An Alternative Industrial Extension Model: The Experience of the Food Manufacturing Industry

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The ability to reach small manufacturers with productivity enhancing technology requires implementation of alternative industrial extension strategies. We describe one such strategy being pursued in the food manufacturing industry. Given the large numbers of small manufacturers and of potential technology suppliers, the challenge is to create an effective approach that takes advantage of the market aggregation capacity of food industry trade associations. Through a food manufacturing coalition, this extension effort will identify common industry needs for technology; assess and adapt existing technology; stimulate vendors to capitalize on the technology; and rely upon market forces to encourage innovative problem solving.

Framing the Questions

As the Clinton administration's fourth year progresses, the federal government continues to pursue a policy initiative in industrial extension designed to influence institutional changes in the way government, universities, federal labs, community colleges, and other organizations provide technical assistance and modernization services to the 380,000 small and medium-sized manufacturers in the United States. Federal government and state governments together are seeking to stimulate economic development by providing industry with industrial extension services for promoting efficiency, competitiveness, and technical innovation.

The administration's powerful message to manufacturers is that productivity, international competitiveness, and profitability are increasingly affected by scientific and technological factors which small businesses are poorly equipped to handle; and that it is necessary to strengthen industry performance by correcting the deficiency through dependable institutional arrangements. The organizational landscape of states has been peppered with seed money, with a variety of institutional demonstrations, and with prototype arrangements in the form of manufacturing technology centers. Funding is provided by the National Institute of Standards and Technology (NIST) and matched by state governments. A basic expectation of industrial extension advocates is that creation of a new extension system will stimulate small manufacturers to generate a pull, or demand, upon R&D capacity and upon technology sharing with direct benefits to problem solving and to improved operations.

With that premise in mind, we evaluate the practical needs of small manufacturers and explore an alternative industrial extension approach that is being utilized in the food manufacturing industry. The questions are: To what extent is industry confronted by choices that can be clarified by timely technical inputs? When technology is required, do effective arrangements exist for its use? Is technology too abstract, remote, or costly for small business? What does technology mean to hard-pressed small business managers? Is small manufacturing receptive and organized enough to reach out for technology when there is a need? Do we need new ways of viewing technology in the environment of small business? Can we create a delivery system that will match technology to user needs for early results; and can we detect and overcome the barriers to the use of technology?

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The Environment for Technology

Small manufacturers usually have the tools and the technology, but operate with a flawed management system. We can also cite problems of communication barriers, inadequate personnel, cost constraints, and the lack of systematic approaches for matching user needs with available technology. Sensing the need for technology is one thing, but creating an effective delivery system is quite different. A 1993 National Research Council report identifies some of the roadblocks facing much of the nation's industry (National Research Council 1993).

Fragmentation and isolation of the user market. The tremendous number of small firms constitutes a complex target at which to aim technology. Firms often face common problems but typically have few opportunities for interactions with similar companies that may have sources of innovative technology.

Fragmentation of technology sources. The equally complex array of technology sources makes it difficult for small manufacturers to cope with the system. Private suppliers, manufacturing extension centers, federal labs, universities, and community colleges, are all struggling to position themselves to provide technology sharing.

Disproportionate impact of regulations. The economic impact of regulatory compliance as a percentage of capital investment affects small businesses much more than it does large businesses. Furthermore, smaller companies have few places to go for affordable help in complying with regulations.

Lack of awareness about where to seek advice. Small manufacturers often are unfamiliar with changing technology and it is difficult for them to find high-quality, unbiased information and assistance.

Changeover costs. Modernization funds are difficult for small manufacturing firms to obtain and to justify when management of day-to-day operations of the firm is of paramount importance. A crunch in company finances can result in a reduction in nonmandatory spending; technology thus becomes a discretionary resource.

Because of the nature of research and development products that users must consider, research efforts are frequently delivered in the form of reports that cannot be readily interpreted for application to an industry problem. Small manufacturers have the task of interpretation: integrating the results of disparate research projects, identifying and perhaps investigating the unknown, determining relevance, and estimating costs and benefits. They must therefore be cautious about increased expenditures and uncertain from the use of the new technology.

Need for Technology in Small Manufacturing

When industry seeks new technology through extension programs, it typically is a reflection of needs imposed by high priority pressures and associated with demands for complying with consumer safety, occupational safety, and environmental regulations. Other reasons include the need to reduce high input costs and with manufacturing modernization requirements involving process improvements, distribution, inventory storage, preservation, retrieval, and personnel training. This strengthens the view that the most effective type of industrial extension is to be found in promoting mechanisms that address specific needs for technology and that reduce the endless horizon of research to a menu that has utility to users.

Industrial extension strategies work best when the user market is "preorganized" to receive modern and advanced technology so that between technology and user needs may converge. The operative word is utility. Current congressional, executive, and state government policy leans toward establishing three types of industrial extension incentives: (1) a process for defining user requirements; (2) agent-to-user technical support for meeting cost and performance criteria; and (3) demonstration projects for marketing the technology. Since the user market of small manufacturers comprises a large, baffling, and constantly moving target, the market must preorganize. This preorganization may take several forms. Manufacturing extension centers may deploy agents to work with individual companies in creating the necessary symmetry between the needs and expectations of the user market and the technology. Identifying a given technological response to an industry problem is not useful unless the agent can provide technical help in adapting or modifying the technology. This critical step should be done face to face, and a consultant may need to accomplish the transfer: The third party can be a catalyst for transferring the technology.

Although this approach, using direct technical assistance to help selected clients, is highly endorsed, it has possible drawbacks (National Research Council 1993):

- Many potential clients will remain unserved because of the large number and widely scattered locations of many firms.

- Administrators of federal and state-supported industrial extension programs find themselves in the awkward position of choosing clients from among competitors in an industry, often on the basis of their ability to pay. They treat the resulting information sharing and technical assistance as proprietary knowledge rather than as information and service in the public domain.

- Exclusive reliance on the labor-intensive, one-on-one process will not result in the market aggregation necessary to stimulate interest in potential technology commercialization that can meet industrywide needs.

- The efforts of manufacturing extension centers may be interpreted as competing with private sector service providers.

- Technology transfer is defined as an individual agent imparting what that agent knows about an individual company's problem, rather than as the introduction of innovative technology via the marketplace in response to demand-driven needs of industry.

The objective of an industrial extension program may be to gain engineering consultation for a company, such as promoting information about CAD/CAM, or about what is commercially available through Thomas' Register. It may involve problem solving for companies on hot-pursuit issues.

However, the objective of an industrial extension program may be promoting innovation through marketing, making improved technology available even to the smallest manufacturer via the marketplace. An alternative but complementary type of industrial extension is to be found in promoting mechanisms that aggregate the market and that link its technology needs with the outflow of federal, university, and private sector R&D. (The engineering consultation approach may in fact be more appropriate as a state-level strategy, while the market aggregation approach is more appropriate as a national-level strategy.)

Contrary to the conventional wisdom that most small manufacturing needs are solvable through commercially available technology, the alternative model is based on the notion that technology does not come prepackaged, but is similar to a prescription for a diagnosed need. The user and the supplier must work together to achieve the desired efficacy. A key ingredient of this model is achieving generalizability. If certain users are chanting the same questions or research agendas, the technology alternative should give them roughly the same answers. If priorities are congruent, the chances of market aggregation, innovation, emulation, and significant scale economies can be realized. This philosophy is the basis for an active industrial extension effort in the form of a food manufacturing coalition supported by the Environmental Protection Agency, USDA's Cooperative State Research, Education, and Extension Service, USDA's Rural Business and Cooperative Service and carried out in conjunction with major food industry trade associations.

Using industry-defined needs as a starting point, current industrial extension efforts are supplemented by matching existing technical solutions to companies' common and generic problems. An example of this process is the Department of Energy labs' multiclient efforts for the U.S. textile industry. The labs, through the American Textiles (AMTEX) program, identify what a cluster of clients needs to know and deliver the answers. With the same client focus, a user market "prestructuring" begins with a joint definition of the problem to be attacked, including a delineation of the scope and expected products. The next step is to identify technological alternatives, and to participate in monitoring evaluations. The third step is to match technology and resources with user objectives in and to test, demonstrate, evaluate, and deliver technology solutions. This is very different from designing industrial extension efforts without market involvement and with no built-in user assurance.

A basic premise underlying the food manufacturing industrial extension effort is that industry trade associations can perform as a forum and identify common industry technology needs. Prestructuring the user market, by working with industry associations, is expected to result in a leveraging effect that systematically taps the existing resource base, promotes dual use, and heightens spinoff possibilities. Through this process, several hundred million dollars of federal, university, and private sector R&D promotes a vigorous market for technology.

For their part, U.S. trade associations represent a large, diverse, food manufacturing sector that is a prolific user and purchaser of technology on the open market. But there is no indication that the majority of industry is aware of most federal or university research in process or completed, or of the usefulness of querying the system before going into the market for services, or of surveying beyond a search of traditional services and sources. This is especially true of small and medium-sized companies, but of some large firms as well.

The Food Manufacturing Market

Food processing is the largest manufacturing industry in the U.S. with the value of food product shipments reaching $450 billion in 1995. Food processing is also a major source of value-added products accounting for nearly $182 billion in added value of raw materials in 1995. The industry is a significant employer in the manufacturing sector with a projected 1.66 million direct jobs in 1995. The food processing industry is also one of the leading export industries in the U.S. and the size and value of exports is growing steadily. Another growth measure, new capital investment in food processing plants, reached $12 billion in 1995 (Statistical Abstract of the United States 1995).

Geographically, the food processing industry is spread throughout the country and is a particularly important factor in rural economies in most states. Even though the food processing industry is made up of many industry giants, it also encompasses thousands of small and mid-sized companies, and food processing industries are among the largest of the 20 industry groups that form the manufacturing sector. Based on shipments, food processing is five times the size of textiles, apparel, and iron and steel, and accounts for eight percent of employees in manufacturing overall. In addition to food processing, several other allied sectors combine to form an enormous component of the manufacturing base in rural areas. It includes the processing of industrial agricultural products, livestock feed, agricultural chemicals, fertilizer, and veterinary products, and durable goods manufacturing related to agriculture (silos, irrigation equipment, farm implements, and tractors) (Connor 1988).

A quotation from the National Research Council report captures and reinforces the approach being used by the Food Manufacturing Coalition. "Construction and operation of networks of companies with similar interests and needs can be an effective way to share both costs and experience" (National Research Council 1993). Another is "Some programs to help multiple companies can best be provided by professional societies, trade associations, and other membership organizations. These organizations should be encouraged to be more active in determining needs and developing appropriate programs for their membership" (National Research Council 1993). An NRC report emphasizes "There are many opportunities for assistance organizations to leverage their assistance resources and offer help in ways other than one-on-one contacts. In fact, some of these may prove to be even better mechanisms for quickly improving the performance of smaller manufacturers than individually provided help" (National Research Council 1993).

If the food manufacturing industry, through its industry associations, is viewed as the user of technology in this approach, two primary sources of technological know-how on the supply side are the university and federal government laboratory sectors. Another conventional opinion holds that the federal laboratories have little to offer U.S. manufacturing in the form of new technology. The simple answer to that assertion is, how do we know? Without a system for getting at the options available through federal labs, manufacturers have no handle on knowledge and are left to grope in the dark. In reality, a huge body of valuable product and process technology exists in the federal domain, developed at taxpayer expense, that has not been fully tapped by the private sector for addressing technological needs. The Hazard Analysis Critical Control Points (HACCP) technology, developed by NASA for the food safety needs of the astronaut corps in the 1960s, is now being adopted as a standard methodology in the food processing industry.

To exploit federally produced technology on a more systematic basis, labs and other sources must check industry's needs and barriers and undertake concerted industrial extension efforts with those industries. This is a prime role for an industrial extension effort: to operate not as some hothouse off the beaten track, but as a coalition for matching industry with users of a technology, as well as helping a widely diverse food manufacturing sector achieve varied objectives.

The National Research Council report, in referring to the potential role of federal labs, put its finger on the problem. "Smaller firms usually have no research staff who could present their needs in a manner that would be appreciated by the laboratory personnel and they have few mechanisms to demonstrate strongly the importance of their needs to outside researchers. By the same token, smaller firms are unable to participate in most government-sponsored consortia but they would likely benefit from knowledge of research results if they were translated into implementable effort" (National Research Council 1993).

Because it has no forum for preanalysis and preorganization, the user market's research results become lost. On the other hand, a systematic manufacturing extension effort, working through a consortium of food industry trade associations and with existing technology sources, can result not only in solutions to industrywide problems, but can put the U.S. food industry in a globally advantageous and highly competitive position.

The Food Manufacturing Industrial Extension Model

The key features of the first stage program include:

- Initial concentration upon a manageable spectrum of critical food manufacturing needs
- Definition of user needs by industry representatives for establishing requirements
- Targeting need response in the form of technology transfer systems (technology monitoring, technology evaluation, user requirements committees, commercialization strategies)
- Forming a food manufacturing coalition to link to federal, university, and industry centers of technical information and experience
- Appointing a national systems manager to work with industry and to oversee delivery system efficiency

Factors that underlie this effort and that will shape the delivery system are:

1. Companies within an industry often face common technology and training problems that cut across state, national, and even international sectors.

2. Those common problems relate to needs associated with lowering input costs, improving the infrastructure, and complying with regulations.

3. These needs emerge from an aggregated market where multiclient industry sectors become the customer.

4. Industry associations are efficient vehicles for stimulating needs identification and for aggregating markets for technology.

5. New R&D may not be required since emphasis is on exploiting the existing technology and capabilities of federal laboratories, universities, and research centers.

6. The need is to build on, enhance, and coordinate existing outreach efforts by implementing a technical assistance process that emphasizes a demand-driven approach.

7. Through such a demand-driven market aggregation strategy, manufacturing technology centers and university, laboratory, and community college resources will be better able to understand market priorities and to use their technology and training capabilities to achieve them.

8. This strategy uses existing taxpayer-supported R&D to heighten the potential of spinoff and dual use of mission-related R&D, resulting in product opportunities and new markets for private sector suppliers.

9. Working through trade associations to create a market aggregation effect that solves many companies' problems will shift technical assistance from an exclusively one-to-one relationship to a multiclient relationship.

10. This strategy focuses on the needs of all companies, but emphasizes the needs of small and mid-sized companies without the capacity to penetrate universities, laboratories, and other resources.

11. This technical assistance process creates a "win-win" situation in which industrial productivity problems are solved for many companies within a sector through products or services commercialized by U.S. companies. These firms exploit uncommercialized technology, thereby creating the possibility of new businesses, new products, new services, and new jobs.

12. Within this systematic framework for innovation, each technical assistance provider can play a role that concentrates on its capabilities in such areas as network formation, needs identification, data searches, technology analysis, commercialization strategies, training, and technical assistance.

Basic trade group functions include gathering and disseminating knowledge among members and alerting them to innovation. The food manufacturing extension model is designed to pursue every opportunity for exploiting the potential of U.S. trade associations. They may serve as vehicles for innovation within the industrial sectors they represent or they may prove useful in estimating the scale and intensity of industry demand for technology. The major groups and the 5,000+ companies they represent in the Food Manufacturing Coalition include the National Food Processors Association, Food Processing Machinery and Supplies Association, International Dairy Food Associations, United Egg Association, Snack Food Association, and American Meat Institute.

The strategy is to treat the food manufacturing industry as a major purchasing sector in the national economy. The objective is to engage that purchasing leverage with the outflow of R&D results from federal labs, universities, and industry if the technology is timely, cost-effective, and needed. The criteria for this effort are (a) utility, (b) speed in response, (c) user orientation, (d) affordability, (e) deliverability, and (f) satisfaction. It is also important to generalize where possible to industry needs internationally, thereby identifying as large a market as possible.

Problems/Needs

The initial need in constructing a food manufacturing industrial extension model is to focus available technology upon a range of industry needs. Identified through a survey of industry administered in early 1996, these needs include (Philips 1995):

Reduction of waste stream volume
Extraction, separation and/or reuse
Biological oxygen demand (BOD) removal

- Fats, oils, and grease (FOG) removal/ management
- Egg shells (by-products/disposal)
- Training (processing systems management)
- Film (recycling/disposal)
- Efficient use of steam (reduction/alternatives)
- Volatile organic compound (VOC) control
- Inks, coatings, glues (alternatives, removal of undesirable emissions)
- Controlling and managing odors
- Monitoring and managing allergens/toxins
- Raw materials inspection and sorting technology (foreign material, defects, size/shape, and grading)
- Efficient peeling technology
- Establishing critical parameters for humidity and temperature sensors
- Creating alternatives to blanching/drying
- Thawing (bulk products)
- Managing chlorine compounds in production processes
- Real-time monitoring or sensors for microbiology

Around such a framework of priority needs, information can be assembled on the state of ready technology.

Access to Uncommercialized Technologies

At the federal government level, science and technology is big business. Direct R&D outlays are currently $75 billion per year. For their part, universities also have a major potential for promoting industrial extension and commercialization of their research as well. University functions have expanded with the addition of patent administrators, technical centers, research consortia, business incubators, and engineering consultation efforts. There is a renewed orientation toward the university's role as a problem solver and entrepreneur, because such institutions are as concerned with the delivery of knowledge to users as with acquisition and stockpiling.

The R&D investment made each year has resulted in a broad array of uncommercialized technologies. Working against high priority needs, a primary function of the food manufacturing industrial extension project is to analyze the available technology and compare it with uncommercialized technologies in federal labs, universities, and research centers. Accessing uncommercialized technology alternatives will be facilitated through working agreements with the National Technology Transfer Center, Regional Technology Transfer Centers, the Federal Laboratory Consortium for Technology Transfer, The Modernization Forum (representing Manufacturing Technology Centers), The American Industrial Extension Alliance (representing university-based engineering extension), the Midwest Food Manufacturing Alliance, and other university-based food science programs.

The potential of the uncommercialized technology project's focus is based on a modest congressionally mandated diversification of federal laboratory activities. It shifts from strictly mission-related R&D into "horizontal technology transfer," so called because its emphasis is on secondary applications of research results. "Spinoff" has become the operative term. An assumption is that more research is not necessarily the answer to industry needs but rather the systematic adaptation and adoption of technology that already exists. For example, can federal laboratory technology furnish alternatives to methyl bromide as a fumigant in the pasta industry? Can NASA technology offer alternatives to prolonging shelf-life of packaged food or to achieving food safety? Does defense R&D have potential solutions to offer in water reuse?

All these organizations could bridge the two sides of the system: the requirements side and the delivery side. Requirements data will determine what should be taken out of the pipeline of R&D, such as the relevant technical knowledge that is available. Ultimately, the delivery job is the responsibility of industry's supplier companies—to produce products and services in response to market demands and in line with food manufacturing industry and trade association actions.

"Technology Agents"

Critical to achieving results is using a network of technology transfer agents to interface between user groups in the food manufacturing industry and the federal laboratories, universities, and other appropriate resources. The agents, commissioned on an *ad hoc* basis, will be assigned priority industry problems that are consistent with the agents' educational specialization and experience. Those possessing engineering and business backgrounds will be able to communicate effectively with industry groups as well as with laboratory scientists. Their function is to develop detailed problem statements based on industry input, become familiar with and search the federal laboratory and university systems relative to identified priority needs, and evaluate the technical feasibility of alternatives.

The technology agent approach has the advantages of (1) avoiding establishment of a permanent group, (2) allowing for a selection of the proper expertise, (3) multiplying the contacts of top-quality scientists and technicians with either industry or technology sources, and (4) allowing for a termination of the arrangement when the assignment is completed. This approach provides the flexibility necessary to deal with the wide variety and shifting agenda of priority needs in food manufacturing.

The optimal conditions for effectiveness of agents are (1) initiative in searching out workable alternatives consistent with industry priorities, (2) unlimited access to technology helpful for making evaluations that will influence supplier companies, (3) ability to communicate with business executives as well as with scientific and technical peers, and (4) ability to work fast and get results under pressure.

Alternative Solutions

Technology agents will identify alternative solutions that will be documented and published as state-of-the-art reports. The report format will include a description of the technologies having problem-solving potential, raw material requirements, and economic evaluation. Additional analysis will evaluate promising technologies relative to production requirements and costs, training needs, market size, projected usage rates, environmental and worker safety factors, and other appropriate solution considerations and constraints. This format is important, given the fact that technology transfer and adoption of innovations hinges on an understanding of economic and organizational realities as well as of technological factors.

Potential Suppliers

State-of-the-art reports developed by the technology agents will be distributed to the memberships of appropriate product or service suppliers. This dissemination effort will serve as an efficient arrangement to promote information utilization among relevant organizations. Firms interested in applying for a license to produce and market a technology can contact the laboratory or university identified in the state-of-the-art report for details.

When a major new technological alternative is identified in a state-of-the-art report but adaptive engineering requirements, lead times, or institutional barriers are substantial, the project will pursue joint ventures, cooperative research, and funding for demonstration projects. Small Business Innovation Research (SBIR) programs, for example, would be a prime source of funding for innovation where a market has been identified through the activities of the Food Manufacturing Coalition..

Industry hesitates to risk capital in developing targeted products and services for industrial customers that are fragmented and disaggregated; they should be organized to structure and maintain effective demand. To the degree that industry sectors are willing to agree on product standards and performance and to use their purchasing leverage, supplier companies' readiness to respond with technological innovation will be decidedly better.

The industrial extension process will directly benefit the firms for which new product opportunities are identified. As the situation now stands, new product opportunities are identifiable in the federal lab system, universities, or other sources by a limited number of firms with "boundary spanning" capabilities. The Food Manufacturing Coalition will communicate new product opportunity information to firms in the industry. Thus, applicant quality for a license to produce and market the product should improve. Other beneficiaries of the technologies are the large number of firms able to increase productivity, improve competitiveness, increase profits, and reduce unemployment.

Does industry want a partnership with the federal government for advancing industrial extension on a national basis? The Food Manufacturing Coalition for Innovation and Technology Transfer is a case in point. The Environmental Protection Agency, through the Environmental Technology Initiative, and two agencies of the U.S. Department of Agriculture support the coalition and are committed to accelerating the uses of technology.

The national investment of over $75 billion annually in federal research and development justifies a systematic effort to reap wider domestic benefits from the investment at a tiny fraction of the cost. The technology, or its potential, exists in large part. The users are searching for workable answers. Supplier industries are ready to respond if a market demand can be assembled. The federal government's new strategies for industrial extension, as a route to economic growth and exports, should add priority to industrial coalitions for technological innovation. No elaborate new organizations have to be invented, because the basic mechanisms already exist. What is required is to put it all together and to create incentives to commitments.

Additional Reading

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