics, regional economic statistics, and summaries of current economic conditions. Also provided are regular updates on key economic and business indicators, including Treasury rate quotations, foreign exchange rates, bond rates, consumer price index, producer price index, advance retail sales, manufacturing and trade inventories, and employment and unemployment statistics. In addition, Trade Opportunity files (TOPS) and International Marketing Insights (IMI), which are compiled by American embassies and consulates, are made available on a weekly basis.[47] As more and more files are added, issues of financing and pricing will need to be dealt with. It is likely that regular institutional users will be required to pay an annual flat fee, while infrequent users will pay according to use.[48]

Federal agency information useful to business can also be accessed through the Library of Congress Information System (LOCIS). Using the new search tool LC Marvel (Machine-Assisted Realization of the Virtual Electronic Library), businesses can retrieve Presidential documents, speeches, and White House press releases; portions of the Federal Register and the Federal Information Exchange (FEDIX); as well as files from key federal agencies such as the Departments of Agriculture, Commerce, and Energy; the Food and Drug Administration; NIST; the National Institutes of Health, the Patent and Trademark Office; and the Office of Management and Budget (OMB).[49]

Government provision of economic data can clearly help businesses identify new opportunities and reduce overall transaction costs. However, this practice, if carried out extensively, may also give rise to a number of policy issues. For example, there is a rapidly growing industry comprised of commercial firms that repackage and add value to federal information for sale. While benefiting from access to government information provided in an electronic format, many firms in this industry are concerned about the possible adverse affects from government competition. Efforts by OMB to establish policy in this area have proven to be controversial .50 The advent of electronic dissemination of federal information also raises equity concerns. To the extent that electronic formats have distinct advantages (for example, in terms of timeliness and searchability), those without electronic access will likely be disadvantaged.[51] Thus, if equity is the goal, policies that aim to pro-

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[45]Eric Bruder, "Commerce Department Opens a 'B ISNIS' Center for Newly Independent States of Ex-U. S. S.R.," *Business America*, June 29, 1992, p. 17.

[46]For a discussion of how this information can be accessed, see Mary J. Cronin, "Internet Business Resources," *Database*, December 1993, pp. 47-50.

[47]Ibid. See also Rosalind Resnick, "Log on to Trade Leads," *International Business*, vol. 4, No. 3, November 1991, pp. 63-64.

[48]Ibid.

[49]Ibid See also, "How to Use the Freedom of Information Act to Benefit Your Business: This We]] -Known Act Is Little Used by Business, But It Should Be," *Agency Sales Magazine*, June 1993.

[50]OTA, op. cit., footote 42, p. 9.

[51]Ibid.

mole information dissemination will need to be closely linked to policies that affect technology access and technological literacy.

OPTION C: Provide Greater Support for Business and Business-Related Education

In its efforts to help rural Americans make the adjustment from an agricultural to an industrial-based economy, the federal government did not limit itself to promoting technology transfer through extension services. Equally important were its efforts to train people in the new ways of doing business. The land grant colleges, provided under the Morrill Act of 1862, played a key role. Responding to the major structural changes taking place in the economy, these universities were called on to expand beyond their traditional role of training gentlemen as preachers. lawyers, and doctors. Using applied research, universities were asked to develop the more practical applications of education in fields such as agriculture, engineering, home economics, and business administration.[52]

The impact of the Merrill Act was very evident in the field of engineering. Before the act wits passed, state legislatures had been reluctant to invest in technical education. Responding to the offer of federal grants, however, they quickly sought to establish new types of schools; private colleges. caught up in the movement, also established departments of engineering.[53] Schools of engineering expanded rapidly thereafter, numbering 110 by 1886. The number of engineering students similarly increased from 1,000 in 1890 to 10,000 in 1900.[54] As more and more engineers were educated in formal institutions, there was a greater emphasis on engineering in science. With the establishment and growth of these institutions, a profession was developed and with it a means of preserving, transmitting, and increasing an evolving body of engineering knowledge.[55]

Today, the government is engaged in a number of similar efforts to ease the transition from an industrial to a knowledge-based global economy. However, most of these undertakings are focused on technology development and technology transfer alone; much less attention has been paid to the problems of organizational barriers, and the need to help businesses reconceptualize and redefine the way they think about and carry out their activities. This gap needs to be filled. If businesses fail to adapt their thinking and their organizational culture to the structural changes taking place in their environment, both they and the nation will fail to reap the full benefits that communication and information technologies afford. Just as the government turned to the land grant colleges to help farmers adapt to the industrial era, it might now look to universities to develop and widely disseminate a business curriculum that is more appropriate to a changed economy.

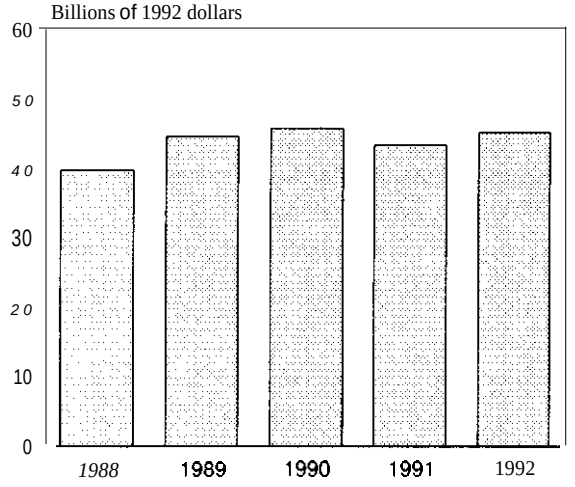
Recognizing that organizational culture and organizational change are critical factors for success, many large firms are already spending con-

52 This law provided land to the states, the proceeds of which were to be used to teach in the fields of agriculture and mechanical arts. Subsequent legislation provided federal financial support for research and the operation of the land-grant colleges. Democratic and populist in origin. these universities were open to children of all backgrounds. Moreover, unlike the traditional colleges, the land-gram colleges were not isolated communities. Through then agricultural expcriment stations and their service bureaus, their activities were designed to serve the states. See, for a discussion, Clark Kerr, The Uses of the University (Cambridge, MA: Harvard University Press, 1972).

53 David Noble, *America by Design: Science, Technology and the Rise of Corporate Capitalism* (New York, NY: Alfred A. Knopf, 1977), pp. 38 39.

54 Edwin T. Layton, Jr., *The Revolt of the Engineers: Social Responsibility and the American Engineering Profession* (Cleveland, OH: The Press of Case Western Reserve University, 1971).

FIGURE 6-1: Total Training Budgets for U.S. Corporations (billions of 1992 dollars)



SOURCE *Training* October 1992 p 32

siderable amounts of money to reeducate themselves[56] (see figure 6-1). To do so, they are importing some of the best faculty members from the top business schools to lecture on their premises. The cost of this kind of in-house training is high, ranging between $5,000 to $20,000 per day. Although expensive, this approach not only allows businesses to stay up to date in their understanding of successful corporate strategies; it also allows them to apply these lessons to their company's specific problems and goals.[57]

Drawing on faculty from both business and engineering, some of these programs are highly innovative. Ford Motor Co. and Wayne State University, for example, have recently established a joint venture to create a program offering a Master's Degree in Engineering to be offered to employees on Ford Motor Co. premises. This is an interdisciplinary program with courses and faculty drawn from both the Schools of Business and Engineering at Wayne State University. Taking into account both the organizational and technological problems entailed in technology deployment, this program provides both depth in engineering and breadth in business management. The Massachusetts Institute of Technology (MIT) is currently putting together an innovative interdisciplinary program that also involves both business and engineering (see box 6-3). Unlike Wayne State's program, it will be delivered by interactive video technologies. Both Wayne State and MIT's programs are full degree programs.

Smaller companies can hardly afford such services, however. Operating with minimal staff and narrow time constraints, they rarely have the time or resources that full degree programs require. One way to meet their educational needs, however, is through targeted distance learning classes. The development costs of programming and other training materials can be shared among many users, and participants can schedule the viewing of such courses at their own convenience.

In England, a distance learning educational program for small-business managers is now being offered through the Open University.[58] This program was jointly developed by the Cranfield School of Management, the Open University, and the British Broadcasting Corp. The course materials, which draw on the experience of over 200 entrepreneurs, are designed to teach the principles of good management. In addition to video programming, students are also provided with audio cassettes and workbooks. A number of workshops have been set up to allow face-to-face interactions. Initial financial support for this program, totaling 1.5 million pounds, was provided by the Training Agency (formerly the Manpower Services Commission). Over the long run, however, the program is intended to be self-supporting.[59]

[56] See Paul Froiland, "Who's Getting Trained," *Training*, October 1993, pp. 59-65.

[57] See Lori Bongiorno, "The Professor Is In," *Business Week*, Oct. 25, 1993, p. 105.

[58] David Oates, "Switched onto Distance Learning," *Director*, June 1990, p. 127.

[59] Ibid.

BOX 6-3: MIT's Engineering-Management Distance Learning Project: Filling a New Educational Gap

After engineers have been in Industry for several years, they frequently move into project leadership positlons and must then expand their knowledge base to Include not only more of the engineering systems with which they work, but also more of the business and Industrial systems Only with knowledge of the "big picture" can such leaders and managers take products efficiently and effectively from design to manufacturing to sales Today, practicing engineers who are formally trained in both technology and business and able to run large-scale design projects are rare Rarer still are educational programs geared toward filling this professional gap in the workplace

The Massachusetts Institute of Technology (MIT) is currently designing a new engineering/management curriculum to address this gap through distance learning The project, still under development, proposes to grant engineers a "second professional degree " Because of MIT's firm belief that the best education is interactive, it wiIl likely utilize interactive video between professors at MIT and on-premise company locations The on-premise arrangement is Important because industry generally does not want to do without valuable engineers for more than a few months In addition to combining traditionally separated engineering and management courses, the project is further driven by two other themes First is the need to bridge MIT's strengths in basic technical and management knowledge and industry's strengths in applications Yet another strong driver is to better educate America's professional workforce, which necessarily entails learning from and working with industry

This project builds on the experience of MIT's successful Leaders for Manufacturing (LFM) program that also combines engineering and management Now in its sixth year, the LFM program is a partnership between MIT and about a dozen large U S manufacturers Students in the program get practical experience by doing a term-long internship in a manufacturing company Participants get two master's degrees one from MIT's School of Management and one from the School of Engineering MIT's new distance learning program differs from the LFM program in two respects it emphasizes engineering design rather than manufacturing, and introduces remote delivery Both programs are intended to give students an understanding of the whole company Also, the successful LFM program model of university-industry interaction and cooperation wiIl likely be duplicated in the distance learning project

wiIl graduates of this new program be a new breed of upskilled managers? Perhaps wiIl this model of distant education be emulated by other universities that have strong engineering and business programs? Perhaps Importantly the new curriculum has strong interest by both MIT and industry Since industry is under competitive pressure, they need engineer-managers trained in both the newest technology and management practices And MIT's engineering and management professors wiIl benefit by their exposure to Industrys present concerns Ultimately, both MIT's engineering and business courses can be made more effective by addressing real world problems

Government, as the promoter of both education and a National Information Infrastructure has a stake in supporting pilot projects, such as M IT's, that combine elements of industry-relevant workforce education technology and business knowledge diffusion both ways between industry and academia and demonstration of state-of-the-art "information Infrastructure" such as interactive video technologies

SOURCE Private communication John D C Little Institute Professor and Professor of Management Science and Joel Moses Dean of Engineering Massachusetts Institute of Technology, March 1994

Similar types of programming could be provided in the United States, either via public broadcasting or the public switched network. In states that already have a vast educational infrastructure in place, programming and delivery mechanisms could be provided as part of the overall educational system. In the State of Maine, for example, the University of Maine system has created a network that is comprised of an extensive interactive television system reaching 77 sites, an electronic library catalogue database including the holdings of the state's major libraries, and other data and information technologies. Efforts are now underway to greatly enhance the network's potential for use by the citizens of Maine. The university and its partners are forming the Maine Information Technology Users Consortium (MITUC), a new nonprofit membership organization that will consist of Maine schools, not-for-profits, state agencies and departments, municipalities, businesses, labor organizations, professional and trade associations, and educational and cultural institutions. This consortium will foster education and training, professional development, access to information databases, teleconferences, legislative and other public policy briefings and hearings, and cultural and other programs. The anticipated startup costs of such a program are between $400,000 and $500,000.[60]

To support new developments in business education, the federal government might also pursue an approach similar to the one it took to promote science education following World War II. Recognizing that advanced technology was critical for both the nation's economic growth and its defense, the government established the National Science Foundation (NSF) to improve the nation's potential in scientific research and science education.[61] Provoked by the successful launching of the Soviet spacecraft Sputnik, defense considerations also motivated the passage of the National Defense Education Act of 1958 (NDEA), whose goal was to improve instruction in mathematics, science, and foreign languages. Under this law, funds were provided on a matching basis to public schools and as long-term loans to private institutions. Funds could be used for needed equipment in these instructional fields, curriculum development, guidance counseling, vocational education in defense-related fields, and teacher training in foreign language instruction.[62]

With the nation's shift from defense to national and economic issues, government could complement its efforts to promote technology and technology deployment with steps to prepare its citizens to make the most productive use of these technologies. In recognition of the complex relationship between technology and organizational social change, the government might support the development of new centers of research and new curricula that would extend beyond the realms of engineering and business to incorporate disci-

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60 The consortium is presently seeking a federal grant of $400,000 to pay for startup costs, which the University of Maine will match with $100,000 cash and in-kind investments.

61 The philosophical basis for establishing NSF, and the rationale for including the development of scientific manpower within its organizational mission, was explained by Vannevar Bush in *Science-The Endless Frontier*, his report to the President on a program for postwar scientific research. About the need for scientific manpower, he said: "Today, it is truer than ever that basic research is the pacemaker of technology progress. In the 19th century, Yankee mechanical ingenuity, building largely on the basic discoveries of European scientists, could greatly advance (he technical arts. Now the situation is different.

A nation that depends on others for its new basic scientific knowledge will be slow in its industrial progress and weak in its competitive position in world trade, regardless of its mechanical skill." *The National Science Foundation and Pre-College Science Education: 19S0-/975,* report prepared for the Subcommittee on Science and Technology, U.S. House of Representatives, 94th Cong., 2d sess., by the Congressional Research Service, Library of Congress, January 1976, p. 19.

62 The passage of the NDEA resulted i, substantial increases in federal aid to education. Since federal dollars had to be matched by state and local funds under provision of the act, the overall investment in NDEA programs was large. Between 1958 and 1961, $163.2 million in federal funds were disbursed. Approximately 75 percent of these funds were directed to the development of science curricula. See OTA, *Information Technology R&D: Critical Trends and Issues*, OTA-CIT-268 (Washington, DC: U.S. Government Printing Office, February 1985), ch. 5, "Education and Human Resources for Research and Development."

plines such as anthropology, psychology, sociology, and technology assessment. In addition, as in the case of the NDEA, financial incentives in the form of loans might be provided to encourage students and faculty to pursue these interdisciplinary areas of research. To enhance the benefits of such a program. students might be provided the option of repaying their loans, in part, by working with small businesses, perhaps in the context of an organization such as an MTC. Matching funds might also be provided by state and local entities.

Implementing such an option might be difficult because any curriculum that deals with business will likely have political overtones. On the other hand, faced with the need to explain differing patterns of growth across countries, many in academia recognize the need for a more interdisciplinary approach to understanding economic phenomena.[63]

OPTION D: Provide Greater Support for Worker Training

Given the constitutional limitations on the federal government's role in education, the responsibility for developing human resources has always been shared by a number of different social institutions ranging from the family to the business communi - t y. As American society has become more technologically advanced, however, the federal government has been increasingly called on to play a more significant role. The pressure on the government to be more active in this area is particularly strong today as the nation seeks to maintain its place in a highly technical and competitive world environment.

Although Americans were aware of the economic benefits associated with having a skilled labor force, the nation did not original] y adopt a formal system for transmitting vocational and technical skills when agriculture was the dominant mode of production.[64] It was only with the rapid industrialization of society at the end of the 19th century that education came to be valued in economic and technical terms.[65] As Americans learned that special technical knowledge was the key to prosperity in the modern age, secondary educational institutions were restructured to prepare American youth for an increasing] y differentiated set of economic roles. Not only were vocational courses added to the educational curriculum, but the schools themselves were remodeled to conform to the prevailing business standards of efficiency. The business community played a major role in bringing about these changes, Concerned about strikes, labor turnover. and increasing worker absenteeism, they hoped that schooling would socialize a growing number of immigrant youths for the workplace.[66]

The educational and training strategies for an industrial era are increasingly less relevant today. given the changing nature of the American workplace and the structural changes in the economy.[67] Yet the quality of the U.S. workforce matters now more than ever before. In today international

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6 {See for instance, Joseph E. Stiglitz, "Social Absorption Capability and Innovation," CEPR Publication No. 292, Center For Economic Policy Research, Stanford University, November 1991, and Douglas Cecil North, *Institutions, Institutional Change, and Economic Performance* (Cambridge, UK: Cambridge University Press, 1990).

[64]Instead, most formal educational institutions were designed to serve general social and political functions, while general vocational skills were left to be passed on more or less informally by family members or through apprenticeship systems. See, for discussions, Bernard Bailyn, *Education in the Forming of American Society* (New York, NY: W.W. North, 1980); and Lawrence Cremin, *Traditions in American Education* (New York, NY: Basic Books, Harper, 1976).

[65]David K. Cohen and Barbara Newfeld, "The Failure of High Schools and the Progress of Education," *America's Schools: Public and Private, Daedalus*, spring 1981.

[66]David Tyack and Elizabeth Hansot, "Conflict and Consensus in American Education," *America's Schools: Public and Private*, ibid.

[67]This section of the report is drawn extensively from OTA, *Worker Training: Competing in the New International Economy*, OTA-ITE-457 (Washington, DC: U.S. Government Printing Office, September 1990).

economy, motivated workers who can produce high quality goods and services at low cost can enhance industrial productivity and competitiveness and keep American living standards high. Workers must be trained, however, to change the way they do their jobs in order to capture the benefits from rapidly evolving technology. Well-trained workers go hand-in-hand with productivity, quality, flexibility, and automation in firms that perform well.

Unfortunately, most American workers are not well trained, especially when measured by international standards. Foreign countries place much greater emphasis on developing workforce skills at all levels (see table 6-2). Experienced production workers at Japanese auto assembly plants, for example, get three times as much training each year as their American counterparts. American workers are so mobile, especially when they are young, that most U.S. companies offer training only sporadically. Workers in many smaller firms, in fact, may receive no formal training at all. Although larger firms provide more formal training, most of it is for professionals, technicians, managers, and executives. Rarely do American workers voluntarily upgrade their skills for job advancement (see figure 6-2).

The need for better training is clear in both manufacturing and service industries where skills and responsibilities are broadening. Work reorganization forces employees to take more responsibility, cooperate more with one another, understand their roles in the production system, and act on that knowledge. Competitive manufacturing and service firms are increasingly relying on employees with good higher-order skills such as reasoning and problem-solving.

TABLE 6-2: Comparison of Workforce Training

	United **States**	**Germany**	**Japan**	**Korea**
School-to-work transition	Left mostly to chance, some employers have ties with local schools	Apprenticeship for most noncollege-bound youth	Personal relationships between employers and local schools	Employers recruit from vocational and academic high schools
Vocational education				
Extent	Available in most urban areas	Universally available	Limited, mostly assumed by employers	Universally available
Quality	Wide range, poor to excellent	Uniformly good	Fair to good	Vocational high schools uniformly good
Employer-provided training				
Extent	Largely limited to managers and technicians	Widespread at entry level and to qualify for promotion	Widespread	Limited, employers rely on public vocational Institutes
Quality	Wide range, some excellent, but more often weak or unstructured	Very good	Very good	Generally poor
Public policies	Federal role very limited, state aid to employers growing	Govern apprenticeship, encourage continuing training	Subsidies encourage training by small firms	Directive-some employers resist policies

SOURCE Off Ice of Technology Assessment, *Worker Training Competing in the New Internatinoal Economy, OTA- ITE-457* (Washington DC U S Government Printing Off Ice, September 1990)

Demographic changes are also shaping training needs. Over the next few years, the labor force will expand more slowly than at any time since the 1930s. In the year 2000, the average worker will be nearly 40 years old compared with 36 today. Keeping this slowly aging workforce up to date and flexible will require ongoing training. New entrants in general will need better basic skills, including reading, writing, arithmetic, and oral communication. Americans already in the labor force will require better skills as well.

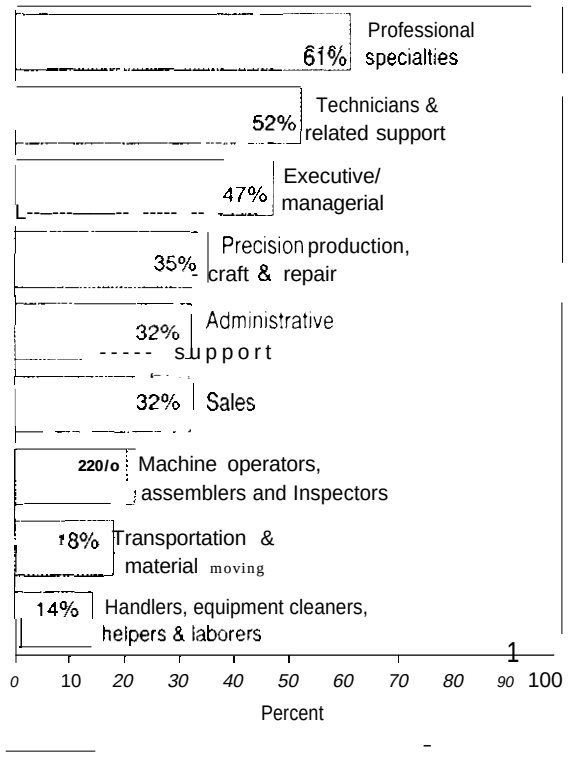
Simply providing more training will not be enough, however. If work is not organized to tap employees ' skills, the firm's investment will be wasted. In addition, training must not only be focused on workplace problems, but it must also be delivered effectively. Efforts to employ more innovative and effective training approaches are still rare outside of sophisticated firms with large training budgets. Instead, most programs lag far behind state-of-the-art training.

If training is to be made available to businesses and other firms with 1imited resources, new institutional structures will be needed to make affordable training available to employees of small businesses and other firms with limited resources. A variety of approaches. including industry training consortia, involvement of employer organizations in training. state assistance programs, and joint labor-management programs promise to enhance the scope and quality of training. While such efforts are currently limited, government can act to foster these developments in a number of ways.

One approach the government might take, for example, is to reduce the barriers to company training. These barriers include 1imited funds, an inadequate awareness of training needs, a lack of knowledge about good training pract ices, and a reluctance to train young and older workers. To address these problems, the government could encourage the establishment of training consortia through government startup grants. Such a program would allow companies to share the costs and risks of training. A related possibility would be to expand technical assistance to trade associations, other industry groups, and joint labor-management organizations to aid in the development of training programs for their members.

The federal government could also use financial inducements, such as tax credits, to make training investments more attractive. It would be important, however, to ensure that the revenue loss is matched by an increase in the desired train-

FIGURE 6–2: Upgrade Training by Occupation (percent of workers reporting upgrade training in their current job)[a]



a NOT E:On average 35percent of all workers reported skill improvement training for their current job

SOURCE Max Carey and Alan [ck How *Workers Get Their Training* (Washington DCUS Department It of Labor Bureau of Labor Statistics 1985) pp 18 19

ing activities. This could be done by establishing a national payroll levy. [68] Congress could also expand assistance available to firms for certain activities, such as basic skills training and vocational skills upgrading, that would make it easier for employees to participate in training activities.

Over the long term, federal support for work and learning research, and for the development and dissemination of new training technologies, could also improve worker training at a relatively low cost. The quality of training varies greatly. Although some U.S. firms are world leaders in training, others know little about best practices. Moreover, research about how adults learn often fails to be integrated into training practices. To address this problem, Congress could direct federal agencies that have education and training programs (e.g., Defense, Education, Labor, Commerce, Health and Human Services) to develop and disseminate information about new educational technology and best practices. In addition, the government could support the periodic updating and dissemination of information on workplace training.

[68] Under such an option, companies would choose between either spending a specified percentage of their payroll on particular types of training or contributing that percentage to a national fund for training initiatives. Several countries (including France, West Germany, Ireland, and South Korea) use such levies to encourage worker training. In the United states, four States now raise training funds through this type of levy. For a more detailed discussion, see ibid,