THE ENERGY, ENVIRONMENT, AND MANUFACTURING TECHNOLOGY ACCESS STRATEGY FOR SMALL AND MID-SIZED METAL FABRICATORS

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Under a Technology Reinvestment Program (TRP) project award for Energy, Environment and Manufacturing Technology Access (EEM), the National Institute of Standards and Technology (NIST), the U.S. Department of Energy (DOE), and the Environmental Protection Agency (EPA) have collaborated on a project to develop an integrated assessment tool that includes energy efficiency, environmental waste reduction/pollution prevention, and manufacturing improvement. This two-year project helps metal fabricators (metal finishers, metal formers, and screw machine products manufacturers) identify opportunities, implement, and benefit from new and existing methods and technologies. A number of unique partners in this innovative project test the concept that small and mid-sized metal fabricating industries respond best when technical and financial resources are linked and coordinated. There are four distinct partnerships involved: 1) the project partners--The Industrial Technology institute, Cleveland Advanced Manufacturing Program, Sandia National laboratories, and the Northeast-Midwest Institute; 2) participating federal agencies; 3) trade associations--The National Association of Metal Finishers, National Screw Machine Products Association, and the Precision Metalforming Association; and 4) state and local technical and financial resources.

This paper discusses the potential and limitations of these various partnerships as they have evolved in this federally funded, pilot program approach. Concrete examples of pitfalls as well as successes illustrate the power of partnerships in facilitating enhanced competitiveness, reduced environmental impacts and compliance costs, and improved energy efficiency. Technology transfer to small and mid-sized manufacturers is crucial; the barriers, many.

The strengths and limitations of partnerships can be discussed best in the context of the program's goals and design. This discussion occurs one year and a quarter into a two-year project. The observations reflect mid-course perceptions without the advantage of final results. Comments include material from interviews with the major partners, but ultimately represent primarily the author's views.

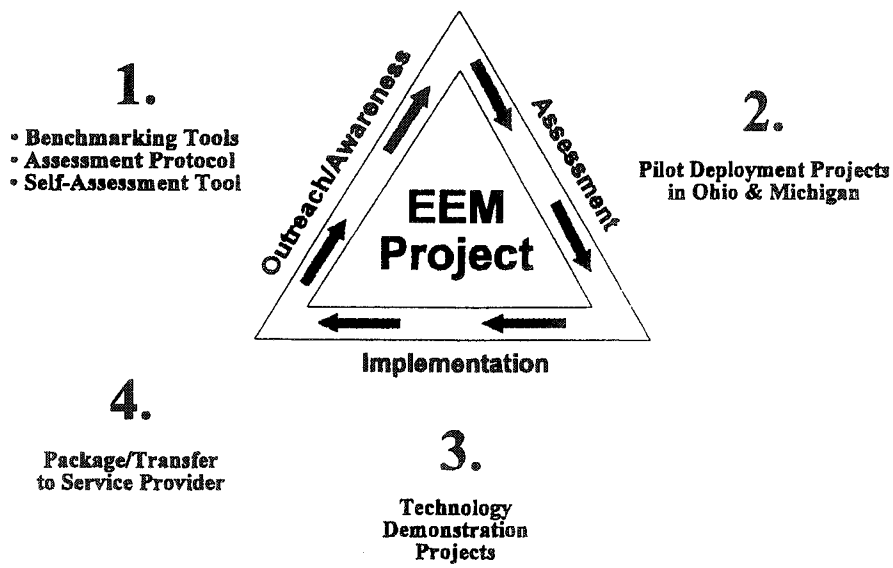
THE EEM PROGRAM OVERVIEW

The EEM program encompasses a number of related activities: 1) tool development; 2) EEM assessment projects; 3) technology demonstration projects and 4) the packaging and transfer of tools and experience to other potential technology transfer organizations. ITI with its expertise in energy efficiency assessments and CAMP with its expertise in waste minimization assessments have worked together to develop an integrated assessment protocol which can be used by service providers to evaluate manufacturing processes and provide cost-effective recommendations for possible energy efficiency, waste reduction, and operation improvements. The goal is to make the small and medium-size companies more cost competitive and environmentally responsible.

Strengths and limitations of a partnership approach

All three sponsoring agencies direct programs for small manufacturers independently. This project has opened up the opportunity to take a more integrated approach and assess the interconnected issues. The program is particularly apt at a time when government can't afford to duplicate programs and must develop greater knowledge about other agencies' efforts while exploring cost-effective ways of working together. The benefits from the collaboration stem from missed opportunities that result from a narrow approach to problems. The greatest challenge in the collaborative approach is the discipline required to maintain a consistent focus. Each partner contributes insights from her perspective and at the same time wants his concept of priorities to prevail.

Technical Assistance for Small Manufacturers



Tool development

Tool development includes an assessment protocol, a bench marking tool, and a self-assessment tool. The TRP team developed an initial assessment protocol which has been piloted and refined through work with three industry groups. In order to develop an integrated assessment, EEM project partners reviewed over 80 energy, environmental, and manufacturing assessment tools. Currently, twenty pilot assessments are being completed to test the protocol which uses the following five-step process.

- **Step-1 Initial Company Contact.** Explain process and gather preliminary data and information about the company.
- **Step-2 Preliminary Site Visit.** Half-a-day tour of facility.
- **Step-3 Site Visit.** Day One--interviews and data collection; Day Two--off-site team brainstorming session to develop list of opportunity areas; Third Day--on-site debrief company management on opportunity areas.
- **Step-4 Analyze and Prepare Report.** Final report completed within two weeks after site visit.
- **Step-5 Report Presentation, Evaluation and Follow-up.** Includes developing an action plan for implementation.

The assessment protocol identifies fairly straight forward opportunities that both have an impact and can be implemented with a short payback. The assessment team has limited itself to four to five recommendations, believing that companies are unlikely to implement more than that. The teams have limited time and tend to do less with the manufacturing side, since it is such a huge cost, both to the manufacturer and to the assessment team in terms of effort needed. However this is where the savings are huge as well. For example, many screw machine shops carry inventories that may tie up as much as fifty percent of their assets. If the plant manager reduces inventory 10 percent savings can easily add up to $100,000. This is not the case with energy and environmental savings. These shops may make 20,000 widgets rather than 10,000 and put them in storage so they will have them when they get an order. However, sometimes the widgets rust in inventory and have to be scrapped. Often plant operators pay insufficient attention to how they schedule. They will put another order in and pull the one they are running, trying to keep up with the most recent priorities. Many plants could improve by utilizing a scheduling person with a computer system to organize and provide reliable information on runs.

In contrast, energy efficiency lighting gives payback in 2-4 years generally, unless there are substantial utility rebate programs. Similarly it takes assessors a lot of time to acquire information on motors compared to other opportunities available in the operation. More importantly, "company presidents look down on us if we spend time counting light bulbs, like we can't do anything else." Often the payback on eliminating hazardous waste per se is less than focusing on solid waste disposal. One company for example spent $30,000 a year on hazardous waste disposal, versus $250,000 on solid waste.

The same basic approach works with all three industries. The assessment protocol lists questions that guide assessors to the key processes and systems within the plant. They are designed to guide the assessor to collect information on major cost elements in the plant, so the assessors can productively target resources in their analysis. The bench marking studies guide the search for trigger points in the plant.

The EEM Assessment Protocol developed by the EEM-TRP Team has established a set of information requirements that addresses operations and costs common to manufacturers. Sandia National Laboratories is developing a PC-based tool to meet the organization, analysis, and reporting requirements of the Protocol.

Teams performing EEM Assessments at manufacturing facilities have no time to waste gathering, organizing, and assessing information. The assessment tool is a windows-based software package that will allow users to rapidly enter information, perform calculations, view results, print intermediate reports, and export tables and results to a word processor for final reporting. In addition to the final report, the software tool will export information from the assessment that will be useful for bench marking future assessments and comparisons within industry sectors. Over time, this set of information will be a valuable tool in itself as MTCs build a database of measured costs and operations for specific industry sectors.

The package is being developed with an eye to future possibilities. Already planned is the ability to add templates to analyze performance requirements for common pieces of equipment such as air compressors. Another possibility is the capability to deal with imprecise costs and operational information that would be better described as spanning a range rather than a single data point. Also planned is the possibility that the assessment tool will be used to aid follow-on assistance by the MTCs. In this regard, the tool will have the capability to build a cost model based on eight cost categories and perform multi-level process mapping of operations.

The Performance Bench marking Service (PBS) at ITI has made progress in developing a manufacturing, energy and environmental bench marking metrics for the metal finishing and coating, screw machine, and metalforming industries. The service, started in 1991, has delivered over 1,500 customized bench marking reports to over 1,300 manufacturing companies. The reports provide best practice metrics in many areas, including:

- design and manufacturing lead times
- labor productivity and training
- inventory turns
- scrap and reject rates
- scheduling and timeliness
- technology use.

Each company completes a user-friendly, self-explanatory, five-page bench marking questionnaire, out of which the PBS calculates more than 40 performance measures and prepares a free customized 25 page report. The report measures their performance against that of a customized comparison group of companies drawn from PBS's large database. Each company is compared against firms like theirs -- those in their industry, of similar size, running similar parts, facing similar customer demands.

As part of the EEM TRP project, PBS is incorporating bench marking in the energy and environment areas. The metal finishing and coating bench marking questionnaire has been completed and administered to roughly 1000 companies nationwide. The screw machine products and metalforming questionnaires have also be completed and administered. Over 100 companies in metal finishing and coating completed and returned the questionnaires for customized reports. Company profiles showed:

- annual sales between $1 million and $6 million;
- employment size ranging from less than 20 to over 80 employees;
- participating companies served the auto, aircraft and aerospace, communications and electronics, and other industries;

- majority of respondents were metal platers (56 percent), 25 percent were coaters, another 14 percent were annodizers, with 5 percent miscellaneous.

The fastest growing 10 percent of firms saw their sales increase by more than 71 percent over the past two years, while the bottom 25 percent of the industry experienced a net decrease in sales. Some companies spent more than 14 percent of their sales on waste treatment, disposal, and environmental compliance costs, while others spent less than 1 percent of sales on these costs. Water use varied widely in the group. Some companies used almost 7 gallons of water for every dollar in sales, while others used one third of a gallon for every dollar in sales. Extensive computer use in this industry is relatively rare. Partially as a consequence of rapid growth in sales, many metal finishing companies are experiencing declining on time performance--fully 40 percent of companies were late more frequently now than two years ago, and only 14 percent improved their on-time performance. Additionally, many companies regularly expedite jobs by interrupting production and bumping other jobs from the existing schedule. On average, companies expedited over 17 percent of their jobs! However, a full 54 percent of companies have bought scheduling or inventory control software in the past two years--probably to cope with this problem.

The single most important measure of productivity is a company's value added per employee (value-added is the difference between the purchase price of raw materials and the selling price of the finished work" it is a measurement of the market value of all work completed in a company). There was a wide range on this metric too. Some companies had value-added of more than $77,000 per employee, with others falling below $35,000. Since value-added measures the productivity of the entire shop, low value added generally reflects low capitalization and skill levels. Plants ranged from a high of at least 9.44 percent of sales costs going for energy use to a low of 2.08 or below. On average, plants showed a modest 13 percent reduction in energy costs as a percent of sales over the past two years, with 37.6 percent showing an increase and 60 percent showing a decrease. Kilowatt hours of electricity use per $100,000 in sales varied from at least for 10 percent of companies to 1 percent or below for the lowest 10 percent of companies. Only 22.8 percent of companies formally track energy use by machine or activity, although 72.6 percent said they instituted simple energy saving practices (such as using energy-efficient light-bulbs or reducing air compressor leaks). Fully 65.3 percent said they modified manufacturing processes or practices in order to reduce energy costs. However only 15.6 percent reported using a facility-wide peak demand control system; 26.3 percent recovered heat; 46.8 percent used variable speed drives and 37.7 percent used automatic process controls such as programmable logic controllers.

One of the biggest barriers to improvement is the perception that a company is doing better than they actually are. When companies fill out their bench marking questionnaire they also rate themselves vis-a-vis their competitors. According to ITI's bench marking team, half of all companies they surveyed believe that they perform in the top 10 percent of their industry. As this self-rating suggests, such perceptions can prevent plant managers from realizing there are reasons and a need to improve. As one plant owner confided, competing in the market is like playing football without knowing the score until the game is over.

The EEM Tool Development Team is developing an EEM Self-Assessment Tool in the form of a questionnaire that will help companies find out where they stand on key energy, environment, and manufacturing measures. The Tool Development Team is searching through available information on performance measures, and will select a few key questions that will help managers do a quick reality check. Some measures under consideration are:

- percent change in sales;
- value added per employee;
- on-time deliveries;
- solid waste generated;
- water use;
- hazardous waste disposal costs;
- natural gas use; and
- energy costs.

Based on bench marking data, the company can determine if they really are above average. For example, in the metal finishing industry, an above average firm would have a value-added per employee of at least $46,000, a minimum 5.4 percent increase in sales in the past 2 years, environmental compliance costs less than 4 percent of sales, and energy costs less than 5.4 percent of sales.

The team expects to have the first questionnaires ready by July 1995 with field testing through September 1995. Present plans call for publication of self-assessment questionnaires in several industry association magazines (such as *Products Finishing, Metal Forming,* and *Automatic Machining),* targeted for first quarter 1996. Articles would include the questionnaire, industry comparison scales for each question, guidelines for interpretation, and information on how to access resources to follow-up (such as how to obtain a full Energy, Environment, and Manufacturing Assessment from a qualified service provider).

Strengths and limitations of a partnership approach

The physical separation of the two organizations has made collaboration difficult, although initially, the teams did one assessment in Detroit and in Cleveland together. However, six hours of driving time on top of the working day has meant that this level of collaboration was not practical. One of the drawbacks of having two teams involved in the protocol design was the difference of opinion in the design as it was set up. One approach was to come up with a basic protocol design and then modify the approach as it is field tested in the assessments. The other approach was to experiment with different protocols and then draw on the best features of each for the final protocol. Had the teams developed their own protocol they would have tested both approaches to see which worked best. Because they had agreed to field one approach both teams had to agree on the same one. The challenge to the assessment teams now is to cut out an additional 30 to 40 percent of the time required to perform an assessment to keep the costs within realistic limits. The most time consuming part of the assessment process is writing the recommendations. Sandia's development of a software package should cut down on the writing time as it will provide a framework or templates which will be industry specific to help generate reports.

The trade associations have been extremely valuable in getting companies to participate. Their involvement in the project has added credibility with the companies involved. Acceptance has come largely from the national associations. Some have the attitude that they just want lower taxes and less regulation rather than government programs. They have continued to support the project by including information in newsletters. CAMP and ITI have participated in association meeting and the associations have reviewed the industry reports and the industry profiles. However, their participation and active involvement in the TRP project has varied substantially. For example, AESMF has been very involved in environmental issues and it has been easier to focus on their problems since they tend to be at a level that the project can deal with.

The industry working groups, made up of six to ten companies, provide important information about their major challenges. These groups have been valuable in part because company owners are more open in these informal discussions with their peers. Participation in these groups has allowed the TRP teams to get a sense of the issues these companies struggle with daily. Some of these needs are outside the scope of EEM and the immediate project. For example, screw machine industry considers employee problems paramount. The issues cluster around training, hiring, and retaining employees that are reliable, will stay on the job for any length of time, and have basic skills. A challenge for TRP assessors is sharing results with the working group openly, since there is concern about revealing information that would allow plants to be identified. Confidentially concerns dictate the sharing of generic information only.

Industry Working Groups have limited time to commit to meetings. Initially the meetings were extremely helpful, but attendance has dropped at subsequent meetings. Companies that receive project assessments tend to be more involved in the project and more willing to attend meetings.

EEM assessment projects

Currently, ITI has completed seven assessments and CAMP, nine. ITI performed assessments for a screw machine operation and a stamping plant in the fourth quarter of 1994, a screw machine shop, two stamping plants and a metal finishing operation in the first quarter of 1995, and then completed an assessment of a metal forming/extrusion plant in April.. Assessments scheduled for May include two metal finishing operations and one stamping plant. CAMP assessed two metal finishers, three metal stampers, and four turned products manufacturers, with one more planned. Both ITI and CAMP report that companies are pleased with the assessments and recommendations. As the assessments progress and the TRP team continues to modify the process, the protocol will be a more effective tool to assist manufacturing in controlling costs and wastes, and improve operations. ITI made the following recommendations to the companies it assessed:

RECOMMENDATIONS

Description	Potential Cost Saving Per Year	Estimated Implementation Cost	Payback (years)	Comments
Reduce Non-productive Compressed Air Use	$9,500	$8,500	0.9	Fix leaks, install automatic shut off, control system, serve feed mechanism
Reduce Plant Air Pressure	$5,000	$0	Immediate	Reduce plant air pressure from 110 psi to 90 psi
Install Common Air Header	$9,500	$10,000	1.2	Install a load manager
Reduce Cutting Oil Waste	$12,850	$4,725	0.4	Increase efficiency of chip wringer, reduce air emissions and oil loss to parts washer
Upgrade Compressed Air System	$2,800	$1,100	0.4	Fix air leaks, reduce line pressure, outside air for intakes.
Upgrade Compressed Air System	$6,977	$5,190	0.7	Fix piping design and air leaks, outside air intake, exhaust heat inside
Upgrade Compressed Air System	$4,600	$3,100	0.7	Fix leaks, outside air, exhaust air inside
Upgrade Compressed Air System	$4,500	$11,600	2.5	Reduce line pressure, install control system, outside air at intake, load manager.
Upgrade lighting System	$6,900	$8,400	1.2	Install high efficiency lights and ballasts; install occupancy sensors.
Upgrade Lighting System	$8,385	$11,723	1.4	Install high efficiency lights and ballasts.
Upgrade Lighting System	$362	$707	2.0	Install high efficiency lamps.
Improve Batch Oven Efficiency	$28,471	$42,100	1.5	Keep oven doors closed, install stack heat exchange for space heating

Upgrade Part Manufacturing System	$124,000	$270,000	2.2	Implement a production cell at the press including part washing and packaging.
Reduce Rework	$6,000	$15,000	2.5	Improve process control, require key entry of all orders, check surface area calculations, operator training.
Upgrade Parts Washing System	$7,000	$5,000	0.7	Place parts directly onto a conveyor to the parts washer, eliminate WIP storage.
Upgrade Parts Washing System	$84,800	$86,000	1.0	Switch from vapor degreasing system to aqueous parts washing.
Implement Statistical Process Control	$20,600	$35,400	1.7	Eliminate redundant inspection.
Idle Equipment Shut-off	$9,000	$0	immediate	Instruct operators to shut off machines not in use.
Reduce Machine Idle Time	$1,486	$4,000	2.7	Install automatic shut-off controls
Reduce Water Use	$25,000	$21,122	1.2	Fail safe operation of recirculating pump; temperature control on heat exchangers
Improve Existing Motors and Drives	$2,000	$4,200	2.1	Install high efficiency motors and V-belts.
Install High Efficiency Motors	$4,000	$4,800	1.3	Replace motors as they wear out.
Implement Returnable Packaging	$6,630	$8,000	1.2	Reduces packaging material costs and need to wash parts.

OPPORTUNITY AREAS

Area	Comment	Potential Savings
Shut down unit heater	Shut off redundant gas heater	$270 annually
Use parts washer and grinders during off peak time	Reduce demand by shifting operations to off-peak	$1,1056 annually

Install overhead steel storage	Improve plant layout and material handling	Improved through-put, savings depends on strategy selected.
Improve parts storage system.	Store parts by part number instead of machine number	Increase inventory turnover and improve delivery
Install Variable Speed Drives	Retrofit presses with VSD	Reduce energy demand by 20%, savings depends on implementation strategy.
Reduce Chemical Use	Reduce coolant use by installing intermittent spray when feasible. Reduce detergent use by filtration & recycling.	Savings depends on implementation strategy.
Reduce Raw Material Inventory	Reduce quantity of steel stock.	10% reduction yields $13,290 if invested at 6%.
Insulate Oven Conveyor	Enclose conveyor system to keep heat within the oven.	Savings of $400 annually, payback of approx. 3 years.
Reduce Work in Process	Proper staging and queuing of bins.	10 bins tied up in process yields $3,060 if invested at 6%.
Reduce Chemical Use	Reduce use of alkaline cleaner and acid pickling solutions, by installing appropriate micro filtration and ion exchange systems.	Typical systems cost $20-30,000, result in savings of approximately 90% of chemicals used, giving payback of 1-3 years.
Reduce Finished Goods Inventory	Warehouse management program.	Reduce labor costs picking orders, eliminate need to expand warehouse space.
Proper Dilution of Cutting Oil	Use appropriate additive in the correct amounts to reformulate oil	Reduces tool wear, misting in plant.
Preventative Maintenance Program	Follow up on "critical items"	Reduce machine downtime
Improve Plant Layout	Remove "old equipment" storage from critical areas	Reduce material handling costs, improve throughput.
Purchase Hollow-tube Stock	Investigate trade-off between purchased cost and scrap value	Depends on purchased cost of solid vs. Hollow and scrap value
Improve Assembly Area Layout	Increase throughput by improving material handling. Balance operation to even out work load.	Eliminate need for an extra person to inspect parts.
Expand In-house Processing Capability	Develop capability to perform critical outside services in-house	Better control over scheduling, quality, and delivery, reduce inventory in process and transportation costs.

Strengths and limitations of a partnership approach

One of the assessment team leaders pointed out that the strength of the integrated assessment is moving into a plant with an open point of view. Since the approach forces the team to look at the total plant process, it forces the team members to ask questions and probe processes outside of their narrow expertise. The team developed a protocol that allows them to get to the heart of the process quickly. These small manufacturers for the most part are working under constant pressure to get the product out the door. They have little time to stop and try to figure out if there is a better way to do things. Opportunities range from bit items, such as upgrading a part of the production process to smaller more mundane projects. For example, the team noticed that in one plant there was an excessive amount of detergent being used to remove oil from parts. The maintenance engineer explained that the cleaner contained no oil. Yet when they checked the composition of the cleaner it did in fact contain small amounts of oil. This was causing heavy use of detergents to clean off the parts so they could be laminated with rubber. In another plant the maintenance engineer had the air compressor hooked up backwards because he was having trouble with corrosion in the compressor. In fact the compressor was parked on top of a sludge pit. The strength of the approach lies in evaluating problems and solutions from the vantage point of the impact on all three: energy use, waste generation, and productivity or product quality. Typically a company focuses narrowly on the problem and try to solve it without evaluating the impact on other variables. The EEM utilizes a systemic approach and catches things that would fall through the cracks of a more narrowly focused assessment.

One of the limitations is that nobody is a generalist adequately prepared to assess a plant in all areas. Assessments performed by a team can overcome this limitation, but the limitation of the assessment teams at ITI and CAMP is that no individual has a manufacturing training--the ability to evaluate and deal with scheduling, inventory control and plant layout evaluations. The team is also limited by time and budget. They estimate it would take an additional three to five days to do that assessment of these nested problems since it would require them to analyze information flow and management problems.

One of the benefits of having two groups collaborating on protocol is dealing with similar industries supplying different markets. For example, stampers in the Cleveland area are more likely to suppiy the appliance market, whereas in the Detroit area they are more likely to work with automotive companies. Although the assumption is that pilot programs can be transferred nationally, they may in fact be more regionally bound than previously assumed. There are significant differences between Detroit and Cleveland. Automotive companies have separate sets of issued that don't transfer directly to companies supplying appliance market. ISO 9000 is a high priority issue for all three auto companies, but is not part of appliance manufacturers concerns.

Technology demonstration projects

EEM project management has based their approach to demonstration project identification and selection on a combination of:

- Company EEM assessments;
- Industry Working Group discussions;
- Expert views and recommendations;
- Trade Association discussions; and
- Federal government R&D agendas.

The project is moving ahead identifying and evaluating potential demonstration projects. Based on experience to date, many of the projects under consideration deal with environmental issues. This is due to the lack of comparative information about environmental technologies. In contrast, vendors and industry associations are providing such information on energy or manufacturing technologies. Ideally, the project will demonstrate technologies that solve immediate environmental problems as well as yield energy and process performance improvements.

In a meeting with EPA staff at the Risk Reduction Engineering Lab in February, the EPA suggested that demonstration projects flow from EEM assessments. Resulting assessment implementation projects should reduce the overall amount of hazardous materials generated--primarily from source reduction. While source reduction pollution prevention is preferred, industry is also interested in a full range of waste reduction projects, including recovery of expensive raw materials (such as recycling parts cleaning solutions) and ones that provide alternatives to disposal such as reclaiming metal from plating sludge. Recovery technologies are less risky and easier to implement than source reduction programs such as material substitution (for example, aqueous cleaners substituted for solvent based cleaners).

Material substitution involves adjustments in product quality and process reliability, and are not readily implemented unless all of the questions are answered based on an operating process. Finding these projects are a problem in that a technology must already have been demonstrated to some extent to be a candidate for demonstration!

Currently, the EEM Assessment Teams are assisting in a search for appropriate matches of situations and technologies that are innovative and can be implemented by smaller commercial job shops. Generally, the projects will meet the following criteria:

- recommended as a part of an EEM assessment;
- state-of-the-market or practice technologies (rather than R&D projects);
- involve participants willing to commit financial resources;
- appear to be economically feasible; and
- offer potential energy, environmental and/or manufacturing benefits.

Industry Working Group discussions have identified the following environmental technology areas of interest.

Metal Finishing:

- Closed-loop water recovery systems;
- Acid recovery systems;
- Alloy plating of steel as a substitute for stainless steel;
- Replacements for cadmium plating and hexavalent chromium; and
- Waste recycling/recovery.

Metal Forming:

- Waste recycling is a big potential cost saver. This includes recycling of coolants, lubricants, water, air, and materials.

Screw Machine Products:

- Oil mist;
- Liquid and metal waste streams;
- floor oil management; and
- Aqueous parts cleaning.

The role of Sandia Laboratory could be significant in identifying DOE or the U.S. Department of Defense SMP operations and transferring some of their knowledge to commercial shops.

Metal finishing has the most pressing regulatory (EPA and OSHA) requirements that will require some replacement of hexavalent chrome, cyanide and cadmium use. In general, the project's EEM assessments have identified the following areas as important for metal finishing demonstration projects:

- Recycling/reduction in use of plating solutions (electrodialysis, ultrafiltration, improved plating efficiency, recapture from rinse water); and
- Recycle/reduction in use of rinse water solutions (ultrafiltration, dialysis).

Ultimately the above processes lead to a closed loop operation.

Dealing with hexavalent chrome applications may involve use of Maximum Achievable Control Technology (MACT) for hexavalent chrome emissions. The industry has indicated its interest in demonstrating and evaluating MACT technologies suitable for small hard chrome job shops. Other recommendations that have been made to the EEM-TRP Project:

- Recycling/reduction in use of parts-cleaning solutions (micro-filtration, ultrafiltration, solvent substitution--n-methyl pyrollidone);
- oil and dirt removal from aqueous cleaning bath with a ceramic membrane micro filtration system;
- An assessment of process control software systems;
- A database on alternative parts cleaners matched to membrane systems; and
- The Boeing "Aerogel" system from removing salts from baths.

At the American Electroplaters and Surface Finishers (AESF) Compliance Technology Research and Needs Workshop held February 16, 1995, several knowledgeable people recommended bath life extension projects as a focus area--especially information on vendors and techniques. The following comments from that workshop regarding technology demonstration projects are probably valid for all three industries involved:

- Technologies have to be very durable in terms of operation and maintenance.
- They have to be used in a shop by operators for 6-12 months to prove themselves.
- Controls and operation should be suitable for high school graduate level operators.
- Lots of technology options exist; companies need help comparing systems, knowing what works under different situations. Project guidelines for proposing and evaluating EEM technology have been reviewed by the EEM-TRP Industry Council. The team is in the process of selecting demonstration projects now.

It is too early to determine how much difficulty Sandia National Laboratory will have identifing emerging technologies that could have beneficial applications. Communication has been difficult from a technical viewpoint, each laboratory tends to have different technical languages and approaches. Similarly, the national laboratories have grown up under a culture that permitted zero defects. This mentality is diametrically opposite to that of a job shop which is a volume, low margin business. The laboratories tend to be slow at sharing information.

State and local resources

The Northeast-Midwest Institute has been involved in identifying state and local technical and financial resources that manufacturers could use as they move through implementation of the recommendations. The pilot program established with Detroit Edison is one example of an effort to coordinate technical and financial resources, testing the theory that a combination could result in higher implementation rates. The Northeast-Midwest Institute is writing a guide to programs for manufacturers. Although state and local organizations often offer a myriad of programs and resources, the Institute's efforts identify programs that can be effectively utilized by the small and mid-sized industrial facility. The Institute has also set up working groups for technical and financial group representatives to suggest ways to provide financing and other resources to the plants as they move through implementation.

The Institute has identified many useful resources but few manufacturers have taken advantage of the programs . The state of Ohio has earmarked $10 million for its Pollution Prevention Loan Program, a relatively new program. In a meeting convened for state and local resource representatives and EEM TRP partners, a participant pointed out that plant officials applying to another state funding program ended up not utilizing it because the processing time was too long. State program representatives pointed out the new program's promise of a quick turn around time, which was met with some skepticism. The working group agreed that it would be helpful to encourage plant owners to apply for the funding to see if the state delivered on its processing promises. In a related discussion working group members pointed out that electroplaters often have special difficulty getting bank loans because of the perceived difficulty bank officials envision with companies' ability to handle future compliance issues. This in turn makes it difficult for platers to arrange financing as the new state program relies on the ability of a facility to negotiate bank financing.

Detroit Edison Partnership

Detroit Edison Company (DECO) committed $300,000 to a pilot program to test the impact of the EEM assessment coupled with an energy efficiency incentive up to on average $15,000 for cost-effective improvements. In this pilot program, Detroit Edison provides 10 metal fabricators in its service area with a free $15,000 EEM assessment, performed by ITI's assessment team. DECO offers the energy efficiency incentives to customers to buy down the payback period to two years (in some cases, down to one year). DECO officials select their customers and accompany the assessment team to the plant during the initial walk through and then again for the report presentation. The companies DECO selects average 80 to 120 employees working in plants averaging 50-100,000 square feet. In comparison, the average company ITI works with in the TRP project runs 40-60 employees working in 40,000 square feet.

Detroit Edison officials give more detailed feedback on the reports than the companies themselves. They also push the assessment team to give more numbers, suggest implementation steps, and provide more detailed cost estimates. So far the ITI assessment team has completed four assessments, three reports are finished and one company has been debriefed. The reaction at the first presentation of an assessment was very positive. Initially the president of the company chided the Detroit Edison representative about how he would rather have Detroit Edison lower rates than offer programs like this one. However, after the presentation of the findings and recommendations, he commented on how helpful the assessment was. He was also pleased to learn about the energy efficiency incentives Detroit

Edison was able to provide. The major recommendation would save an estimated $80,000 in energy costs with a 2-3 year payback.

Representatives from Detroit Edison commented that they found the EEM approach beneficial. The environmental focus brings great value to the assessments and companies have been pleased with the work so far, although it is early to have any definitive results. There is some question whether or not the $15,000 will be an adequate incentive to get plants to implement recommendations. There is some sense that it might be enough to push a company into implementation if the project is not too large. Customers definitely respond positively to the financial incentive and DECO thinks that implementation rates will be higher with the incentive than it would have been without.

Conclusion

This project is an ambitious one, involving multiple partners. In retrospect it may be overly ambitious. The complexity of the project requires substantial time administering and trying to focus program activities. Inevitably things get missed and the program may not be as creative as it could have been. Two years is not adequate time frame to accomplish tool development, testing, and follow through with implementation. Focusing on one industry rather than three might have been more realistic as well.

The multiple partners, while contributing complexity, also provide a rich learning environment for all concerned. That fascinating and tantalizing observation that has emerged so far is that a manufacturing focus may not only deliver the biggest economic benefits for the facilities, but may drive the greatest energy efficiencies and waste reductions as well. One serious limitation of this project is not having funding for program impact analysis. The project was designed to create tools to help small and mid-sized manufacturers, yet the strongest marketing tool for the program itself is its impact on the companies it targeted and worked with. Without additional financing to follow-up and assess the results of the assistance provided these companies, there will be little available beyond anecdotal evidence to suggest how effective these tools are to the companies themselves.

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