

Pollution Prevention Activities in Ohio under PPIS Grant

Final Report (Oct., 2000 to Jan., 2004)
for a grant awarded by the

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in
cooperation with the following NIST centers

EISC
CAMP
EWI
TechSolve

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Keywords

Keywords	P2 Assessments, Workshops, General Technical Assistance and Training, Computer Software
Product(s) produced	<p>This PPIS proposal consists of the following activities that will supplement OSEN's existing pollution prevention efforts:</p> <ol style="list-style-type: none"> 1. Coordination of the Ohio Statewide Environmental Network to provide comprehensive pollution prevention planning and implementation efforts statewide, 2. Training in source reduction techniques: Presentation of seminars and workshops to provide outreach to Ohio Manufacturers, providing follow-up measurements of the impact of these seminars on pollutant generation within the manufacturing sector, and 3. Technical Assistance targeted to small and medium size manufacturers: Source reduction through pollution prevention, environmental management systems, and energy consumption assessments. Also, measure the success of the program using different indicators.
Brief description of product(s)	<p>OSEN meetings are conducted in Columbus, OH. Seminars are given throughout Ohio to cover various aspects of pollution prevention and energy assessment activities. Assistance is provided in conducting P2 and energy assessments for small and medium size manufacturers.</p>
Quantity of product(s) produced	<p>During Oct., 2000 to Jan., 2004 the following products have been produced:</p> <ol style="list-style-type: none"> 1. Twelve OSEN meetings (Dec./March/June/Sept.) were conducted. 2. Twenty seven seminars have been presented to Ohio manufacturers. 3. Twenty nine pollution prevention assessments were completed. 4. Five P2 tools were developed and posted on the website http://www.p2tools.utoledo.edu/.

Abstract

NIST Centers along with the University of Toledo (UT) provided technical assistance to small and medium size manufacturing plants in Ohio. During the three years of the grant 29 assessments were completed in the areas of pollution prevention, energy efficiency, environmental management systems, and lean manufacturing. The pollution prevention benefits of these assessments were reduced waste materials and reduced generation of polluting emissions.

During this grant, numerous helpful recommendations were made to different industries involved in the assessments. Implementation of these recommendations will lead to the enormous benefits, some of which are listed below:

1. Potential reduction in emissions for a Cincinnati based facility of 596,000 lb/yr CO₂, 3 million g/yr SO₂, and 1 million g/yr NO_x.
2. Rethinking the disposal of Sulfuric acid so as to increase the economic benefits for a screws and bolts manufacturer.
3. Reduction of sand blast waste by around 1600 tons per year.
4. Reduction of toxic air emissions and identification of PBT chemicals.
5. Estimated reduction of annual electric energy usage by 25% for a Toledo establishment thereby reducing the emissions of CO₂ (117,000 lb/yr), SO₂ (1493 lb/yr) and NO_x (503 lb/year).
6. Potential reduction in emissions for a metal coating facility of 13,000 lb/yr (an emission reduction of 30%), and a reduction in hazardous waste of 2,300 lb/month (a cost reduction of \$25,550/yr).
7. A cost saving of \$29,000/yr for a Cincinnati based automotive parts manufacturer through recycling of materials and reduction in waste generation.
8. Potential saving of \$59,000/yr for an Ohio based shim manufacturer through recycling, reduction in hazardous waste generation, and waste treatment prior to disposal.
9. Potential savings of \$76,000/yr for a facility through usage of rail cars for shipment of raw materials, recycling of materials, and reduction in hazardous waste generation.

In addition to the pollution prevention assessments, NIST Centers organized 27 seminars/workshops that were attended by about 500 individuals including professionals from industry; the University of Toledo worked on the development of five computer tools for the use of small and medium size companies; and OSEN members met 12 times to exchange information. More than 26 Ohio companies expanded or started P2 work; and 28 new requests were received by NIST centers from the seminars presented during the grant period.

Results show that five companies have implemented 100% of the recommendations and 15 companies have also benefited in one or more areas of pollution prevention by implementing some of the recommendations (10-75%) made for P2 opportunities. Information about implementing recommendations is not available for seven companies and two companies have not implemented any recommendations.

The above results demonstrate that it is possible to implement pollution prevention initiatives at the small and medium size companies in Ohio.

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Project Activities

The following activities were completed during the three years of the PPIS grant.

Task A: Coordination of OSEN

We have coordinated twelve meetings and received information from different agencies (Ohio EPA, ODOD, and Battelle) on available resources. Referral system for pollution prevention services is working fine. The OSEN Hotline was designated to be the Tech Resources Quest line number, 800-824-0488 as agreed during fall, 2000.

Meetings and e-mails were used to plan the activities under the grant. University of Toledo (UT) resolved the questions related to the sub grants. Every one was clarified about their role in the project discussion and brainstorming sessions were held to establish a baseline of practical knowledge and experience in pollution prevention principles, definitions and practices. Each participant gives a project update during the meeting. Comments received were incorporated in the rest of the activities of the grant. UT handled all the questions related to the grant throughout the year.

The following information was distributed during the meetings to exchange information:

1. Ohio EPA Publications for small businesses – Fact Sheets and Web site addresses
2. Ohio EPA Prevention Quarterly
3. Resources for small businesses by Ohio EPA
4. Energy loans
5. Seminar on available technologies by Battelle
6. Information on hazardous waste seminar by Ohio EPA
7. New appointments in different government departments
8. Presentation on the environmental technology commercialization center
9. Air pollution control equipment loan program by OAQDA

In addition to the above each organization provided an update on pollution prevention related projects carried by the organizations during the last three months.

Measurement and Evaluation

The details on the OSEN meetings are given below:

The quarterly OSEN meeting on December 5, 2000 was attended by 13 people from 10 different organizations. Rick Mazur, EISC, presented an overview of the ISO 14001 Environmental Management System program for manufacturers.

7 people attended the quarterly OSEN meeting on March 21, 2001 from 7 different organizations. All attendees presented an update to the group on their pollution prevention related initiatives and activities.

The quarterly OSEN meeting on June 6, 2001 attracted 9 people from 9 different organizations. The pollution prevention activities of Ohio EPA were discussed.

10 staff members attended the quarterly meeting of Sept. 21, 2001 from 9 organizations.

8 people attended the quarterly OSEN meeting on December 7, 2001 from 8 different organizations.

6 people attended the quarterly OSEN meeting on March 12, 2002 from 6 different organizations. All attendees presented an update to the group on their pollution prevention related initiatives and activities.

11 people attended the quarterly OSEN meeting on June 18, 2002 from 7 different organizations. All attendees presented an update to the group on their pollution prevention related initiatives and activities.

The last meeting for the 2nd year grant was held in Columbus on Sept. 30, 2002. 8 persons from 7 different organizations attended the meeting. Attendees discussed new areas of activities for the coming years.

7 people attended the quarterly OSEN meeting in December, 2002 from 6 different organizations.

6 people attended the quarterly OSEN meeting on March 28, 2003 from 6 different organizations. All attendees presented an update to the group on their pollution prevention related initiatives and activities.

9 people attended the quarterly OSEN meeting on June 13, 2003 from 6 different organizations. All attendees presented an update to the group on their pollution prevention activities.

6 people attended the quarterly meeting on Sept. 26, 2003 from 5 different organizations. Every one presented the progress made on pollution prevention in their areas.

Thus the meetings provided a place to discuss the progress of PPIS work and to plan new activities. Difficulties encountered during the projects were also discussed. Overall the coordination of OSEN was successful.

Task B: Seminars

Twenty seven seminars have been conducted during Oct., 2000 to Jan., 2004. The details are as follows:

1. EWI conducted a “Lean Manufacturing Simulation” for 15 employees from 6 different manufacturers in the Columbus area on Dec. 1, 2000.

2. EISC Inc. presented a two-hour “ISO 14001: An overview” seminar on Jan. 30, 2001. Number of people attending the meeting was 11 from 6 different organizations.
3. EISC Inc. presented a two-hour “ISO 14001: An overview” seminar on March 30, 2001 was conducted in Toledo. 4 people from 2 different companies participated in the seminar.
4. CAMP conducted a seminar on “Lean for the Process Industry with Simulation” for 9 people in Cleveland area on April 3, 2001. A one- hour presentation on PPIS was included.
5. ISO 14001 seminars were organized by EISC Inc. in Toledo area. The two-hour overview seminars were held on April 24 and May 24, 2001. Discussion on pollution prevention was a part of the seminars.
6. Tech Solve presented a Lean Manufacturing workshop on May 15 in Piketon, Ohio. This is a relatively untapped rural area.
7. EWI/MRO did a second Lean Seminar in Marietta, OH on June 5, 2001 with attendance of 15 people representing 4 different companies.
8. EISC Inc. presented a two-hour “ISO 14001: An overview” seminar on Feb. 27, 2002. Number of people attending the meeting was 5 from 2 different organizations.
9. EISC presented an 8-hour “ISO 14001 EMS Auditing” seminar on April 17, 2002. This seminar also covered practical examples of pollution prevention initiatives. The attendance was 8 people from 4 different companies.
10. CAMP conducted a “New Energy Market Opportunities for Manufacturers Workshop” for 14 people in Youngstown area on December 13, 2001. Presentation on pollution prevention was included. This seminar was developed in cooperation with ODOD.
11. Tech Solve presented a daylong workshop on Lean Manufacturing to 13 representatives from five area manufacturers on Dec.11, 2001 in Dayton, Ohio.
12. PBT Chemicals: UT conducted two half-day seminars on March 12, 2002 at EWI in Columbus and TechSolve in Cincinnati. 8 professionals attended the Columbus seminar and 24 individuals attended the Cincinnati seminar.
13. UT presented Green Engineering Workshop at EISC Inc. on Sept.12, 2002. 33 individuals attended the seminar.
14. EISC Inc. presented a 3-hour “Profiting from Green Initiative- ISO 14001 Seminar” on Oct. 22, 2002. 11 people attended the seminar from 8 different organizations including 5 different manufacturing companies.
15. CAMP/EISC presented a 2-hour “ISO 14001 EMS Overview & Pollution Prevention Examples” at CAMP on Feb. 12, 2003. 9 people attended the seminar including six from three different manufacturing companies.
16. EISC Inc. presented a 16-hour “ISO 14001 EMS Internal Auditing & Pollution Prevention for Auditors Seminar” on March 24 & 25, 2003. 6 people attended the seminar from a manufacturing company.
17. EISC Inc. presented a 2-hour “ISO 14001 EMS Overview & Pollution Prevention Examples” on March 27, 2003. 5 people attended the seminar including three from a manufacturing company.
18. TechSolve presented a storm water pollution prevention seminar on March 11, 2003. The topic was Combined Sewer Overflow and Storm water Pollution Prevention. The workshop provided an update on sewer capacity issues, how they are to be

addressed, and how manufacturers and other organizations can prevent storm water from becoming contaminated. The meeting was attended by 22 professionals, including manufacturing (14), USEPA (3), OEPA (2), ODOD (1), Cincinnati Metropolitan Sewer District (2)

19. TechSolve worked with the local chapter of AESF to put on an environmental workshop for the local electroplaters on March 24. 35 people attended the workshop from industry, USEPA, OEPA, and other local agencies. Topics covered in the workshop included local pollution prevention resources, regulatory compliance and pollution prevention for hazardous waste, and an improved wastewater recycling technology.
20. On March 17 and 18, TechSolve conducted a two-day educational session for a manufacturer. The topics covered under this session were ISO 14001 overview, specific requirements under ISO 14001 (e.g. objectives and targets, environmental policy), and pollution prevention. In attendance in these various sessions were approximately 190 employees from this manufacturer on a three-shift cycle.
21. TechSolve conducted a P2 training session to cover P2 resources and financial programs on April 8th from 2 to 4 pm. 15 manufacturing representatives and 3 government employees attended the training session.
22. EWI presented two "Lean Simulation" seminars by Bry-Air, Inc. in Sunbury, OH on April 3, and April 11, 2003. 18 people attended each seminar, for a total of 36.
23. TechSolve presented a ½ day energy workshop on September 16th on the DOE Motor Master program. 4 from industry and 2 from government attended.
24. TechSolve presented a half-day "Recycling and Environmental Resource Management" seminar on September 19th. There were 60 people from government and industry in attendance. The speakers included Cam Metcalf from KPPC, Tom Votta from the Tellus Institute, and Dave Weber and John Foley from United Recycling. 14 vendors also displayed during exhibit viewing period.
25. TechSolve had a full-day Steams System training course on November 14th based on DOE's program. Dr. Greg Harrell from the University of Tennessee came up and instructed 17 participants from government and industry on the use of the Steam Systems Assessment Tool.
26. EISC presented a 16-hour seminar on auditing an Environmental Management System including a discussion of auditing Pollution Prevention initiatives at the company. The seminar was presented August 26-27, 2003 to 13 employees of a stamping company.
27. EISC presented a 16-hour seminar on auditing an Environmental Management System including a discussion of Pollution Prevention initiatives and successful sample programs from related industries. The seminar was presented January 26 – 27, 2004 to 14 employees of a synthetic fabric manufacturing facility.

Each NIST Center was involved in the publicity for the seminars. UT did publicity of PBT seminar and Green Engineering Workshop. ODOD and Ohio EPA did additional publicity for the seminars.

NOTE: During Oct., 2000 to Jan., 2004, we intended to conduct thirteen 1-day seminars and one 1/2-day seminar. Each center was allowed to offer several seminars of short duration to cover more manufacturers. In the first and third year of the grant, seminars exceeded the commitment. In the second year, the commitment was not met, but EWI met it in the third year of grant.

Measurement and Evaluation – A summary is given in **Table I**. NIST Centers received 28 new requests for pollution prevention work as a result of these seminars. More than 500 professionals attended 27 seminars. Thus the seminars were successful in expanding P2 work in Ohio.

Table I: Measurement and Evaluation Statistics for Seminars

Center	Number of seminars conducted	Number of attendees	Number of request for assistance	Number of companies expanded/started P2 type work	Summary of evaluations
EISC Inc.	4	19	5+	5+	Met or exceeded expectations
CAMP	1	9	2	In Progress	9 (1-10 Scale) 1 being the lowest 10 is highest
TechSolve	1	30	1	0	Very good to excellent
EWI	1	15	0	0	Exceeded expectations
EISC Inc.	2	13	6	6	Valuable P2 information
CAMP	1	14	0	0	Valuable information
TechSolve	2	13+24	2	2	Both programs were well received by participants and promoted new ideas
UT/EWI/ EISC	2	8+33	N/A	1	Met or exceeded expectations. Some comments on improvement
EISC Inc.	3	22	5	4	Seminars lead to P2 programs at manufacturers
CAMP	1	9			NA
TechSolve	3	245+	1	2	Stormwater P2- Participants found the info to be helpful AESF - Participants felt the program was informative ISO 14001 - Manufacturer appreciated insight in to P2 and ISO 14001 and timely manner in which the presentations given
TechSolve	1	18	2	2	Attendees found the information helpful to identify P2 opportunities
EWI	2	36	1	1	Lean manufacturing evaluations showed a high degree of comprehension of lean techniques and a desire to implement them ASAP
TechSolve	2	23	1	1	Participants felt the information could help them identify energy saving opportunities
TechSolve	1	60	2	2	Attendees found the information useful and would like additional sessions in the future

Task C: Assessments and Computer Tools

C1: Assessments

NIST Centers identified different opportunities for pollution prevention, lean manufacturing and energy assessments. Proposals were aggressively submitted to the Ohio companies for assessments. During Oct., 2000 to Jan., 2004, 29 assessments were completed. An expanded abstract of each assessment is given in a separate report (Kumar et al., 2004) and is available at <http://p2tools.utoledo.edu>. The University of Toledo students participated in the assessments based on the needs of each center. The summary of the assessments carried out is given below.

1. CAMP: An assessment involving hazardous waste and non-hazardous waste streams for a screws and bolts manufacturer was completed. CAMP believes that there may be an opportunity for a cost saving in both areas at this plant. The company is currently pursuing a shot blast option to reduce the use of sulfuric acid. The equipment in the “Old Pickle House” to reduce the amount of waste oil that is generated seems to be a great way of reducing this waste stream. CAMP has developed a set of recommendations for the company (see **Table II**).

Table II: Examples of Environmental Programs Identified in Assessment no. 1

Issue	Objective	Target	Program	Payback
Cardboard waste	To explore economically feasible options of waste disposal	To reclaim 100% of cardboard waste generated	Invest in a cardboard baling machine	Return of investment will be in 2 years
Sulphuric acid disposal		To study economically viable improvements to the sulphuric acid recycling process	Invest in a shot blaster to be included as a part of the plant pickling process	Return of investment in this case will only need 1 year

2. EISC: UT worked with an auto part supplier from Nov. 2000 to Feb. 2001 on analyzing chemicals used by their suppliers. This company supplies nearly 80% of its products to the Ford Motor Company. The students contacted all the suppliers (time consuming aspect) and obtained MSDSs. They inspected each supplier’s MSDS files to determine if the ingredients in the ecoating process contained any chemicals on Ford’s restricted materials list. It was also noted whether these chemicals were prohibited or reported by Ford Motor. Next, the students determined which chemicals contained PBT chemicals. A report has been prepared and given to the company. Note that the EISC is assisting the company in the development of EMS based on ISO 14000.
3. EISC: UT worked with a solvent/lubricant manufacturer in Toledo area. The project started on March 23, 2001. The work involved an examination of 69 MSDSs and searching for information on the Internet for different chemicals. The students completed a materials assessment to determine which chemicals contain PBTs as ingredients as listed on their MSDSs. They also determined whether the chemicals used are on the USEPA prohibited list, the European (EINECS) list, and if it is included in

SARA section 313. Furthermore, they looked at both of the hazardous and the non-hazardous chemical lists. A list of these chemicals and the various lists they were/were not included in, was prepared.

4. EISC: The electric motor assessment involved about 150+ electric motors located throughout the facility. The motors range in size up to 125 HP (grinder motor) and a wide range of ages, frame sizes, type and duty cycle. There are a few high tech Variable Frequency Drives (VFDs) already in use. The power factor at this facility is usually less than 1. The goal of this motor assessment was to develop a complete list and categorize the type and HP based on the label information and to perform a rough estimate of duty cycle and motor loading by observation to the extent possible. A lay out of the motors was also developed. The company had some information already formulated. This listing was used as the basis to develop a motor management program to determine which motors and applications need to be upgraded /changed. The listing assisted the company in establishing an energy efficient preventative maintenance schedule and program. The goal was to reduce electric energy usage and peak demand and improve the power factor.

5. CAMP: An assessment for a circuit board manufacturer in Cleveland area was started in the month of April. The purpose was to evaluate the process flow involved in the manufacture of a typical circuit board in order to better understand the non-value added activities involved in the process. The study improved the productivity of the company and reduced the release of pollutants released per unit of production. The company will save about 2.5 million dollars per year by reducing non-value added activities.

6. TechSolve: TechSolve completed a pollution prevention and energy assessment for a Cincinnati industrial screening equipment manufacturer. Six different systems were audited for energy and water savings including:

- Building lighting
- Compressed air
- Motors
- Hot water boiler
- Control systems
- Once through cooling

7. EWI/MRO: An ISO 14001 Gap Analysis for a local manufacturing company was completed on May 3, 2001. The study made five recommendations to reduce pollution. Some projects identified during the gap analysis include:

- Reduction of electrical usage by automatic monitoring of all power aspects
- Improvement in scrap reduction
- Switch over to all electric injection molding machines
- Reduction of defective goods

A UT student helped EWI during the study. **Table III** provides examples of environmental programs and how they should be linked to objectives and targets identified during the study.

Table III: Examples of Environmental Programs Identified in Assessment no. 7

Issue	Objectives	Targets	Responsibility	Program
Preventative Maintenance	Conserve Natural Resources	Investigate the feasibility of on-site hydraulic fluid recycling by 2001	Maintenance Engineer	Research equipment requirements Cost benefit analysis
Storm water	Improve quality of storm water from property	Reduce level of contaminants in storm water by 50% by 2001	Facility Manager	Install cover over scrap/recycling storage area to reduce oil runoff due to rain
Resources	Reduce use of resources	Reduce use of energy by 10% 2001	Facility Manager Maintenance	Conduct energy audit of facility Install automatic light switches in bathrooms and conference rooms
		Increase rate of recycling by 20% by 2002 relative material purchases.		Document recycling program. Provide incentives for effective recycling by department

8. EISC: An assessment of the electrical energy requirements on the EISC building was completed with the goal of reducing overall energy consumption. A UT student assisted in the study. The assessment included the office area, air conditioning system, CAD/CAM/CAE training area with 15 work stations and the shop area which has 30+ pieces of tool making related machines including a 25 HP CNC mill, surface grinders, wire EDM, lathes and mills. The study determined that 25% of the total kWh could be saved if all the recommendations are implemented. This will result in a reduction of pollutants released during the generation of the power. The assessment will help in carrying out other industrial assessments.

9. EWI/MRO: An EMS was developed for a local manufacturing company. Potential reductions as a result of this project will be subject to the Targets & Objectives section of ISO14001 that the company determines to be the achievable near term goals for them. These will typically include:

- ___ Annual reduction of material sent to landfill as a result of scrap reduction by implementation of statistical process control - 5%
- ___ Annual reduction of landfill from packaging material waste - 5%
- ___ Annual reduction in energy use by conservation initiatives - 2%
- ___ Annual reduction in solvents disposal by use of contract service - 10%

10. TechSolve: TechSolve completed a pollution prevention and energy assessment for a concrete slab manufacturer located in Springboro, Ohio. The assessment examined:

- ___ Building lighting
- ___ Boiler efficiency

- ___ Hot water heater
- ___ Compressed air
- ___ Sand blast waste
- ___ Facility recycling program

Recommendations for these systems will save the company a total of 9,757 ccf per year and approximately 1,600 ton of sand blast waste.

11. CAMP: An assessment involving hazardous waste and non-hazardous waste streams and air pollution sources for a metal coating industry was completed. The assessment involved finding the source of waste, which involved detailed study of the process. Finally, avenues to alleviate the pollution problems have been explored and a cost reduction analysis has been performed (see **Table IV**).

Table IV: Examples of Environmental Programs Identified in Assessment no. 11

Issue	Objectives	Targets	Responsibility	Program
Waste reduction	Reduce waste	Rework the customer parts coating process	1) Facility Manager 2) Employees	Reduce exposed area of coating tank Redo placement of hooks
Waste reduction	Reduce waste Reduce air emissions	Addressing problem of paint sludge	Facility Manager Employees	Reduce exposed surface area of coating tank Mechanical mixing rather than hand mixing of paint sludge

12. EISC: Energy assessment was performed at an auto parts manufacturing facility in Findlay, Ohio with the help of UT students. The plant manufactures rubber moldings for use in automobile parts. The assessment was intended to cover the various uses of energy within the plant. The areas covered were the lighting, HVAC systems and motors used in the plant. A complete spreadsheet of power usage by lighting and motors in the plant was generated. Avenues to effect more energy efficient consumption of power were explored. Examples of environmental programs identified during the assessment are given in **Table V**.

Table V: Examples of Environmental Programs Identified in Assessment no. 12

Issue	Objectives	Recommended Action	Responsibility	Targets
Energy assessment	Reduce energy consumption	Analyze energy usage in lighting, HVAC and motors Suggest improvements	Maintenance manager Facility manager	Retrofitting lighting by use of energy efficient fixture replacements or additions Replace motors with energy efficient models

13. TechSolve: TechSolve conducted an ISO 14001 gap analysis and implementation guidance, and pollution prevention assessment for an automotive parts manufacturer. The manufacturer is required to obtain ISO 14001 certification to maintain automotive supplier status. TechSolve incorporated pollution prevention as part of

this program to get the manufacturer started in the requirements for program sustainability.

14. CAMP: Waste minimization assessment was performed for a shim manufacturing facility of an international company. The assessment was intended to study the hazardous as well as non-hazardous waste generation and to find out avenues for waste minimization and savings. Several recommendations have been made.
15. CAMP: Waste minimization assessment was performed for Company A, which included both hazardous and non-hazardous wastes. Recommendations have been made for pollution prevention and waste minimization opportunities.
16. TechSolve: Pollution prevention assessment was performed for Company B, a manufacturer of small plastic injection molded parts. The assessment included evaluation of two waste streams, oil and antifreeze, and investigation of waste reduction opportunities.
17. TechSolve: TechSolve was contracted to help initiate ISO 14001 program and to provide pollution prevention ideas for Company C, which manufactures high-end shock absorbers for the automotive industry.
18. EISC: This VOC reduction project was aimed at helping a company manufacturing vinyl playground balls in reducing VOC emissions. Graphics and clear coat shiny finish on balls contribute to the emissions. Avenues for reducing VOCs by reformulating the ink and coatings and developing improved spray methods were investigated. UT students helped on the project.
19. EISC: The center focused on electric energy at a metal fabrication manufacturer. The assessment consists of energy efficiency alternatives and development of management programs. A project identifying the E2 opportunities associated with plant lighting in the existing plant and a planned new addition is underway. This E2 / P2 project is part of a new ISO 14001 Environmental Management System implementation.
20. CAMP: The material that an auto parts manufacturers uses for wires; contain some amount of lead and chromium (+6) compounds. These compounds are generally used in the coloring pigments and can be used for other purposes. The purpose of the project was to suggest the alternatives for the hazardous compounds mentioned above which are present in the manufactured products consisting primarily of wires harness assemblies. Examples of environmental program identified by EISC are given in **Table VI**. UT students participated in the study. It is hoped that PBTs and other hazardous materials can be eliminated through design and material changes.

Table VI: Examples of Environmental Programs Identified in Assessment no. 20

Issue	Objectives	Targets	Responsibility	Program
Presence of Cr 6+	Eliminate the use	Minimization	Company	Active and ongoing
Presence of lead	Eliminate the use	Minimization	Company	Active and ongoing

21. TechSolve: Two meat packers originally hired TechSolve but one meat packer went out of business due to financial difficulties before the study could be completed. TechSolve conducted a pollution prevention assessment of their wastewater stream. The company was facing financial hardship due the high surcharges they were encountering due to the blood and solids that were discharged in to the sewer. Investigated in this study was the reuse, treatment or collection of blood from the kill floor, reuse or treatment of solids consisting of meat fragments, manure, and bone, and reduction in water usage. Because of the layout of the facility and limited space, TechSolve recommended the collection and rendering of blood and the filtration of solids to help the company reduce BOD, TSS, and TKN in their wastewater. **Table VII** shows the examples of environmental programs identified in this assessment.

Table VII: Examples of Environmental Programs Identified in Assessment no. 21

Issue	Objectives	Recommended Action	Responsibility	Targets
Waste water stream	Reduce discharge cost	Separate the components of waste at the origin, if possible	Company	Collection of blood Filtration of solids

22. TechSolve: The pollution prevention assessment to assist a local window manufacturer to reduce zinc, COD, oil and grease, and ammonia in the wastewater from their operations was successfully completed. TechSolve identified the true source of the wastewater contamination and prescribed pollution prevention techniques to reduce or eliminate these sources.

23. EISC: UT students participated in conducting pollution prevention work at a leather manufacturer in Toledo area with the help of EISC Inc. They examined boilers and coating lines to find opportunities for saving energy and reducing waste.

24. EISC: UT students spent time visiting metal fabricator plant along with EISC staff. They examined the lighting and motors to find opportunities for energy savings and pollution prevention. The study included data on HVAC system supplied by the company. Final recommendations will be developed by EISC.

25. EISC: UT students got involved with automobile part manufacturers to conduct lighting survey. They examined motor data. EISC also looked at the HVAC system for pollution prevention opportunities.
26. EWI: After an energy management systems diagnostics using the EnVinta© tool, ABC Chemicals a compounded plastics and formaldehyde producer in Columbus, OH -- contracted EWI to perform an energy assessment of its plant. The assessment employed an integrated approach that looks at energy conservation, waste stream reduction and productivity enhancement.
27. EWI: Also after an energy management systems diagnostics using the EnVinta© tool, ABC Magnets -- a flexible magnet materials manufacturer in Marietta, OH -- contracted EWI to perform an energy assessment of its plant. The assessment also employed an integrated approach that looks at energy conservation, waste stream reduction and productivity enhancement.
28. CAMP: A stamping company was assisted in identifying the environmental aspects and impacts throughout the company. EISC worked with the staff to identify 70+ environmental aspects and discussed possible pollution prevention initiatives including spill prevention measures, toxic material substitution possibilities, welding controls to reduce scrap and improve quality and scrap container management practices to prevent storm water pollution.
29. TechSolve: The environmental compliance for a 38-person ISO 14001 registered company was reviewed. Walkthrough was conducted with the Hamilton County Solid Waste District to determine areas for waste reduction improvement.

Measurement and Evaluation: The success of assessments was evaluated in different ways. As the first step, statistics of various assessments were collected from NIST centers and are given in **Table VIII**. The table clearly shows that the assessments led to environmental improvement as a result of the actions by the companies. Analysis of variety of assessments given in **Figure I** clearly shows that most of the assessments involved direct pollution prevention work. A few assessments involve indirect benefit to pollution prevention using reduction of energy usage/improvement in energy efficiency and resource consumption.

The next step in this analysis was to look at the pollution prevention benefits derived from the assessments. NIST centers were again contacted to provide the information given in the **Tables IX a, b, c**. These tables indicate that the companies have received some pollution prevention benefits as a result of these assessments.

The next step in evaluating the success of the assessments was to look at the number of recommendations implemented by the companies. Table X presents the statistics compiled from the responses received from companies by NIST centers for each assessment. The data shows the following:

Table VIII: Statistics of Various Assessments

Center	Variety of assessment	Environmental impact considered	Types of pollution prevention addressed	Match by company	Action by company (environmental improvement)	Reduction in amount of waste
CAMP (00-01)	P2	Health risk due to chemicals	Toxic chemicals	Yes	Company is in the process of implementing the assessment findings. The company is adding shot-blasting technique in order to reduce its sulfuric acid usage.	N/A
EISC (00-01)	P2	Health risk due to chemicals	Toxic chemicals/ PBT chemicals	Yes	Elimination of chemicals by their suppliers or selection of new suppliers.	38.2% reduction in pollutants will be effected (approx. 782 tons)
EISC (00-01)	P2	Health risk due to chemicals	Toxic chemicals	Yes	Identification of pollution prevention opportunities.	N/A
EISC (00-01)	Energy assessment/ P2	Energy Reduction	Reduction in release of pollutants	Yes	Identified opportunities to reduce electricity consumption and consequently reduce pollutant emission.	Recommendations will reduce 473013 lb/yr CO ₂ , 6073 lb/yr SO ₂ , and 2068 lb/yr NO _x approx.
CAMP (00-01)	Lean manufacturing/ P2	Reduction in time of production	Energy savings	Yes	Reduction in production time.	Potential savings of \$ 2.5 million /year
TechSolve (00-01)	Energy assessment/P2	Emissions for energy production, wastewater generation	Energy and water	Yes	Identified opportunities for waste/energy reduction, considering both for implementation.	Recommendations will reduce over 596,000 lb/yr CO ₂ , 3 million g/yr SO ₂ , and 1 million g/yr NO _x .
EWI (00-01)	EMS/P2	Waste Generated	Landfill reduction	Yes	N/A	N/A
EISC (00-01)	Energy assessment/P2	Energy Reduction	Reduction in release of pollutants	Yes	Identified opportunities for power saving and reduce pollution prevention.	Recommendations will reduce 117,000 lbs/yr CO ₂ , 1493 lbs/yr SO ₂ , 503 lbs/yr of NO _x approximately.
EWI (00-01)	EMS/P2	Air Contaminants	Prevention of release of dust	Yes	In progress	N/A
TechSolve (00-01)	Energy assessments/P2	Energy, solid waste	Energy, solid waste	Yes	Investigate opportunities further, contact vendors.	Recommendations will save the company a total of 9,757 ccf per year and approximately 1,600 ton of sand blast waste.

CAMP (01-02)	P2	Health risk due to chemicals	Toxic chemicals	Yes	Under consideration	30%; estimated saving:\$25000
EISC (01-02)	Energy assessments/P2	Reduction in CO ₂ , SO ₂ , NO _x achieved by less power usage	Energy related air emissions	Yes	Installed lab A/C economizer, Revised plant lighting layout	Est. \$4,000 savings so far, projected \$ 30,000/yr. total
TechSolve (01-02)	EMS/P2	Impact on all media	Waste Reduction	Yes	Company is pursuing options for three waste streams	Estimated \$31000 savings
CAMP (01-02)	P2	Health risk	Waste minimization	Yes	N/A	N/A
CAMP (01-02)	P2	Risk due to hazardous waste	Hazardous and non-hazardous wastes	Yes	N/A	Potential reduction of 75,500 lb of hazardous waste
TechSolve (01-02)	P2	Oil and antifreeze wastes	Waste streams, oil, and antifreeze, and investigation of waste reduction opportunities	Yes	Currently evaluating options	5% potential reduction
TechSolve (01-02)	EMS/P2	Significant aspects	Toxics and VOCs	Yes	Evaluating option	For future consideration
EISC (01-02)	P2	Health risk, air emissions	VOC reduction	Yes	Reduced VOC by 3-5% so far	Reduced VOCs
EISC (02-03)	Energy assessment	Reduction of resources	Cut down in pollutant release from energy sources	Yes	Reduce energy and indirect air pollution	Goal: 10%
CAMP (02-03)	P2	Chromium (+6) and lead	Design and material changes	Yes	Initial identification of Substances of Concern	To be determined
TechSolve (02-03)	P2	Wastewater	Reduction of blood and solids to wastewater	Yes	Began collecting blood and shipping to renderer for reuse	75,000 gal/yr blood
TechSolve (02-03)	P2	Wastewater	Reduction of chemicals	Yes	Raw material substitutions and better housekeeping techniques	Elimination of \$4000 per month wastewater surcharges
EISC (02-03)	Energy assessment/P2	Energy Reduction	Reduction in release of pollutants	Yes	In Progress	In Progress

EISC (02-03)	Energy assessment	Reduction of energy use and pollution	N/A	Yes	In Progress	In Progress
EISC (02-03)	Energy assessment	Reduction of energy use and pollution	N/A	Yes	In Progress	In Progress
EWI (02-03)	Energy assessment/ P2	Reduction of resources	Cut down in pollutant release from energy sources	Yes	Installed monitoring devices for energy use on critical processes	1,873,000 lbs. CO2 per year
EWI (02-03)	Energy assessment/ P2	Reduction of resources	Cut down in pollutant release from energy sources	Yes	N/A	1,200,600 lbs. CO2 per year
CAMP (02-03)	EMS/P2	Pollution prevention	Spill prevention measures, toxic material substitution possibilities, and welding controls and scrap container management practices to prevent storm water pollution	Yes	Not available	To be determined
TechSolve (02-03)	P2	Waste reduction	Waste	In-Kind	Identified areas to reduce waste and assisted with compliance	To be determined

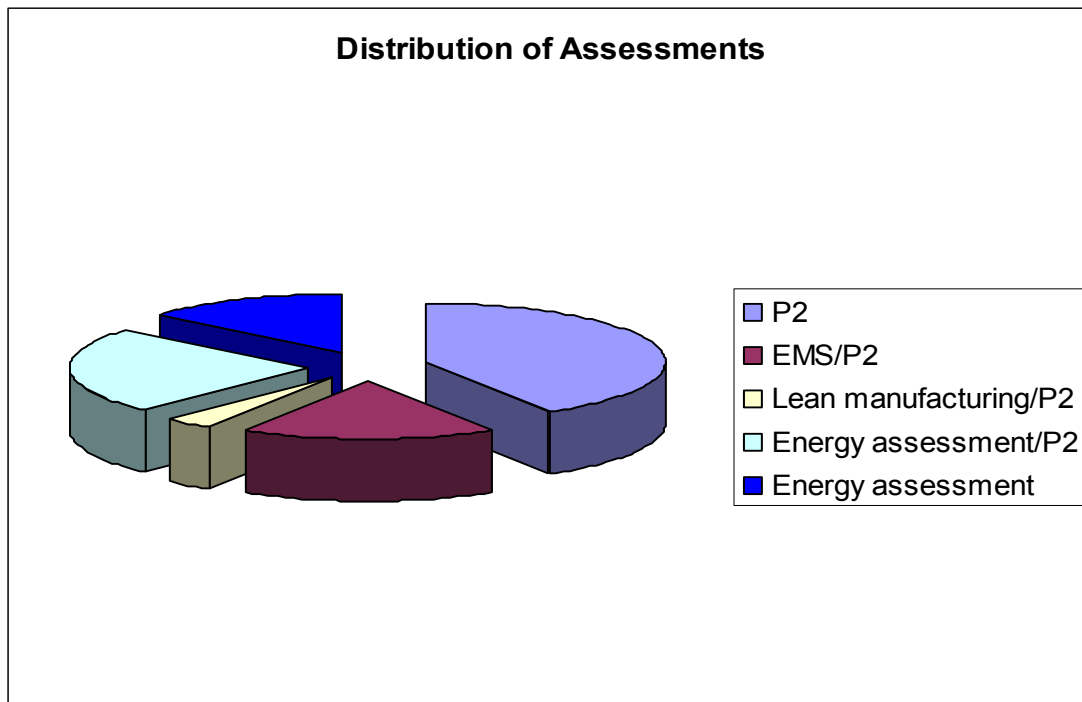


Figure I: Distribution of Assessments during the PPIS Grant

Table IXA: Pollution Prevention Benefits from Assessments 1 to 10

Benefit	CAMP	EISC	EISC	EISC	CAMP	TechSolve	EWI	EISC	EWI	TechSolve
Raw materials savings by recycling	<i>N/A</i>	Yes	Yes	<i>N/A</i>	No	Yes	<i>N/A</i>	No	<i>N/A</i>	Yes
Material substitution savings	<i>N/A</i>	Yes	Yes	<i>N/A</i>	<i>N/A</i>	Yes	<i>N/A</i>	No	<i>N/A</i>	Yes
Elimination of pollution control equipment	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>
Improved process productivity	<i>N/A</i>	Yes	Yes	<i>N/A</i>	Yes	Yes	<i>N/A</i>	Yes	<i>N/A</i>	Yes
Better product quality	<i>N/A</i>	<i>N/A</i>	Yes	<i>N/A</i>	No	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>
Reduced labor from pollution elimination	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>
Reduction of permitting requirements	<i>N/A</i>	Yes	Yes	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	Yes
Reduction and /or elimination of off-site waste disposal	Yes	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	Yes	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	Yes
Reduction and /or elimination of off-site waste storage	Yes	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	Yes	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	Yes
Reduction of personal injury risks under OSHA	<i>N/A</i>	Yes	Yes	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>
Permitting requirements minimized	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>

Table IXB: Pollution Prevention Benefits from Assessments 11 to 18

Benefit	CAMP	EISC	TechSolve	CAMP	CAMP	TechSolve	TechSolve	EISC
Raw materials savings by recycling	Yes	N/A	Yes	Yes	Yes	Yes	N/A	N/A
Material substitution savings	Yes	Yes	N/A	Yes	Yes	N/A	N/A	Yes
Elimination of pollution control equipment	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Improved process productivity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Better product quality	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Reduced labor from pollution elimination	Yes	Yes	Yes	Yes	Yes	Yes	N/A	Yes
Reduction of permitting requirements	N/A	N/A	N/A	N/A	N/A	N/A	Yes	Yes
Reduction and /or elimination of off-site waste disposal	Yes	No	Yes	N/A	N/A	N/A	Yes	No, Less Toxic
Reduction and /or elimination of off-site waste storage	N/A	No	N/A	Yes	Yes	N/A	N/A	No
Reduction of personal injury risks under OSHA	N/A	Yes, less toxic	N/A	N/A	N/A	N/A	N/A	Yes, less toxic
Permitting requirements minimized	N/A	Yes	N/A	N/A	N/A	N/A	N/A	N/A

Table IXC: Pollution Prevention Benefits from Assessments 19 to 29

Benefit	EISC	CAMP	Tech Solve	Tech Solve	EISC	EISC	EISC	EWI	EWI	CAMP	TechSolve
Raw materials savings by recycling	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes		N/A	N/A
Material substitution savings	Yes	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Elimination of pollution control equipment	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Improved process productivity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Better product quality	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A
Reduced labor from pollution elimination	Yes	Yes	Yes	Yes	Yes	Yes	N/A	Yes	N/A	N/A	Yes
Reduction of permitting requirements	N/A	N/A	N/A	N/A	N/A	N/A	Yes Air	N/A	N/A	N/A	Yes
Reduction and /or elimination of off-site waste disposal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Yes
Reduction and /or elimination of off-site waste storage	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Yes	Yes
Reduction of personal injury risks under OSHA	N/A	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Yes
Permitting requirements minimized	N/A	N/A	N/A	N/A	N/A	N/A	Yes	Yes	Yes	N/A	Yes

Table X: Progress made on Assessments

Center	Assessment	Number of recommendations made	Recommendations implemented by the end of Jan. 30, 2004 by the company	Percent of recommendations implemented	Amount of waste eliminated
CAMP	P2	7	1	14	40% reduction in spent sulphuric acid waste
EISC	P2	2	2	100	Working on new product recipes
EISC	P2	3	3	100	Substituted low toxic materials
EISC	E/P2	1	Lighting & equipment operation changes	100	473013 lbs of CO ₂ , 6073 lbs of SO ₂ , 2068 lbs of NO _x
CAMP	L/P2	20	2	10	N/A
TechSolve	E/P2	8	3	37	507 gallons of waste cleaning solution
EWI	GAP/P2	16 (main)	Still open	Still open	N/A
EISC	E/P2	7	2	10, further actions being investigated	Proposed 117000 lbs of CO ₂ , 1493 lbs of SO ₂ , 503 lbs of NO _x
EWI	EMS/P2	5	5	100	N/A
TechSolve	E/P2	9	3	33	Company replaced boiler for energy and efficiency
CAMP	P2	5	N/A	N/A	N/A
EISC	E/P2	4	4	100	Energy
TechSolve	GAP/P2	5	2	40	20 cu. yd. and 108 cu. Yd. metal waste recycled
CAMP	P2	5	N/A	N/A	N/A
CAMP	P2	8	N/A	N/A	N/A
TechSolve	P2	2	0	0	N/A
TechSolve	GAP/P2	4	0	0	N/A
EISC	P2	4	3	75	Less toxic
EISC	P2/E2 YSW	4	1	25%	Reduced lighting energy
CAMP	P2 A	3	1	33%	Reducing Pb, Cr in product
TechSolve	P2	6	4	67%	7500 gal/yr

TechSolve	P2	7	5	71%	Amt fluctuates, \$4000 per month surcharges
EISC	P2/Energy Tex	11	3	27%	Improved condensate return from 25 to 50%
EISC	Energy/P2 Alex	6	1	16%	Identified welding scrap reductions
EISC	Energy/P2 GB	4	1	25%	Identified KWD decrease of 4%
EWI	Energy/P2	6	In progress	N/A	N/A
EWI	Energy/P2	5	In progress	N/A	N/A
CAMP	EMS/P2		In progress	N/A	N/A
TechSolve	P2	5	1	20%	Utilizing alternative for MEK cleaning

- a. Five companies have implemented all the recommendations made by NIST centers.
- b. Fifteen companies have implemented (10% to 75%) recommendations made by NIST centers.
- c. Seven companies are still considering implementing pollution prevention recommendations.
- d. Two companies have not implemented any recommendations.

A look at all the above measurements shows that Ohio companies have participated in implementing pollution prevention activities.

C2: Computer Tools Developed by the University of Toledo

UT students worked on the development of five tools for the use of small and medium size companies. These are: 1) Gap Analysis tool, 2) MSDS Manager for P2, 3) Energy Efficiency Analysis tool, 4) Lean Manufacturing, and 5) HVAC Checklist. A brief description of each tool is given below:

Gap Assessment Tool (GAP 1.0)

This tool performs a GAP analysis, based on ISO 14001, to gauge the implementation of an Environment Management System. This tool has been developed using a combination of Microsoft Excel and Visual Basic for Applications and provides a checklist for verification of percentage implementation of the environmental management system for an organization. The tool will help environmental managers to identify pollution prevention opportunities.

MSDS Manager Tool (MSM 1.0)

The MSDS Manager is a software tool that enables the user to maintain an electronic database of MSDSs (Material Safety Data Sheets). By using this tool, an user can upload scanned MSDSs of a chemical in a database and print them, if required. The individual MSDSs can be retrieved from the database as and when required. This tool will make aware of all the chemicals used at a plant and will help in further investigations for pollution prevention. Examination of MSDSs is a first step in many pollution prevention assessments.

Emission Reduction Calculator (ERC 1.0)

The Emission Reduction Calculator is a software tool that enables the user to estimate pollution prevention of an energy conservation project. The tool calculates the reduction in emission of three pollutants (CO₂, NO_x and SO₂,) that can be achieved by reducing energy consumption. The tool uses the EPA regional emission factors to calculate the reduction in emission of the pollutants.

Lean Assessment Screening Tool (LEAN1.01)

The software can be used for a screening assessment of the amount lean and green engineering implemented in a facility. The tool is divided into four sections. Each section has different outputs, which can be viewed in text format or spreadsheet format. Web links are provided which give users more information on lean principles.

HVAC Checklist (1.0)

This checklist, developed with Microsoft Excel, provides a list of measures to improve an existing HVAC system to make it more energy efficient.

The above tools are available for download to small and medium size companies from the Internet site maintained at the University of Toledo <http://www.p2tools.utoledo.edu/>. A user's guide is provided for each tool along with a PowerPoint presentation. These slides have been prepared so that user could learn online.

A P2 tools guide is prepared for the use of manufacturers and is available for download from <http://www.p2tools.utoledo.edu/>. This tool guide provides details of many tools available on the Internet and also provides information about the tools developed by the University of Toledo along with user's manuals and PowerPoint slides for the same.

C3: Other Educational Material Developed

A P2 tool website was developed to share the work conducted during the PPIS grant. This site also provides links to other useful tools developed elsewhere. A brief description of other tools is given below.

Manufacturing Efficiency Decision Support Tool (MEDS)

As the name suggests, this is a decision support tool, which assists buyers in making decisions regarding purchases of manufacturing and facility equipments. The Michigan Manufacturing Technology Center has created this tool. It has information for all equipment used in a facility right from energy systems to ancillary plastic equipment, enabling the user to make a decision guided by his/her requirements.

Manufacturing Assessment Planner (MAP)

MAP has been designed as an aid in performing low cost assessments. It can be used for multiple industry sectors and is integrated with the **MEDS** tool mentioned above. The tool provides assessment on efficiency in manufacturing, energy and environment. A notable feature of this tool is the availability of a consistent format for report writing. MAP is a product of **Michigan Manufacturing Technology Center**.

Motor Master + 3.0

This is a popular tool that assesses motor and motor system efficiency. The primary use of this software is to identify inefficient and oversized motors and calculate energy and demand savings when energy efficient motors replace these. The software is available from the Department of Energy website.

Coatings Guide™

The Coatings Guide™ contains several tools that help to identify low-volatile organic compound/hazardous air pollutant coatings that may serve as replacements for existing coating operations. It includes a section for assessing costs involved in changing from one coat to another, a section for low-emitting coating replacements and various other sections.

Environmental Indicators

So far six environmental indicators have been identified. A study was done to identify high-risk areas in Ohio using these indicators and TRI data. A report has been posted on the Web site at <http://p2tools.utoledo.edu/>. A synopsis on PBT chemicals is also available on the above mentioned web site which was prepared during the first year of the grant. Sources, health effects and methods of exposure of PBT chemicals are discussed and a list of chemicals identified as PBT by EPA is also provided in it.

CONCLUDING REMARKS

The University of Toledo successfully executed the technical work outlined in the PPIS proposal with the help of NIST Centers, OhioEPA, ODOD and Battelle. The activities led to the reduction of waste during the grant period and have the potential of reducing

waste in the coming years by small and medium size manufacturers. As of January 2004, five companies have implemented all the recommendations made for P2 opportunities, and most of the companies have already benefited in one or more areas of pollution prevention. Fifteen companies have implemented 10% to 75 % of the recommendations made by the NIST Centers. Five computer tools have been posted on the website to assist in pollution prevention work. A P2 tools guide has been prepared and is available to download by manufacturers.

REFERENCES

- Kumar et al., 2001. Pollution Prevention Activities in Ohio Under PPIS Grant.
<http://p2tools.utoledo.edu/>.
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