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Materials and Energy Efficiency in SMEs

Thomas J. Bierma

Illinois State University
Normal, Illinois

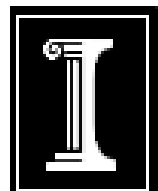
Dan Marsch

Illinois Sustainable Technology Center
Institute of Natural Resource Sustainability
University of Illinois at Urbana-Champaign

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Abstract

Efficiency performance contracts (EPCs) for small and medium enterprises (SMEs) are a market-based approach that rewards suppliers for improving efficiency and reducing waste in SME operations through pollution prevention and energy efficiency (P2E2) innovations. They are similar to programs such as chemical management services, energy savings performance contracts, and resource management contracts that have been successfully used in larger enterprises. However, they are unique in that they combine a variety of “spends,” such as tooling, chemicals, paint, and energy, in order to achieve sufficient economies of scale.

In a pilot project combining tooling and metalworking fluid spends, the SME realized a 40% reduction in tooling costs while improving process efficiency and reducing tooling waste. Evidence suggests that similar EPC programs could successfully bring P2E2 innovations to many SMEs while simultaneously reducing costs and increasing profitability.

However, significant barriers exist and EPC programs are unlikely to be adopted on a widespread basis without efforts by government or non-profit organizations to overcome these barriers. Most importantly, many suppliers are not willing to form the alliances necessary to make EPCs successful, particularly in the area of energy efficiency. Several steps to overcome these barriers are recommended.

Executive Summary

Small and midsize enterprises (SMEs) have a significant economic and environmental impact on Illinois and the nation. Yet SMEs have been slow to adopt pollution prevention and energy efficiency (P2E2) practices and technologies that would both reduce waste and increase profitability. Many of the market-based programs that accelerate adoption, such as chemical management service, energy savings performance contracting, and resource management are not available to SMEs because they lack economies of scale.

This research focuses on the feasibility of bringing market-based efficiency programs to SMEs in the metalworking industry by expanding the program “footprint” – thereby achieving sufficient economies of scale. The footprint could include chemicals, paint, tooling, electricity, natural gas, and other purchases. We use the term *efficiency performance contracts* to represent these expanded footprint programs. We propose that the success of such programs depends upon eight conditions; we state these conditions as “propositions” to be tested in the research.:

- Proposition 1 – Key aspects of operations that have the greatest environmental impact (chemicals, paints, energy, tooling, water, waste) are outside of SME management’s core competence.
- Proposition 2 – These key non-core aspects, are not as well managed as aspects of operations that are within the core competence of SME management.
- Proposition 3 – Taken together, annual spends in these key non-core aspects commonly exceed \$500,000 for SMEs with over 100 employees.
- Proposition 4 – SME management prefers to work with a single supplier to improve efficiency in key non-core aspects rather than with multiple suppliers.
- Proposition 5 – Given the above conditions, SME management will be willing to partner with an appropriate supplier to implement an efficiency performance program.
- Proposition 6 – Through improvements to each key non-core aspect, and synergies between aspects, suppliers have the capability of creating sustained improvements in efficiency (with a tentative target value of at least 20% efficiency improvement within three years using technologies with a payback period of no more than 3 years).
- Proposition 7 – Economies of scale and mass replication at other SMEs will significantly reduce the cost of efficiency performance programs for suppliers.
- Proposition 8 – Given the above conditions, suppliers will develop alliances and propose efficiency performance programs to SMEs.

Our research found that EPC is clearly feasible and profitable. In one pilot project, the SME experienced a 40% reduction in tooling costs in the first two years of the program and is now

adding metalworking fluids to the program and considering the addition of electricity. However, it is also clear that EPC will not be widely adopted without outside efforts to initiate supplier partnerships and assist SMEs in the initial adoption process. Our research found strong support for propositions 1-4, and partial support for propositions 5-7. Proposition 8 was not supported.

Efficiency performance contracts are unlikely to arise spontaneously because of deficiencies and uncertainties in supply markets. To overcome these problems and increase the development of efficiency performance contracts, we make the following recommendations.

1. Demonstrate, through at least one pilot project, a comprehensive application of technology and practices to increase efficiency in metalworking operations.
2. Document the success of efficiency performance contracting for tooling and metalworking fluids.
3. Begin pilot projects for efficiency performance contracting in paint and pretreatment operations.
4. Foster the evolution of supply markets to support efficiency performance contracting.

Introduction

SMEs need innovative P2E2 assistance

Small and medium-sized enterprises (SMEs) have a significant economic and environmental impact in the State of Illinois yet they have been slow to adopt pollution prevention and energy efficiency (P2E2) technologies and practices that could both reduce waste and increase profitability. Though Illinois has devoted significant resources to assisting SMEs in the adoption of P2E2, evidence suggests that only a small percentage of companies have taken advantage of these opportunities.

The 2002 Economic Census indicated that Illinois manufacturers in the fabricated metal products industry (NAICS code 332) numbered 3,673 and employed 113,000 people, an average of only 31 employees per establishment (U.S. Census Bureau 2005). Total payroll exceeded \$4 billion with sales of over \$17 billion. Yet Illinois has lost 222,500 manufacturing jobs since 1990, and median family income has declined over \$6,000 in real terms since 1999 (CTBA/NIU 2005). To survive international competition and retain jobs, Illinois manufacturers must cut costs through greater efficiency.

There are no accurate data on the environmental impact of Illinois SMEs in the fabricated metal products industry. However, typical wastes from such facilities can be significant, and include metalworking fluids, heavy metals, cleaning and surface treatment chemicals, paints, and solvents as well as emissions from energy consumption (USEPA 1995). Nationally, fabricated metal products facilities released over 58 million pounds of wastes reportable under the Toxic Release Inventory in 2005 (USEPA 2007). In 2002, the fabricated metal products industry consumed over 388 trillion BTUs of energy, including over 47 million kilowatt hours of electricity and 204 billion cubic feet of natural gas (EIA 2002a). This represents approximately 87 billion pounds of carbon dioxide emissions (EIA 2002b, 2005). More than 99% of fabricated metal products companies have fewer than 250 employees.

A wide array of P2E2 practices and technologies are available to reduce both wastes and costs to metal fabricators (NEWMOA 2001, USEPA 1995, WSDE 2005). Many of these practices and technologies have relatively quick payback periods and can reduce costs by reducing the purchase of energy and materials as well as the cost of waste disposal. Yet the adoption of P2E2 by SMEs has been slow (Ashton et al 2002, de Bruijn and Hofman 2001, Lindsey 1998, Rothenberg and Becker 2004, Worthington and Patton 2005). Many reasons have been suggested for this slow diffusion. Bierma and Waterstraat (1995) found that SMEs' trusted sources of innovation information do not include the organizations with the most P2E2 information – government agencies and consultants. Lindsey (1998) noted that P2 technologies are often perceived as complex and incompatible with the standard practices of many businesses. He found that demonstrations, and especially pilot projects, were critical to provide businesses with the “how to” knowledge that they lacked (Lindsey 1999 and 2000).

We argue that there are three important factors that limit the adoption of P2E2 practices and technologies by SMEs (Bierma and Waterstraat 2000):

1. Lack of core competence
2. Incorrect incentives
3. Operation-specific approaches to system-wide problems.

Lack of core competence

Businesses tend to be very good at what they do – otherwise they would not survive long in the face of international competition. All businesses, and especially SMEs, have core activities at which they are highly competent. For example, in the metal products fabricating industry, these core competencies often include customer relations, turning customer's specifications into efficient production processes, and managing and developing employees. These core competencies reflect management's passions and generally offer the paths by which employees can rise through the management hierarchy.

However, there are many parts of the business outside the core competence of management. In some cases, management recognizes this lack of competence and chooses to purchase these products or services rather than provide them themselves (e.g. telecommunications, product components, laundry services, etc.). However, there are other aspects of production that the business continues to manage despite a lack of core competence. In the metal products fabricating industry, for example, this often includes management of energy, metalworking fluids, cleaning chemicals, and wastewater treatment.

Areas outside the business' core competence are typically not as well managed and operate less efficiently than those within core competence areas. This is likely to be particularly true for SMEs in the metal products fabricating industry, since the most significant wastes – chemicals, paints, energy, etc. - are only indirectly related to the metals with which they work (USEPA 1995). Thus, managers often lack the critical knowledge needed to assess and successfully implement P2E2 technologies (Lindsey 2000). Innovations in these areas are not as easily identified nor well understood by plant staff. Companies that *do* have a core competence in these areas – the company's suppliers – have a strong incentive to avoid sharing that competence. It is to this point that we now turn.

Incorrect incentives

Traditional supply relationships discourage efficiency. Standard pricing - \$/lb or \$/gallon – rewards suppliers for volume, not value. Efficiency, under such incentives, is in direct opposition to the financial interests of the supplier. The supplier may need to share enough information avoid losing the account, but no more. Thus, a wealth of expertise on efficiency improvement generally goes untapped.

Operation-specific approaches to system-wide problems.

Inefficiency in production operations is often the result of attempting to manage pieces of the operation independently rather than optimizing the process as a whole. This is particularly problematic when many parts of the process are outside a company's core competence. Plants typically try to control costs and solve problems on an operation-specific basis. Attempts to involve suppliers in problem-solving can produce a "finger pointing" response, blaming the problems on a supplier of a previous step, or the equipment supplier blaming the materials and energy suppliers and *vice versa*. Though the plant and suppliers may be aware of the need to optimize the system as a whole, the market provides no mechanism for this. Thus, many innovations that could dramatically improve efficiency are not adopted

Current market-based programs don't help SMEs

Innovative market-based programs have evolved to address the three barriers above. These programs work well for larger enterprises in selected business sectors, and provide valuable insights for accelerating the adoption of P2E2 among SMEs.

- **Energy savings performance contracting (ESPC)** – Energy service companies (ESCOs) provide financing, engineering, general contracting, and training to improve energy efficiency. Customers pay for the capital improvements and services out of the energy savings produced. A key feature of ESPCs is that the ESCO guarantees the energy savings, reducing uncertainty for the customer in this non-core area of business. Also, the ESCO is able to increase profits by finding more energy efficiency opportunities, creating an incentive that drives efficiency improvement. For example, an ESPC at the Washington State capitol complex reduced electrical consumption by over one-third, and total energy costs by over \$800,000 per year, with improvements paid through the energy savings (WDGA 2002). Similarly, an ESPC at a prison in Michigan reduced energy consumption by almost \$1 million over a 7-year project period, approximately half of which went to pay for the efficiency improvements (MDL&EG 2001). (For more information on ESPC, see NAESCO 2005).
- **Chemical management service (CMS)** – CMS providers meet the chemical needs of a plant in exchange for a service fee rather than the sale of chemicals. The more efficient the plant becomes, the lower the volume of chemicals needed, and the higher the profits for the CMS provider. Similar to ESPC, CMS creates an incentive for the chemical supplier to continuously improve an area of operations outside the customer's core competence. Most business customers experience 5-25% reductions in chemical costs during the first year, and 30-80% reductions over the life of the contract (Kauffman Johnson 2005). For more information about CMS, see Bierma and Waterstraat 2000 and 2003, and CMS Forum 2005.
- **Resource management (RM)** – Resource management companies manage the entire waste stream from a facility in exchange for a service fee. The RM provider works with the customer to recycle and reduce components of the waste stream to lower costs and

increase profitability. (USEPA 2005, Votta undated). Results can be dramatic. For example, an auto assembly plant achieved a 25% reduction in waste and 30% reduction in waste-related expenses in three years. A utility company reduced hazardous waste by more than 90% and attained a 94% recycling rate on non-hazardous waste (Votta undated).

These market innovations work because they alter incentives to encourage suppliers to apply their core competence to areas of plant operations outside the customer's core competence. Moreover, they cut across operations to better enhance overall process efficiency. However, none are currently available to SMEs because the lack of scale economies limit profitability for suppliers (Bierma and Waterstraat 2004). ESPC is generally available only to government and non-profit organizations that lack easy access to capital markets, allowing ESCOs to subsidize capital improvements through longer payback periods. Moreover, none of these innovations is capable of truly addressing efficiency across entire processes.

Research Propositions

The goal of this research is to determine the feasibility of a modified market-based program to accelerate adoption of P2E2 practices and technologies in SMEs in the metal products fabricating industry. Specifically, the modification of interest is expanding the program "footprint" to simultaneously cover multiple non-core aspects of operations, such as chemicals, paints, and energy. In theory, a larger footprint could provide the scale economies needed to make such accounts profitable for suppliers as well as provide an opportunity for more system-wide optimization. Because the focus is on improving efficiency across a variety of non-core aspects, we refer to these programs as *efficiency performance contracts* (EPCs).

We propose that the feasibility of efficiency performance contracts is based upon the presence of eight conditions. The first five relate to the SME and the last three relate to the supplier. We state these conditions as propositions to be tested in this research:

- Proposition 1 – Key aspects of operations that have the greatest environmental impact (chemicals, paints, energy, water, waste) are outside of SME management's core competencies.
- Proposition 2 – These key non-core aspects are not as well managed as aspects of operations that are within the core competence of SME management.
- Proposition 3 – Taken together, annual spends in these key non-core aspects commonly exceed \$500,000 for SMEs with over 100 employees.
- Proposition 4 – SME management prefers to work with a single supplier to improve efficiency in key non-core aspects rather than with multiple suppliers.
- Proposition 5 – Given the above conditions, SME management will be willing to partner with an appropriate supplier to implement an efficiency performance program.
- Proposition 6 – Through improvements to each key non-core aspect, and synergies between aspects, suppliers have the capability of creating sustained improvements in efficiency (with a tentative target value of at least 20% efficiency)

improvement within three years using technologies with a payback period of no more than 3 years).

Proposition 7 – Economies of scale and mass replication at other SMEs will significantly reduce the cost of efficiency performance programs for suppliers.

Proposition 8 – Given the above conditions, suppliers will develop alliances and propose efficiency performance programs to SMEs.

Methods

Existing literature promised some insights into the first two propositions. However, to address all eight propositions, the researchers worked directly with SMEs and suppliers. Initially, researchers focused on SMEs and suppliers separately. As work progressed, it was possible to bring SMEs and suppliers together and study their interactions.

Small and Medium Enterprises (SMEs)

This research project was limited to small and midsize enterprises (SMEs) in the metalworking industry that were located in Central Illinois. In particular, work focused on facilities with significant machining and/or painting operations. Metal finishing operations other than painting (such as electroplating) were not included. A multi-step process was used to identify the most promising candidates. Below is the number of facilities included in each of the screening steps. Each step is then explained in more detail.

Companies Screened:	297
Phone Assessments:	80
On-Site Assessments:	17
SME Partners:	6

SME candidate screening

An exhaustive search was initiated with a four-fold strategy to identify the most promising SME candidates. The strategy utilized leads from the following sources: 1) WMRC's extensive database of Illinois manufacturers, 2) ISU's relationship with alumni and local facilities, 3) IEPA's Office of Pollution Prevention, and 4) Harris' Directory of Illinois Manufacturers. These combined strategies yielded 297 Central Illinois manufacturers of fabricated metal products and machinery, SIC codes 3411 to 3599. These companies were screened using available information and prioritized based on the following criteria:

- Primary operation(s) in metal machining, fabrication, tooling, and/or pretreatment/painting
- Company size and annual sales

Beginning with the highest priority facilities, phone assessments were conducted.

Telephone assessments

Decision-makers within 80 companies were identified and contacted. Their companies were screened for pertinent information, such as:

- Company's use of metalworking fluid and/or pretreatment/paint chemicals
- Annual chemical purchases (ideally \$50,000 - \$250,000)
- Tooling costs (ideally 5 to 10 times chemical costs)
- Expressed initial interest in efficiency performance contracting

On-site assessments were then scheduled at the most promising sites to gather additional information and to determine whether or not to enroll the company(s) in the project.

On-Site assessments

On-site assessments focused on identifying opportunities to reduce wastes and chemical hazards utilizing P2E2 measures. Additionally, the assessors developed a more thorough understanding of SME needs, barriers, and opportunities with respect to EPC, including identification of management "headaches" associated with non-core aspects of their business.

The ISU and WMRC team assessed the candidacy of each company based upon 1) its current chemical usage and utilization, 2) opportunities in process improvements and cost reduction, 3) potential benefit of a nontraditional CMS program, and 4) management's philosophy and goals. Seventeen SMEs met pre-qualification criteria and agreed to on-site assessments. Several were subsequently eliminated because on-site assessments indicated that significant progress on efficiency improvement had already been made, leaving little "low hanging fruit" to support an efficiency performance program. A number of others expressed interest in participating in the research following the on-site assessment, but failed to provide the follow-up data and cooperation needed for the research. Ultimately, six companies were selected as Partner SMEs for the project.

SME partnerships

The six Partner SMEs are described in detail in Appendix 1. All Partner SMEs agreed to:

- Provide annual spend data;
- Participate in in-depth interviews about perceptions, aids, and barriers to efficiency performance contracting at their facility;
- Work with the researchers and selected suppliers on an ongoing basis to explore opportunities for efficiency performance contracting; and
- Allow the researchers to monitor and document any pilot programs initiated with suppliers.

In addition to working with the researchers on efficiency performance contracting, a number of SME Partners expressed an interest in immediately exploring P2E2 technologies. Thus, the researchers and other WMRC staff also conducted technology demonstration and pilot projects with several SME Partners in conjunction with the EPC program.

Suppliers

A wide variety of suppliers participated in this project to varying degrees. Types of suppliers include:

Chemical (primarily metalworking fluids and cleaners/degreasers)

- Chemical Management Service (CMS) providers
- Chemical manufacturers
- Local chemical distributors

Paint

- Painting-related equipment manufacturers
- Paint manufacturers
- Local paint and equipment distributors

Tooling

- Tooling manufacturers
- Local tooling distributors

Energy

- Energy Service Companies (ESCOs)
- Energy consultants
- Local energy-related supply houses/contractors (motors, lighting, etc.)
- Compressed air equipment and management companies

Other

- Environmental consulting and service providers
- Waste/resource management companies

Several methods were used to solicit interest among suppliers. These included:

- Contacts from prior research
- Web and print directories
- Recommendations from SMEs, other suppliers, and government agencies
- Contacts made at supplier conferences (Chemical Strategies Partnership annual meetings for 2004 and 2005, NAESCO mid-year conference for 2005)

The nature of activities with the suppliers varied widely. In addition to facilitating interaction between suppliers and SMEs (see next section), the researchers' communications with suppliers included telephone interviews, e-mail exchanges and face-to-face interviews and discussions. Extensive contacts, including multiple face-to-face meetings with the most proactive suppliers, continued over much of the study period.

SME and supplier interactions

The researchers facilitated and studied two types of SME/supplier interactions: a workshop and on-site meetings. Each is discussed below.

Supplier workshop

A supplier workshop was held at the WMRC offices in Champaign, Illinois on January 19, 2005. The primary focus was to bring suppliers together to explore opportunities for alliances in order to make efficiency performance contracts profitable. However, the workshop was also attended by several of our SME Partners, providing an opportunity to learn from the interaction of SMEs and suppliers. Additional details about the workshop and its results are provided in Appendix 2.

On-site meetings

Four of the six SME Partner companies progressed to the point of on-site supplier meetings. The researchers participated in these meetings to identify barriers and opportunities for moving forward. All meetings involved only one supplier at a time, except for a unique meeting at Plant C. This meeting involved all of the plant's current suppliers to its powder coating operation, including chemicals, paint, painting equipment, and process equipment (pretreatment, ovens, conveyor system) suppliers. Additional details about this meeting are provided in Appendix 3).

Findings

Efficiency Performance Contracting (EPC) is clearly feasible and profitable for some SMEs. In one pilot project, the SME experienced a 40% reduction in tooling costs in the first two years of the program and is now adding metalworking fluids to the program and considering the addition of electricity. This pilot study is presented in Appendix 4. Other Partner SMEs are now pursuing similar programs. However, it is also clear that EPC will not be widely adopted without outside efforts to initiate supplier partnerships and assist SMEs in the initial adoption process. Our research found strong support for propositions 1-4, and partial support for propositions 5-7. Proposition 8 was not broadly supported.

Six SMEs agreed to participate in the research by providing data on processes and costs and working with the researchers to explore options for supplier-incentive programs. Five of these plants are representative of metalworking facilities throughout the nation, focusing on machining (Plant A), painting (Plants C and D), or a combination of the two (Plants E and F). Plant B is unusual as it includes foundry operations, which have a significant impact on their energy costs. However, machining operations within the facility are relatively similar to other metalworking plants. All plants are located in Illinois. Details about the processes, management, and participation of each plant is provided in Appendix 1.

Propositions 1 and 2 – Supported

Proposition 1 - Key aspects of operations that have the greatest environmental impact (chemicals, paints, energy, water, waste) are outside of SME management's core competencies.

Proposition 2 – These key non-core aspects are not as well managed as aspects of operations that are within the core competence of SME management.

Existing literature supports the proposition that the greatest environmental impact from metal products fabricating facilities comes from materials or operations that are tangential to metal fabrication. Other than waste metal, which is almost entirely recycled, primary wastes include metalworking fluids, quench baths from heat treating, pretreatment chemicals, solvents, and paint wastes (NEWMOA 2001, USEPA 1995, WSDE 2005). Significant additional wastes, though indirect, result from energy consumption (EIA 2002a, EIA 2002b, 2005). On the whole, Proposition 1 was further supported by statements of SME management and personnel indicating that their primary passion and expertise is in metal fabricating and customer relationships, not in managing materials such as metalworking fluids, chemicals, or paints, nor in programs such as energy or tooling management.

Literature also supports the proposition that non-core aspects of operations are not as well managed. Core competence is best described as the key skills or knowledge needed to build and maintain a competitive edge (Quinn 1994). Typically, a company has only about 1-5 core

competencies. Often these competencies include product design, assembly, and marketing. Focusing on core competencies is a practical decision that allows management to make the most of the company's limited assets (Ito and Rose 2004). In other words, devoting a company's time and resources to non-core aspects of operations will reduce the overall productivity of company assets. Moreover, career advancement within a company tends to come to those who are deployed to the areas of a company's core competence (Bergenhengouwen et al. 1996). Employees with responsibilities in non-core aspects of operations, such as chemical management, tend to have less opportunity for advancement (Bierma and Waterstraat 2000).

Proposition 2 was further supported by interviews and on-site assessments. During interviews, SME managers and other personnel generally stated that they struggle to stay up-to-date with technological developments and management practices in the areas of chemicals, paints, energy, water, and wastes. They rely upon their suppliers or consultants for most of their information. On-site assessments in most facilities identified significant opportunities for process improvement and waste minimization.

However, there were exceptions. In several plants where on-site assessments were conducted, management expressed the belief that they were staying on the leading edge in these several non-core aspects of operations. They were either involved directly or had assigned personnel to manage these areas. In some of these plants, on-site assessments confirmed that operations were very efficient and there was apparently little opportunity for significant process improvements. However, in the other plants claiming to have core competence in these areas, operations were found to be among the most poorly managed of the plants assessed. Thus, management believed they had optimized their operations, but this was not the case.

During on-site assessments, it also became clear that tooling (primarily perishable tooling, but potentially including tool fixtures and related hardware) should be added to our list of key non-core aspects. Not only is this generally a very high cost area, but managers frequently expressed frustration about proper management of tooling and the optimization of machining operations. Tooling does not appear to have a significant direct impact on the environmental performance of an SME. However, it can indirectly affect scrap rates, metalworking fluid waste, and energy consumption. Moreover, the manufacturing of perishable tooling has environmental impacts, particularly the production of waste cobalt from carbide insert manufacturing (Abraham and Hunt 1995, Kennedy et al. 1995). Thus, more efficient use of tooling and the optimization of machining operations could provide a variety of indirect environmental benefits.

Proposition 3 – Supported

Proposition 3 – Taken together, annual spends in these key non-core aspects commonly exceed \$500,000 for SMEs with over 100 employees.

Though this research did not offer the opportunity to statistically test this proposition, it was well supported based upon our six Partner SMEs. Employee count and annual spend data for these plants are provided below in Table 1. Spend data are also summarized graphically in Figure 1.

Table 1. Employee count and annual spend data for Partner SMEs, 2004 (spends in \$1,000)

	Plant A	Plant B	Plant C	Plant D	Plant E	Plant F
Employees	120	180	40	150	400	250
Annual Spends						
Electricity	\$400	\$400	\$115	\$250	\$300	\$320
Nat. Gas	7	100	91	370	100	125
Tooling	500	230	--	--	1,200	350
Paint	--	--	180	300	200	104
Chemicals	150	33	7	50	100	61
Water & Waste	20	40	17	20	10	49
TOTAL	\$1,077	\$803	\$410	\$990	\$1,960	\$1,009

All plants had combined spends in non-core areas in excess of \$400,000/yr. Plants with more than 100 employees had combined spends approaching or exceeding \$1 million/yr.

In all plants, electricity was a major component of the overall spend for non-core aspects. Tooling was a leading spend in plants with extensive machining operations. For plants with powder coating operations, paint and natural gas (used in drying and curing ovens) were significant costs. No plants reported chemicals as one of their top two non-core spends. Generally, spending on chemicals, water, and waste management were the smallest non-core spends at the Partner SME facilities.

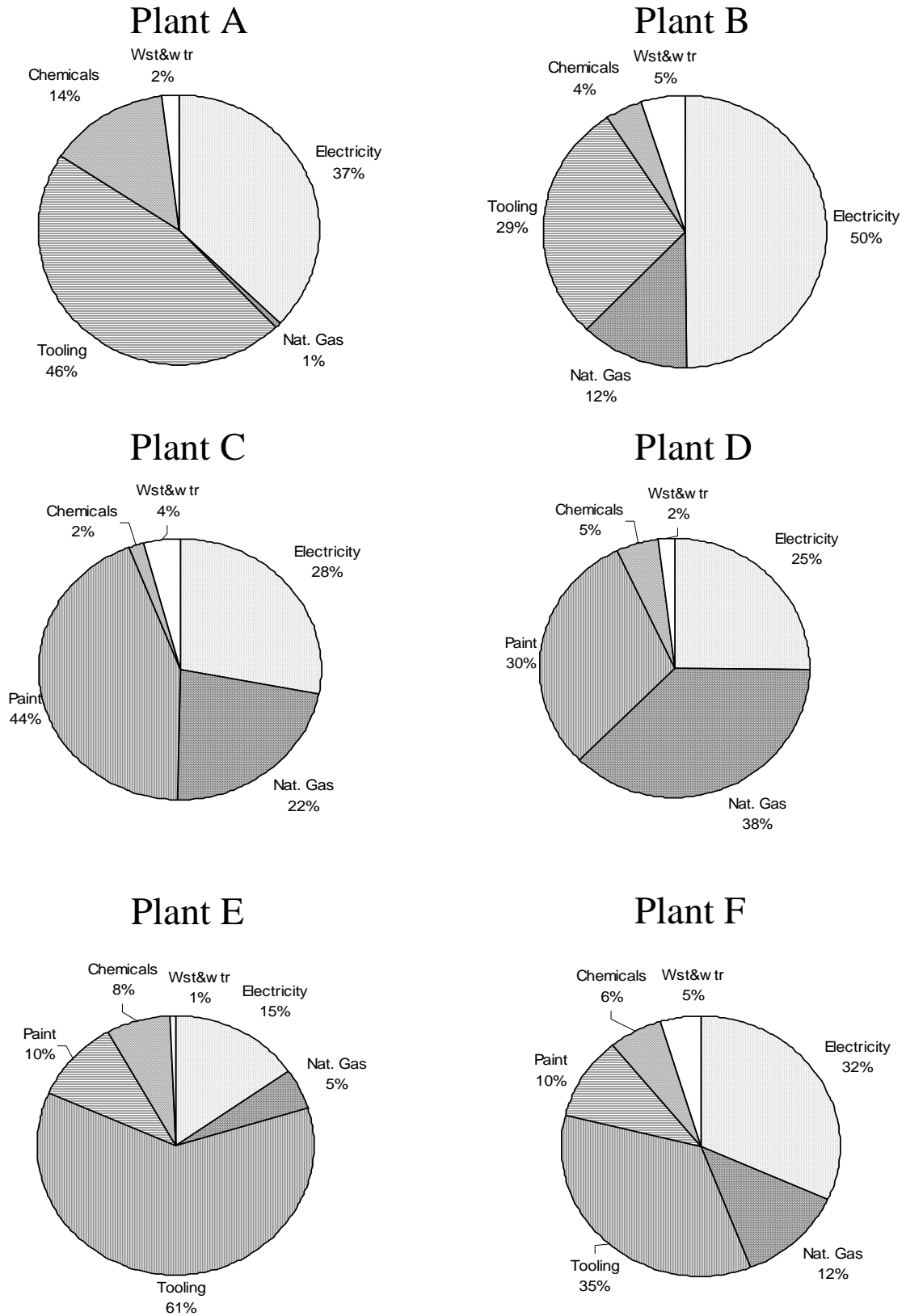
Proposition 4 – Supported

Proposition 4 – SME management prefers to work with a single supplier to improve efficiency in key non-core aspects than with multiple suppliers.

SME managers agreed that they would prefer to work with a single supplier to coordinate process improvements across operations that consume paint, chemicals, tooling, water and energy. In particular, they noted areas where these different spends can conflict. For example, decisions made with respect to metalworking fluid can dramatically affect tooling costs; powder paint choices can dramatically affect energy costs for compressed air, air conditioning, and paint curing; and changes in pretreatment chemicals can affect painting costs and quality.

Managers did not like the conflict of interests that currently exist for the various suppliers in these areas when it comes to optimizing the overall process. Moreover, they did not want “finger pointing” among the various suppliers in response to problems that might arise. They believed that holding a single supplier responsible for overall optimization would minimize these problems.

Figure 1. Relative annual spend data for Partner SMEs, 2004.



Proposition 5 – Partially Supported

Proposition 5 – Given the above conditions, SME management will be willing to partner with an appropriate supplier to implement an efficiency performance program.

While management at the six Partner SMEs was strongly supportive of the concept of efficiency performance contracting, they expressed a number of reservations.

- **Satisfaction with existing suppliers.** A number of SMEs stated that they were very pleased with their current suppliers and would prefer to develop efficiency performance contracts with these suppliers rather than switch to others.
- **Fear of losing control.** Chemicals, paint, tooling, and energy – while not the core business of the SMEs – nevertheless can have a dramatic affect on production, product quality, and customer satisfaction. Managers feared losing control in these areas by allowing a supplier to be more involved in management and decision-making.
- **Skeptical of single-supplier expertise.** SME managers were unaware of suppliers with expertise in even two of the non-core areas, much less all of them. They were skeptical that alliances could be formed that would allow a single supplier to manage improvement efforts in multiple aspects of operations.

Proposition 6 – Partially Supported

Proposition 6 – Through improvements to each key non-core aspect, and synergies between aspects, suppliers will have the capability of creating sustained improvements in efficiency (with a tentative target value of at least 20% within three years using technologies with a payback period of no more than 3 years).

It was not possible to fully test this proposition, given the scope of our research. However, evidence suggested that suppliers could achieve significant efficiency gains using aspect-specific improvements alone (ignoring synergies between aspects) that the technical capabilities of suppliers could bring to SME operations.

- The tooling management company at Plant A demonstrated the ability to produce a 40% improvement in tooling efficiency in the first two years. An additional 16% efficiency improvement was considered very likely in the third year.
- A chemical supplier preparing an efficiency performance contract proposal for Plant D estimated an ability to reduce chemical costs by 10% within the first year and probably 30% within the first two years, most of which would come from efficiency improvements.
- Private conversations with suppliers participating in the meeting for Plant C indicated that most believed their ideas could result in a 10%-30% improvement in efficiency.

- Private conversations with suppliers at the WMRC workshop indicated that most believed their ideas could result in a 10%-30% improvement in efficiency based on past experience working with SMEs.

Though the only empirical evidence is in the first bullet above, suppliers' assessments are consistent with the researchers' own on-site assessments. These assessments are conservative compared to actual results obtained at larger facilities through programs such as Energy Savings Performance Contracting, Chemical Management Services, and Resource Management. Thus, it appears that many suppliers probably have the technical capability to bring 10%-30% efficiency improvements in most of the non-core aspects of operation of concern in this research.

There also appear to be significant opportunities for efficiency improvements from taking advantage of synergies between various non-core aspects. Among the most promising noted by suppliers include:

- Reducing pretreatment chemicals, paint, and natural gas by better coordinating the pretreatment, drying, painting, and curing operations within a powder coat process.
- Extending machine tool life by improving the management of metalworking fluid quality and by optimizing the match between tool and metalworking fluid.

Despite this promising evidence, the researchers must conclude that current data are insufficient to demonstrate that efficiency performance contracting would produce enough efficiency improvement at low-enough capital costs to be economically viable for most SMEs in this industry. Additional research is needed in this area.

Proposition 7 – Partially Supported

Proposition 7 – Economies of scale and mass replication at other SMEs will significantly reduce the cost of efficiency performance programs for suppliers.

Evidence suggests that significant economies of scale and cost savings from mass replication are possible. However, there is insufficient empirical evidence to confirm this.

Most suppliers were skeptical that significant economies of scale could be achieved by combining various non-core aspects under one program¹. This was because the research and expertise required to improve efficiency in each aspect is unique to each supplier and could not easily be acquired by other suppliers in an alliance. In other words, each supplier would have to expend the same time and resources to research and implement efficiency improvements as they would if they were working independently.

¹ Note that economies of scale reduce supplier costs. This should be distinguished from synergies, which provide greater efficiency improvements for SMEs. Most suppliers agreed that significant synergies were possible.

However, preliminary evidence from the pilot program at Plant A indicates that economies of scale may be possible in at least two ways (see Appendix 4). First, program administration does not have to be duplicated as additional suppliers join that program. At Plant A, the program began with tooling management while coolant management was phased in during the second year. The tooling and coolant companies coordinate their activities, yet both programs are administered by the tooling management company. While cost savings data were not available, both suppliers indicated that the program was much easier to implement than if tooling and coolant management programs had been implemented and administered separately.

A second potential economy of scale relates to on-site staff. Evidence suggests that the daily duties of on-site supplier staff may not be too technical to prevent cross-training in multiple non-core aspects. In other words, one person might be able to manage on-site activities for multiple suppliers. Though the research and engineering of efficiency improvements probably will require specialized staff from each supplier, the day-to-day monitoring and control of the program could probably be learned by a single individual. For example, one on-site person could audit and re-supply tooling, check and adjust coolant quality, and perform motor maintenance activities intended to reduce electricity consumption. This could significantly reduce costs for suppliers. Since on-site personnel are part-time, covering multiple plants, lost productivity due to travel time is significant. In fact, at Plant A, it was suggested that the ultimate combination of tooling, coolant, and electricity management could support a full-time supplier employee on site, eliminating losses from travel time and improving working relationships with plant personnel.

Despite concerns about economies of scale, most suppliers agreed that replication of a successful program at other SMEs could dramatically reduce supplier costs. Due to the similarity of metalworking and painting processes at thousands of SMEs nationwide, costs for administration, research, and engineering should decline significantly as new accounts are added.

Proposition 8 – Not Supported

Proposition 8 – Given the above conditions, suppliers will develop alliances and propose efficiency performance programs to SMEs.

Despite the partial or full support of the Propositions 1-7, suppliers did not form alliances within the time-frame of this project. Even at Plant A the alliance between the tooling and coolant management companies came about only at the insistence of the plant. There appear to be at least two major reasons for this: absence of suppliers and perceived risk in the new business model.

Absence of suppliers

In some non-core aspects there was an absence of suppliers either capable or interested in serving the SME market. This was particularly true for energy – both electricity and natural gas. Energy service companies (ESCOs), which have so effectively improved energy efficiency in schools, hospitals, and government buildings, are not interested in serving SMEs in the metalworking industry. Based on our interviews with ESCOs, there are three reasons for this. First, they generally avoid industrial customers due to the relatively short

pay-back criteria employed by industrial managers. While many ESCO accounts operate on 5-10 year pay-back periods, most industry managers insist on 2-3 year pay-back. Second, small utility consumers do not offer the profit opportunities of large utility consumers (utility bills in excess of \$1 million/year). Third, most ESCOs derive much of their revenue from capital improvement and financing operations. Their primary customers - schools, hospitals, and government buildings – have difficulty funding capital improvements and are willing to accept longer pay-back periods in exchange for the opportunity to fund improvements out of energy savings. Industrial SMEs, on the other hand, are likely to achieve much of their energy-efficiency improvements from better management of operations (motors, temperatures, operating times and rates, etc.) rather than significant new capital projects. Moreover, SMEs are generally able to raise capital more easily than many schools, hospitals, and governments. Overall, ESCOs do not see industrial SMEs as a promising growth market.

Existing suppliers of energy-related products and services – such as motors, air compressors, HVAC systems, and lighting – operate very specialized companies. This produces a highly fragmented supply market for energy-efficiency improvements. Energy efficiency consultants, who do bring a broader perspective to improvement opportunities, were reluctant to change from their current fee-for-service model to a fee-for-performance model (see below). Thus, we are aware of no suppliers that are currently positioned to take advantage of efficiency performance programs targeting energy efficiency.

To some extent, a similar problem exists for chemical efficiency. Chemical Management Service (CMS) companies have successful and profitable programs with large industrial customers. However, the small spend at SMEs – generally under \$100,000/year and often under \$50,000/year – do not offer sufficient profit potential to attract many of the CMS companies. Those that *have* expressed interest have not pursued SMEs aggressively (with one exception – see below). This behavior is not surprising, since the CMS market is growing rapidly and many profitable growth opportunities exist in foreign markets as well as untapped U.S. manufacturing markets (CMS Forum 2004).

Fortunately, local and regional chemical supply companies generally offer a wide array of chemicals and have expertise in many of the chemical areas of importance to SMEs, particularly metalworking fluids and pretreatment chemicals. Thus, the market for chemical efficiency does not appear to be as fragmented as that for energy efficiency.

Perceived risk in the new business model.

A second major reason why supplier alliances have failed to form is the perceived risk in this new business model. The perceived risk seems to derive from the following sources:

- **Lack of a successful case demonstrating coordinated efficiency improvement.** Many technologies and practices for efficiency improvement have been well demonstrated. For example, machining fluid purification, energy-efficient lighting, waste heat recovery from air compressors, and air-knife parts dryers are technologies with documented results. However, there are no examples where these and other efficiency improvements have been applied at an SME in a comprehensive and

coordinated fashion. Such an application offers significantly greater opportunity for efficiency improvement, yet is also far more complex – and therefore, risky.

- **Shift to selling performance instead of products or services.** CMS providers and ESCOs are experienced in selling performance instead of products or services, but generally do not see SMEs as an attractive growth market. Suppliers who *are* interested in marketing to SMEs sell products and services, and they are inexperienced in how to profit from efficiency improvement. Thus, many of the suppliers we worked with seemed to view efficiency performance contracting as another means to establish a product or service account, rather than an entirely new business proposition. When faced with the prospect of profiting only when the customer experiences efficiency improvement, many suppliers chose not to move forward.
- **Partnering with other suppliers.** Often, the suppliers who would need to work together in an alliance have no experience with each other. This is particularly true in energy efficiency. Not only do suppliers of paint, chemicals, and tooling have no experience with energy-related firms, but energy-related firms also have little or no experience with each other. Lighting companies do not work with air compressor companies, nor do curing oven companies work with HVAC companies. Creating new business relationships in which the profitability of the venture rests upon the performance of an unknown partner was considered too risky by many suppliers.

Fortunately, some suppliers *do* have experience with each other. For example, the tooling management supplier at Plant A developed a partnership with a metalworking fluid supplier with which they had years of business experience. Similarly, suppliers of pretreatment chemicals, paints, and painting equipment often meet each other in customer's plants. Though they may not have worked together to optimize painting operations, they at least share a common understanding of the customer and the operation.

- **Dependence on SME for performance.** Implementing efficiency improvements requires close cooperation between the supplier and the SME and may require some capital improvements by the SME (provided the projects have short pay-back periods). A number of suppliers indicated that they did not trust some SMEs to take process improvement seriously. They believed that some SMEs would take advantage of personnel and price concessions offered up-front by the supplier and then fail to follow-through with the resources needed for improvements. In some cases, suppliers felt that certain SMEs lacked enough internal control of their plants to actually implement changes.

This is similar to the situation faced by CMS providers as they began to work with large industrial customers in the 1980's and 90's. However, with experience, suppliers were able to do a better job screening candidate customers as well as clarifying to customers what would be expected in a program. It is anticipated that a similar process would work itself out with SMEs. However, given the lower profit

levels anticipated for efficiency performance contracts with SMEs, there is less ability to survive failure.

These sources of risk are well illustrated in an unsuccessful attempt by a CMS provider to initiate an efficiency performance contract with one of our Partner SMEs. The CMS provider spent a considerable amount of time attempting to understand the needs of the SME and the conditions under which it could sustain a profitable program, including alternative financial arrangements and likely efficiency improvements. It was clear that the CMS provider could offer a lower cost program to the SME if the SME was willing to switch to the CMS provider's chemical products. The CMS provider chose to propose a program without a partner to address non-chemical aspects of the operation and would attempt to address these aspects through their own staff. At a minimum, the first year of the program would be spent studying plant operations before any improvements could be expected. Moreover, the CMS provider was unwilling to make many up-front concessions because they were unsure the SME could adequately manage the improvement process. Ultimately, the SME declined the offer. The lack of a partner with expertise in other non-core aspects who could produce significant cost savings quickly, combined with the reliance on switching chemical products (the traditional supply model), seemed to discourage the SME.

Summary of Findings

Our results indicate that there is both the need and the opportunity for efficiency performance contracting to significantly improve efficiency and reduce costs for SMEs, while providing a profitable program for suppliers. The successful pilot program at Plant A has demonstrated that at least two non-core aspects – tooling and metalworking fluids – can be combined successfully in a single program.

However, there are significant barriers. On the one hand, some SMEs are reluctant to include a supplier in the daily management and decision-making of selected plant operations. More importantly, the supplier market is largely unprepared to act on the opportunities presented by efficiency performance contracting. In some cases, such as energy, the supply market is too fractured to easily adapt to the broad, collaborative effort needed to optimize SME processes and dramatically improve efficiency. In other markets, firms with efficiency performance expertise do not see SMEs as a profitable growth opportunity. In addition, companies that typically serve SMEs are uncomfortable with performance-based fees, as well as working with each other.

The next section of this report offers recommendations to overcome these barriers and move forward on efficiency performance contracting in SMEs.

Discussion and Recommendations

This research confirmed the need, opportunity, and feasibility of efficiency performance contracting in SMEs. However, a number of barriers must be overcome before a market for such programs is self-sustaining. The most important barrier is the lack of suppliers who are willing and able to provide efficiency performance programs.

We make four recommendations for overcoming the barriers to efficiency performance contracting for SMEs in the metal products fabricating industry:

1. Demonstrate a comprehensive application of efficient technologies and practices;
2. Document the success of efficiency performance contracting for tooling and metalworking fluids;
3. Begin pilot projects for efficiency performance contracting covering other non-core aspects of operations – particularly pretreatment/painting; and
4. Influence the evolution of supply markets to support efficiency performance contracting.

Each of these recommendations is discussed in greater detail below.

1. Demonstrate a comprehensive application of efficient technologies and practices.

As noted previously, both SMEs and suppliers were unaware how to apply technology and practices in a comprehensive fashion to optimize metalworking processes. As a result, such a venture is considered quite risky. Thus, one or more case studies, particularly where the facility could become an open demonstration site, is needed to reduce this risk.

As a part of the current research, such a project was begun at Plant C. Suppliers and plant personnel were brought together to identify the most promising areas for improvement and develop a list of possible technologies and practices to implement. A number of consultants have provided their input as well. ISU and WMRC staff have been gathering additional information to develop a comprehensive plan for process improvement.

2. Document the success of efficiency performance contracting for tooling and metalworking fluids.

The case study in Appendix 4 documents the success of tooling management, with the recent addition of coolant management, at Plant A. There is significant value in documenting both the successes and difficulties during the next several years of this pilot project. It will also be

important to follow the negotiations for the possible addition of electricity management to this program.

Several other Partner SMEs have requested assistance in implementing tooling/coolant management programs built on the model at Plant A. There would be great value helping to implement pilot programs at these plants and documenting their success. Well-documented case studies will be essential in convincing both SMEs and suppliers to try efficiency performance contracting.

3. Begin pilot projects for efficiency performance contracting covering other non-core aspects of operations – particularly pretreatment/painting.

There are a variety of options for pilot projects beyond the approach taken at Plant C. In particular, other pilots can vary in at least three ways: footprint, financial structure, and metrics. We discuss the options for each of these in Appendix 5.

The relationship between paint and pretreatment chemicals is very similar to the relationship between tooling and metalworking fluids. The spend for both tooling and paint are many times larger than that for metalworking fluids and pretreatment chemicals. However, the selection and management of pretreatment chemicals can have a great impact on the cost and effectiveness of paint, just as metalworking fluids impact tooling. Moreover, the suppliers of paint and pretreatment chemicals are well-positioned to cooperate, just as the suppliers for tooling and metalworking fluids were. Thus, efficiency performance contracts for paint/pretreatment chemicals are likely to be successful. Less work is needed to develop this market than other non-core aspects (see below). Among our Partner SMEs, there are two plants where opportunities for pilot projects are particularly favorable.

4. Influence the evolution of supply markets to support efficiency performance contracting.

The tooling supply market is well positioned to offer efficiency performance programs. Many local tooling supply companies carry a wide range of brands (they are not restricted by contracts with major tool manufacturers). In addition, many currently offer “tooling management” programs, though with neither the incentives needed for efficiency performance contracts nor collaboration with a metalworking fluid supplier. Thus, given additional work with local tooling suppliers, this market is ripe for rapid expansion.

As noted above, the paint/pretreatment chemical supply market is also promising. If one or two pilot projects can be implemented within the next two years, rapid expansion is possible within the following two years.

However, the situation is quite different for energy. The potential for energy savings to drive efficiency performance contracts is great, with annual spends often exceeding a quarter-million dollars and many energy-efficient technologies well demonstrated. Yet the energy-related supply market is highly fractured: specialty firms focus separately on lighting, motors, compressed air,

HVAC or other energy-consuming equipment. No supplier is currently positioned to provide comprehensive expertise in electricity or natural gas, much less both.

Among the many energy-related suppliers with which we worked in this project, the best positioned for efficiency performance contracting appear to be the local motor supply companies. There are several reasons for this:

- Most have developed long-standing relationships with SMEs and do business with a plant several times each year (many other equipment suppliers do business with a particular company only once every several years).
- Most offer services as well as products. Thus they already have business experience with profiting through providing value-added services rather than simply product sales.
- Most offer a wide range of electrical supplies, from meters and controls to lighting and air compressors.
- Most have experience in manufacturing settings and are able to develop practical improvements in energy efficiency.

Nevertheless, motor suppliers' expertise is primarily in motors and would likely need to ally themselves with lighting, compressed air, and HVAC suppliers in order to provide competitive services. Most importantly, they would need partnerships with oven equipment companies if they are to include natural gas management in their contracts.

Developing this supply market will take time. Without a supply market better able to offer comprehensive solutions to SMEs, progress in improving energy efficiency is likely to be slow.

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Appendix 1

Partner SMEs: Processes, Management and Annual Spend

Plant A

Plant A is Hitachi/Nukabe Automotive, Inc. (HNAI) in Effingham, Illinois. They are the only SME Partner plant identified by name in this report. They agreed to public identification due to the case study written about the plant (see Appendix 4), which has been approved for public distribution.

Facility Statistics:

Employees: 120

Square footage: 130,000

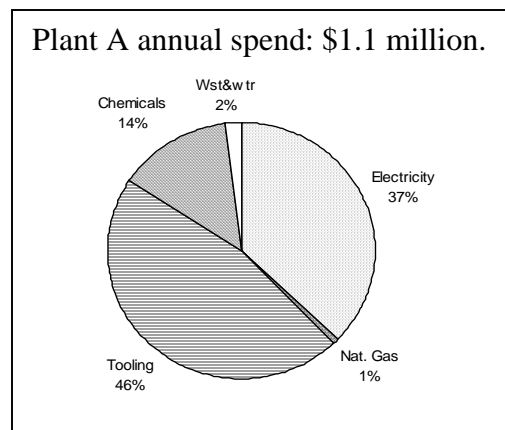
Products and Processes

Plant A manufactures a variety of components for the automobile industry. Operations are predominantly precision machining. Most parts are received as rough castings and are machined to tolerances specified by customers, which include both U.S. and foreign automakers. Relatively little assembly is performed.

The plant has experienced strong growth in recent years, despite troubles in the automotive industry. During the past three years sales have increased over 50%.

Annual Spend

Electricity and tooling dominate the annual spend on non-core purchases. The primary uses of electricity appear to be machining, lighting, compressed air, and air conditioning. Unique among the Partner SMEs, Plant A air conditions the entire facility, not just offices. Given the amount of heat generated from operations, air conditioning is operational during a majority of the year and relatively little natural gas is required for space heating during cold weather.



Machining fluids account for the vast majority of the chemical spend. A relatively small amount of cleaner is used in several small parts cleaners located throughout the plant.

Ownership and Management

The plant is one of several U.S. plants within a corporate industrial group. The group, in turn, is owned by a large foreign firm. Individual plants within the group are given considerable autonomy in developing their own supply relationships. From its beginning in 1989 the plant has developed a strong tradition of promoting employee innovation.

Progress

Plant A has made greater progress in implementing an efficiency performance contract than any of the other SME Partners. In 2004, they implemented a tooling management program with supplier incentives for improved efficiency and cost reduction. In 2005, they incorporated coolant management under the tooling management program. As of the end of this research project they are exploring the inclusion of electricity management within the tooling management program as well. A case study on the efficiency performance management program at Plant A is contained in Appendix 4.

Plant B

Facility Statistics:

Employees: 180

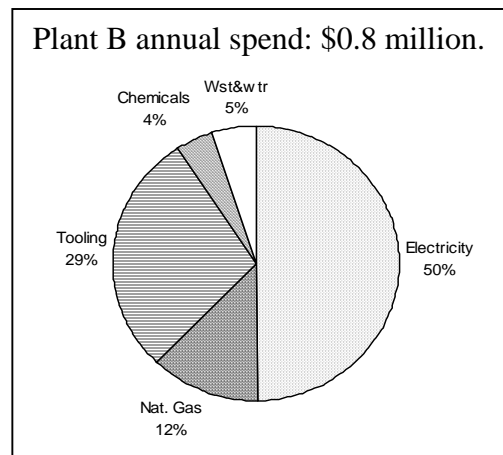
Square footage: 150,000

Products and Processes

Plant B has both foundry and machining operations, making large components for heavy equipment. It supplies customers throughout the world. The plant has experienced steady growth in recent years.

Annual Spend

Electricity dominates the annual spend due to foundry operations. However, the plant also has a significant spend on tooling. Machining fluids account for the vast majority of the chemical spend.



Ownership and Management

Plant B is a locally-owned company. Good management/employee relations have produced relatively low employee turnover for many years.

Progress

Plant B is currently exploring the tooling/coolant management program implemented at Plant A.

Plant C

Facility Statistics:

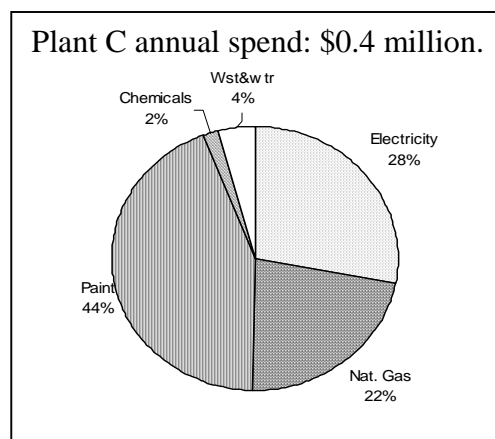
Employees: 40

Square footage: 2 facilities, 45,000

Products and Processes

Plant C produces metal products for a wide variety of customers. Operations are split between its two facilities. One facility performs most of the metal fabrication and the other facility performs powder coat operations. In recent years, some fabricating operations have been moved to the newer powder coating facility. Fabrication operations involve very little machining. Powder coat operations include pretreatment in a five-stage washer (alkaline cleaning, phosphating, and sealing) followed by oven drying, powder coating, and thermal curing.

Historically, Plant C relied upon a single customer for a majority of its sales. A business downturn for that customer has dramatically reduced production at the plant, which is now developing a more diverse customer base.



Annual Spend

Plant C is the smallest of the Partner SMEs. The total annual spend for non-core purchases at both of its facilities totaled only about a half-million dollars. This was dominated by electricity, natural gas, and paint. The primary uses of electricity include lighting, compressed air, fabricating equipment, and air conditioning of powder coat operations. Primary uses of natural gas include drying and curing ovens, and space heating at the fabricating facility (an older, energy-inefficient structure). The chemical spend is driven by chemicals used in the pretreatment operation prior to powder coating.

Ownership and Management

Plant C is a family-owned business. Management has a record of working with state and local agencies to improve efficiency and reduce waste. Many of these innovations have been shared openly with other businesses.

Progress

Plant C participated in the supplier workshop and has actively promoted the development of the efficiency performance contracting concept. However, the annual spend at Plant C may be too small to support an efficiency performance program driven by supplier incentives. Nevertheless, the powder-coating facility is an excellent opportunity to demonstrate the efficiency improvements possible from a comprehensive approach to process optimization. As a result, the researchers are taking a stronger lead in involving suppliers and developing a comprehensive process improvement plan.

Plant D

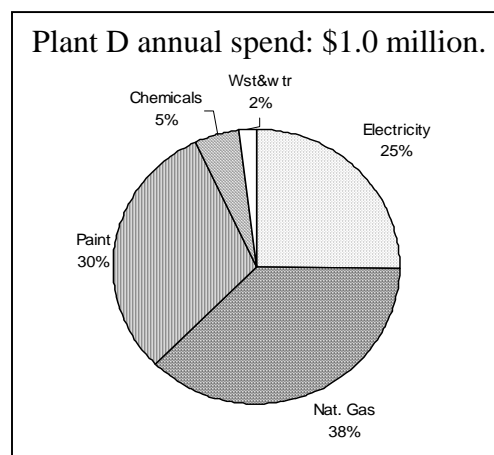
Facility Statistics:

Employees: 150

Square footage: 570,000

Products and Processes

Plant D makes metal products for the retail market, primarily for hardware and home improvement stores. Plant operations are composed primarily of metal fabricating and powder coating. Relatively little machining is performed. Powder coating is preceded by a pretreatment operation composed of alkaline cleaning, phosphating, and sealing.



Annual Spend

The annual spend is dominated by painting operations, including paint, natural gas (for product drying and curing ovens), and pretreatment chemicals. The primary uses of electricity include lighting, compressed air, and machine operations. The chemical spend is primarily for pretreatment chemicals, though metalworking fluids are used in limited machining operations.

Ownership and Management

Plant D is owned by a holding company that includes a number of other U.S. metal fabricating facilities.

Progress

Plant D recently switched its purchase of pretreatment chemicals to a supplier that has been active in promoting efficiency performance contracting, though the new supply contract currently is based on traditional pricing without special supplier incentives. The plant participated in the supplier workshop and continues to work with the researchers on exploring efficiency performance contracting to improve its entire powder coat operation, from pretreatment to powder coating to curing.

Plant E

Facility Statistics:

Employees: 400

Square footage: 155,000

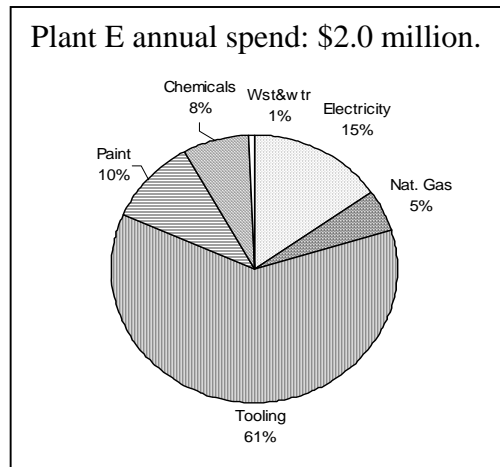
Products and Processes

Plant E manufactures thousands of different products for the heavy equipment industry. The plant uses a variety of metal fabricating processes, including extensive machining operations. Many of its products are painted and require pretreatment, powder coating, and thermal curing operations. The enormous variety of parts manufactured at the plant results in low-volume production runs, frequent tool changes, and difficulties tracking process efficiencies.

The plant has experienced rapid growth in recent years, and opened a new 75,000 ft² expansion of the plant in 2005. This additional square footage and its impact on the plant's annual spend are not included in the statistics in this report.

Annual Spend

The annual spend at Plant E is the largest of the Partner SMEs. It demonstrates the spend pattern of plants focused on machining (with a large tooling, machining fluid, and electricity spend) as well as painting (with a large paint, pretreatment chemical, and natural gas spend).



Ownership and Management

For decades, Plant E was a family-owned business. However, in 2005, a majority stake in the business was sold to a management company with holdings of other manufacturing facilities in the U.S. This has resulted in some changes in management staff, though most of the senior and mid-level managers continue from the family-owned business.

The greatest challenge to management has been coping with rapid growth, with business almost doubling in the past few years. The rapid growth, combined with the job-shop characteristics of production, pose a significant challenge to management for efficiency improvement.

Progress

Plant E was the first Partner SME and has been active in promoting the efficiency performance contracting concept. In addition to actively participating in the supplier workshop, the plant held negotiations with one of the suppliers participating in the workshop. Unfortunately, negotiations did not lead to a pilot program. Recently, a management team visited Plant A to study their tooling/coolant management program and is now developing plans for their own tooling/coolant management program. Negotiations with suppliers are currently underway.

Plant F

Facility Statistics:

Employees: 250

Square footage: 200,000

Products and Processes

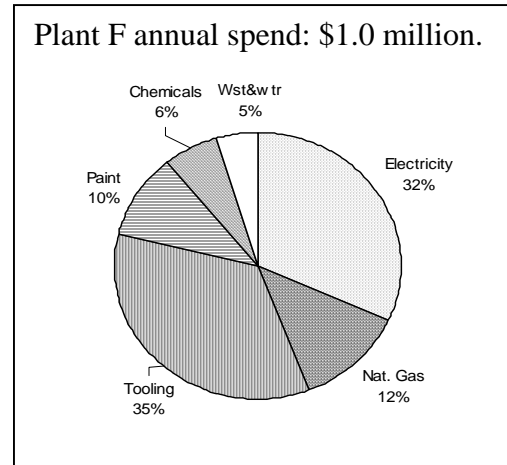
Plant F produces products for direct sale to business customers, including manufacturers and construction companies. The plant uses a variety of manufacturing operations, from metal fabrication (including machining) to painting and assembly. Painting operations include both powder and wet paint.

Annual Spend

As with Plant E, Plant F has a spend pattern consistent with extensive machining operations (tooling, metalworking fluids, and electricity) as well as painting operations (paint, pretreatment chemicals, and natural gas).

Ownership and Management

Plant F is part of a small industrial group with manufacturing facilities in the U.S. and overseas, headquartered in the southern U.S. This group is held by a large holding company with manufacturing facilities throughout the world. Though the plant was run for decades as a locally-owned business, it has changed hands several times in the past ten years.



Progress

Plant F was the last plant to become a Partner SME. They have expressed a strong interest in improving metalworking fluid management and are currently exploring the tooling/coolant management program implemented at Plant A.

Appendix 2

Supplier Workshop

January 19, 2005

A supplier workshop was held at the WMRC offices in Champaign, Illinois on January 19, 2005. The purpose, agenda, attendees, and results of the workshop are presented below.

Purpose

The primary purpose of the supplier workshop was to bring together suppliers from the various non-core aspects of metal fabricating operations covered in this research effort (paint, tooling, chemicals, and energy) to evaluate the prospects for efficiency performance contracting and begin to explore alliances with other suppliers. A secondary purpose was to begin a dialogue with Partner SMEs that could lead to pilot projects.

Agenda

The agenda appears at the end of this Appendix.

Attendees

SMEs

Plant 1	Dallas & Mike
Plant 2	Charles & Gary
Plant 3	Jeff
Plant 4	Chad & Alex

CMS Providers

AVChem	Ron Woods
Castrol/BP	Paul Bedford
Chemico Systems	Doug Hoag
GE/Betz	Phil Stanga Brian Settle

Houghton International David Hays
 Howard Kravitz

PPG Industries Pat Harshall
 Joe Archacki

Crown Industrial Anders Kauserud

Henkel Chuck Wagner
 Tim Adlington

Chemical Distributors

Coral Chemical Tom Boland

Madison Chemical Sam George
 Tom Ribbeck

Solvent Systems Steve Rundell
 Sheldon Cohen

Ulrich Chemical Clint Olin

Resource, Waste and EH&S Management

Heritage Environmental Joanne Jones

Energy Service Companies

GE Energy Kevin Rowe

Other Suppliers (tooling, paint and equipment, compressed air)

DeLeon- Thompson, Inc John Thompson
 Dennis Hill

Kennametal Inc. Chris Gray

Nordson Corp. Joe Laubenthal

Power Supply Ind. (PSI) Greg Dierker
Jim Timmersman

RMC Specialties Dan Brush

Wagner Systems Herb Stockman

Results of Participant Survey

SMEs: 86% of SME respondents indicated that they were either *very likely* or *extremely likely* to pursue an efficiency-based ("shared savings") supply relationship in the next 6 months. The same percentage found the workshop *very valuable* or *extremely valuable*. Suggestions for ISU/WMRC moving forward included

- Develop a supplier network list - including services offered as part of shared-savings programs
- Facilitate coordination between SMEs and supplier groups
- Keep focus on energy and other critical areas beyond chemicals
- Help with RFPs/RFQs
- Begin a pilot program at their plant
- Hold another workshop

CMS Providers and Chemical Distributors: 75% of respondents indicated that they were either *very likely* or *extremely likely* to pursue an efficiency-based ("shared savings") supply relationship in the next 6 months. 83% found the workshop *very valuable* or *extremely valuable*. Suggestions for ISU/WMRC moving forward included:

- Hold more workshops of this type, particularly in the Chicago area
- Include accountants in future workshops
- Create a *mission statement* - "higher efficiency helps keep jobs in the U.S."
- Develop a theoretical scope of work and distribute to suppliers to evaluate and respond to - share results
- Help drive best practices in CMS
- Help define details, especially scope, metrics, and costs that drive individual SME programs
- Continue to educate and interest additional SMEs

Other Suppliers: 67% of respondents indicated that they were either *very likely* or *extremely likely* to pursue an efficiency-based ("shared savings") supply relationship in the next 6 months. 75% found the workshop *very valuable* or *extremely valuable*. Suggestions for ISU/WMRC moving forward included:

- Continue communications and facilitate best practices development
- Help develop the facilitation ("point person") and compensation models

- Establish programs to assess SME costs and baselines
- Continue to educate and interest additional SMEs
- Hold additional workshops and have attendees bring questions to be answered



Supplier Workshop

Process Efficiency Improvement for Small Manufacturers: A Search for Innovative Business Models

Wednesday, January 19, 2005
Illinois Waste Management and Research Center (WMRC)
Champaign, Illinois

Workshop Agenda:

- 10:00 am Registration and refreshments
- 10:30 am Welcome – Tim Lindsey, Illinois WMRC
- 10:50 am Small manufacturers: needs and opportunities – Tom Bierma, Illinois State Univ. and Dan Marsch, Illinois WMRC
- 11:30 am Small work groups – mix of suppliers and small manufacturers, facilitated group discussion of needs and opportunities.
- 12:15 pm Lunch
- 12:30 pm Summary of small group sessions (continue lunch)
- 12:50 pm Business networking session - exploring supplier alliances and the interests of small manufacturers. (short tours available of WMRC research technologies – membrane filtration, oil separation, etc.)
- 1:50 pm Workshop wrap-up and plan for the future.
- 2:30 pm Workshop ends – space available for any ongoing discussions

Appendix 3

Plant C Supplier Meeting

7/20/05

Area of savings or improvement:

P=Paint, E=Electricity, NG=Natural Gas, C=Chemicals, O=Other (labor, water, cycle time, quality, flexibility, etc.)

GENERAL – Goal is system balance

1. Identify key process parameters for each part produced (times, temperatures, flow rates, concentrations, equipment settings, etc.) and explore ways to operate the process optimally for each part. Develop tracking system for these parameters. (P, E, NG, C, O)
2. Install meters/monitors on key process parameters (electricity, natural gas, water, etc.).

LOADING/UNLOADING

1. Install new hook and rack system to speed loading and unloading and improve line density. New hooks may also contribute to improved cleaning, drying, painting and curing. (O, P, E, NG, C)
2. Hook cleaning – no improvement possible at this time
3. Flexible staging – using data from GENERAL ideas and new hook system, create a staging system to maximize line density and optimize system. (O, P, E, NG, C)

PRETREATMENT

1. Review customer salt spray specs and company targets
2. Use lower or ambient temperature chemistries based on the results of #1. (NG)
3. ID optimal rinse flows, install flow meters and flow controls, and develop procedures to maintain optimum flow (O)
4. Install conductivity meters or other system to automatically maintain optimal water flow. (O)
5. Insulate hot water pipes (NG)
6. Install heat containment pans on baths (NG)
7. Use thermal separation to eliminate emulsified oils and extend bath life (O)
8. Combine stages 1 and 3 (C, NG, O)
9. Set exhaust fan to minimum required, or make adjustable to conditions. (NG)
10. Automate chemical monitoring and/or chemical additions.(C)

OVENS - GENERAL

1. Get oven PM instructions and resume oven PM program – including repair of air seals or other malfunctioning equipment. (NG)
2. Set exhaust fan(s) to minimum required, or make adjustable to conditions. (NG)

3. Explore heat exchange to pre-heat combustion air. (NG)
4. IR scan to check status of insulation. (NG)

DRY OFF OVEN

1. ID minimum drying temperature needed for each part. Develop procedures or technology to adjust temperature for each part. (turn off at times?) (NG)
2. Use air knife of other “pre-dry” technology. (NG)
3. Explore impact of rack design and orientation changes on drying. (NG)

CURING OVEN

1. ID minimum curing temperature needed for each part. Develop procedures or technology to adjust temperature for each part. (NG)
2. Use technology other than air seal to retain heat at oven entry. (NG)
3. Use low-temperature curing paint. (NG)

PAINTING

1. Develop data on paint cost/ft² (or per part, per lb, per rack)
2. ID critical control settings for each part. Adjust settings manually or automatically for each part to optimize painting system. (P, E, O)
3. Review customer mill specifications and reduce excess paint thickness. (P)
4. ID and explain PSI of compressed air for each painting activity and piece of equipment. Adjust PSI to meet this need or provide alternative source of compressed air for high PSI needs. (E)
5. Install new digital paint controllers. (P, E)
6. Improve first pass transfer efficiency with other technology or “best practices.” (P)
7. Install new feed center to save labor. (O)
8. Install new Duratech booth. (P)
9. Use “high coat” paint and reduce paint thickness. (P)
10. Remove AC air handler to outside painting area.

AIR COMPRESSOR

1. Adjust PSI to minimum needed by system and/or use supplemental air for high-PSI applications. (E)
2. ID and fix air leaks throughout system. (E)
3. Recover waste heat to use in pretreatment system. (E)
4. Bring in air compressor companies for ideas at both plants. (E)

AIR CONDITIONER

1. Replace 20T unit with waste heat recovery unit and use to heat pretreatment system. (E)

Appendix 4

Plant A Case Study

The wave of supply integration strategies has brought tooling management to many machining facilities. Such programs can dramatically improve tooling supply logistics and relieve the inventory management burden. Yet few tooling management programs result in continuous process improvement and tooling cost reductions. HN Automotive, Inc., of Effingham, Illinois, has enjoyed all these benefits in their savings-target tooling management agreement with Decatur Custom Tool.

HN Automotive, Inc. (HNAI) operates a precision machining and assembly facility that produces automotive parts including manifolds, brackets and suspension components for many of the major automotive companies. The company has a history of commitment to quality and continuous improvement, obtaining certifications such as TS16949, Ford Q1, and ISO 14001. The plant has also earned the Nissan Zero Defect Award and Honda Quality Award. As a result, sales have grown over 50% in the last three years and HNAI currently has approximately 120 employees at the 130,000 ft² facility.

A 40% reduction in tooling costs, resulting primarily from process improvement, not price concessions.

A Tooling Technology Partner

In 2003, HNAI recognized that to make significant progress in improving machining operations and holding down costs, they needed more than just good tooling suppliers. They needed a tooling technology partner that would work closely with the plant, sharing both the risks and rewards. As Joe Forbes, HNAI General Manager explains, “We know we need tooling – anyone can supply us with that. What we are really after is the technical support, a technology partner.”

HNAI began negotiating a unique tooling management agreement with one of its tooling suppliers, Decatur Custom Tool, Inc. (DCT) of Decatur, Illinois. DCT had established tooling management programs with other facilities in Illinois, Indiana, and Missouri, providing inventory management, tool tracking, and logistical support. But HNAI wanted more than that. They wanted a tooling management company that was just as committed to continuous improvement as they were. So they included two unique provisions: 1) annual savings targets, and 2) cost tracking on a cost-per-unit-produced basis. HNAI believed that these provisions would align the interests of both companies, and keep them focused on continuous process improvement.



However, they also recognized that it would take time to develop both the data and the working relationship to operate on a cost-per-unit basis. So the negotiated three-year agreement would evolve in phases:

Year 1 – Standard tooling management program plus a savings target of approximately 10% of the \$500,000 annual tooling spend.

Year 2 – Move to cost-per-unit tracking, with a savings target of an additional 10% to come from process improvement.

Year 3 – Additional 10% cost-per-unit savings target from process improvement.

Milling was completed in one pass instead of two, and tool life was extended three-fold.

Though the agreement originally specified only a 2% savings target for Years 2 and 3, both companies quickly realized that 10% savings were not only possible, but necessary. As Alex Hagler, HNAI Plant Engineer, explains, “When our customers are asking for 5% price reductions, we can’t get by with just 2% cost savings. To stay ahead, we have to create savings much greater than that.”

“Testing and tooling improvement - it’s our bread and butter.”

In 2004, DCT became the tier 1 tooling supplier, managing the 40-plus tier 2 tooling suppliers to the plant. They took ownership of all tooling inventory, not charging HNAI until a tool is issued to an operator. They automated the tooling crib process, tracked tool use and inventory electronically, and installed vending machines. These activities eliminated outages and expedited orders, and won operator acceptance for reliability. Due to re-negotiated pricing with tier 2 suppliers and several like-for-like tool substitutions, Year 1 produced hard tooling savings of \$54,000, exceeding the 10% savings target. In addition, HNAI saved on the cost of holding inventory, freight, and expedited order payments. They were also able to better utilize staff who were originally devoted to tooling inventory management by shifting their focus to process improvement and cost reduction. The savings in purchase orders alone was significant. HNAI estimates that it costs them \$30-\$50 to process a P.O., and now they only issue one each month – to DCT.



The greatest benefit from Year 1 was information. Using the data collected in the electronic tool tracking system, HNAI and DCT were able to reliably calculate the tooling cost for all of the products at the plant. This prepared them to move beyond traditional tooling management and into systematic process improvement. “We used a Pareto approach,” notes Forbes. “From the data we could easily identify the three products with the highest tooling costs. Then, for each of those products, we identified the five tools that contributed the most to those costs.”

One by one, they focused on each of the high-cost machining operations. “We collect data on the machine, the tool, the part, existing speeds and feeds – all the critical data,” explains Mike Moran, Vice

President of DCT. “Then we invited in the tooling suppliers to study the process and recommend tooling to test.” One recent example is the milling operation on a manifold production line, which contributed 50% of the tooling cost for that product. “We’ve probably tested five or six cutters on the milling machine in the last six months,” commented Moran. “And each test can last up to three weeks.” But the results have been worth it. Not only was the best tool able to complete the operation in one pass instead of two, tool life was extended three-fold.

Through this systematic approach to process improvement, DCT and HNAI accomplished a 30% reduction in tooling cost-per-unit, far exceeding their 10% target for Year 2. They anticipate no problems in achieving their 10% target in Year 3. As Moran explains, “Testing and tooling improvement – it’s our bread and butter. We keep an eye on the technology, we go to the tooling trades shows, watch the tooling publications, maintain contacts throughout the tooling industry. It’s our core competence, whereas it’s just a distraction for many of our customers.”

The cost-per-unit tracking system also allows the program to adjust to changes in production volume, which would otherwise confound a flat-fee system. So, although the annual tooling spend has increased due to increased production, the cost-per-unit produced continues to decline due to the program. Business is up, but the cost-per-unit is down.

Coolant Management: The Next Step

To capitalize on the successful relationship created by the tooling management program, HNAI has asked DCT to develop a coolant management program. The coolant supplier will not only provide the logistical support needed to manage the coolant, but will also have an annual savings target. As with tooling management, it is a flat dollar savings target the first year, but is expected to evolve to a coolant cost-per-unit fee and savings target by the second year. This will insure that continuous improvement in coolant use efficiency is an integral part of the program.

It is also clear that a coolant management program would not have been possible at HNAI if the tooling management program were not in place, given the annual coolant spend of only about \$100,000/yr.

HNAI management was already convinced that the cost-per-unit and savings-target approach works, reducing marketing costs for the coolant management company. In addition, the personnel and other resources DCT is already devoting to the plant will be used to assist with coolant management. Moreover, because the coolant management program is managed by DCT as part of the tooling management program, there is incentive to optimize the coolant/tooling interface. For example, a more expensive coolant may be used as long as it produces an even greater decrease in tooling cost. “I think the biggest, most quantifiable savings from coolant management is in the tooling,” explains Chad Hill, Engineering Manager for HNAI. “Right now, with the tool tracking program DCT has put in place, we’ll know when we’ve made a difference. Unlike some other places where the operator might say, ‘Yeah, I think this stuff works a little bit better,’ we’ll have the hard data to prove it.”



Intangibles Make a Big Difference

Though performance is measured in hard savings, it's many of the intangibles that assure HNAI that they've made the right decision with DCT. The process improvements have reduced cycle times and increased production flexibility. It has even saved on machine wear and electricity to achieve the same production with fewer hours of machine operation. Plant personnel previously devoted to tooling inventory management have been able to focus more time on process improvement and cost reduction.

Training has been another important intangible. Hill notes, "DCT has done a lot of training for us as part of this program. Some of it is just basic training on machining and machine tools. Or it might focus on coolants or new machine tool technologies."

Another intangible is the unique role that DCT plays in the relationship between HNAI and their tier 2 tooling suppliers. As Mike Moran of DCT explains, "HNAI needs to stay in touch with these suppliers if they want to stay on the cutting edge. But all that contact use to take a lot of time for HNAI personnel. Under the new agreement, HNAI still makes the decisions, they still have control, but we facilitate the process. We not only respond to contacts from suppliers, we go out and solicit suppliers to address priority problems in the plant. Our suppliers are a great resource – we need to keep them interested in doing business with us."

But overall, it may be the working relationship that has developed between the two companies that is most valuable. It is not a trust that has come easily, but from open and honest communication. "When we're holding something up," comments Forbes, "they let us know. And if they're holding something up, we let them know. We are critical of them and they are critical of us – but we have built trust without building animosity."

The Future

"This will reach the point, and we don't know when, that it will get harder and harder to make significant process improvements," notes Chad Hill. So both HNAI and DCT are already exploring other ways that the relationship can continue to bring new benefits to the plant. The coolant management program is just one example. It may be possible to address other costs of machining as well, such as equipment and energy efficiency.

Is this type of tooling management program viable in other plants? In many ways, HNAI is an ideal facility. According to Mike Moran, "They have a pretty sizable tooling spend for a smaller facility, they have a relatively stable product mix with dedicated production lines, and – most importantly – they have a progressive culture that values continuous improvement." Yet, Moran believes that only the last attribute

Key features and benefits of the tooling management program.

Features:

- DCT is sole tier 1 supplier, overseeing 40-plus tier 2 tooling suppliers.
- DCT owns and manages all inventory
- Tooling is dispensed through vending machines and tracked electronically.
- DCT is tracked on a cost-per-unit-of-production basis, with annual savings targets.
- DCT facilitates the testing of new tooling for process improvement.

Benefits:

- 20% reduction in hard tooling costs in first two years. Additional 10% savings anticipated in third year.
- Improved machining process efficiency.
- Complete, accurate, and timely information on tool life and tooling cost for all products produced at the plant.
- Re-direction of plant personnel from tooling inventory management to process improvement.
- Elimination of tooling outages and expedited orders.
- Reduction in tooling-related purchase orders to one per month.

is essential. “We’ve done testing and process improvements at \$10,000 accounts. We may not be able to get cost-per-unit data in every job shop, but we can still improve processes and control costs. But you have to have a progressive management team for this sort of thing to work. It has to be about process improvement.”

Photos courtesy of HNAI.

Appendix 5

Options for Efficiency Performance Contracts

Footprint

We use the term “footprint” to represent the key non-core aspects included in a single efficiency performance contract. When determining the appropriate footprint there is a tradeoff between gaining economies of scale and synergies on the one hand, and extending beyond a supplier’s expertise on the other. Here we present five alternative models for contract footprints, from the smallest footprint to the largest.

With regard to footprint, there are several relevant findings from our research.

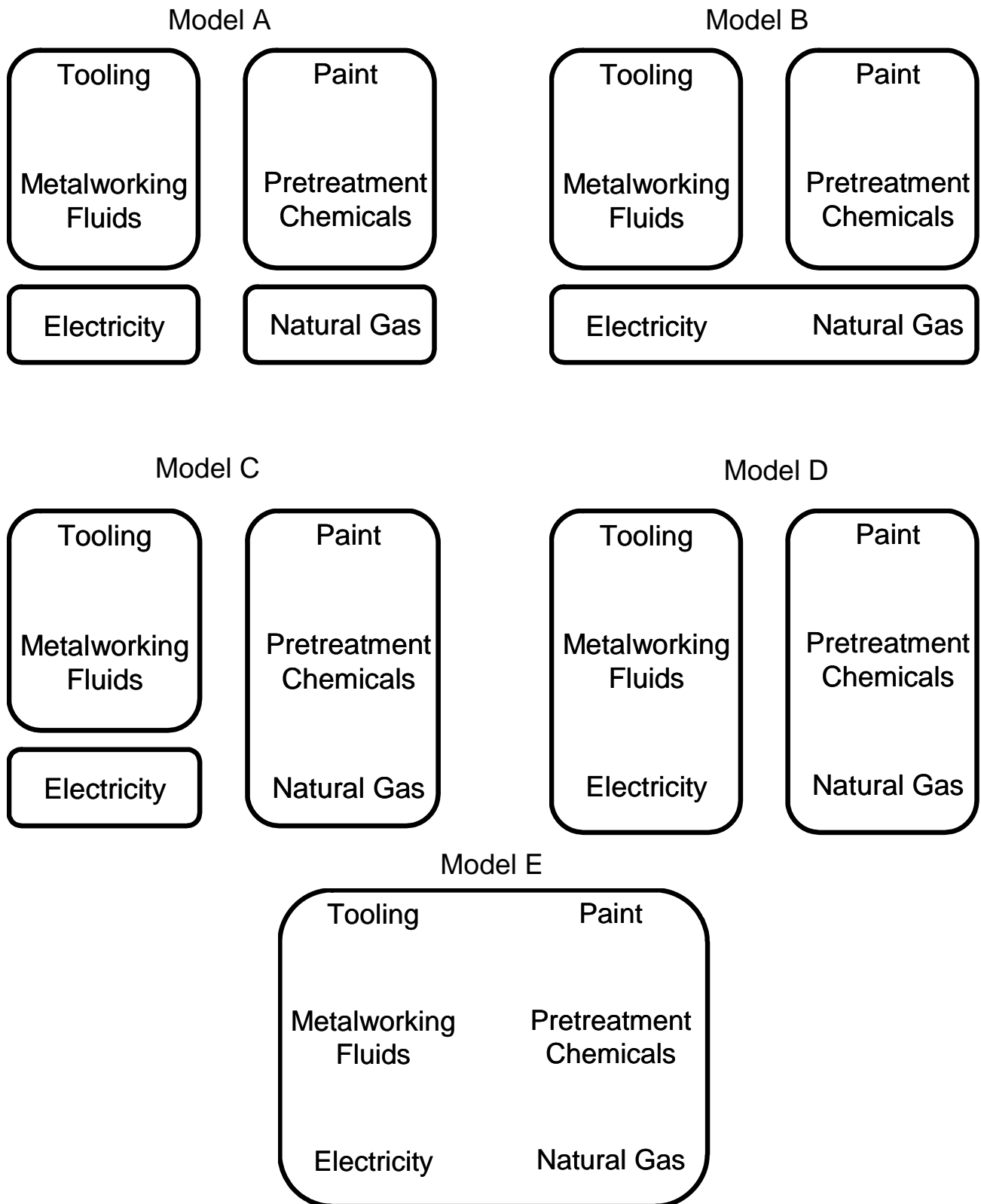
- An efficiency performance contract must include at least one of the major spends – tooling, paint, or energy.
- A footprint of tooling and metalworking fluids is successful, at least in certain circumstances.
- The energy field is highly fractured, with no suppliers currently ready to participate in a contract. Engaging a supplier to manage electricity or natural gas would involve an alliance of energy-related suppliers.

Model A presents the smallest footprints (see Figure 2). It is based on the known success of a tooling/metalworking fluid footprint at Plant A, and the assumption that a parallel program combining paint and pretreatment chemicals would be successful as well. In the energy field, it separates electricity and natural gas, on the assumption that there are few synergies between these two aspects, and that supplier alliances needed to address either aspect will already require significant effort.

Model B is different from Model A only in that it assumes alliances between electricity- and natural gas-related suppliers. In this form, it may be possible to take advantage of more synergies and economies of scale.

Model C combines natural gas with the paint/pretreatment chemicals contract. The logic in this model is that the largest user of natural gas is typically painting and drying ovens. Model D further combines electricity with the tooling/metalworking fluid contract, since one of the largest users of electricity is machining (including motors, air compressors, and lighting).

Figure 2. Five alternative models for the footprint of efficiency performance contracts in SME metalworking companies.



In Model E, all of the non-core aspects are combined in a single contract. This creates the greatest opportunity for synergies and economies of scale. However, it also requires the broadest reach of alliances between suppliers.

It is our belief that Model A is the most promising in the short term. Given the hesitancy of both SMEs and suppliers to experiment with efficiency performance contracts, both will probably prefer to start small and grow the footprint as success is demonstrated. However, we also believe that Model C is very feasible, given the dominance of the ovens in natural gas consumption. Overall, we expect a slow evolution of contract footprints from Model A to Model E.

Financial Structure

Performance contracts in the chemical, energy, and waste fields have used a variety of financial structures to create the correct incentives, while minimizing risk and accounting costs. These are outlined below.

- **Unit Pricing** – Under unit pricing, the supplier is paid a fixed fee per unit of production. This is perhaps best typified by Chrysler’s Pay-as-Painted program (Bierma and Waterstraat 2000). The paint supplier is paid a fee for every vehicle that passes paint inspection. This creates an incentive for the supplier to both improve process efficiency and product quality. In most SMEs, unit pricing will not be possible due to the wide variety of parts produced and the changing mix of production. Plant A in our research produces a narrow range of products and uses “tooling cost per unit” as a metric for evaluating the tooling management contract, but has not yet moved to unit pricing.
- **Fixed Monthly Fee** – A fixed monthly fee paid to the supplier is appropriate when the variety of products are too numerous to establish a unit price, yet overall production and material/energy usage remains relatively constant even when the mix of products changes. The CMS program at Navistar’s engine plant is an example (Bierma and Waterstraat 2000). The mix of engines produced may vary, but overall demand for metalworking fluid does not, although it may be adjusted for overall production level. This creates an incentive for the supplier to reduce costs by improving efficiency.
- **Pass through plus management fee** – In this arrangement, the customer pays for the material/energy “at cost” to the supplier, and then adds a fee paid to the supplier in exchange for services. An advantage to this structure is that it is simple. A primary disadvantage is that it does not create an incentive for the supplier to improve efficiency. In fact, if there is residual profit for the supplier in the “at cost” prices, it creates a negative incentive. To maintain a proper incentive, it must be combined with one of the incentive structures below.
- **Gainsharing** – Simply stated, gainsharing is when savings created by the supplier are split between the supplier and customer. In theory, gainsharing is an ideal way to create incentive for both supplier and customer, since both gain from their cooperation. However, in reality, gainsharing has been problematic. In some cases it is difficult to accurately document the savings. In addition, it can be difficult for the customer to issue

payment (especially a large payment) that is not for a particular product or service. Gainsharing can be used with any of the structures listed above.

- **Savings Targets** – Another simple way to create incentives for the supplier is to set targets for savings or efficiency improvements. Supplier fees or contract renewal can be made contingent on meeting the targets. The downside of targets is that they create incentive to reach the target, but not exceed it. In fact, once the targets have been reached, the supplier has incentive to “save” additional efficiency ideas for future years. Savings targets can be used with any of the structures listed above.

The successful efficiency performance contract at Plant A used pass through, plus savings targets. However, instead of assuring that the pass through prices for tooling and metalworking fluids are “at cost,” the plant uses the savings targets to drive down their costs. In other words, if the supplier can reduce their purchase prices by 15%, but the savings target from the customer is only 10%, the supplier keeps the additional 5%. Of course, new savings targets are implemented each year and eventually the customer receives the benefit of the lower prices. (see Appendix 4 for more detail on the program at Plant A). This approach, a pass through plus savings targets, may be a good way to begin for most SMEs. It requires little change in the billing/payment process and eliminates the need to assure that pass through prices are “at cost.”

Identifying an appropriate financial structure for efficiency performance contracts that include energy may be more difficult. ESCOs commonly use a structure similar to a loan repayment, where payments are made from the energy savings produced by capital improvements. As discussed previously, these types of programs are not likely to succeed with SMEs, who often do not need major capital improvements and who require relatively short payback periods for investments. Another problem is that the suppliers of energy – utilities and gas brokers – are not players in efficiency performance contracts. This makes it impossible to use a pass through structure unless the supplier begins paying the SME’s utility bill.

Based upon both the difficulties and opportunities for including energy in an efficiency performance contract, we propose the following additional financial structure.

- **Power management contract** – Whether stand alone or as part of a broader efficiency performance contract, the power management contract could include the following components:
 1. Supplier becomes the sole source for energy-related equipment such as motors, transformers, HVAC systems, etc., provided prices are competitive. (This is essentially a pass-through agreement on equipment).
 2. Savings targets are set for energy efficiency improvements, adjusted for production volume.
 3. Gainsharing is used to reward negotiation of lower electricity and natural gas rates, as well as efficiency improvements beyond targeted levels.

Metrics

Metrics are an essential part of a successful efficiency performance contract. The metrics included in a contract should cover all of the critical performance objectives. This could include:

- **Usage and Cost per Unit** – For each non-core aspect, reducing the usage and cost per unit of production is likely to be a top priority. For example, plants would like to reduce tooling usage and cost per unit, or energy usage and cost per unit. Ideally, cost information would include not only the purchase cost, but the total cost for each non-core aspect. For example, tooling cost would include not only the spend on tooling, but also related “hard” costs such as inventory and distribution costs. This is the approach being used in the pilot program at Plant A.

Unfortunately, cost per unit is impractical for facilities that produce a wide variety of products, or whose mix of products changes frequently. In these situations, other measures may provide a suitable proxy. For example, SME Partners mentioned measures such as cost per pound, square foot, or dollar value of production. One particularly promising idea was tooling and metalworking fluid cost per pound of metal removed in machining operations. Thus, although cost per unit may be a difficult measure for many plants to obtain, Partner SMEs seemed optimistic about developing suitable proxies.

- **Other cost reductions** – Some costs may apply to more than one non-core aspect and require a separate metric. For example, EH&S costs could be reduced from substituting less hazardous chemicals, better management of MSDSs, or improved safety training. Similarly, purchasing, maintenance or waste disposal costs may decrease due to a variety of improvements in non-core aspects.
- **Other performance measures** – A variety of other performance measures may be relevant to assuring the performance of non-core aspects. These could include:
 - personnel time in-plant
 - on-time delivery
 - process downtime due to product or service failure
 - process set-up and cycle times
 - scrap and reject rates
 - proper temperature control