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Evolving Pollution Prevention

sustain

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Cover Photo: Technology diffusion at work in process water management with conductivity controllers installed on a manufacturer's plating line.

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Evolving Pollution Prevention: From Grass Roots to Suits

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Since its conception in the late 1980s, pollution prevention (P2) continues to struggle to become the environmental management approach of choice for all organizations that use natural resources, consume energy and generate solid and hazardous wastes. It has become increasingly clear over the years that pollution prevention (P2) programs have been refocusing efforts to anticipate and meet new environmental challenges and maintain relevancy into the future in order to remain the service providers of choice. The evolution of successful pollution prevention (P2) programs has been a process of finding new ways to work with organizations, while accepting a realistic level of public awareness and involvement as a driver for environmental performance and P2 results.

With the exception of environmental activists and citizens directly impacted by industry activities (e.g., those living near chemical or wastewater plants), mainstream America is essentially apathetic about environmental issues and pollution prevention. Despite the commendable efforts being made to educate the next generation about pollution, climate change and the environment, consumers continue to have little say in what gets done environmentally from a broader, societal perspective. This is based on the fact that being a driver of environmental change requires a certain level of awareness, interest and effort, largely lacking in the public. Unfortunately, environmental concerns are just one thing competing for attention and it often falls very low on the average American's priority list. This isn't surprising when one considers the range of other significant factors competing for the average American's attention today – from the struggling economy to other pressures of everyday life such as job security, making sure dinner gets on the table, and taking the kids to soccer practice. While this establishes the public as an important target for pollution prevention awareness efforts, the lesson learned for the future is that environmental initiatives that require extra effort, a conscious decision or extra cost on the part of the consumer are not likely to advance very far. More environmental courses with a pollution prevention focus are emerging in all levels of the education system, and in the future, people may have a better understanding and appreciation for pollution prevention in the workplace and as consumers. For now, responsibility for pollution prevention and environmental achievements must rely largely on the evolution of pollution prevention (P2) programs and on an organization's ability to transparently incorporate environmental improvements into products and services without a loss in product performance or an increase in cost.

Defining Pollution Prevention (P2)

The evolution of P2 programs has been a progression from "grass roots to suits" – a cycle of pollution prevention culture developed at the local level that has moved to the centers of political leadership – with increasing acknowledgment, funding and respect. In the beginning, the mission and goal for state P2 programs was to help organizations prevent or eliminate environmental challenges at the front-end rather than managing them at the end of the pipe. Initially, the focus was on definitions and meanings e.g., What is P2? How does P2 function? Pollution prevention programs became bogged down with numerous iterations of the P2 definition which sparked significant debate over interpretation. Finally, we had it – almost. The Pollution Prevention Act of 1990 defined source reduction as "any practice that reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment or disposal." The act embraced a multimedia approach and went further to explain that pollution prevention meant feedstock substitutions, process and equipment modifications, product reformulation, and management practices or housekeeping alterations. From my own perspective, the most significant breakthrough was the EPA memo that stated: "P2 can also be defined as source reduction and other practices that reduce or eliminate the creation of pollutants through: increased efficiency in the use of raw materials, energy, water or other resources; or, protection of natural resources by conservation." For the first time, it seemed that pollution prevention programs and organizations could focus on overall resource management and contain or reduce cross-media pollution.

Still, P2 programs needed to develop a coherent and coordinated approach to environmental management and pollution prevention planning and programs that organizations could support. Several states required pollution prevention plans, while the rest adopted voluntary P2 plans and programs. Because some pollution prevention programs were volunteer-based, not based on regulatory requirements, pollution prevention programs were challenged to demonstrate the many benefits of incorporating P2 policies into business practices. The pollution prevention programs' role became one of promoting and cheerleading to inform organizations about how incorporating P2 policies made good business sense. Alternative measures, such as Governor's P2 awards and environmental leadership programs, also served as drivers for organizations to implement P2 and begin moving up the maturity scale toward sustainability.

Key elements of pollution prevention plans and programs included a P2 policy, waste assessments, development of options, opportunities and champions, setting goals, and measuring results. Pollution prevention fact sheets, checklists, and anecdotal stories for different sectors multiplied and P2 programs focused on being brokers of pollution prevention information through training and other media. During this period, many pollution prevention programs and organizations felt that the easily implemented and cost effective P2 techniques and methodologies were already in place – the "low hanging fruit had been picked." Unfortunately, the truth is that there are lots of low hanging fruit still to be picked or much of it already lying on the ground rotting. For pollution prevention programs to continue to evolve and succeed, P2 practitioners must accept the challenge of training and assisting organizations to be "better and higher fruit pickers." Pollution prevention programs, such as the Kentucky Pollution Prevention Center (KPPC), continue to expand and embrace other emerging global environmental concepts, such as sustainability, eco-efficiency, and cleaner production to help maintain the ongoing pollution prevention evolution as depicted in figure 1.

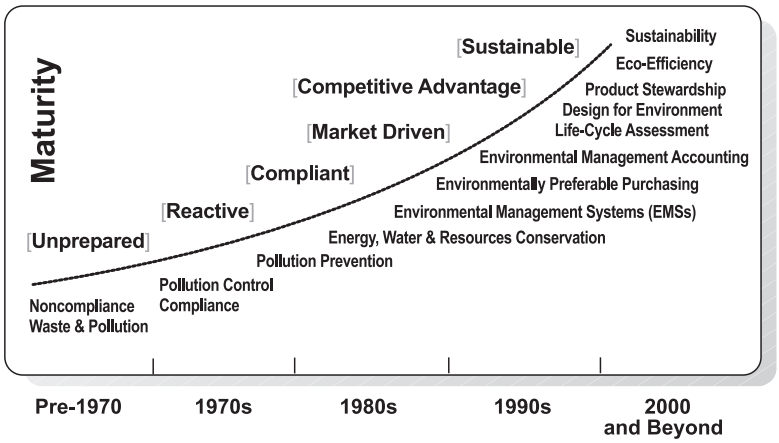
Setting the Stage for a Paradigm Shift

The early focus for pollution prevention programs was minimization. This minimization perspective was seen in P2 assessment reports as opportunities for reduction in the use and losses of materials, water, and energy. However, many organizations focused their perspective on optimization – increased market share, reduced set-up and cycle time, reduced defect and reject rates, and improved flexibility of production. This apparent divergence of perspectives actually moved pollution prevention programs into a new phase of evolution by forcing them to consider integrating P2 into existing programs within an organization. For example, how does pollution prevention fit into productivity enhancement, lean and six sigma quality management systems, preventive maintenance, inventory control, and product development? The stage was set for a pollution prevention program paradigm shift – a change in our programs' basic beliefs in order to achieve a major pollution prevention breakthrough for our customers. The old paradigm could be described as investigation and implementation of pollution prevention projects, usually accomplished with a champion from the organization's environmental department. The new paradigm called for long-term organizational change and an integrated systems approach that involved employees from a variety of the organization's departments.

The old pollution prevention paradigm of investigation and implementation focused on setting up P2 plans and programs, establishing new channels of communication, and implementing existing P2 opportunities. The long-term change paradigm began with a focus on integrating pollution prevention with existing programs, using existing channels of communication, and preparing for, and initiating, new P2 opportunities. While the initial focus was on information transfer, changes occurred that began to give way to information analysis and moved from creating pollution prevention awareness to promoting action. The initial premise for using pollution prevention program services for P2 projects was built on trust, but long-term change in an organization requires increased credibility of the program and its practitioners. Overall, the shift was from modifying existing activities to modifying the contexts and framework for manufacturing design, production, shipping, and afterlife of products and services.

The pollution prevention assessments also became more integrated when examining systems and practices to ensure that pollution prevention strategies were tailored to an organization's objectives and targets. The integrated pollution prevention assessment investigated manage-

Figure 1.



ment's goals and policies, its organizational structure, the amounts and types of planning and perspectives on current operations in order to determine management's commitment, priorities, and triggers for pollution prevention implementation. Purchasing and procurement methods and relationships with suppliers and quality assurance were examined more closely to determine the potential for more coordination and to establish a policy for environmentally preferable purchasing. Support functions and services within an organization were better scrutinized for cost accounting and overhead allocation, the capital budgeting process, training programs, and the quality program's methods and tools used by the employees. This information provided a more accurate cost for environmental management, a clear picture of the quality of resources available for pollution prevention planning and implementation, and ways to integrate P2 into quality improvement efforts. At this point, pollution prevention programs were performing P2 assessments that would soon be recognized as Environmental Management System (EMS) gap audits.

Promoting the EMS

The use of the Environmental Management System (EMS) by pollution prevention programs has slowly emerged and has now proven to be an effective operational tool for promoting and achieving P2 objectives and targets. The Kentucky Pollution Prevention Center (KPPC) has promoted the EMS "systems approach" for the past ten years as a framework for organizations to use in implementing pollution prevention and energy efficiency (E2) concepts and projects through continual improvement. The EMS has also evolved through lessons learned, but started initially aligned to the elements of ISO 14001. The initial focus for pollution prevention programs was to get management's attention and commitment to implement an EMS because, without such a commitment, an EMS is not possible. The mantra was "environmental management system," and leadership responded to the concept of improved environmental compliance and performance. Once an EMS is adopted, employee involvement is a must. However, the employees' concept of the EMS initially was "environmental management system," and they felt the environmental staff was responsible for implementing and maintaining the system. In order to get their involvement and commitment, the long-term viability of the organization to survive was tied to overall environmental performance, economic productivity, and individual and societal needs – the "triple bottom line" of sustainability. This stage of EMS evolution was called the "sustainability management system," and it recognized the need for sustainability as a core value that drives the long-range strategy for continual improvement of resource management and of an organization's economic survival. Sustainability is a criterion for determining the significance of an organization's environmental impacts and resource management.

During assessments, all systems and processes are analyzed to determine types, amounts and costs of wastes generated.

KPPC's latest version of an EMS is the "Environmental Sustainability Manage-ment System" (ESMS) that recognizes the need for sustainability as a core value which drives long-term strategic planning and resource management and uses the EMS as the operational tool to achieve annual environmental objectives and targets. Think of an ESMS as a construction project: sustainability is the structure you want to build; the sustainability strategy is the blueprint; the EMS represents the construction codes and standards; pollution prevention and energy efficiency are the choices to use the highest quality materials; and compliance is the foundation. Sustainability is the overriding environmental goal for pollution prevention programs and "higher fruit pickers," and the environmental management systems approach is the framework for meeting pollution prevention challenges.

Bringing in Technology Demonstration and Diffusion

About the same time the EMS emerged as an operational tool, pollution prevention programs began to implement technology diffusion to promote the use of innovative pollution prevention technologies. Technology diffusion or deployment is a method used to achieve adoption of pollution prevention solutions that are commercially available but have not achieved widespread market penetration. Organizations need technology education assistance to create pollution prevention technology awareness and promote understanding of technical principles. Therefore, pollution prevention programs began providing the market conditions necessary to address uncertainty issues associated with how to implement the technology. This is often accomplished through pilot trials at an organization's facility that builds confidence by verifying the effectiveness of the selected technologies

and demonstrates potential improvements in environmental performance and competitiveness. This pollution prevention program method is based on the University of Illinois Waste Management and Research Center's (WMRC) successful Accelerated Diffusion of Pollution Prevention Technologies (ADOP^{2}T™) program.

A technology diffusion initiative extends the pollution prevention assessment phase into more in-depth data gathering, better identification of proven pollution prevention technologies for organizations, and continued technical assistance during the implementation phase of the project. A key role for pollution prevention programs is linking technology and product developers with the end-users who are trying to solve real-world problems.

Technology diffusion at work in process water management with conductivity controllers installed on a manufacturer's plating line.

A primary goal of the technology diffusion approach is to document barriers to the implementation of innovative pollution prevention technologies and to document how those barriers were overcome. The pollution prevention programs that offer this type of assistance have focused on several sectors such as metal finishing, printed circuit boards, painting and coatings, and reinforced fiberglass plastics. The pollution prevention programs using this approach provide on-site technical assistance to the organizations before, during, and after implementation of these pollution prevention opportunities. Again, a special effort is made to assist in cost/operational justification, document barriers to be addressed, and ensure a commitment to adoption. It is important to mention that the principles of technology diffusion also apply to idea-based innovations, such as EMS and chemical management service programs.

Looking Ahead at Pollution Prevention

In the future, survival and competitive advantage will move pollution prevention programs into product life cycle assessment, design of sustainable products, and product stewardship. Pollution prevention programs must work with organizations to design and develop products that not only result in minimal environmental impact when manufactured, but also have a minimal environmental impact when disposed. Europe leads the way in this area and provides good examples of what must be done. European manufacturers of white goods (major appliances such as refrigerators and washing machines) demonstrate the design-to-disposal life cycle approach by: using paints with no more than 5 percent (by weight) organic solvents; using no cadmium, chrome, nickel or nickel compound plating; using plastics containing no substances based on cadmium, lead, mercury/mercury compounds, or chlorinate/brominated paraffins; using plastic parts labeled for ease of recycling at end-of-service life; requiring a plan that describes a method and estimates costs of disposing of white goods at end-of-service life; and packaging materials with no additives containing metals.

In the future, it will become increasingly important for pollution prevention programs and organizations to understand that it is more effective to prevent environmental damage and to prove there is no safer way of proceeding in production of products when adopting a guiding principle of cleaner production. This will require an integrated approach for resource use and consumption and an understanding that environmental risks cannot be shifted among workers, consumers or media – land, air and water. This multimedia approach to pollution prevention will ensure that source reduction of wastes occurs not just cross-media pollution where, for example, pollution control techniques remove air pollutants only to place them in water or solid waste streams.

In the post 9-11 era, pollution prevention programs now have an extraordinary opportunity to evolve and make a unique contribution to homeland security and provide a new driver for pollution prevention implementation. The time to design and implement a more preventive, risk-reduction approach based on pollution prevention protecting human health, the environment and community is now in this new arena of environmental security. Pollution prevention, energy efficiency and EMS assessments can be expanded into vulnerability assessments by adding cyber security into the process. Using pollution prevention methods, such as substituting less toxic materials in production, environmentally preferable purchasing, and process modifications, will result in organizations having less hazardous materials and wastes on-site and therefore, a reduction in vulnerability. This preventive approach will gain in popularity as organizations realize that simply responding to incidents as they happen may not be the best approach for protecting the environment, human health, and the community.

The job of informing and involving interested stakeholders in pollution prevention requires constant attention and change. Change management is the focus of many pollution prevention programs' new initiatives starting with EMSs, ener-

Assessors review hazardous materials usage to determine if opportunities for raw material substitutes are available to reduce risk and vulnerability in the workplace.

gy efficiency, design for the environment (DfE), and environmental security. While pollution prevention programs have accomplished a great deal through their evolution, there are still many challenges ahead in defining sustainable development within the context of pollution prevention. Through partnerships and pollution prevention, we can turn the considerable potential for sustainable development concepts into reality and success. Continued support is necessary to expand our pollution prevention programs' efforts to reduce generation of all wastes, use of toxic chemicals, improve resource conservation and management, and expand environmental security through pollution prevention.

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What if Technical Assistance Really Works?

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The Tool of Technical Assistance

Most people don't seem to know very much about the advent of technical assistance as a tool of environmental governance, unless they have sophisticated knowledge of environmental policy and programs, or they have received such assistance. But these programs have become a vital part of our system of environmental protection. Starting in the 1980's, state after state began developing technical assistance programs for pollution prevention (at that time, more commonly called "source reduction", or "waste minimization"). In 1990, every state in the Union had a program to help businesses reduce pollution by preventing it, rather than addressing it after the fact. In the beginning, these programs typically focused on hazardous waste but soon grew to address the use of toxics and how reducing that use can reduce air emissions, wastewater discharges, workplace exposures, transportation accidents, and toxics in products. In the 21st century, technical assistance programs usually comprise assistance in environmental management systems, water conservation, energy efficiency and clean sources of energy, solid waste reduction, other aspects of environmental sustainability, as well as pollution prevention or toxics use reduction.

What most people also don't seem to know is that these programs have been very successful. The association that represents professionals in this field, the National Pollution Prevention Roundtable, (NPPR), has estimated that perhaps 167 billion pounds of pollution has been prevented through the efforts of these really quite small agencies (often only a handful of staff)[1].

Integrated Strategies

Our view of the job of environmental agencies is still primarily that of enforcement.[2] Many in environmental policy, however, have envisioned a different approach, one of combining carrots and sticks. EPA's Office of Enforcement and Compliance Assurance (OECA), formally recognized the importance of assistance when it created a federal advisory committee on compliance assistance in the late 1990's and asked it for advice on how to coordinate assistance and enforcement. Many regions have experimented with various models. One notable example is EPA Region One's invitation to colleges and universities to work with EPA on a cooperative and voluntary basis, while noting the possibility of enforcement actions if necessitated. At the April 2004 Environmental Assistance Summit hosted by NPPR and EPA, OECA presented a framework for integrating strategies for addressing environmental problems that clearly recognized the value of relying not just on enforcement, but of using all the tools at one's disposal – including assistance.[3]

One useful image is that of "two-handed" environmental governance. This is a personal, relational way of sorting out the issue of how enforcement and assistance are best coordinated. Imagine officials from a government agency approaching you. They have their hand out, offering a handshake. They want to work with you. They have their other hand in reserve, the one that might give you a penalty slap. They don't lead with that, or you might learn to avoid their presence. (Leading with enforcement, however, might be necessary when it is foolish to lead with the outstretched hand, such as when there are persistent, knowing violations).

A sensible plan for integrating and coordinating assistance and enforcement avoids the downside of promoting assistance – which is that some have seen it as a replacement for enforcement. This use of the assistance and voluntary program is essentially deregulatory, and the association of assistance with deregulation is unfortunate. It is exacerbated by the fact that this tool has developed during a time of serious reductions in funding for traditional environmental enforcement.

This paper, which asserts that technical assistance has played a major role in recent progress, places it squarely in the context of enforcement. The Massachusetts program discussed herein has also been a complement to enforcement, and has depended on the existence of a strong enforcement program for its own success. The results seen here would not likely have been achieved if the assistance had not been provided against a backdrop of potential enforcement actions[4]. Those of us who have worked in assistance know that companies are most often willing to take our good advice when they recognize that there

could be serious consequences for poor performance in the environmental arena.

If technical assistance really works, our next move must not be to shift resources from enforcement. It is, rather, cause to design programs that make good use of both tools – an approach to environmental governance that uses a "fully equipped" toolbox.

The Importance of the Massachusetts Data

But does technical assistance really work? How effective can a voluntary effort really be? The 1989 Massachusetts Toxics Use Reduction Act (TURA) provides dramatic evidence that technical assistance for pollution prevention can be very effective. And what is seen in Massachusetts is very possibly true for many, if not all, of the other programs that have conducted similar activities.

That we don't see reports from other states such as that described herein is due to the fact that they do not impose requirements on companies to report toxics use. Massachusetts does. It is this that has enabled Massachusetts to show the results of its efforts. The only other thing unique about Massachusetts is that the assistance program is a bit larger than most – during the 1990's the MA Office of Technical Assistance (OTA) had from 20 to 30 employees, most of them engineers who visited companies. The state also has a companion program, the Toxics Use Reduction Institute (TURI), which does not have as a primary function providing direct, one-on-one assistance to companies as does OTA, but which does educate toxics users. TURI's assistance efforts for companies has been massive, including several annual training events, publications, and notably, laboratory services that companies can use to test out safer alternatives to toxic solvents. The state also has a well-developed toxics use reduction planning requirement, and large quantity toxics users must also pay a fee for their chemical use. All of these elements combined have made for a very strong state program. The data discussed below provides indications that this suite of tools has reduced more than a half-billion pounds of toxics.[5] The focus of the study reported in this article, however, is on what the TURA data tells us about OTA's one-on-one, direct, technical assistance.

OTA's staff visit companies on a voluntary basis, to help them review their chemical use, to help them come up with alternative chemicals, or ways to use less of what they use. The staff point out compliance issues if they note them, and assist the company in understanding their options about changes in processes, equipment, or materials. OTA helps companies to identify where the chemicals spill, leak, evaporate, or otherwise get lost or become waste. The office works with the companies to help them become more efficient in their operations.

It is possible to be skeptical, and people often are, that such a program could work. Why, you might say, would a company continue operating with wasteful practices, if they could save money – or stop costly losses – by changing them? And how, you might ask, could someone who doesn't even work in the industry, know what changes could be made, in a cost-effective way?

These are legitimate and compelling questions. However, those in the field, who have worked with companies in this voluntary way, have shared through the years, through NPPR and other venues, innumerable anecdotes about how well the approach has worked. See, for example, the websites of the pollution prevention assistance programs of – pick any state. They are filled with case studies and success stories. In each case, helpful, friendly people from the government, or government-supported organizations (perhaps out of the state university), have visited companies and found implementable options that have not just reduced pollution and toxic risk, but have also saved the companies some good money. These are not in short supply, and OTA is not very different in its methods or results from dozens of other programs all over the United States. What is in short supply is information that is other than anecdotal. Those who are tempted to be skeptical can always claim that these are inflated examples, or unusual, or that in some way our method of examination is selective and not representative or even particularly meaningful.

Because the Massachusetts data provides an objective way of looking at the effectiveness of one technical assistance program, perhaps we can see that as a representative example. If we discern a result there, perhaps we can understand that it might be a good indication that the success stories of other programs are meaningful signposts. The answer to the question of effectiveness should be of great importance to those who want our environmental programs to work. If confidential, business-friendly, pollution prevention and compliance-oriented one-on-one onsite technical assistance visits can dramatically reduce toxics use, should we not give more serious consideration to investments in this available tool for environmental progress?

Mass Balance Measurement

Large quantity toxics users in Massachusetts are required to report their use of toxic chemicals, as well as their byproduct – that which does not go into useful product. This provides a mass balance measurement. This is a very useful and far more accurate and precise method of measuring pollution prevention than tracking releases or waste generation. Those latter methods are simply output – just one side of what is really an input/output equation. The Massachusetts data gives you the whole picture, as well as production level data (a relative, not an absolute measure) that may be used for adjustment of the chemical use/byproduct numbers. (This production ratio is considered more reliable than the federal Toxics Release Inventory (TRI) production ratio, because in Massachusetts there are specific requirements that it be measured relative to the reported chemical use, extensive guidance has been provided, and a quality assurance effort has been implemented).

Therefore we can look at the chemicals used by each large quantity toxics user (Massachusetts Toxics Use Reduction Act thresholds are very similar to the thresholds for reporting to the TRI[6])

and determine, with a specificity impossible in no other state (except for New Jersey), that the chemical is now being used with more or less efficiency.

OTA has visited well over a thousand facilities, about half of them covered by TURA. But because OTA works confidentially and one-on-one with companies, few know what it has been able to achieve, beyond the case studies it has posted on its website, and the stories that have been told at its conferences and workshops. When budgetary cuts threatened the office, and the dedicated fund for its continued operation was eliminated, OTA realized it had to provide some assessment of whether or not it had been effective. Thus it embarked upon the analysis reported herein.

Two Kinds of Toxics Use Efficiency

We can look at two basic kinds of efficiency. Is more or less of the toxic chemical being used to make the same amount of product (Input efficiency)? Is more or less waste byproduct being produced for each pound of chemical used (Byproduct/use efficiency)? The first kind measures whether companies are able to substitute or use less of the chemical to make the same amount of product. In other words, if the company is using less of chemical X because it is making less of the product that contains chemical X, no reduction will show up. Only if the company is using less per unit of product made, will a reduction be measured.[7]

The second kind measures whether companies are able to use the chemical with more or less waste per pound used. It is independent of the production level.

Eliminating Distortions for Group Comparisons

Using the two measures of chemical use efficiency described above, OTA compared the performance of the companies with which it had worked, before and after it began working with them. It also compared the performance of the visited group with those who had never worked with OTA. The office used very simple methods of measurement, and then subjected the data to extensive review, and gave it to independent researchers to perform alternative, econometric analysis.

To avoid distortions from unreliable data, we did not use the data generated during the first years of the program, when a great many mistakes in reporting were made (This had the drawback of failing to capture the improvements OTA may have helped companies to make when the concepts of pollution prevention were new to them and there was much "low-hanging fruit". However, this simply makes our findings conservative estimates). During the examined period, 1993 to 2002, 612 facilities were in the not-visited group, and 443 had been visited (This is 90% of the 1172 companies reporting during the period 1990 – 2002, the entire period for which TURA data existed at the time of the study). The companies visited had entered 2699 chemical reports, and the companies not visited had entered 2216.

We multiplied the base year of reported chemical use – the first year the company reported use of the chemical – by the subsequent annual production ratios self-reported by the company. This generated an expected quantity of chemical use. These "expected pounds" were compared to the actual number of pounds of chemicals used in the examined year. This calculation is a best estimate, not a precise measurement of what toxics use has been avoided.

Chemicals no longer reported (used in amounts below the threshold for reporting) were counted by using the amount reported in the base year, the first year the chemical was reported by that facility. Some would say that a chemical eliminated in one year is a recurring annual reduction in all subsequent years. We employed a more conservative method and one better suited to comparing performance over time and among groups: counting reductions only in the year they occurred.

Dropouts (companies no longer reporting) that were not due to chemical reductions, but to changes in regulatory coverage, were not counted: chemicals and chemical categories that have been delisted from the TURA list were eliminated. Electrical utilities (38 companies in SIC category 49) were also eliminated, because reviewers felt utilities have qualitatively different chemical use patterns and requirements, and their quantities can be extremely high and act to skew the results.

Because variations from group to group could be dependent on the composition of that group, we developed percentage reduction measures. For example: the average pound reductions of a group with a lot of companies having small successes, but with very large amounts, could be much higher than those of a group with many companies having dramatic reductions, but who on average use much smaller amounts. We divided the use reductions in each year by the expected use in that year to produce a percentage reduction.

There were two groups of companies not visited by OTA: those never visited by OTA during the entire time frame examined, and those who would be visited later but had not yet been visited in the examined year. One could surmise that the willingness of a company to invite OTA in for a visit – and not the assistance provided - could account for differences in performance between visited and not visited companies. To correct for this, we compared already visited companies to those who would be visited later – (the "not yets") - both groups containing the kind of company that would ask for a visit.

We used "skew limits" to avoid measuring the performance of a tiny handful instead of the performance of the larger group of more typical population members (This is a problem when measuring average total pounds, and not when using the measures that are independent of size: percentage reductions, advancer/decliner ratios, and byproduct/use ratios). For example, we kicked out toxics users who reported over 10 million pounds of use.

We estimated the importance of the shut-down effect, which occurs when companies have dropped out of the system not because they are making their

products without a toxic chemical, but because they have closed their doors. We researched every visited company that reported chemical dropouts. We estimated that the maximum percentage of reduced pounds of toxics use that could be due to this was no more than one-sixth of reductions. We also calculated how the "just-below threshold" effect, where a company is no longer reporting but has not eliminated use – it is still using the chemical in quantities below the threshold for reporting. Assuming that the amount is "just below" provides the worst case scenario. We found that in most years the maximum of this effect was less than five percent.

For byproduct reductions, TURA reporting combines all kinds of waste - all nonproduct output - into one byproduct number, which includes the chemical that is emitted to air, discharged to water, or shipped in a drum – everything that is neither destroyed nor converted in process nor incorporated into product.[8] We calculated a "byproduct/use ratio" for each chemical, for each year. We compiled the byproduct/use ratios for all visited companies up to the examined year and compared the results to the performance of nonvisited groups in the same years. In order to measure how much change took place among the typical population members, we removed chemical reports that had zero or 100% byproduct in both the base and examined years, so that we could obtain a more accurate picture of the dynamic population, where change occurred.[9] When reducing input is not technically or economically feasible, the byproduct/use measure becomes the critical efficiency measure.

At the time of the analysis, information was available concerning 613 companies that had dropped out of the TURA system (A company can become a "drop out" by ceasing to have above threshold quantities of chemicals, by closing up shop or going to less than 10 employees, or because a chemical has been delisted).

The dropout population consisted of 179 companies visited by OTA and 434 that were not visited. To gain another indication of how visited companies performed relative to nonvisited, we compared the rates at which they dropped out because of TUR.

Close-in-time Analysis

In one phase of our analysis, we looked at performance in the three years surrounding the visit year. Looking at the changes that occurred in the discrete time frame surrounding the visit reduced the potential impact, inherent in a longer time-series evaluation, of other intervening factors. Also, OTA's recommendations are often practical solutions that can be implemented within a reasonable business time frame. The average changes in pounds reduced, and the average percent changes, were developed for both visited and not visited companies, and compared. As another comparative indicator of how groups fared, we looked at how many members of each group did better or worse. We called those who reduced their use more than in previous years *advancers*, and those who used more of the toxic chemical than before, (to make the same amount or less product than before), *decliners*. The ratio of advancers to decliners was calculated for each group, as well as the percentages that advanced and declined.

Before and After Analysis

Percent reductions were also calculated for all years for all companies, from 1994 to 2002 (the data included 1993, but it takes two years to develop an estimate of reductions, so performance results are recorded from 1994 on). All the performance measurements for visited companies were grouped into one large "before" and one large "after" population, and the average of each group was compared. The statistical test, analysis of variance (ANOVA), was applied to determine if the difference found in the average performance of these groups was significant.

To dilute the effect of potential factors occurring at a certain time, we grouped all the performance measurements in categories of numbers of years before and after being visited, and calculated the average performance of each time category. This reduced the importance of competing factors to which causation could reasonably be attributed.

Results

Being covered by TURA is associated with TUR improvements. Out of 4189 chemical reports, toxics use was reduced in 76.9% of reported chemicals - the ratio of advancers to decliners for all TURA chemicals was high - 3.75 to one. If the companies covered under TURA had continued to use chemicals at the same rate as when they began reporting to the public on such use, they would have used an additional 559 million pounds.

Tables 1a and b compare how much toxics use reduction the average visited companies accomplished in the year before being visited, to the year visited, and the performance in the year after being visited to previous performance. The year-to-year changes in amounts of chemicals reduced are comparative measures, not total amounts of reductions, and they are averages for each group (visited, never visited, not-yet visited). *OTA companies performed better after being visited than they were performing before being visited*. The year of the visit, an average of 20.5% more pounds than before, were reduced. The year after the visit, the average change was 15% more pounds reduced. These numbers are from 3 to 5 times higher than the comparable advances by the not visited groups in those same time frames.

The average change in terms of pounds was about the same magnitude higher for visited companies. In the year of the visit, companies reduced 5,114 pounds more than the year before. At the same time, those never visited only reduced 1,513, and those who would be visited later, but had not yet been visited, reduced 1,980. The year after being visited these differences are very similar: the pattern holds.

Looking at the ratio of advancers to decliners in each group, companies visited by OTA had 63.8% advancing the year of the visit, and 66.5% the year after.

Companies never visited had a ratio of 55.2% and 55.3% in the same time frames, respectively. Companies visited later (the "not-yet visited") had 56.9% and 55.8% advancers/decliners in those same years. *More visited companies showed improvements than those not visited*. See Fig. 1.

RATIO OF ADVANCERS TO DECLINERS IN EACH GROUP – CHEMICAL USE

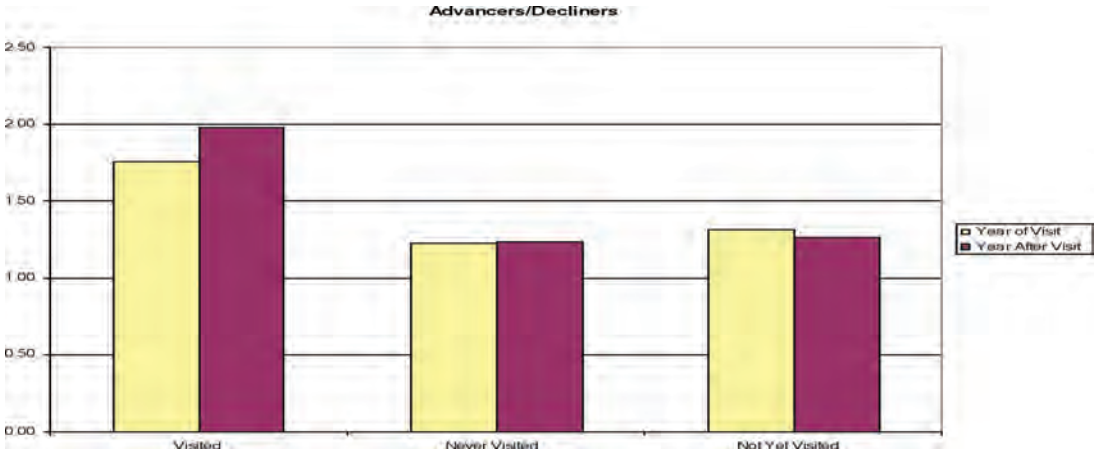

Figure 1. The ratio, in each group, of those who had more reductions ("advancers") in subsequent years, than before, to those who increased toxics use ("decliners"), compared to previous performance.

The total before and after analysis (1321 data points) showed that after being visited, 61% of companies were advancers, averaging 6.95% reductions in use. Before being visited, only 56% were advancers, and the population showed an average increase in toxics use of 2.49%. The statistical test confirmed that *the 9.44 percentage point difference was significant*, with a very high degree of confidence[10].

Of the nonvisited dropouts, 115 cited TUR as the dropout reason. This is 26% of the nonvisited dropout population. Of the visited dropouts, 83 cited TUR as the dropout reason. This is 46% of the visited dropout population. Adding in the dropouts for which we didn't have information on the cause of dropping out, the total is a possible 76% for visited companies who could have dropped out because of TUR. The maximum for the nonvisited is 45%.

The companies visited by OTA also had lower byproduct/use ratios in every year examined, than the groups not visited. In most years, the visited companies averaged less than half of what the other groups attained. Over all the examined years, an average of 10.3 pounds of every 100 pounds of chemicals used by the visited companies became nonproduct waste (10.3%). For those companies never visited, the average was 20.9%, and for those companies who would be visited by OTA but were not yet visited in the year examined, the average was 22.2%. See Fig. 2.

Independent Boston University researchers examined 25 chemicals for which there was a sufficient population of reporting companies in both visited and nonvisited populations. OTA visits were associated with a statistically significant decline in usage for eight of the chemicals[11] and in byproduct for two chemicals.[12]

The predominance of findings reveals a pattern of post-visit improvements, higher than the performance of unvisited companies, within the same time frame. Over all years, visited companies have consistently generated less waste per pound of chemical input than those not visited, and they get out of the program by doing TUR at a higher rate than those not visited. On all measures, the visited companies performed much better than those who would be visited later. Companies also had better performance after being visited, compared to their own past performance.

COMPARISON OF HOW MUCH USE BECAME WASTE BYPRODUCT

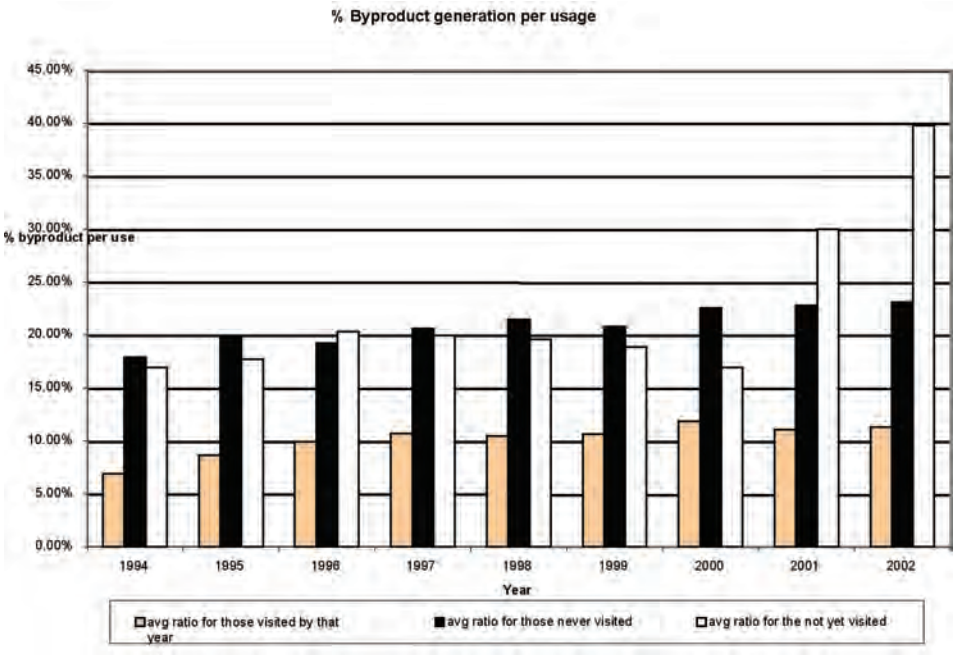

Figure 2. Average byproduct/use ratios for all three groups, for all companies up to the year examined.

In addition to finding this result in a variety of perspectives, the independent econometric analysis provided confirmation of the proposition that OTA's visits are associated with significant toxics use efficiency performance improvements.

The meaning of these results

What does it mean to avoid some significant amount of toxics in a state of 6.5 million people? An examination of the value of this result would have to account for the reduced likelihood that each of these inhabitants will be exposed to toxic chemicals. Their water and soil, their air, will be cleaner. There will be fewer accidents on the roads of the state. There will be fewer toxics in products, less hazardous waste to manage, and less toxic solid waste when the products are disposed. The costs to businesses to manage their compliance matters will be reduced. The potential liabilities for businesses, for accidents, toxic torts, end-of-life product disposition, and workplace exposures will all be reduced. The costs to government for managing the toxics use by businesses would be reduced as well – the costs of monitoring air pollution, wastewater discharges, hazardous waste movements, right-to-know, and enforcement for noncompliance: all reduced, because toxics use is at the root of all of these problems.

Perhaps the most difficult aspect to quantify, however, is the improvement in the way companies conduct business that often occurs when companies benefit from a pair of fresh eyes. The assistance programs provide this service. When someone from the outside takes a walk through a facility, and asks questions from the perspective of reducing unnecessary material use or waste, (or, as is now done, other resources such as energy and water), new ideas often emerge. The evidence of this is anecdotal, but it provides powerful suggestions of the value of technical assistance.

For example, one company visited by OTA was asked in 1990 if it had calculated the full costs of managing the toxic solvent cleaner it was using. These costs included the time spent on manifesting the waste and the cost of disposal; the time and cost of complying with air permit reporting, and with OSHA and Right-to-Know requirements; the energy used to ventilate the area where it was used; emergency planning; and the insurance necessary in the event of accidents and cleanups. When the company estimated how much it was spending for all of this labor, even without any serious mishaps, it decided it was actually cheaper to switch to a less-hazardous cleaner that cost more to purchase – but didn't have all those other ancillary costs. OTA recently revisited the company and found that it has continued to implement pollution prevention projects, using a life-cycle full cost approach.[13] The advice given in 1990 changed the way the company does its business, and it recently estimated that it has saved about $2 million over ten years as a result.[14]

Other examples involve changes that produced economic benefits far beyond the environmental cost avoidance. A printing company switched to ultraviolet-cured inks and didn't just avoid volatile emissions, but increased its available production time by 33%.[15] A metallic product company started regenerating instead of discharging its acids, and saved six jobs.[16] An electronics firm switched from ozone-depleting cleaners to an alcohol-based cleaner and found that its products were cleaned better than ever before.[17] Companies that take a new look at their materials and processes are reexamining assumptions that may need revising, and when they find new and better approaches, they often have lower reject rates, faster production times, or higher product quality. When they clear the air in the workplace, they often have more productive output. Company staff have limited time to do all the things they have to do. It is easy to miss these opportunities during the press of events, because they are usually not immediately evident, and often not directly relevant to the corporate mission. But what the many assistance program success stories show is that even when the importance is indirect, the results may still be very powerful for both the bottom line and the environmental and workplace contexts.

Social Intellectual Capital

A fully-implemented pollution prevention program, with expert assistance, is an investment by society in a very important intangible resource: it creates a common pool of shared knowledge. What technical assistance professionals observe on site helps them to help others, and design research and educational tools and events that help ever larger populations.

The social intellectual capital that results from assistance programs may be the positive outcome that is most difficult to quantify. The case studies, the guidance, the fact sheets and outreach developed by pollution prevention assistance programs all across the country are all visible indications that the pool of shared knowledge for developing a better and safer economy is growing. The analysis described above shows that the anecdotal information about pollution prevented by one assistance program is a true indicator that the program is indeed reducing toxics at the source. What course of action is thus most sensible, if the many programs producing success stories are likely also having a similar effect? Should we wait until they, too, can prove their efficacy, even though they don't possess the information to duplicate this analysis? Or should we surmise that all such programs likely merit closer consideration as key tools for effective environmental governance?

THREE YEAR COMPARISON – CHEMICAL USE REDUCTIONS

	Year of Visit	Year After
Visited in 1995	11.50	11.30
Never Visited	4.60	7.70
Not Yet Visited in 95	4.00	3.20
Visited in 1996	13.20	6.04
Never Visited	5.50	6.60
Not Yet Visited in 96	10.60	6.90
Visited in 1997	12.50	21.60
Never Visited	3.30	6.60
Not Yet Visited in 97	2.00	5.10
Visited in 1998	34.60	7.40
Never Visited	5.80	4.70
Not Yet Visited in 98	5.40	9.40
Visited in 1999	37.66	27.87
Never Visited	4.20	2.80
Not Yet Visited in 99	14.30	7.40
Visited in 2000	13.60	16.20
Never Visited	2.20	4.20
Not Yet Visited in 2000	0.70	-5.90
average, all years, visited	20.51	15.07
average, all years, never	4.27	5.43
average, all years, not yet	6.17	4.35

1a Percent Reduction

	Year of Visit	Year After
Visited in 1995	2,929	4,549
Never Visited	2,412	3,121
Not Yet Visited in 1995	1,028	545
Visited in 1996	4,459	2,278
Never Visited	2,093	2,808
Not Yet Visited in 1996	3,680	2,483
Visited in 1997	5,304	4,979
Never Visited	894	1,696
Not Yet Visited in 1997	1,095	1,418
Visited in 1998	5,255	4,805
Never Visited	983	789
Not Yet Visited in 1998	1,209	2,811
Visited in 1999	5,793	8,108
Never Visited	1,199	1,125
Not Yet Visited in 1999	4,150	1,787
Visited in 2000	6,945	6,943
Never Visited	1,496	1,315
Not Yet Visited in 2000	717	-3,554
average, all years, visited	5,114	5,277
average, all years, never	1,513	1,809
average, all years, not yet	1,980	915

1b Pounds Reduced

Tables 1a and b. Both tables compare the year of the visit and the year after the visit to previous performance. Successful reductions result in positive numbers. Negative numbers mean toxics use has increased. Table 1a compares the average percent change in use, and Table 1b shows the average number of pounds reduced. For example: for companies visited in 1995, the average percent change is 11.5, and 2,929 more pounds of toxics use were reduced, on average, than the year before the visit. The year after, the average percent change 11.3, and 4,549 more pounds were reduced.

Rick Reibstein has been working at the MA Office of Technical Assistance, on and off, since before it began. He worked in a predecessor office, the Office of Safe Waste Management (OSWM), and helped develop the specific activities and practices of OTA when it began, based on the successful pilot projects of OSWM. He teaches environmental law and policy at Boston University (and will soon be teaching at Clark, as well). He has served as an enforcement attorney at U.S. Environmental Protection Agency Region 1, and briefly at the MA Department of Environmental Protection. Reibstein would like to acknowledge the excellent work of MA OTA staff, and its directors who supported this work, as well as the many reviewers who assisted in the evaluation effort described herein.

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1 *An Ounce of Pollution Prevention is Worth Over 167 Billion Pounds of Cure: A Decade of Pollution Prevention Results*, 1990- 2000, 2003 (http://www.p2.org/p2results/2418_historyfinal.pdf).

2 Personal observation of the author, having worked in assistance for twenty years, derived from the continuing surprise expressed when people learn what he does for a living.

3 Delivered by Karin Leff, OECA, April 19, 2004, at: http://www.p2.org/summit2004/documents/Presentations/Integrated%20Strategies%20Workshop-2.ppt

4 About half of the companies with which OTA has worked have also interacted with the MA DEP. Although none are required to work with OTA, or required to do toxics use reduction to come into compliance, results showing the success of technical assistance should be interpreted, to some significant degree, as the success of an integrated strategy.

5 *The Effect of Providing On-site Technical Assistance for Toxics Use Reduction*, The Massachusetts Executive Office of Environmental Affairs, July, 2006, p. 31. http://www.mass.gov/envir/ota/publications/pdf/ota_effectiveness_study_final_2006.pdf.

6 As with TRI, the thresholds are 25,000 pounds per year when the chemical is manufactured or processed, and 10,000 pounds per year when otherwise used, and there are lower thresholds that apply for Persistent, Bioaccumulating and Toxic chemicals (PBTs). (Until 2006, the triggering of a lower threshold by an 'otherwise used chemical' caused the 25,000 pounds threshold for manufacturing or processing to drop to 10,000 pounds for all chemicals at the reporting facility, but this was changed for the 2006 reporting year).

7 This is not to disparage the importance of absolute numbers, it just has limited utility for TUR performance comparison.

8 TURA would not count as byproduct that which is managed as a useful raw material – even if not the originally intended use - if used or sold as is, or recycled in an integral fashion.

9 A few chemical reports that exceeded 100% were also eliminated. Looking at both years meant that the only data removed were "static" situations where all of the chemical became byproduct, or none of it did, and that never changed.

10 Using a skew limit of 500% change.

11 Acetic acid, acetone, ammonia, ethylene glycol, methanol, sulfuric acid, toluene, and 1,1,1 trichoroethane.

12 An average reduction of 28% was found overall. The as yet unpublished paper can be obtained from the authors, Robert Kaufmann of Boston University, kaufmann@bu.edu, or Rick Reibstein, rick.reibstein@state.ma.us.

13 Such an approach does not have to be time-consuming in and of itself. Even rough, back-of-the napkin estimates, as opposed to a very detailed life-cycle analysis, should be much more useful than ignoring all but up-front purchasing costs.

14 *Technical Assistance Revisited: Lightolier, Elimination of Trichloroethylene*, OTA, 2007: http://www.mass.gov/envir/ota/publications/cases/lightolier_tar_final.pdf.

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17 *The Merrimack Project*, OTA, 1995, available from OTA.

Technology Diffusion – An Approach for Demonstrating the Value of P2 to Enhance Deployment

By: John Sparks, Technology Diffusion Coordinator
Tom Wright, Technology Diffusion Specialist
Kentucky Pollution Prevention Center,
J.B. Speed School of Engineering,
University of Louisville

Pollution Prevention (P2) practitioners have long been baffled by industry's reluctance to implement P2 technologies. As research has shown, pollution prevention is a far more desirable approach than pollution control because it reduces initial consumption, reduces the need for control and disposal, cuts costs, improves environmental performance, and in the end is much more profitable.

Pollution prevention seemed to be such a win-win approach that early assistance providers were convinced that industry would be anxious to seek out and implement pollution prevention technologies and practices. Congress even passed the Pollution Prevention Act of 1990 to further support activities in the U.S., stating that pollution prevention was to be the nation's primary approach to environmental protection. The act was followed by a flurry of awareness activities and demonstrations supported by the Environmental Protection Agency and other environmental agencies. To everyone's surprise, industry's adoption of pollution prevention technologies was cautious and extremely slow. To begin to bring about change, another approach was needed. The Kentucky Pollution Prevention Center (KPPC) at the University of Louisville saw the need to directly demonstrate how implementing P2 activities can produce both environmental benefits and financial rewards for industries in Kentucky. To validate this approach, a specific effort was focused on the metal finishing sector with the introduction of the Technology Diffusion Initiative.

A New Approach — Technology Diffusion Initiative (TDI)

With a federal appropriation, the University of Louisville's Kentucky Pollution Prevention Center in partnership with the University of Illinois's Waste Management and Research Center (WMRC), the University of Minnesota's Minnesota Technical Assistance Program (MnTAP), the University of Kentucky's Kentucky Business Environmental Assistance Program (KBEAP), and the National Pollution Prevention Roundtable (NPPR) began using technology diffusion approaches to accelerate the adoption of innovative pollution prevention and energy efficiency (P2/E2) technologies in specific industrial sectors. The regional TDI partnership is following the Accelerated Diffusion of Pollution Prevention Technologies (ADOP2TTM) model developed by WMRC. Energy efficiency (E2) is included because it often compliments the pollution prevention effort. KPPC believes that introducing energy efficiency is timely because of the urgent need to conserve natural resources, particularly energy and water, and to reduce pollution and CO2 emissions that result from on-site or upstream energy generation using fossil fuels. Energy costs are also a rapidly growing component of a company's operating expenses.

In 2000, KPPC developed the Kentucky Metal Finishing Initiative (KMFI) to help implement pollution prevention technologies within the industry. KMFI worked with several metal finishing companies and their vendors to conduct demonstrations and launch pilot projects designed to illustrate the benefits of implementing proven technologies. In 2004, KMFI was rolled into KPPC's Technology Diffusion Initiative (TDI). Technology diffusion is the spread of technology to general use and wide application within a segment of industry. The TDI model used by KPPC is aimed at industry and is a multi-step, risk-reduction, confidence-building process that promotes market conditioning for technology innovations and practices. Traditional pollution prevention methods that simply promote P2 technologies have not resulted in a high level of implementation or acceptance by many industries. By introducing a TDI model that focuses on actual production processes, KPPC helps companies realize that pollution prevention is a profitable alternative to "end-of-pipe" pollution control because prevention measures can reduce waste, energy, water and natural resource usage, while lowering operating costs.

TDI starts with KPPC-hosted focus groups of industry experts that identify P2/E2 technology solutions to problem issues in their industry sector. The next step is to build confidence by verifying the effectiveness of the selected technologies with demonstration trials and extended field testing in actual production processes. To ensure credibility, KPPC partners with well-known and respected "opinion leader" companies for the in-process trials. This approach validates the technology's performance and mitigates the perceived risk of adopting innovative technologies. For unproven or emerging

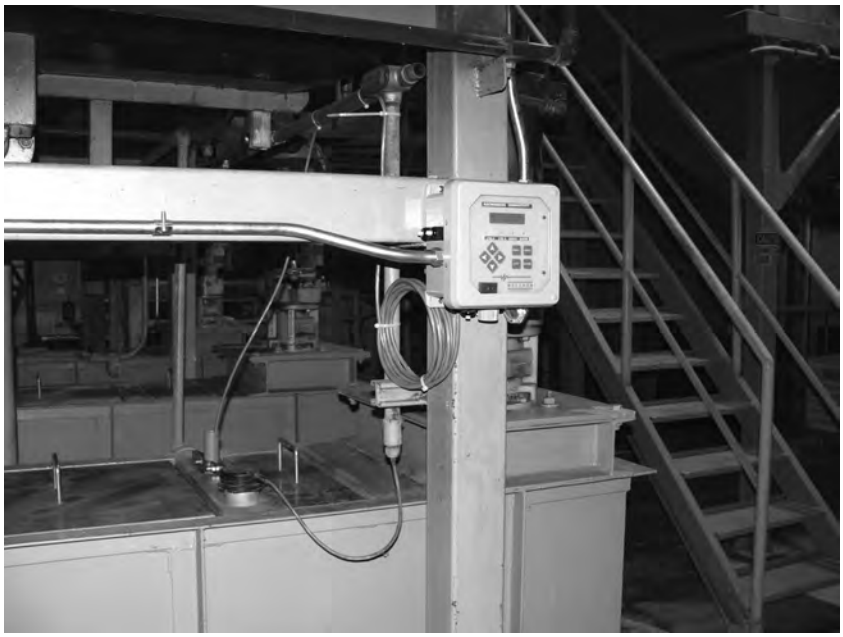
Figure 1 ADOP^{2}T^{TM} Program Process Map

technologies, KPPC uses research and development facilities that can test, improve, and confirm performance prior to implementation. A general process map describing how this could be applied to a given sector is presented in Figure 1. As shown, the model begins by working with various stakeholders - including government agencies, trade associations, vendors and consultants - to identify the best technologies and practices for an individual sector based on their current operations and interests.

Using the technology diffusion model, industry opinion leaders gain greater access to the new technologies firsthand. This knowledge and experience increases the likelihood that they will adopt these innovative technologies. Once the technologies are proven and accepted by these leaders, a critical mass is achieved and the marketplace often takes over. Through a team approach, the adoption becomes self-sustaining and often leads to assessment of additional opportunities. Following the TDI model, KPPC technical personnel identified process water usage as a common denominator between sectors and saw an opportunity to expand its technology diffusion efforts beyond metal finishing, painting and coating.

Technology Diffusion Initiative (TDI) In Action — KPPC's Process Water Management Program

In working with the metal finishers, KPPC found that many of the pollution prevention and cost reduction opportunities resulted from the efficient use of water in aqueous processes. One of the simpler, but often overlooked, technologies was the use of conductivity controlled rinse waters following various processes such as plating, etching and conversion coatings. However, plant owners and managers showed considerable resistance to using conductivity controls because earlier versions were not very reliable and were considered high maintenance devices. The general opinion within the industry was that these controls did not work, making companies reluctant to buy and implement them. Trials had demonstrated that the current generation of conductive controllers had overcome many of these problems and that the newer models are inexpensive, reliable, and very effective in managing rinse waters. KPPC's challenge was to convince industry opinion leaders to perform their own in-plant trials to demonstrate that the new controllers were reliable, effective and affordable.



A non-contact, torroidal controller installed on a plating line resulted in significant savings in water, labor, wastewater treatment chemicals and sludge disposal.

One company framed the challenge for us. The owner and CEO said they would be "gambling on pollution prevention" to buy and try a failed technology. KPPC was confident that the newer, non-contact, torroidal technology would perform and offered an innovative contract to the company that removed the

"gamble" perception. KPPC would buy the equipment for demonstration on one plating line on the condition that the company would reimburse KPPC if the equipment performed as expected and provided a one year or less return on investment. The company agreed to the trial and conditions and the results were even better than expected. By adopting this new technology for efficient water management, product quality was unaffected and the payback was realized in less than six months. The savings in water, labor, wastewater treatment chemicals and sludge disposal was so impressive, the company extended the rinse-water control technology to all five process lines. Although production has increased by 50 percent since implementation, water usage in the plant has steadily decreased from 1,000,000 gallons before improvements in 2002 to 690,000 gallons per month for the first-half of 2005 - a savings of 310,000 gallons per month (3.7 million gallons per year) and about $50,000 annually. Using this opinion leader as an example, this same technology was implemented at other metal finishing companies with aqueous processes and similar water use efficiencies and pollution prevention successes were achieved.

Business strategies built around the radically more productive use of natural resources can solve many environmental problems at a profit.

– Amory Lovins, Hunter Lovins & Paul Hawken, *A Road Map for Natural Capitalism,* 1999

Through market conditioning efforts, KPPC found that most companies assume that water is a relatively inexpensive component of manufacturing and not worthy of a significant management effort. They assumed the cost of water was simply the price of incoming water as metered. Through a team approach and utility bill analysis, KPPC demonstrated to them how the cost of water starts at the meter, then accumulates more costs as it passes through each process — finally incurring significantly more costs in waste water treatment prior to discharge. Once aware of these accumulating process costs, most companies had a totally new perception of water use costs verses the price of water.

With significant potential cost savings, KPPC determined the TDI methodology was evolving into an effective process water management focused program. In February 2007, KPPC rolled out the Process Water Management (PWM) Program and began working with five major companies. By process-mapping water use in these companies, KPPC identified water reduction opportunities and even more pollution prevention opportunities. Because the cost savings for P2 through efficient water management were beyond expectations, a behavioral change occurred — the companies became more proactive through teams and began identifying even more opportunities. In June, 2007, KPPC held its first workshop dedicated to PWM. Of the seven companies that attended, three are already in a PWM mode. Another workshop was held on August 29, 2007 and was attended by 7 companies and one person from USEPA.

Because of the success of the process water management efforts, KPPC anticipates taking the PWM approach to other sectors such as food processing, bottling, brewers, distillers, and paper mills in the future. KPPC's role will continue to be linking technology and product developers with the end-users that are trying to solve real-world problems. KPPC's partnerships with companies will continue to demonstrate how identified technology opportunities will improve environmental performance and competitiveness.

TDI –Process Water Management – Case Study: Akebono-Elizabethtown Plant

Editor's note: Results from pollution prevention (P2) and energy efficiency (E2) assessments conducted by the Kentucky Pollution Prevention Center (KPPC) are strictly confidential. The subject of this case study, Akebono-Elizabethtown Plant (formerly Ambrake Manufacturing, Ltd.), granted KPPC permission to publish the following information.

Akebono-Elizabethtown Plant, an automobile parts supplier in Elizabethtown, Ky., is one business that collaborated with KPPC and benefitted from the Technology Diffusion Initiative. Because many of Akebono's manufacturing processes are aqueous-based, water use management is important to the company.

One of Akebono's environmental issues was the amount of water used in the facility's electro-deposition paint line. Electro-deposition produces a high-performance, corrosion-resistance coating that is specifically required by the automotive industry. The process requires excellent cleaning followed by a zinc phosphate surface treatment prior to the actual coating process. Continuous overflowing water rinsing between these steps is an essential part of this precision, pre-paint surface treatment process, which uses thousands of gallons of water per day.

Drawing on previous experience, KPPC knew that non-contact torroidal conductivity sensors and controllers for rinses were reliable, required little maintenance and greatly reduced rinse water usage without sacrificing the quality of the product. KPPC's TDI personnel recommended that Akebono install the sensors and controllers in the freshwater rinses on their pre-paint surface treatment line.

KPPC proposed to purchase the equipment for a six-month trial, and if the equipment could pay for itself in 12 months or less, Akebono would reimburse KPPC for the purchase.

Akebono agreed to the proposal and began collecting baseline daily water usage data. Over a period of several months,

As illustrated in the photo, most metal processing companies use water intensive processes for surface preparation and plating.

the electro-deposition pretreatment line used an average of about 7,000 gallons of water per day in the rinses alone.

The new equipment was installed in December 2005. Following a two-week calibration period, daily reading began in January 2006. Water usage steadily fell over the next few months and stabilized by mid-May at an average daily usage of 2,700 gallons - a daily savings of 4,300 gallons or 60 percent. This also reduced the water flow to waste treatment, which reduced waste treatment chemical usage. With payback realized in less than one year, Akebono purchased the equipment and has already installed conductivity meters in another pretreatment line and plans to use them in its many other aqueous processes with overflowing rinses. The partnership and technology demonstration project has helped Akebono dramatically reduce water usage.

For its efforts in implementing sound environmental technologies in its day-to-day activities, products and services, Akebono was accepted into the Master level of the Kentucky Excellence in Environmental Leadership (KY EXCEL) program in 2006. KY EXCEL is a voluntary environmental stewardship program sponsored by the Kentucky Division of Compliance Assistance and recognizes and rewards initiatives that demonstrate commitment to improving environmental performance.

Akebono's other environmental performance accomplishments include:

- ✓ Certified as an ISO 14001-2004 facility.
- ✓ Implemented technology in waste treatment that will reduce zinc levels below the City of Elizabethtown zinc limit of 1.78 parts per million.
- ✓ Extended dump cycles to save even more water in the parts cleaner and rinses.
- ✓ Extended dump cycles in cleaner tanks, which reduces alkaline cleaner usage.

John Sparks manages KPPC's Technology Diffusion Initiative. John spent 10 years at U.S. EPA Headquarters, Office of Air and Radiation (Stratospheric Ozone Protection) and Office of Pollution Prevention and Toxics (Design for the Environment Program). He also has 20 years of industrial experience mostly with in-process finishing operations that used metal working, metal painting and metal finishing techniques.

He holds a Bachelor of Science degree in chemistry from the Ohio State University and a Master of Business Administration degree from Miami University (Ohio).

Thomas J. Wright, Technology Diffusion Initiative Specialist. Tom has 30-plus years of experience in manufacturing, which includes developing and coordinating environmental health, safety and maintenance improvement programs. He has extensive knowledge in cost saving programs, training program development, regulatory applications, financial and management auditing, quality improvement programs, shop floor maintenance and managing through teams.

Tom received his Bachelor of Arts degrees in Political Science and English from Brescia University of Owensboro, KY. He is a Certified Hazardous Materials Manager (CHMM), ISO14000 Auditor and a Radiation Safety Officer.

Green Suppliers Network: Strengthening and Greening the Manufacturing Supply Base

Helping the small companies that supply America's large manufacturers

by Heidi R. Karp
Green Suppliers Network Program, Pollution Prevention Division of the U.S. Environmental Protection Agency

As large manufacturers increasingly rely on lengthy supply chains, the environmental impacts of suppliers continue to grow. A voluntary program called the Green Suppliers Network is helping provide suppliers with on-site technical assistance that aims to improve their process efficiency, business profits, and environmental performance. This article explains the program's innovative design, how the program works, and the results it is achieving.

The Changing Business Model for Manufacturers

Corporations have changed the way they do business over the past 20 years. In an effort to cut costs, America's largest manufacturers began outsourcing some of their production to smaller companies, both within and beyond the U.S. borders. As a result of this changing business model, large manufacturers have developed lengthy supply chains that often include hundreds, or even thousands, of small manufacturers.

According to the U.S. Bureau of Labor and Statistics, in 2002 there were 344,188 manufacturing establishments in the United States[1]. Almost 90 percent of these establishments meet the Small Business Administration's definition of "small business" (having 500 employees or fewer per facility).

Small manufacturing establishments account for 6 million (out of a total 14 million) people employed in U.S. manufacturing. While this number includes both small companies and smaller facilities within larger manufacturing corporations, it is clear that most U.S. manufacturing occurs in small facilities.

As a result of the structural changes that have occurred within industry, large manufacturers are dependent on the productivity and solvency of their small and medium-sized manufacturing suppliers in ways they never were before. Ironically, as this dependency has increased, the length and complexity of supply chains is causing the entities involved to become more segregated.

In most cases, large manufacturers have little or no contact with their lower-tier suppliers. This can create problems for manufacturers because, even while outsourcing disperses environmental impacts throughout the supply chain, the public still holds large manufacturers responsible for the environmental effects of their final products and components.

Large companies are now recognizing their connection to the cumulative environmental footprint of suppliers. Notes Harold Kutner, group Vice President of Worldwide Purchasing and North American Production Control and Logistics for General Motors, "Working together with our suppliers, we can accomplish much more to improve the environment than GM can alone."[2]

Large manufacturers have the financial and technical resources to ensure that they are including environmental considerations in their manufacturing decisions, but they do not have the resources needed to reach out to their entire supply chain.

Large companies are now recognizing their connection to the cumulative environmental footprint of suppliers.

Corporations are also mindful of the legal liability issues that may be involved. If a large corporation tells a supplier to make a particular change on the factory floor, and the change results in an occupational hazard, the large corporation ultimately could be held responsible.

Small suppliers often do not have adequate resources to devote to environmental issues, as they are constantly being pressured by their customers to cut costs and remain competitive. Yet as more industrial sectors have turned to small manufacturers for components, the cumulative economic and environmental impact of small suppliers has grown, and will continue to grow.

Keeping Pace with Business

In this changing marketplace, a question arises: How can large manufacturers help their suppliers remain competitive and efficient, while also ensuring that they operate in an environmentally sound manner? The Green Suppliers Network offers a solution.

Small manufacturers need on-site help to reduce waste and improve environmental performance. That's where the Green Suppliers Network comes in. The Green Suppliers Network is a voluntary program, jointly sponsored by industry, the United States Environmental Protection Agency (US EPA), and the United States Department of Commerce (US DoC).

The Green Suppliers Network provides assistance on lean manufacturing and pollution prevention to small and medium-sized manufacturers through on-site technical reviews. These dual-focused reviews identify and quantify operational and environmental improvement opportunities that can help companies create effective processes and products, generate higher profits, and reduce environmental impacts.

Establishing the Business Case for Change

Small manufacturers rarely have resources to devote to environmental issues. The key to getting small manufacturers to pay attention to their environmental footprint is to demonstrate that reduced environmental impacts can improve their bottom line.

Many manufacturers acknowledge the benefits of lean manufacturing, a paradigm that aims to eliminate all non-value-added activities and wastes through continuous improvement. Lean manufacturing benefits include:[3]

- reduced cycle time;
- reduced inventory;
- reduced work-in-progress;
- reduced costs;
- increased capacity;
- improved lead times;
- increased productivity;
- improved quality; and
- increased profits.

Many of these benefits can be expanded by including environmental considerations in the lean manufacturing approach. This expanded strategy, which is referred to as "clean manufacturing," involves broadening the definition of waste to include air and water emissions, solid and hazardous waste generation, and toxics use.

The results attained by combining "lean" and "clean" manufacturing into one approach can be staggering: savings to individual companies in the hundreds of thousands of dollars, improvements to production efficiencies, and enhancement of overall environmental performance.

GM Saturn Pilot Results

In 2001, a Green Suppliers Network pilot project with General Motors (GM) Saturn Corporation found that four supplier manufacturing facilities could realize over $1 million in cost savings by implementing environmental and operational improvement opportunities identified during the program's review process.[4]

The review generated 16 improvement recommendations, almost all of which were capable of creating direct cost savings for the supplier facilities. In addition, five of the opportunities also offered direct cost savings to GM. Twelve of the 16 opportunities were related to environmental improvements.

The Green Suppliers Network's Innovative Approach

Clearly, the Green Suppliers Network offers an important option for supplier manufacturing facilities. The issue then becomes: How can the program reach the many small suppliers who could benefit from assistance?

Partnering with NIST MEP

To meet this challenge, US EPA has paired with the U.S. Department of Commerce National Institute of Standards and Technology's Manufacturing Extension Partnership (NIST MEP) program. NIST MEP centers are the nation's leading provider of lean manufacturing technical assistance to small and medium-sized manufacturers.

NIST MEP centers usually derive one-third of their funding from the federal government, an additional one-third from the state government of the jurisdiction where they are located, and one-third from fees for their services.

With 60 centers located throughout the United States, and nearly 1,500 field staff, NIST MEP has a strong national presence. NIST MEP ensures that each MEP center has a core set of competencies in lean manufacturing, and that the program offers consistent service in each state.

NIST MEP centers are the nation's leading provider of lean manufacturing technical assistance to small and medium-sized manufacturers.

Combining Lean and Environmental Expertise

A Green Suppliers Network lean and clean review team usually consists of one MEP lean expert and one environmental expert. In most cases, the environmental expertise is augmented by each state's technical assistance providers (TAPs). The various state TAPs have different areas of focus (including pollution prevention, waste minimization, and energy efficiency), but all are well versed in the concepts of process improvement and material substitution.

By combining these two skill sets (lean and environmental), Green Suppliers Network reviews offer small and medium-sized manufacturers a unique opportunity to identify operational and environmental solutions simultaneously.

Reaching Out to Smaller Companies

The next issue involves how to identify and encourage participation by thousands of smaller manufacturers, many of which operate below the radar screen. The Green Suppliers Network uses an innovative top-down approach: working with large manufacturers (also known as original equipment manufacturers, or OEMs) to identify, and drive the participation of, small and medium-sized manufacturing suppliers.

Perhaps the greatest attraction of the Green Suppliers Network program is that all cost savings resulting from implementing review recommendations remain with the suppliers themselves.

In some cases, suppliers are also recruited using a bottom-up approach, as states and MEP centers use their existing relationships with companies to encourage participation.

Aligning Interests

The Green Suppliers Network offers a successful model for strengthening and greening company supply chains because it aligns the interests of suppliers, OEMs, state governments, and federal government agencies.

The program offers a way for suppliers, OEMs, and government agencies to work collaboratively to improve the environmental and economic impacts of the supply base through fostering a commitment to continuous improvement.

Suppliers

Despite their limited resources, suppliers are willing to participate in Green Suppliers Network review because it offers low-cost, on-site technical assistance in lean and clean manufacturing, which can add to their bottom line.

While lean manufacturing is a paradigm that has existed in industrial practice for several decades, many small manufacturers do not have the resources to pay for on-site assistance that can help them take advantage of lean methods. Green Suppliers Network review offers a low-cost, hands-on solution.

The review process focuses training on a single process line at the supplier facility but allows employees to learn how to apply lean and clean methods to other process lines as well. Steve Beurkens, a manager at H&L Advantage, a small injection-molding manufacturer located in Grandville, Michigan, states that because of the on-site training that occurred during his company's Green Suppliers Network review, "We are now able to start new events ourselves. . . The lean and green principles have become our way of doing business for everything we do at H&L, and it's now in our DNA."

Perhaps the greatest attraction of the Green Suppliers Network program is that all cost savings resulting from implementing review recommendations remain with the suppliers themselves.

Typically, a Green Suppliers Network review costs the supplier about $7,000.[5] The return on that investment generally is greater than three-to-one.

While suppliers are not required to share these cost savings with their customers, having the extra cash affords them the opportunity to remain competitive and grow their businesses.

Suppliers also like the fact that their largest customers, the OEMs, are involved in the process. In some cases, customer specifications are among the main factors that hinder supplier improvements in efficiency and environmental performance. A Green Suppliers Network review can serve as a third-party confirmation of the nature of such barriers, while also providing a forum for small suppliers to work with their large OEM customers to remove the barriers.

An important part of the Green Suppliers Network program is ensuring that all facility-specific information remains confidential. All facility review reports remain with each MEP center, and OEMs and US EPA view only aggregate data. This ensures that OEMs cannot identify a specific supplier's results and ask the supplier for cost reductions based on them. Facilities can decide to share their individual results with customers and with US EPA, and some have done so.

OEMs

OEMs agree to participate in the Green Suppliers Network program because the health and financial stability of their supply-chain manufacturers is integral to their own success.

Many OEMs want to help their suppliers operate more efficiently and achieve better environmental performance, but they do not have the resources to help all the companies in their supply chain. Participating in the Green Suppliers Network enables OEMs to leverage governmental resources and

expertise to assist their supply-chain members. Says Mary Ellen Mika, a manager at Steelcase:

"The Green Suppliers Network is an extension of our in-house efforts to continuously improve. We see it as a 'win-win' for Steelcase and our suppliers. If waste—and therefore unnecessary cost—can be removed from our suppliers' processes, that translates into a stronger supply chain, which is good for both of us."

Competitive suppliers create and retain jobs in the community, thus having a measurable positive impact on the state's economy.

The Green Suppliers Network program also enables OEMs to reconnect with their lower-tier suppliers, with whom they otherwise might have little contact. The aggregate results achieved by small supply-chain companies offer OEMs confidence that their suppliers are working to improve their operational and environmental performance.

State Governments

State governments support the Green Suppliers Network program because it offers their state's manufacturers the expertise and know-how they need to remain competitive in the global marketplace. Competitive suppliers create and retain jobs in the community, thus having a measurable positive impact on the state's economy.

The program also assists state environmental regulatory agencies, as the Green Suppliers Network becomes a delivery mechanism for pollution prevention information and resources. According to Laura Rauwerda of the Michigan Department of Environmental Quality (DEQ): The Green Suppliers Network encourages the leveraging of waste reduction and environmental management programs in such a way that both federal and state expertise on these topics may be shared with industries of any size to assist them in successfully achieving their production performance goals while improving their profitability and strengthening relationships.

Federal Government Agencies

The Green Suppliers Network program helps fulfill the missions of US EPA and US DoC to improve the environmental performance and economic vitality, respectively, of American manufacturers. While suppliers may be small individually, the cumulative economic and environmental footprints of the supply base are large within the nation's communities.

How the Green Suppliers Network Operates

Getting Started

Program participation generally begins with a large manufacturer or OEM approaching Green Suppliers Network staff at US EPA or US DoC to learn more about the program and start the process of joining it.

Next, Green Suppliers Network personnel work with the company to educate staff in its environmental, purchasing, and supplier development departments about the program. In some cases it has become apparent that the environmental, health, and safety (EHS) and purchasing departments at these companies have had minimal interaction prior to their participation in the Green Suppliers Network program.

By involving all levels of employees, the Green Suppliers Network review team is able to obtain the input needed for process change, in addition to getting worker buy-in.

Once connections have been made, all groups meet to decide what kind of suppliers to nominate for program participation. A company can decide to target suppliers based on a number of factors, including product lines, financial stability, a history of environmental challenges, likelihood of participation, or a desire to meet other OEM corporate goals (such as reaching out to minority-owned suppliers).

Involving Suppliers

Once suppliers are invited and have committed to participating in the Green Suppliers Network program, a MEP lean expert and (usually) a state pollution prevention expert meet with the supplier to identify and prioritize issues and implement solutions that can achieve business and environmental results.

• Understanding the Process

The review looks at one process line per facility. The first step in the review process seeks to understand the current state of the process. This involves a benchmarking exercise and "walking the floor" to understand how the company's financial and operational performance compares with the performance of others in its sector.

By involving all levels of employees, the Green Suppliers Network review team is able to obtain the input needed for process change, in addition to getting worker buy-in.

• Mapping the Current Process

The next step involves training the facility team on how to create a value stream map and process map showing the current state of the process.

A value stream map is a lean tool that is "used to create a material and information flow map of a product or process." [6] The map begins with raw materials and continues through to the final product. It aims to identify places where value is lost or gained through a set of activities.

A process map is a tool that evaluates the inputs and outputs of a process to identify waste generation.

• Creating "Future-State" Maps

Once the current state of the process is mapped, the Green Suppliers Network review team helps suppliers create future-state value stream maps and process maps indicating how the process is to be improved. This empowers suppliers to align and prioritize their operational goals.

• Final Report

Review team members then generate a final report that lists operational and environmental improvement opportunities and evaluates these opportunities in a cost-benefit analysis. This information remains with the supplier, who can then implement the opportunities based on its own priorities.

Implementation Incentives

In order to help ensure that suppliers have the resources to act on the opportunities identified in their reviews, the Green Suppliers Network offers implementation incentives. Suppliers are eligible for a $1,000 implementation credit if they begin working on an environmental project within three months of the Green Suppliers Network review.

The Green Suppliers Network also helps suppliers on industrywide environmental issues, such as packaging (in the automotive sector) and toxics use reduction (in the office furniture sector).

Companies Participating in the Green Suppliers Network

The Green Suppliers Network began in 2001as a pilot project in the automotive sector, working with General Motors.[7] Since the pilot's initial success, the program has grown to include 24 OEMs in the aerospace, office furniture, and health care/pharmaceutical sectors. While these companies are in various stages of program participation, collectively they have already identified 103 suppliers that they would like to see participate in the Green Suppliers Network program. An additional 35 suppliers are either in-process or are finalizing plans to complete reviews.

Getting Results

Since the pilot project, 29 suppliers have undergone Green Suppliers Network review. Exhibit 1 shows aggregated results identified during the supplier reviews that had been completed as of October 2005.

These results include estimates for one process line per facility only. They do not include the benefits that can be achieved when the identified improvement opportunities are applied to additional process lines within the target companies.

Exhibit 1. Potential Financial and Environmental Savings Identified from Green Supplier Network Reviews*

Value of Environmental Impact Savings	$4,305,161 per year
Energy Conservation (MM Btu/kWh)	221,789/64,983,720
Water Conservation (gallons)	8,930,459
Air Emissions Reduction (lbs)	81,200
Solid Waste Reduction (lbs)	573,669
Hazardous Waste Reduction (lbs)	2,700
Toxic Hazardous Chemical Use Reduction (lbs)	600
Water Pollution Reduction (gallons)	128,250
Value of Lean Opportunities	$12,375,349 per year
Value of Other Cost Savings Opportunities	$189,193
Total Potential Impact	$16,869,703 per year
Value of One-Time Lean Opportunities	$8,421,466

* Aggregate results for 29 supplier reviews completed as of October 2005.

Case Study: Medegen MMS

Many supplier participants currently are working to implement recommendations made during their Green Suppliers Network reviews. One such company is Medegen Medicine Manufacturing Services (Medegen MMS) of Ontario, California. In the spring of 2003, Medegen became the first health care supplier to undergo Green Suppliers Network review.

The company, a supplier of injection-molded parts to the health care industry, employs 180 workers. After being invited by one of their largest customers to participate in a Green Suppliers Network review, Medegen assembled a cross-functional team that included material managers, representatives from accounting, engineering, and quality control, and manufacturing floor employees to participate in the process.

As part of the Green Suppliers Network review team, California Manufacturing Technology Consultants (local MEP experts) worked with Medegen to identify 13 lean and clean improvement opportunities. In less than two years, Medegen implemented nine of the review recommendations, realizing significant cost savings and environmental improvements in the process. Medegen's accomplishments include:

- Investing in six energy-efficient injection mold presses. This enabled the company to retire 14 old presses and eliminate 660 gallons of hydraulic oil waste.
- Changing the injection-mold cleaning method to one that uses ultrasonic cleaning tanks and a mild citric acid cleaner. This change reduced hazardous waste generation by 50 percent. By eliminating the need for kerosene, acetone, and cleaning cloths, the company also saved the costs associated with waste removal.
- Replacing the water cooling system with a machine that responds to actual cooling demand requirements. This modification reduced Medegen's electrical energy consumption and costs by 2.3 percent annually.
- Changing the way the facility internally packages products for reuse in its operations. This change greatly reduced the facility's generation of cardboard and plastic waste.

Case Study: H&L Advantage

In addition to realizing direct cost savings and achieving environmental improvements, some companies experience collateral benefits through participation in the Green Suppliers Network program. This has proved to be the case for H&L Advantage, a small injection-molding manufacturer located in Grandville, Michigan.

The Green Suppliers Network program offers on-site technical assistance in lean manufacturing and environmental improvement to small and medium-sized companies that supply to large manufacturers.

Through the Green Suppliers Network review process, H&L Advantage worked on site with Michigan DEQ and The Right Place, Inc., West Michigan's MEP center. These experts in lean and clean manufacturing techniques helped H&L Advantage identify over a dozen improvement opportunities. In addition, H&L Advantage credits the Green Suppliers Network with helping it achieve the following:

- Remaining competitive with its customers: H&L Advantage has committed to implementing most of the recommended lean and clean improvement opportunities over the next year. These opportunities, when fully implemented, could save the company 10 to 15 percent in operating costs. After realizing the potential savings that could be gained from implementing these opportunities, H&L Advantage plans to offer cost controls, and possibly even cost reductions, to its customers.
- Integrating lean techniques into its operations: After at least two previously unsuccessful attempts to implement lean principles using only its own resources, H&L Advantage believes that the Green Suppliers Network on-site training approach made it easy for them to learn, apply, and implement lean techniques within their facility.
- Accessing state pollution prevention resources:

As a small business, H&L Advantage was not aware of the information, resources, and assistance programs that were available to them from US EPA and Michigan DEQ.

Since working with these agencies through the Green Suppliers Network, H&L Advantage plans to take advantage of a number of state programs, including a DEQ intern program that will support implementation of opportunities discovered during the program review process.

Conclusion

The Green Suppliers Network program offers on-site technical assistance in lean manufacturing and environmental improvement to small and medium-sized companies that supply to large manufacturers. By helping to align the interests of many key players (including suppliers themselves, their large customers, and state and federal government agencies), the program offers important resources for companies that are dedicated to greening their supply chain while improving their bottom line.

Participation in the program is the first step in helping suppliers improve their environmental performance, become more competitive, and focus on continuous improvement. As the manufacturing business model continues to evolve, the Green Suppliers Network will continue to help ensure that the U.S. manufacturing supply base has the resources it needs to remain lean, green, and competitive.

Acknowledgments

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University of North Carolina at Chapel Hill, and is currently pursuing a Juris Doctor degree at the George Washington University Law School.

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5. US EPA currently offers a $2,500 subsidy for suppliers who commit to review. The subsidy will be offered only during the initial stages of the Green Suppliers Network program, and while funds are available.

6. See note 3.

7. The automotive group has formed a trade association to manage its Green Suppliers Network activities. For more information, see www.supplierspartnership.org

For More Information

For more information about the Green Suppliers Network, visit the program Web site at

www.greensuppliers.gov.

Working up the P2 chain with packaging

By:
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ASRC

The P2 waste hierarchy of elimination, reduce, reuse, recycle, landfill is well known by many environmental professionals. The difficulties of this hierarchical list of pollution prevention alternatives are to challenge situations which might be improved and to find the best solutions that meet business needs and cost requirements. In this article, the authors discuss the challenges which have been faced by one Kentucky company trying to improve its pollution prevention performance with the waste stream associated with the packaging of its manufactured product.

American Synthetic Rubber Company(ASRC) is located in Louisville Metro in southwest Jefferson County, Kentucky. First constructed by the US government in 1943 to produce synthetic rubber to support the war effort, the company is now a division of Michelin North America, Inc. The site's 350 employees produce synthetic rubber polymers for use in tire manufacturing and for use in fuel rocket engines for space flight. The company became ISO 14001 certified in 2000 and is part of the Kentucky EMS network through the Kentucky Pollution Prevention Center. The company was the first in Jefferson County to become a member of KY Excel, Kentucky's environmental leadership program and the first chemical company in Kentucky to be accepted into EPA's National Environmental Performance Track program.

ASRC's main products are 75 pound bales of synthetic rubber packaged together in one ton containers. ASRC ships the containers to tire manufacturing sites throughout the United States and the world.

The Initial Problem

In the mid-1990's, ASRC began to see a sharp increase in quality complaints from its customers due to packaging issues. Its bales of rubber, wrapped in a meltable film, were breaking through the film and sticking to the cardboard containers. The customers were having difficulty unloading material from boxes without paper contamination. The 1 ton containers consisted of a large sophisticated cardboard box design on a wooden pallet. Several customers requested that the company stop the use of cardboard containers and wood pallets – a source of possible contamination to their processes.

At this time, ASRC was disposing/ recycling more than 5 million pounds of cardboard and wood pallets per year. A few years previous to this, the company had begun a packaging return program of the cardboard containers for domestic customers. This allowed for an overall packaging waste reduction as the cardboard containers could be reused one or two times. During this period, ASRC developed and implemented an environmental management system which was certified to the ISO14001 standards. As part of the environmental management system, significant environmental aspects of plant operations were identified and rated as to their significance. Wastes from cardboard and pallets became one of the significant operational aspects of the plant.

Solution Approach

This problem was found to be a common issue among various synthetic rubber manufacturers most of whom had standardized the use of cardboard containers in the industry. A series of possible solutions to the problem were tried over several years, many with negative or mixed results. Tested solutions included various metal containers, plastic containers, and some modified cardboard containers. Finding a design to adequately hold a semi-solid product that could meet customers quality demands, hold up to the strenuous demands of nationwide shipments, and meet requests to be reusable proved to be too much of a challenge for many suppliers of packaging products. Ultimately, a solution using lightweight aluminum containers was found.

Cardboard shipping container.

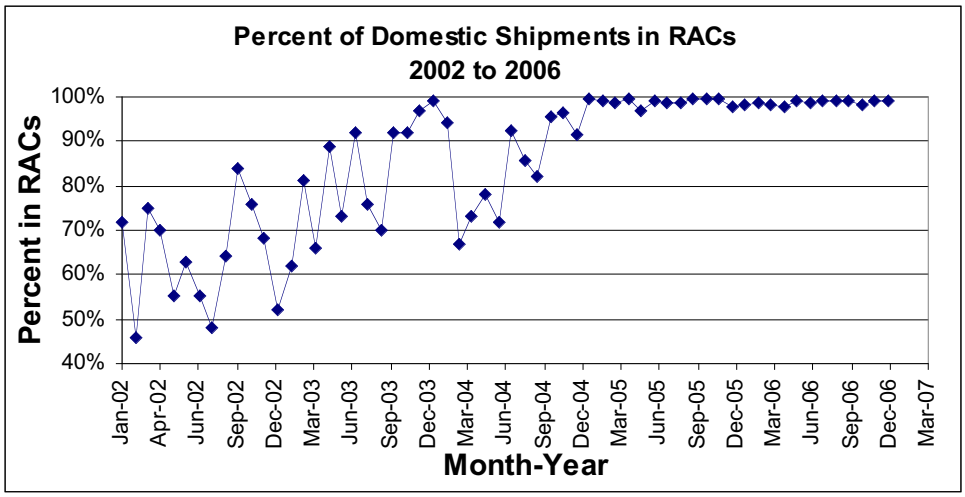
A Domestic Customer Solution

The gradual shift to a returnable aluminum container (RAC) provided some improvement to both quality and environmental needs. The aluminum container provided the quality solution that customers required (no paper or wood). It also provided a reusable container that would likely be reused for well over 10 years. Unusable containers could be scrapped and recycled within an already developed aluminum scrap market. The containers could handle the heavy weight of the product and fared well in domestic transportation on truck and rail.

Aluminum shipping container.

While initial financial reviews suggested a cost reduction using the returnable container, after a few years of use, the repair and tracking costs to containers continued to rise to the point where the solution was cost neutral. Containers have latches that are sometimes damaged in transit. Mishandling of containers can also lead to cracks in the weld seams of the containers. Welding of aluminum can be difficult and requires qualified personnel. The containers also had to be rigorously tracked whereas the cardboard containers did not. Due to the cost of the container, it became much more important to have accurate tracking of where the containers were within the logistics system. Customers not returning containers were invoiced for the container costs. Security also became a concern. As the price of scrap aluminum increased, so did the issues with theft of empty aluminum containers.

Due to an inability to guarantee the return of containers from export shipments, use of aluminum containers was limited to domestic shipments, which limited the quantity of aluminum containers which could be used overall. Cardboard containers continued to be used for export shipments.



Steel shipping container.

The aluminum container solution allowed the company to reduce its cardboard container and pallet wastes by a little more than 87 percent in 2006. While this was a significant improvement, the challenge still existed to find a packaging solution which could be applied globally.

Global Solution

In 2006, ASRC was the largest exporter in the State of Kentucky in terms of manufactured volume by weight. In order to try to reduce operational costs and improve environmental performance, the company approached a global logistics company specializing in re-usable shipping products. The logistics company provides standardized steel containers which are rented to companies to ship their products. The containers remain the property of the logistics company. Once a customer empties the container of the product, the logistics company retrieves the container from the customer. The logistics company cleans the containers and repairs them as needed. It then rents the container to someone else. Because it is a global company providing containers for a variety of different products from food products to manufacturing, container renting and return is convenient and affordable. There are no longer the concerns about tracking empty containers, repair costs for damages, and investment costs for purchase of containers. The sturdy steel container adapted well to our product and does not cause any quality concerns for the customers.

While the logistics company is a global company operating in most countries, there are still some areas of the world that it will not permit the use of its containers. For these customers, ASRC still uses cardboard containers. This represents a very small percentage of shipments and allows over 90% of shipments in returnable containers. This global solution allows at least a 93 percent reduction in the amount of cardboard and wood pallets.

Summary

Within the hierarchical list of pollution prevention alternatives of elimination, reduce, reuse, recycle, landfill, American Synthetic Rubber Company was able to largely eliminate the use of cardboard containers. A cost effective, more environmentally-friendly solution using reusable containers on a global scale was eventually found. In the process, customer quality issues regarding packaging were addressed. Domestic shipment wastes from cardboard and wood pallets were reduced from 2004 through 2006 by more than 87 percent.

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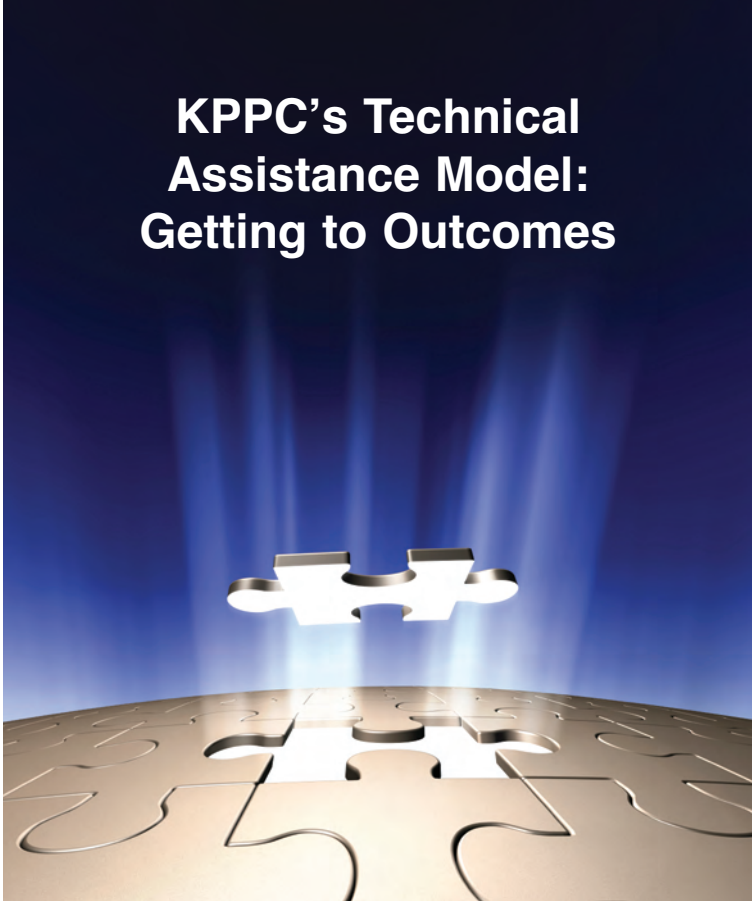
KPPC's Technical Assistance Model: Getting to Outcomes



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Providing technical assistance for pollution prevention while working within the business structures of industries, businesses and organizations has been a constant challenge for pollution prevention service providers. For the past twelve years, the Kentucky Pollution Prevention Center (KPPC) has been providing innovative pollution prevention (P2) technical assistance to organizations throughout the state of Kentucky to meet this challenge. For KPPC, one of the key objectives of pollution prevention assistance is to facilitate change within an organization that results in the elimination or reduction of pollution at its source. The primary approach to delivering this service is to offer onsite assessments that demonstrate how pollution prevention (P2) and energy efficiency (E2) strategies can be successfully integrated into an organization's business model. The assessment process involves site visits, information gathering, opportunity assessment and delivery of a high quality technical report that details specific pollution prevention and energy efficiency recommendations. The assessment service model deployed by KPPC in the past had typically included the client as a facilitator for KPPC staff conducting the assessment. Although each facility was different, KPPC's approach had been to deliver assessment services with a "one size fits all" approach. A refined assessment model was needed to improve the implementation rate among clients with different resources, business drivers, and levels of commitment.

KPPC has conducted pollution prevention and energy efficiency assessments for more than 600 clients over the years and has been successful in identifying opportunities for resource management that add value to an operation and offer the potential for saving millions of dollars while improving environmental performance. While KPPC's clients have successfully implemented many recommendations that have improved their environmental performance and realized cost savings, KPPC observed a fair share of lost opportunities by clients that did not implement the recommendations. Although the service model and potential for success were often the same, the implementation rate varied among different organizations. After reviewing implementation patterns, it became clear that an organization's failure to take action on the recommendations depended on a variety of factors, which included a lack of expertise and manpower, a lack of understanding of how pollution prevention relates to the business model, a lack of financial resources needed for implementation, or simply lost interest relative to other business drivers. Since these factors can and do prevent organizations from moving forward with implementation of opportunities that could have improved their environmental performance, KPPC began to address the various aspects of delivering pollution prevention and energy efficiency assessments to improve its services and increase the overall level of implementation.

Business Condition

A review of clients who were successful in implementing pollution prevention recommendations revealed that their organizations had the ability to assimilate the information provided, recognize the relationship of environmental performance improvement relative to the business model and had systems and resources in place to take action. These clients had within their organizations the resources and the full support of management, both of which are necessary to successfully respond to the opportunities identified by the pollution prevention assessment. Proactive management and financial stability within an organization will typically parallel the evolution of their environmental management and commitment to sustain-

KPPC's assessment team looks for every opportunity to cut costs and improve environmental performance for each of its clients.

ability. As business and industry increasingly embrace the concept of a global economy, sustainability has become a key component in achieving competitive advantage. Typically, a proactive company will be better positioned to respond more effectively to implementing pollution prevention opportunities and achieving sustainable practices.

Performance Metrics Guide the Way

The first step in developing meaningful performance metrics is to understand how the technical assistance process is linked to the Center's goal of effectively delivering a value-added service for the client – the success of the client is a direct measure of the Center's success. Measuring the performance of the Center is vital to understanding where the service process has succeeded in the past in terms of environmental performance-based accomplishments and where modifications need to be made to achieve success in the future. Accomplishments can be viewed in terms of outputs and outcomes. Outputs refer to environmental management activities and work products that contribute to producing positive or negative environmental outcomes. Outcomes refer to the results, effects or consequences that occur from pollution prevention implementation efforts.

In order to refine and redevelop the Center's support services, it became necessary to find a way to measure the performance level of KPPC services. The US Environmental Protection Agency (USEPA) has created the National P2 Results Data System to provide an efficient and effective way of analyzing and presenting the results of pollution prevention assistance efforts. The purpose of the National P2 Results Data System is to facilitate continual improvement of pollution prevention programs and to exhibit the tangible environmental and economic benefits that are being achieved by potential pollution prevention users. The cornerstone of this system categorizes performance metrics in terms of activities, behaviors and outcomes. This system provided a guide for the Center in determining how to improve pollution prevention implementation leading to positive environmental outcomes. When reviewing those clients who successfully implemented P2 recommendations, it was clear that there were systems and behaviors in place within their organizations that made successful implementation likely. Clients who chose not to implement recommendations did not have all these key factors in place. Clients who followed up with implementation typically had an environmental policy that indicated management commitment to environmental performance, a leader or manager of the effort to reduce environmental impacts, and a cross-functional team representing various perspectives of the business processes.

Organizational Capability

Client

In measuring performance and assessing results, KPPC now must consider the organizational capability of its clients. Organizational capability includes both the ability and the desire to systematically implement pollution prevention and energy efficiency recommendations into business operations for continual improvement of environmental performance and outcomes. The business conditions an organization finds itself in, where it consistently operates between a reactive and proactive approach to market and operational demands, is representative of organizational capability. In terms of environmental performance or management, KPPC tries to discover whether the organization's focus on environmental performance is driven by regulatory compliance (reactive) only or whether it has instituted a systematic approach that supports the forward (proactive) view of business planning? The relationship between organizational capability and categories of performance, where achieving outcomes is the driver, is depicted in Figure 1.

As Figure 1 shows, an organization's behaviors are vital to a proactive approach toward achieving outcomes. Further analysis of clients who were not successful in implementing pollution prevention recommendations indicates that the behavioral component is the likely gap between performing standard activities "for the bean count" and managing change for outcomes of reduced resource usage, wastes and costs. To assist organizations in their implementation efforts, KPPC also considers what approaches work best for delivering pollution prevention assessment services that will strengthen the organizational capabilities of successfully implementing identified opportunities.

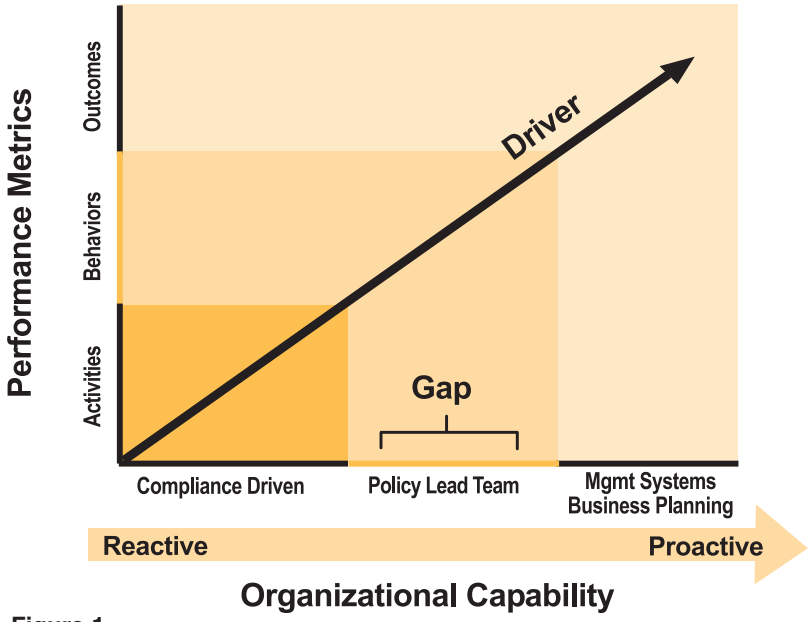

Figure 1.

Technical Service Provider

As a technical service provider, KPPC must build client confidence by verifying the effectiveness of technologies and practices that solve real-world problems. Technical assistance programs must effectively and efficiently deploy technical resources that integrate with the client's culture and result in internal standardization of improvements. Delivering value-added services for determining specific P2 and E2 opportunities *with* the client instead of *for* the client, requires a baseline understanding of organizational behaviors that support achieving outcomes that are measurable and meaningful to the organization's bottom-line.

The Service Model

KPPC reviewed it's pollution prevention and energy efficiency assessment model and identified six main service processes; outreach, a client's request for assistance, partnering with a client to analyze specific needs, providing the client-specific services needed, following-up with the client on implementation efforts, and managing the knowledge derived from the service event for continual improvement of the model. With a clear view of organizational capability for achieving outcomes, KPPC modified its approach to delivering P2 technical services by partnering and involving the client in the process. By offering initial guidance and expertise, KPPC provides the resources necessary for increasing the client's readiness and involvement in the pollution prevention assessment process. Clients are encouraged to establish an environmental policy if one does not exist or to determine if an existing policy provides the necessary drivers to achieve pollution prevention goals and objectives. To be successful, the client needs to designate a leader of the pollution prevention assessment and implementation effort and deploy a cross-functional team to help identify environmental performance improvement opportunities. With these components in place, assistance efforts can be focused on working with the client's team and not working simply as an outside agent. The Center's role as a facilitator and primary resource for pollution prevention information coupled with the client's knowledge of processes and operations results in greater buy-in, ownership and increased acceptance by the organization.

Outreach

Marketing and outreach are keys to making clients aware of the technical resource that the Center has to offer. KPPC's technical service group works closely with their marketing and outreach team to communicate which resources and programs are available to assist Kentucky industries and organizations in adopting pollution prevention and energy efficiency measures. KPPC has developed a comprehensive Web site, conducts seminars, webinars and workshops, offers online training and distributes a quarterly newsletter with regular updates of activities and new services.

Request for Assistance

When an organization requests assistance, it is briefed on the partnering process approach and what role it will have as part of the pollution prevention assessment. An assessment and analysis information packet is sent to the client that, when completed and returned, provides a meaningful measure of the client's environmental management and business systems. It also provides a very basic, initial indicator of a client's commitment to the process. KPPC has seen a direct correlation between how quickly and thoroughly the information packet is completed and returned and the client's commitment during the pollution prevention assessment and implementation phases.

Needs Analysis

In order to properly assess an organization's needs, the assessment and analysis information packet has become a necessary first step in the process. The information packets provide insight and understanding of the key aspects of the client's organizational capabilities. A quick gap analysis is done relative to organizational behaviors which examines a number of conditions. Do they have an environmental policy that indicates management commitment? Has a project or team leader been selected and assigned responsibilities and is a cross-functional team in place representing employee involvement? A review of existing management systems provides insight into organizational capability and how that capability could be leveraged to improve outcomes or identify opportunities to improve operational behaviors. Active employee and management involvement are key components of a successful assessment effort that is specifically tailored to a client's operations.

Providing Assistance

KPPC conducts pollution prevention assessments to help organizations become more profitable, efficient and environmentally responsible through development and implementation of resources and application of best management practices. KPPC recognizes that the primary role of a technical service provider is to facilitate a change in organizational behavior through awareness and knowledge that empowers the client (process owners) to improve its environmental performance. KPPC seeks to provide "readiness training" as a key component of delivering the client-specific assessment service that will demonstrate a systematic approach to improved environmental performance. The pollution prevention report is structured to provide relevant information for both decision-makers and the team that will implement and track performance.

The assessment process involves site visits, information gathering, opportunity assessment and delivery of specific, value-added recommendations to the client.

Follow-up

Determining performance metrics for all categories of the technical assistance (activities, behavior and outcomes) is the basis for determining continual improvement opportunities in service delivery. Performance metrics function as a measure of success or "profitability" for a non-profit technical service provider. The pollution prevention recommendations provided with the assessment serve as a checklist for the follow-up cycle that continues until the client has determined a course of action or disposition for all recommendations. A client may make an immediate determination that a recommendation will not be implemented. If this is the case, there is an opportunity for the service provider to understand the basis of that decision and what barriers may exist to prevent implementation. Some recommendations may require additional planning and investigation by both the service provider and the client with the intent to implement. The Center's role in this phase is to overcome perceived barriers and demonstrate how the opportunities will improve environmental performance and competitiveness.

Knowledge Management

From KPPC's perspective, knowledge management is a tool that allows the organization to create, capture, analyze and act on information gathered through its service and training activities. Products of knowledge management include reports, case studies, staff experiences, cataloging, databases and publications. Capturing and managing the knowledge of lessons learned through successful experiences with clients is a key factor in continual improvement of its services. Making knowledge management a distinct process related to the assessment service model enables the Center to take a programmatic approach to improving and sharing intelligence gained from experience and deliver a more valuable technical assistance service to its clients.

Successful Outcomes

The true measure of a technical service provider's success is ultimately the success of its clients. The Kentucky Pollution Prevention Center continually seeks to improve its delivery of services through careful analysis of its client's needs, capabilities and commitment to the assessment process. By using performance metrics tools to help track activities, organizational behaviors and final outcomes, KPPC can measure, adapt and refine its services to meet the ever-changing needs of its clients.

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Pollution Prevention: Graduating to Competency-Based Training

By:
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Introduction

For the past twenty years, new pollution prevention (P2) facilitators have been trained using traditional methods. This training was designed to help them understand what they needed to know. P2 trainers relied on the many excellent databases available on the Internet that contain success stories and anecdotal information. For the most part, these new facilitators learned about material substitutions and P2 technology diffusion.

More recently, P2 trainers seek to include some level of skill development. The US Environmental Protection Agency publication, "An Organizational Guide to Pollution Prevention," presented information about process mapping, the Systems Approach, environmental management systems, and basic problem solving tools including root cause analysis. People have to realize that it takes time and experience to develop skills. The rush to get the P2 facilitators in the field often is at odds with skill-based training. Traditional P2 training is often ineffective when the goal is to train individuals to perform specific job-related skills.

There have been other problems with traditional P2 training. With its focus on success stories, new trainees do not learn that chemical substitutes that remove the threat of carcinogenicity may be flammable or cause severe allergies with the people who use them. New technologies create problems with the process since they are not properly introduced with a "systems" view. There is little realization that "everything is connected to everything else." Unwittingly, the P2 training is encouraging the focus to shift from environmental problems to health and safety problems which create process upsets elsewhere in the system. These problems point out the importance of grounding the training in the real world where P2 is applied.

One way to improve the quality of the training of P2 facilitators is to move to a technique known as "competency-based training" (CBT). This approach to training is a system that measures success through mastery of specific knowledge and the skills to use that knowledge. While traditional, time-based approaches are instructor-based, the CBT approach is conversely a participant-centered approach. Although each approach to P2 training has its proper place in a facilitator's learning pathway, CBT appears to offer some significant advantages in the area of P2 training.

What is CBT?

Competency-based training is a participative method of training. It does not feature a lot of lectures. Focused exercises are used to develop knowledge and skills. There is continual feedback being provided by the CBT instructor to the candidate. There is no grading in competency-based training. Participants are examined as either "competent" or "not yet competent." There are no failing grades. Someone who is "not yet competent" will be provided with a "learning pathway" by the CBT instructor in order to provide more evidence or more assessment opportunity until the candidate achieves competency (ability to perform the task). The CBT instructor keeps working with the candidate until the required skill can be demonstrated. This is very much like apprenticeship programs of the past.

It is important that CBT be adequately prepared. An organization known as RABQSA[1] is a leading promoter of CBT and has a very informative web site with guidance for preparing these training programs. The steps in preparing a CBT training program include the following:

- P2 competencies are selected carefully
- Supporting P2 theory is integrated with skill practice
- Essential knowledge is learned to support the performance of skills
- Detailed training materials are keyed to the competencies to be achieved and are designed to support the acquisition of knowledge and skills
- Methods of instruction involve mastery learning - all participants can master the required knowledge or skill, provided sufficient time and appropriate training methods are used
- Participants' knowledge and skills are assessed as they enter the program and those with satisfactory knowledge and skills may bypass training or competencies already attained
- Flexible training approaches including large group methods, small group activities and individual study are used

- A variety of support materials including print, audiovisual and simulations keyed to the skills being mastered are available
- Satisfactory completion of training is based on achievement of all specified competencies.

Many countries operate their entire education system using CBT. However here in the United States, the traditional education model rules. RABQSA certifies CBT courses and instructors for quality and environmental management systems. The CBT techniques work quite well for P2 facilitator training as well.

Defining Competency

One of the documents included in the RABQSA CBT courses is entitled, "Guidelines for Quality and/or Environmental Management Systems Auditing[2]." It provides a reliable listing of the components that constitute competency (see Figure 1).

The P2 facilitator's knowledge will be defined by the individual competencies that the CBT training provider feels are important for successful work in this P2 discipline. It is important to note that unlike the case of the ISO quality and environmental management standards, no independent body has yet determined what the P2 facilitator skills should be. If one was to use the competencies for a RABQSA certified environmental management specialist as a guide, the P2 consultant would have to demonstrate competency in the following areas:

- Understand the application of P2 principles
- Understand the P2 needs of different operational processes
- Assess the risks with and without P2 actions
- Assess the effectiveness of P2 methodologies making sure there is no transfer of problems to other parts of the system of shifting an environmental problem for a health and safety problem
- Assess the P2 roles and responsibilities with the context of the organizational environment
- Assess the P2 projects in light of the overall business strategy
- Determine the adequacy and effectiveness of the overall P2 program.

A significant effort is required to determine the competencies for a P2 facilitator. For each of the seven competencies listed here, a CBT training provider would have to determine the performance criteria that will be used to judge each of the competencies. The training providers would also have to prepare a listing of evidence that they will accept that demonstrates that a P2 facilitator is indeed competent. Figure 2 shows a representative table with an idea of how the information would be presented.

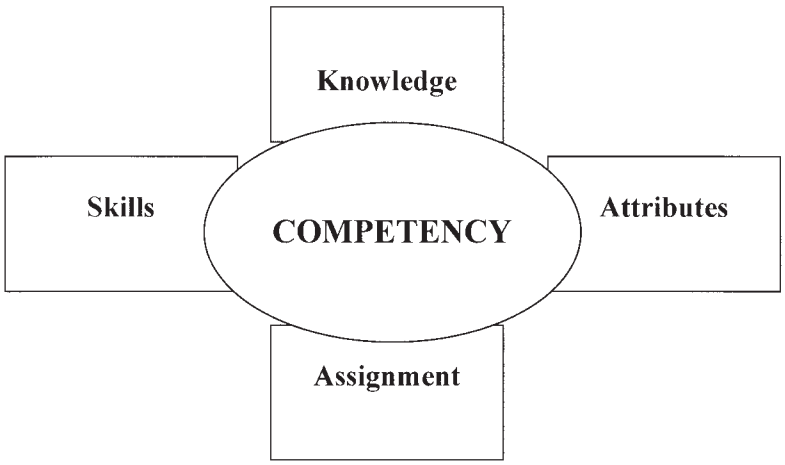

Figure 1 - Elements that constitute the competency of a P2 facilitator.

Failure to properly identify these knowledge competency elements and making them very clear at the outset will likely result in ineffective training. CBT trainers help the participants move down a learning pathway by observing their progress with exercises designed to develop the skills necessary to use the knowledge that is provided. It is important that the trainers be educated in CBT so that they will not revert to the traditional way of teaching and not adhere to the CBT model.

The CBT process should make P2 facilitators aware of how personal ***attributes*** enable them to be more effective in their role as a P2 facilitator. The P2 facilitator should be:

- Open-minded – willing to consider alternative ideas or operator views
- Diplomatic – tactful in dealing with the employees
- Observant – actively aware of physical surroundings and activities
- Perceptive – instinctively aware of and able to understand situations
- Versatile – adjusts readily to different situations
- Tenacious – persistent, focused on achieving objectives
- Decisive – reaches timely conclusions based on logical reasoning and analysis
- Self-reliant – acts and functions independently while interacting effectively with others
- Able to see opportunities rather than threats.

Many of these attributes are commonly found as selection criteria for P2 facilitator positions. Even with very little experience in the P2 facilitation field, it is easy to see the importance of these attributes. They enable the P2 facilitator to work effectively with employees and the management representatives in the organization. Not everyone will have all these attributes. However, they must be aware that these attributes will help them be more successful when working on P2 assignments.

Competency	Performance Criteria	Evidence Guide
1: Understand the application of the principles, procedures and techniques of auditing	1.1: The principles, objectives and techniques of auditing management systems, as outlined in ISO 19011:2002, are understood and applied.	In accordance with ISO 19011:2002 guidelines, with omission or deviation justified Presented verbally, written or other via means; accurate, concise and within context. The evidence of 'understanding' must be measurable and relate directly to the requirements of the Standard. **********
	1.2: The terms and definitions of ISO 19011:2002 are understood and applied.	Understanding of the auditing principles and practices as identified in ISO/IEC19011:2002 is demonstrated. correct use of terms and definitions of IEC19011:2002 is demonstrated.
	1.3: Audit criteria relevant to the auditee's business and operation are identified.	elevant audit objectives, scope and criteria are accurately defined. The issues affecting the feasibility of an audit such as information requirements, auditee co-operation, and resource availability are identified.
	1.4: An audit plan is developed to meet the agreed audit criteria.	A document review within the audit criteria is conducted with omission or deviation justified and appropriate actions communicated to the auditee. On-site audit activities are planned and a written audit plan is prepared, including an audit timetable that accurately reflects the achievement of the audit objectives within the agreed or prescribed timetable.
	1.5: A document review is completed.	An audit checklist, or other relevant work documents, that conforms to the requirements of the reference standard is developed.
	1.6: All aspects of the on-site audit activities are understood and applied.	

TOPIC

STANDARD

Figure 2 – Collation of Knowledge Competency Based on the RABQSA Model.

It is important to consider the typical P2 ***assignments*** and determine how to prepare the P2 facilitator for this work. This specialist works closely with the organization's employees to identify, evaluate, recommend and assist in implementing source reduction practices that result in the elimination of waste, regulatory compliance requirements and unnecessary costs associated with the process prior to its improvement. Among the assignments are the following:

- Conducting process mapping with confirming facility assessments
- Verifying information with employees and seeking their opinions on opportunities to improve the processes
- Involving management in the prioritization of opportunities to improve the process
- Facilitating employee team P2 projects using root cause analysis, brainwriting of potential P2 alternatives, bubble sorting to prioritize the alternatives and the preparation of an action plan for management review and implementation
- Researching existing and new technologies to supplement the knowledge of the employees and management in the facility
- Coordinating P2 awareness activities
- Ensuring regulatory compliance
- Establishing partnerships and building a strong P2 program
- Measuring P2 program effectiveness and contribution of value to the organization
- Fulfilling administrative responsibilities to sustain the P2 program.

A P2 facilitator should have the following ***skills***:

- Apply P2 principles, procedures and techniques
- Plan and organize the P2 assessment and program effectively
- Prioritize and focus on matters of significance
- Collect process and input/output information through process mapping and resource accounting
- Interview, listen, and observe the people involved with the process
- Review documents, records and data
- Understand the appropriateness and consequence of stepping out of their facilitation role
- Verify the accuracy of collected information
- Confirm the sufficiency and appropriateness of the information and other best practice information
- Assess those factors that can affect the reliability of the P2 projects
- Maintain the confidentiality and security of information
- Communicate effectively.

Most of these are skills which need to be developed during the CBT efforts.

Advantages of CBT

One of the advantages of CBT is that the focus of the training is on the success of each P2 facilitator enrolled in the class. It is particularly useful when the training participants already have some knowledge of P2. Information is readily available on a variety of different P2 web sites. The key benefits of CBT include:

- Participants will achieve competency required in the performance of their P2 facilitation activities
- Participants build their confidence as they succeed in mastering specific competencies
- Participants can receive a transcript that lists the specific competencies that they have achieved through the training
- Training time is used more efficiently and effectively as the trainer is a guide to learning as opposed to a provider of information
- Much more of the time is devoted to working with the course participants individually or in small groups as opposed to presenting lectures
- More training time is devoted to evaluating each participant's ability to perform essential job skills

- Participants become aware of the attributes and skills that will help them perform their P2 facilitation with greater ease and effectiveness.

An effective P2 program helps the organization meet its commitment to "the prevention of pollution" in its environmental management system. This program is a key to the effective operation of the preventive action program and the ability to continually improve with clear financial value through this preventive approach.

In a business sustainability program, P2 is usually called "eco-efficiency" or "cleaner production." The stakeholder perspective is included when prioritizing the environmental aspects and impacts. Much of the program's focus on prevention is a result of a strong P2 facilitator turned sustainability facilitator.

CBT in the Real World

You can tell from the number of bullet points in this article that CBT is not for the faint at heart. While the financial value contribution from an effective P2 program makes the investment in CBT worthwhile in most cases, there are some limitations that need to be considered.

A CBT course is only as effective as the process used to identify the competencies. When little or no attention is given to identification of the essential job skills, attributes and assignment, then the resultant training course is likely to be ineffective. A professional association like the National Pollution Prevention Roundtable (NPPR) can take the lead in creating P2 facilitator competencies using the RABQSA model as a guide.

There are some P2 training courses that may be classified as competency-based, but unless specific CBT materials and training approaches are present (i.e., competency charts, learning guides, and a CBT trained instructor), it is unlikely that the resulting course will be truly competency-based. The organization that establishes the competencies needs to effectively manage these worrisome market issues.

Many blame the downturn in P2 interest on the fact that the so called, "low hanging fruit" is gone. It is now hard work to be involved in P2. This is precisely the reason CBT is needed. If people thought P2 was difficult, wait until they seek to help an organization move down the path to business sustainability. But there are ways to make the process work better. P2 facilitators can participate in what is referred to as "blended learning." Face to face CBT training would be supplemented by e-learning models offered through a web site. The participants would work on independent projects and interact with the CBT instructor and perhaps other classmates using on-line discussion board tools.

Many of the environmental and quality management system auditors have been trained using CBT. They may already have some P2 facilitator experience. In this case, a program known as "Recognition of Prior Learning" (RPL) can be used to allow the candidates to receive credit for the competencies and skills they can demonstrate using the evidence in the table presented in Figure 2. When accepted by the CBT trainer, some of the training can be waived.

It would not be difficult to have an experienced CBT training organization create a similar program for P2 facilitators and business sustainability facilitators. P2 technical assistance programs and industries that use P2 to continually improve their processes can work through a professional organization like the NPPR to start down this path. With the increased demands of business sustainability, it would make a lot of sense for the P2 community to prepare for these new challenges.

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SEPTEMBER 2007

Northeast States Succeed in Reducing Mercury and Continue to Address Ongoing Challenges

Prepared by Northeast Waste Management Officals' Association (NEWMOA) Staff with Assistance from the NEWMOA Mercury Workgroup & Interstate Mercury Education and Reduction Clearinghouse Committees

Since 2000, states in the Northeast have enacted major legislation to address mercury use in products and ultimately in solid and hazardous waste. This legislation includes bans and phase-outs on the sale of certain products, requirements for product labeling, and requirements for manufacturers to report on their use of mercury in products that are sold in the region. These laws affect a wide variety of products, including mercury thermometers, thermostats, switches and relays and products that contain these components, various measuring devices, linear and compact fluorescent bulbs, button batteries, and others.

In addition to these requirements, state environmental agencies have initiated mandatory and voluntary programs for collecting certain mercury-containing products at their end-of-life. Mercury-added products that have been targeted for collection and recycling include convenience light switches in cars; linear and compact fluorescent bulbs; fever thermometers; thermostats; dental amalgam in wastewater; and various measuring devices, such as dairy manometers and sphygmomanometers (i.e., blood pressure cuffs). Finally, state programs have also focused on eliminating or reducing the use of mercury and mercury-added products by various types of facilities, such as schools and hospitals, and removing the existing inventory of these products at those locations.

This paper presents a brief quantitative summary of the mercury reduced from the waste or wastewater stream as a result of these key initiatives in the Northeast, where data are available. Overall, the state programs collected and recycled approximately 7.5 tons of mercury through product collection and recycling initiatives in the region from 2000 to 2006. The states' best estimate of the mercury that has been eliminated through restrictions on product sales in the region from 2000 to 2006 is approximately 14 tons. This is the first attempt by the states in the region to quantify the overall results of their regulations and programs, and this paper outlines the methods NEWMOA used to estimate these reductions and describes some of the associated uncertainties.

The reduction estimates presented here are conservative because, while state and local governments have initiated a number of programs to reduce and collect mercury, they have not been able to fully quantify the associated reductions in mercury from all of those efforts. Furthermore, the estimates of the impacts of the state phase-out requirements and product bans are conservative because the estimates are based on information from manufacturers of the products, and the states continue to find additional products that must be phased out and to identify product manufacturers that have not been reporting their mercury use as required by state laws. Also, if a company reported that it was at some point in the middle of a year that it stopped selling its product or eliminated the use of mercury in its products, NEWMOA used a conservative approach in estimating the reduction for that year.[1]

Overview of Major Sources of Mercury in Waste

A recent report, titled *Mercury in Products in Massachusetts: Summary and Analysis of the Mercury-added Products Database, June 2006,* (available at

1. For example, if a company reported that it eliminated mercury use in products it was selling in the region as of June 2004, NEWMOA estimated the reductions associated with that change starting in 2005, rather than trying to make estimates or reductions for partial years.

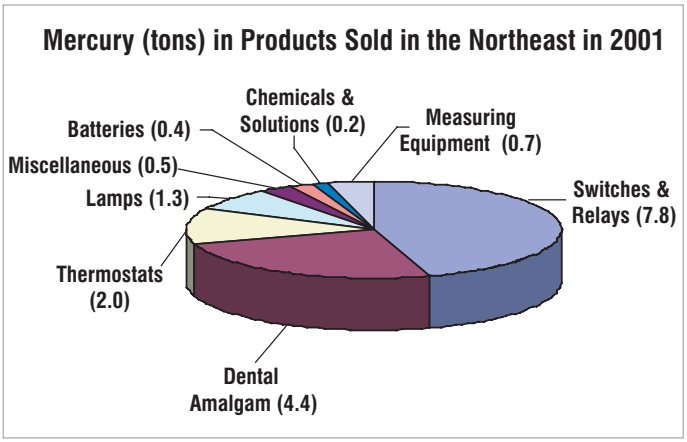
http://www.newmoa.org/prevention/mercury/imerc/FactSheets/index.cfm) summarizes the major types of mercury-added products that are currently sold in the Northeast, and, hence, potentially enter the waste stream. The report identifies the following types of mercury-added products as the major categories sold in the United States as of 2001:

- switches and relays and the products that contain these components
- dental amalgam capsules
- thermostats
- lamps (i.e., fluorescent, high intensity discharge, mercury short arc, compact fluorescent, ultraviolet, mercury capillary)
- batteries (e.g., button cell and mercuric oxide)
- sphygmomanometers (blood pressure cuffs), manometers, barometers, psychrometers, and other measuring equipment
- fever, laboratory, and industrial thermometers
- chemicals and solutions (e.g., preservatives, mercury compounds, and elemental mercury)

Manufacturers or their representatives submit information on these products to the states through the Interstate Mercury Education Reduction Clearinghouse (IMERC)[2] in compliance with laws in the states of Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont. In 2001, a few of these states began requiring companies that manufacture, distribute, or import mercury-added products to report certain information on these products. A searchable database of the product information submitted by the manufacturers since 2001 is available at *http://www.newmoa.org/prevention/mercury/imerc/notification/*.

According to the June 2006 Massachusetts report, a total of 122 tons of mercury were sold in the above products in the United States in 2001 by original equipment manufacturers.[3] The largest total amounts of mercury were sold in switches and relays and dental amalgam capsules. These product categories accounted for 70 percent of the total amount of mercury that was sold in products in the U.S. in 2001, or approximately 86 tons. Switches and relays are components in a wide variety of larger products, including but not limited to electric and gas meters; motor vehicles; commercial and residential electric and gas ranges; boilers; heating, ventilation, and air conditioning (HVAC) equipment; pumps; hospital beds; circuit boards; manufacturing equipment; and fire control units.

FIGURE 1



Using a simple, population-based method[4], the estimated amount of mercury sold in products in the Northeast in 2001 was approximately 17.3 tons. Figure 1 presents a breakdown by product category of the total estimated amount of mercury sold in the eight NEWMOA-member states.

Figure 1 presents a summary of the available data from manufacturers and distributors for mercury use in products sold in the Northeast in 2001 only. As such, the information provides a snapshot in time of the amount and distribution of mercury sold recently in products in the U.S. and in the Northeast. This presentation does not provide information on mercury-added products that were sold prior to 2001 that are still in use or in storage and can potentially enter the waste stream. Historical uses of mercury in products include use in old barometers, various antiques, numerous types of industrial equipment that contain mercury switches and relays, convenience light switches in many models of cars sold before 2003, alkaline batteries (made before 1999), old models of freezers that contained mercury light switches, old flow meters at sewage treatment plants, and such novelty items as games and jewelry.

2. IMERC is a program of the Northeast Waste Management Officials' Association (NEWMOA). In 2001 the NEWMOA member states launched IMERC to provide 1) ongoing technical and programmatic assistance to states that have enacted mercury education and reduction legislation, and 2) a single point of contact for industry and the public for information on mercury-added products and member states' mercury education and reduction programs. Since 2003, non-NEWMOA member states have joined IMERC, including Washington, Illinois, California, Minnesota, and North Carolina.
3. Data reported by the manufacturers of final products are not included because of the possibility of double counting the same mercury. For example, a mercury-added product, such as a switch, could be reported by the original equipment manufacturer (OEM), a gas range manufacturer that purchases the switch and installs it in the range, and a distributor that sells the range in at least one of the IMERC states.
4. By applying the percentage of U.S. residents living in the eight NEWMOA-member states to the total quantity of mercury sold by product, a rough estimate can be made on the amount of mercury sold in these products in the Northeast in 2001. According to 2005 Census data, approximately 14.2 percent of U.S. residents live in the Northeast states.

Figure 1 likely underestimates the amount of mercury sold in products in the Northeast in 2001. The information presently available may not represent the entire universe of mercury-added products because IMERC continually discovers uses of mercury that were previously unreported. IMERC constantly identifies companies that manufacture mercury-added products sold in the Northeast and should be providing notification but have not yet done so.

Potential Mercury Releases during Waste Management

When mercury-containing products, such as switches and thermostats, are disposed of as municipal solid waste, mercury can enter the environment through multiple pathways, including vaporization into the air and leaching into soil and water. The mercury in these products is usually in the liquid (elemental) form, and is often contained in breakable glass housings within the product. During solid waste handling and management, the products can break and release the stored mercury. The liquid mercury can evaporate, emitting vapors at various stages of the solid waste management process, including during transportation and at transfer stations on the way to a landfill or other waste management facilities (e.g., from collection containers and transport vehicles); from the working face, or active portion of the landfill; and during waste handling operations. If the solid waste is destined for a municipal solid waste (MSW) incinerator or resource recovery facility, the mercury can be released during incineration. The states and EPA have implemented regulations to substantially control these emissions, but recent estimates demonstrate that MSW incinerators are still the largest source of mercury emissions in the Northeast (NESCAUM 2005).

EPA and other researchers have shown that substantial amounts of mercury are released while waste loads are in transit to a landfill or incinerator, and during waste handling activities, such as dumping, distributing, and compacting (Southworth et al. 2005, Lindberg 1999a, 1999b). Studies also show that broken fluorescent bulbs and thermometers in dumpsters can continue to act as sources of mercury releases for days or weeks (Aucott 2003, Lindberg 1999b). Fluorescent bulbs contain mercury in both a vapor and powder form, and the powder form can continue to emit mercury for weeks after the bulbs break in the waste load.

Landfills can also be a source of organic mercury, a more toxic form of the element. Once mercury-containing wastes are buried, some of the inorganic mercury in the landfill can be converted by bacteria into the organic form. Organic mercury can be released into the atmosphere from landfills in the same way that inorganic mercury is released. Researchers have measured one organic mercury compound, dimethyl mercury, in gas destined for landfill venting at levels 1,000 times higher than what has been measured in open air (Lindberg 2001). Organic mercury is primarily a local pollution concern because it generally deposits quickly after being emitted.

Mercury can also be released from landfill gas vents when the methane gas produced at landfills is collected and either burned or vented to the atmosphere. Flaring or burning landfill gas, before emitting it to the atmosphere, breaks down organic forms of mercury, but many landfills do not use flaring. Flaring does not break down inorganic mercury.

Mercury can also leach from landfills into groundwater. Available data show that mercury in groundwater near older, unlined landfills can exceed drinking water standards, but mercury is less likely to leach into groundwater from landfills that are lined and use leachate collection systems. Depending on how the leachate is treated, however, mercury collected in leachate systems may reenter the environment.

Dental amalgam wastes can enter the waste stream as both a solid waste and as suspended or dissolved particles in wastewater. Most of the states in the Northeast now require dental clinics to install amalgam separators to separate the mercury from their wastewater discharges. States and EPA are urging dental clinics to properly store and recycle the solid amalgam waste and to keep this material separate from municipal solid waste.

Mercury contained in certain formulated products, such as preservatives, reagents, and compounds, can also enter the environment if poured down the drain and discharged to a wastewater treatment facility.

While all of these pathways for mercury releases to the environment from products can be important in local areas, there are no overall estimates available for these releases in the Northeast. However, the Northeast states have taken a number of precautionary steps to prevent these releases, because mercury persists and bioaccumulates in the environment. Studies have shown that in total the various sources of mercury from products can be significant contributors to the overall mercury emissions to the environment in the region (NESCAUM 2005).

Impacts of Restrictions on the Sale of Mercury-Added Products in the Northeast

State environmental agencies in the Northeast have begun to quantify mercury reductions resulting from mercury product manufacturers complying with the states' mercury product reporting (often called notification) and product sales restrictions and requirements. This evaluation includes an estimate of the total mercury reductions reported to the states through IMERC by manufacturers discontinuing mercury product lines or ending the sale of products in one or more of the Northeast states. The majority of these are manufacturers of mercury-added switches and relays or products that contain these components.

Estimated Reductions Due to Reported Product Discontinuations

In the Northeast, as shown in Table 1, the total estimated mercury reduction from 2000 to 2006 due to the discontinuation of mercury-added product lines by manufacturers is approximately 11.6 tons. Note that this analysis assumes that an amount of mercury discontinued in a given year is cumulative. That is, if 1,785 pounds of mercury was no longer used by a switch manufacturer starting in 2002, it was assumed that 1,785 pounds of mercury was no longer used or sold by the manufacturer each year from 2003 through 2006.

TABLE 1 AMOUNT OF MERCURY DISCONTINUED IN THE NORTHEAST BY MANUFACTURERS, 2000-2006*

YEAR	TOTAL AMOUNT OF MERCURY DISCONTINUED (POUNDS)
2002	1,785
2003	3,254
2004	5,554
2005	6,110
2006	6,542
Total	**23,245 lbs. or ~ 11.6 tons**

** Table presents the estimated quantities of mercury in products that manufacturers reported they stopped making or selling in the region. The amounts are based on the quantities of total mercury reported by manufacturers reporting through the IMERC notification process. Mercury reductions were assumed to start the year after the phase-out was reported, unless the phase-out was reported to have occurred in January or February. The totals for companies phasing out only in Connecticut (or Maine and Rhode Island) were multiplied by the percent of U.S. population living in the state. For Connecticut, the percent used was 1.2%. For Maine, Rhode Island, and Connecticut combined, the percent used was 2%. 2001 totals were used when available. 2004 totals were used for companies that did not have 2001 totals or reported phasing-out during or after 2004. The table assumes that the reductions that occurred in one year continue to occur during each subsequent year, and that these reductions are, therefore, cumulative over the five-year period.*

Estimated Reductions Due to State Product Sales Restrictions

The Northeast states have also estimated mercury reductions associated with products that are subject to state restrictions on sales that went into effect in 2004. The first effective date for these restrictions was July 2004 in Connecticut. Additional states have enacted similar restrictions (often called product phase-outs or bans) since that time, including Maine, Massachusetts, New York, Rhode Island, and Vermont. (For a summary of the effective dates for the laws enacted by these states, go to *http://www.newmoa.org/prevention/mercury/imerc/phaseoutinfo.cfm*) Many of the restrictions or phase-outs on the sale of certain types of mercury-added products by the states in the Northeast took effect after December 2006. These restrictions generally allow for manufacturers to apply for an exemption, and the states have been ruling on exemption applications since 2004. The mercury reduction estimates presented in Table 2 were calculated by summing the total amounts of mercury sold by manufacturers of products subject to sales restrictions in the region, minus the total amounts of mercury reported by manufacturers who have received an approval on their application for an exemption from the phase-outs. NEWMOA pro-rated these reductions for each state that has enacted the product restrictions based on their effective date. As shown, NEWMOA estimates that the total annual mercury reduction associated with the implementation of state restrictions on the sale of products in the region through 2006 is approximately 5,368 pounds or 2.7 tons.

Impacts of Northeast State Actions to Address Releases of Mercury through Collection of Mercury-Added Products

This section presents a summary of the quantitative information available from the state environmental agencies in Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont to estimate the mercury in targeted products that were collected and recycled from 2000 to 2006. The analysis focuses on the following mercury collection and recycling initiatives:

TABLE 2
PROJECTED TOTAL MERCURY REDUCTION (2004-2006) RESULTING FROM NORTHEAST STATE RESTRICTIONS ON THE SALE OF MERCURY-ADDED PRODUCTS (LISTED BY EFFECTIVE DATE)

MERCURY PRODUCT	STATE	EFFECTIVE DATE	MERCURY ELIMINATED* (POUNDS)
All Thermometers	Connecticut	July 2004	97
	Rhode Island	January 2006	12
	Maine	July 2006	7
Mercury Thermostats	Connecticut	July 2004	868
	Maine	January 2006	129
	Rhode Island	January 2006	107
	Vermont	July 2006	31
Barometers	Connecticut	July 2004	10
	New York	January 2006	23
	Rhode Island	January 2006	1
	Maine	July 2006	0.8
Sphygmomanometers	Connecticut	July 2004	129
	Rhode Island	January 2006	16
Hygrometers and Psychrometers	Connecticut	July 2004	1
	New York	January 2006	2
	Rhode Island	January 2006	0.1
	Maine	July 2006	0.07
Hydrometers	Maine	July 2006	0.02
Manometers	Connecticut	July 2004	58
	Rhode Island	January 2006	7
	Maine	July 2006	4
Switches & Relays	Connecticut	July 2004	3,228
	Rhode Island	January 2006	397
	Maine	July 2006	240
TOTAL			**5,368 LBS. OR 2.68 TONS**

**Obtained by multiplying the percent of U.S. population living in the state by the total amount of mercury reported as sold in the United States in 2001. For states with a July 2006 effective date, total estimated pounds were divided in half. For states with a July 2004 effective date, total estimated pounds were multiplied by 2.5.*

- Mercury and mercury-added product removal from K-12 schools
- Collection of mercury-containing auto switches
- Bulk elemental mercury collected from dental offices and dentists that have installed dental amalgam separators
- Collection and recycling of mercury thermostats
- Collection and recycling of mercury and mercury products from hospitals
- Collection and recycling of mercury dairy manometers and plumbing gauges
- Collection of mercury by household hazardous waste programs
- Collection and recycling of mercury fever thermometers

Table 3 summarizes the achievements in mercury collection and recycling in the Northeast. The results in the table are considered a conservative estimate because some of the Northeast states have collected mercury products and bulk mercury, but have not tracked the amounts. For example, many states' household hazardous waste programs are not required to report the

TABLE 3 MERCURY COLLECTION & RECYCLING FOR THE NORTHEAST STATES, 2000 - 2006		
MERCURY COLLECTION ACTIVITY	**MERCURY COLLECTED & RECYCLED (POUNDS)**	**COMMENTS**
Mercury Removal from Schools	**4,696***	456 schools
Auto Switches Collected & Recycled**	**267.5**	120,973 switches
Bulk Mercury Collected & Recycled from Dental Offices	**2,151**	2,151 pounds of bulk elemental mercury was collected from dental offices (in the past dentists used to mix amalgam on-site and many older dental clinics, therefore, had leftover containers of bulk mercury); 6,406 dentists in New England have installed separators*** (represents an estimated 80 percent of dentists in New England)
Thermostats Recycled	**458****	41,764 thermostats
Hospitals Reducing Mercury	**761**	Ten hospitals received Hospitals for a Healthy Environment mercury reduction awards for reducing an estimated 530 pounds of mercury*****; 825 sphygmomanometers collected from MA & VT hospitals & 61 pounds of bulk collected from MA hospitals
Dairy Manometers Collected	**140**	140 dairy manometers
Household Hazardous Waste Collection	**6,092**	
Plumbing Gauges	**74**	
Maple Sugar Thermometers	**0.7**	
Fever Thermometers Collected	**352**	213,322 thermometers
TOTAL COLLECTED IN NORTHEAST STATES = 14,992 OR 7.5 TONS		

** Does not include all mercury equipment collected; some states reported pounds of liquid mercury only while others estimated amount of mercury collected from equipment in addition to liquid mercury*

*** Assumes 1 gram of mercury per switch*

****It is not possible to estimate the amount of mercury that has been eliminated from wastewater by the installation of amalgam separators in the region, but studies have shown substantial declines in mercury in wastewater treatment sludge at facilities following the installation of amalgam separators.*

*****Assumes thermostats contain 5 grams of mercury based on data from TRC*

******Source: Hospitals for a Healthy Environment (H2E)'s Making Medicine Mercury Free Award. More than ten hospitals have eliminated mercury in New England; however, only ten applied for the H2E Award. 530 pounds is based on an estimate derived by H2E of 95.2 grams of mercury/acute care bed removed.*

amounts of mercury or mercury in products collected during their collection events. Similarly, many states have not collected data on the number of dairy manometers or fever thermometers collected, although the majority of states have focused on collecting and recycling these items. States have also been actively promoting the collection and recycling of fluorescent lamps, but have no estimate of the amount of mercury that these efforts have helped to recycle. The sources of the data in Table 3 are:

- Annual reports prepared by the New England Governors' Conference Mercury Task Force for the past five years.
- Written communications with key officials in each state environmental agency.
- Reports provided by the Thermostat Recycling Corporation.
- Reports submitted to the Massachusetts Department of Environmental Protection (MA

DEP) by NEWMOA and individual municipal waste combustors that operate mercury source separation programs.

- Hospitals for a Healthy Environment Program.

From the analysis of the data available from 2000–2006, Table 3 shows that the state environmental programs collected and recycled approximately 7.5 tons of mercury through various initiatives in the Northeast. In addition, 14 tons of mercury have been eliminated through restrictions on product sales in the region during the same period.

Although this is a first attempt by the states in the region to quantify the overall results of their regulations and programs, the results of the data analysis presented in this paper demonstrate that key mercury reduction initiatives in the Northeast are having a positive impact on the amount of mercury in the waste and wastewater streams of the region. As IMERC continues to gather and analyze data from product notifications for 2004, the information will provide an even more precise view of the environmental benefits resulting from state mercury collection programs and mercury-added product legislation.

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For more information, please visit:
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