Final Research Performance Progress Report

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Award Number:	DE-EE0006028
Project Title:	Agile Electro-Mechanical Product Accelerator
Project Period:	01/01/2013 to 04/30/2016
Recipient Organization:	National Center for Defense Manufacturing and Machining 1600 Technology Way Latrobe, PA 15650-0231
DUNS Number:	144078305
Principal Investigator:	Bill Walch, 724-831-5001, bill.walch@ncdmm.org
Business Contact:	Gene Berkebile, 724-539-5743, gene.berkebile@ncdmm.org
Partners:	None
DOE Project Officer/Manager:	Gibson Asuquo, 720-356-1433, gibson.asuquo@go.doe.gov
DOE Project Monitor:	Paul Kingham, 720-356-1653, paul.kingham@go.doe.gov
DOE Award Administrator:	Carlo DiFranco, 720-356-1316, carlo.difranco@go.doe.gov
Submitting Official:	John Wilczynski, Program Manager, 724-539-5352, john.wilczynski@ncdmm.org
Signature of Submitting Official:	

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1. Project Goals/Objectives

NCDMM recognized the need to focus on the most efficient use of limited resources while ensuring compliance with regulations and minimizing the energy intensity and environmental impact of manufactured components. This was accomplished through the evaluation of current machining and processing practices, and their efficiencies, to further the sustainability of manufacturing as a whole. Additionally, the activities also identified, and furthered the implementation of new "best practices" within the southwestern Pennsylvania manufacturing sector.

2. Background

The proposed efforts fulfilled the strategic intent of the DOE grant by maturing sustainable manufacturing practices and processes and accelerated the adoption of a sustainable manufacturing philosophy within the United States Industrial Base starting within the southwestern Pennsylvania cluster comprised of Lawrence, Butler, Armstrong, Beaver, Allegheny, Washington, Westmoreland, Greene, and Fayette counties. The funded project identified, analyzed, and documented methods and tools used in industry; matured and adapted quantitative and qualitative tools in order to make manufacturing decisions; performed site and facility assessments utilizing the identified tools; and executed projects introducing and implementing advanced technologies that reduced life cycle costs and environmental impacts.

The expansive knowledge of NCDMM, as related to machining and processing practices, has engaged in several evaluations of facilities within the past years prior to this grant activity. The evaluations had provided results that far exceeded expectations for energy savings and process improvements. The evaluations had shown savings that were orders of magnitude higher than the investments that were required in tool and process modifications. Collectively, and prior to this activity, NCDMM clients have realized over half a billion dollars in savings through NCDMM projects.

Examples of past projects

- **Advanced Targeting Pod (ATP) Machining**
  Innovation**:** Developed an advanced cutting tool solution that efficiently machined thin walls at a faster rate with no tool chatter.
  Impact**:** Increased productivity by 100%.

- **Ceramic Machining Evaluation**
  Innovation**:** Machine ceramic materials in their bisque state with PCD tooling.
  Impact**:** Reduced operation time by 90%, reduced labor costs, and increased competitiveness of ceramic components.

- More examples can be found at http://ncdmm.org/portfolio/aerospace/aerospace-innovations/

3. Accomplishments

During the three-plus-year contract, NCDMM conducted more than 25 site assessments, inspecting approximately 4 million square feet of manufacturing space. The assessments identified a vast number of recommendations that when implemented and validated will (or did) translate into considerable energy reductions across four critical manufacturing areas that potentially yield the greatest energy reductions: machining and metal processing, compressed air, lighting, building (HVAC) and process heat. In fact, the results far exceeded expectations for energy savings and process improvements. Additionally, the assessments have also indicated savings that were orders of magnitude higher than the investments that are required in tool and process modifications. In addition to these critical manufacturing areas, one facility had an interest in understanding welding best practices, therefore, utilizing our broad alliance partner relationships, their welding was assessed and recommendations were provided. The assessment phase of the AIM initiative also fulfilled the strategic intent of the DOE grant by maturing sustainable manufacturing practices and processes designed to accelerate adoption of a sustainable manufacturing philosophy within the United States Industrial Base starting within the evaluated SWPA cluster. Also, during these assessments, trends were observed, and highlighted areas typically requiring improvement to reduce energy consumption. Through the activity best practices recommended after the assessments provided the average net energy savings as shown in the table 1. The average net energy savings for all processes comes to greater than 55%. A general overview of each of the areas assessed during the grant activity is provided in the remainder of this report, and a more detailed description of each company assessed, and specific areas identified for improvement are included in the appendices.

Process	Average Yearly Energy Savings (net)
Machining	60.6%
Process Heat	60.0%
Compressed Air	35.4%
Lighting	78.6%
HVAC	63.3%
Welding	35.0%

Table 1 - Average Net Energy Savings for the DOE Grant Activity

4. Progress and Status

The general process utilized throughout the grant activity was the use of an initial walkthrough of the facility to provide the manufacturer with an overview and brief description of areas that could benefit from additional investigation, this list of identified areas was then discussed, and assessments/projects were completed for the areas agreed upon. The assessments either provided a qualitative, or quantitative understanding of the assessed process(es) energy consumption, and provided recommendations and justification for the improvement as related to energy and cost savings.

Throughout the grant activity, the companies that chose to partake in assessments brought to light consistent patterns with regard to energy consumption, specifically areas that required investigation, and that could be improved to both reduce the energy consumed, and improve their bottom line. As shown in Table 1, the typical processes provided ample opportunity for improvement, and were found to be consistent areas for improvement through the various unrelated manufacturing companies.

Machining

Machining process optimization, in particular, harmonic tool analysis using the BlueSwarf Metalmax optimization tool, was the largest contributor to machining process optimization. A total of Fifteen (15) tools were optimized across (4) companies. The optimization is based upon harmonic analysis of the chosen tool, and through this analysis, the material removal rate (MRR) of the tool can be increased through the adjustment of machining parameters such as speed, feed, depth of cut and width of cut. A table of the MRR's before and after can be seen in table 2. Based upon past testing, the percentage increase in MRR equates to a similar reduction in energy use. Tool percentages typically show an increase in material removal rate after analysis and tool parameter optimization. However, this is not always the case, if the optimized speed and feed of the tools are slower than the current parameters, benefits will also be realized, such as an increase in tool life, improved surface finish, etc. This also shows that the "slow" tools are a candidate for improvement or reevaluation, and also indicates that the current tool may not be the optimal choice with regard to productivity and energy use. For example, different tool materials can reduce the tool wear characteristics allowing faster tool speeds, increased number of flutes can be utilized to increase the MRR, selecting different cutter geometry can allow an increase in chip-load, etc. All of these tool parameters can be further examined and the best tool can then be chosen, analyzed and optimized. A static example of a dashboard that is created from the harmonic analysis is shown in figure 1. The dashboards provided to participants are interactive, and any one of the parameters can be adjusted to create stable, chatter free operating parameters, that are within the running specifications of that specific tool, within the specific machine and holder.

Tool	Initial MRR (in3/min)	Optimized MRR (in3/min)	Percent Change
3/4" - 4Flute endmill	*	*	45%
1" diameter - 10 flute	*	*	n/a
2" Button Cutter	*	*	20%
1" diameter 3-Flute Carbide Endmill	4.4	11	150%
1/2" diameter 2-Flute Carbide Ball-Endmill	0.03	0.07	133%
2.5" diameter Face Mill	2.93	44.8	1429%
4.0" diamter Face Mill	36	47.1	31%
5" Diameter Face Mill	0.8	1.8	125%
3/8" Diameter Endmill - Roughing	1.1	2	82%
3/8" Diameter Endmill – Contour Roughing	0.4	0.2	-50%
3/8" Diameter Endmill – Contour Finishing	0.8	0.1	-88%
1.0" Dia 1Flute Insert EM (single slot pass)	12.83	4.28	-67%
1.0" Dia 1Flute Insert EM (double milling pass)	4.28	13.71	220%
1/2" Dia 2 Flute EM	1.09	5.04	362%
1.25" Dia 3 Flute Insert EM	5.04	14.03	178%

* *The percent changes are based upon cycle time reductions after changes had been made to the programming, the MMR rates were unavailable for these tools. The 1" tool was a replacement option for the ¾" tool.*

Table 2 - Machine Tool Optimization Comparisons

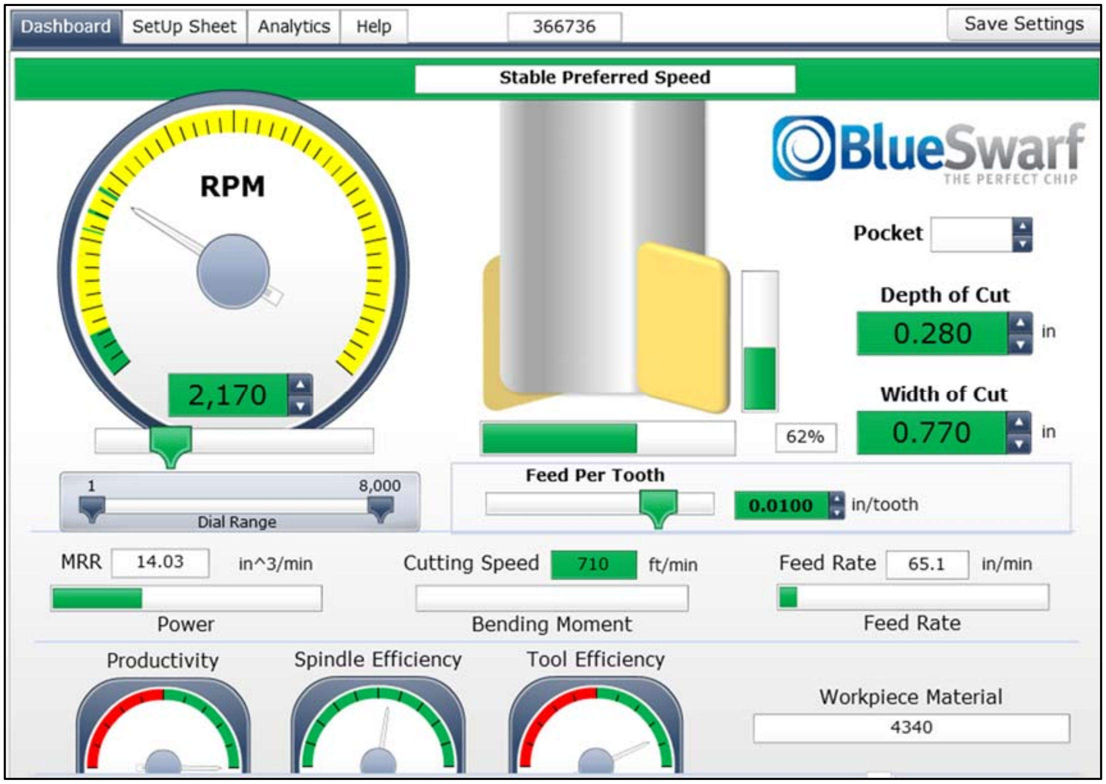


Figure 1 - BlueSwarf Tooling Dashboard Example

Process Heat

Process Heat was analyzed through the use of thermal cameras. This capability was developed and refined throughout this activity, and was utilized to analyze heat treating ovens, forging processes, electric motors, and electrical cabinets and connections. Examples of the use of thermal cameras to identify process heating concerns, is located in the appendices. Typical areas identified for energy savings were shown through the identification of:

- inconsistent process heat showing the need for burner or element repair or replacement
- inconsistent or uneven die heating leading to scrap part creation
- improper or corroded electrical connections, indicating elevated electrical load or unsafe heat at electrical connections
- worn electric motors displaying elevated heat, and therefore compromised efficiency

Compressed Air

Compressed Air analyses were performed in a qualitative manner, where compressed air system inefficiencies were identified, such as improper valving, less than optimal piping configurations, improper system set points, etc. When warranted, subcontractors were utilized to quantify performance and/or inefficiencies. The subcontractor (Atlas Copco) utilized proprietary analysis tools, which were installed on the companies compressed air system for one week, and allowed the development of air system and air compressor load cycle profiles, which allowed the calculation of the energy consumption of the current system, which was then utilized to create an optimized compressed air solution. These two systems energy consumption, current vs. optimized, can then be compared. In addition to the comparison, the system analysis can also highlight potential leaks, improper start-up and shut-down procedures, inefficient pressure set points (either high or low) creating false demand, and improper compressor sizing, just to mention a few. Once the analyses were completed, and energy savings were calculated, potential solutions, and costs, were then detailed to allow financial calculations to be performed. This allowed the companies to make the best financial decisions with regard to energy reduction and system improvements. Typical areas identified were:

- System leaks creating an elevated compressed air requirement, in some cases requiring several horsepower of compressed air capacity to compensate.
- Improper system startup and shutdown of the compressor which can generate more capacity than required, and require longer run times by turning on after the system has pressured down to less than optimal pressure, both leading to inefficiencies within the system and equipment run by the compressed air.
- Machine compressed air set-point higher than manufacturer's recommendation leads to excessive demand upon the compressed air system, and increased energy consumption, with no increase in productivity.
- Utilizing too large, or to small of a compressor, which either utilizes additional energy to run a large compressor, or utilizes additional energy to continuously run the small compressor, which also negatively impacts the maintenance cycles of the small compressor.

Lighting

Lighting is typically the largest or second largest consumer of energy within a manufacturing facility, typically consuming greater than 30% of the facility's energy. Initial benchmarking of the facility lighting, including types, amounts, and wattages used were conducted. Additionally, representative examples of lighting solutions were identified, and energy logging was performed. This baseline profile was then compared to an optimized lighting solution's energy consumption. Energy use for the optimized solution was obtained from published manufacturer data. Optimized lighting solutions ranged from bulb replacement and spanning to the transition to LED fixtures. The lighting calculations and suggestions were conducted for fluorescent bulbs during the early stages of the grant activity, until later in the activity LED lamps became a financially viable energy reducing alternative.

Building Envelope – HVAC

HVAC is another area that thermal analysis was utilized to quantify the amount of energy savings that could be obtained through building improvements. Door seals and current building envelopes that included windows, walls, and ceilings, were analyzed, and calculations were performed to provide an understanding of the current heat loss of the facility, and the potential reduction when applying the recommended practices or building upgrades to the facility. Once the current and optimized heat loss was understood, and through the use of applicable heating degree days, the energy reductions associated with heating and/or cooling could then be calculated. Excerpts from a report submitted to an assessed facility showing examples of each of these calculations and analyses are included in the appendices. Typical areas of concern that were identified, having a negative impact upon the air quality, energy consumption, and comfort level of the facilities were:

- Worn or missing exterior door seals
- Missing HVAC or piping insulation
- Uninsulated, or poorly insulated, exterior walls
- Improper heating type for the building (i.e., radiant vs forced air, etc.)

Welding

Welding was analyzed with the assistance of our alliance partner *The Edison Welding Institute* (EWI). One company had a large, high deposition, weld joint where over forty (40) pounds of welding consumable were deposited. This process was analyzed and several methods to improve weld quality, reduce energy consumption, and insight into what welding process was optimal for this amount of deposition, and joint creation, were all detailed in the EWI recommendations. The recommendations provided by EWI are included in the appendices.

5. Plans for Furthering Energy Reduction in Manufacturing

The experience and skill developed during this grant activity will be utilized to further the energy reductions in southwestern Pennsylvania manufacturing as well as manufacturing on a national scale. The experience and tools developed have allowed NCDMM to engage with DoD subcontractors and manufacturing to assist in understanding and potential implementation and development of their own best practices, and to also assist in complying with the newest energy related executive orders and ISO 50001 compliance, all while providing the manufacturing facilities within the DoD to allow further transition into a world class manufacturing facility, increase the longevity and relevance of the facility, and strengthen its support of the warfighter. The transition of NCDMM from activity within southwestern PA, to national sustainability activities, has begun. For example, activities at Hill AFB, Tinker AFB, the GE aviation sustainability workshop, etc. have been made partially possible through the DOE/AMJIAC grant, and development of the NCDMM assessment tools.

6. Products

a) Publications, Conference Papers, and Presentations

As of this date, no publications have been created. However, presentations have been made to local venues providing an audience that could benefit from the AIM activities being executed by NCDMM.

The venues presented at were:

1. Demo Day 2014 (http://alphalabgear.org/demo-day-2014/)
2. The local chapter of the National Tooling and Machining Association (NTMA, http://pghntma.com/)
3. Pittsburgh Technology Council (PTC, http://www.pghtech.org/)
4. The local chapter of the Product Development and Management Association (PDMA, http://www.pdma.org/)

The venues attended were:

5. EnergySmart Conference was attended in March/2015
6. Aerospace Sustainability Workshop, GE Aviation – October 2015
7. Mazak Open House – November 2015
8. Okuma Technology Showcase - December 2015
9. EnergySmart Conference 2016 April 4-6, 2016

b) **Inventions, Patent applications, and/or licenses**

To date, no inventions, patents and/or licenses that have been a product of this project.

c) **Website(s) or other Internet site(s)**

The web page originally created to highlight the NCDMM/AMJIAC/DOE activities (http://ncdmm.org/aim/) has been updated to provide a more streamlined communication to potential manufacturers. This site maintains the links to our partner sites, allowing the visitor to obtain information regarding the entire cluster group and their capabilities. The site highlights the objectives of the AIM cluster and its participants (NCDMM, Catalyst Connection, Innovation Works, New Century Careers and the Workforce Investment Board), NCDMM's participation in the AIM initiative, and provides contact information for companies that may be interested in participating in the initiative.

Note: our website is currently being renovated, the website for this success story will be included here.

7. Impacts

a) **Impact on technology transfer and commercialization status**

The impacts that may result from the implementation of identified process improvements will be further reaching than our nine county cluster. The reduced consumption of energy, and by extension the reduced overhead cost, will lead to the increased ability of United States manufacturing to compete more favorably on a global scale. This has become more apparent, and quantifiable, after conducting manufacturing assessments at Air Force - Air Logistics Centers (ALCs) in Oklahoma (Tinker) and Utah (Hill).

b) **Dollar amount of the award's budget spent in foreign country(ies)**

No monies were spent in foreign markets.

8. Changes/Problems

a) Scope issues

There were no scope changes through the life of the project.

b) **Actual or anticipated problems or delays and corrective actions or plans to resolve them**

In past site visits, during debrief after a site assessment, and dependent upon the degree of participation provided by the facility, a general overview of areas that would be a candidate for follow-on projects were provided. This had proven to be problematic, depending upon the proactive nature of the site. The problem arose when the site conducted improvements, or improvement projects, after our visit, and prior to our return. The energy and cost savings may be obtained, but the degree of improvement was unknown, and was not able to be applied to the metrics of this program. However, this was solved through an initial site visit consisting of several hours, where preliminary logging sessions were conducted, or by scheduling a follow on visit within the next week. No detailed reporting was provided prior to our return, providing the opportunity for NCDMM to obtain quantifiable data, and providing limited insight for the facility to act upon prior to follow on activity. The first detailed report submitted to the manufacturer, was the identification of potential areas of improvement with supporting baseline data, and energy saving methods including potential ROI calculations.

Also, communicating the value, and combatting the perception, of a "free" service (i.e., that which has no value) proved to be difficult. This was addressed through collaboration, and personal introductions to potential program candidates by AMJIAC team members.

c) **Changes that have a significant impact on expenditures**

None.

9. Budgetary Information

Task Schedule

Task#	Task Title or Brief Description	Task Completion Date				Task Progress Notes
		Original Planned	Revised Planned	Actual Complete	% Complete	
1	Determine Facilities/Sites for Sustainability Assessments, Budget Period 1	6/30/13		6/30/13	100	
2	Conduct Three (3) Assessments, Budget Period 1	12/31/13	3/30/14	3/30/14	100	Site Assessments completed, reports submitted to sites
3	Conduct Six (6) Assessments, Budget period 2	12/31/14		10/08/14	100	Twelve Site Assessments completed.
4	Develop Project List (9 minimum), Budget period 2	12/31/14		11/14/14	100	Seventeen projects (17) identified / (3) completed.
5	Conduct Three (3) Sustainability Projects, Budget period 2	12/31/14		12/04/14	100	Three projects completed/implemented. One additional scheduled.
6	Conduct Six (6) Sustainability Projects, Budget period 3	4/30/16		12/31/16	100	Completed: - One (1) compressed Air upgrade - Fifteen (15) machining optimization projects completed, for four (4) companies - One (1) HVAC upgrade - One (1) Lighting upgrade
7	Transition Technologies to Project Participants	4/30/16		3/31/16	100	All manufacturing assessment information has been transitioned to the project participants, and 4 of 9 projects have transitioned new technology into additional areas of their manufacturing
8	Final Report	4/30/16			100	

Table 3 - Task Schedule

Milestone Schedule

Milestone #	Milestone Title or Brief Description	Milestone Completion Date				Milestone Progress Notes
		Original Planned	Revised Planned	Actual Complete	% Complete	
1	Complete 3 manufacturing assessments at the process or machine level (Budget Period 1)	12/31/13	3/30/14	3/30/14	100	
2	1. Complete 6 sustainability assessments 2. Complete 3 sustainability projects 3. Deliver the source selection plan to the DOE for acceptance. 4. Selected projects with identified scope, deliverables, timeline and budget will be submitted to the DOE for evaluation.	12/31/14	n/a	12/31/14	100	
3	1. Complete 6 sustainability projects 2. Execute a plan to transition and socialize the project findings 3. Complete a final report documenting the results	12/31/15	4/30/16		100	Completed: - One (2) compressed Air projects - Nineteen (19) machining optimization projects completed, for four (4) companies - One (1) Lighting upgrade - One (1) HVAC upgrade All manufacturing walkthrough and assessment information has been transitioned to the project participants, and 4 of 9 projects have transitioned new technology into additional areas of their manufacturing

Table 4 - Milestone Schedule

Project Spend Plan:

Quarter	From	To	Estimated Federal Share of Outlays	Actual Federal Share of Outlays	Estimated Recipient Share (Cost Share) of Outlays	Actual Recipient Share (Cost Share) of Outlays	Cumulative Actual Outlays (Federal + Recipient)
	Start	12/31/2012					
FY13Q2	1/1/2013	3/31/2013	$35,012.58	$19,209.29	$9,117.00	$0.00	$19,209.29
FY13Q3	4/1/2013	6/30/2013	$35,012.58	$13,744.79	$9,117.00	$13,402.14	$46,356.22
FY13Q4	7/1/2013	9/30/2013	$35,012.58	$29,940.22	$9,117.00	$0.00	$76,296.44
FY14Q1	10/1/2013	12/31/2013	$35,012.58	$18,317.68	$9,117.00	$0.00	$94,614.12
FY14Q2	1/1/2014	3/31/2014	$35,012.58	$32,601.37	$8,759.00	$2,315.03	$129,530.52
FY14Q3	4/1/2014	6/30/2014	$35,012.58	$26,878.99	$8,759.00	$12,466.19	$168,875.70
FY14Q4	7/1/2014	9/30/2014	$35,012.58	$23,825.04	$8,759.00	$707.22	$193,407.96
FY15Q1	10/1/2014	12/31/2014	$35,012.58	$33,622.01	$8,759.00	$12.89	$227,042.86
FY15Q2	1/1/2015	3/31/2015	$35,012.59	$43,000.42	$8,430.75	$16,514.41	$286,557.69
FY15Q3	4/1/2015	6/30/2015	$24,239.00	$39,091.11	$5,836.67	$50,523.99	$376,172.79
FY15Q4	7/1/2015	9/30/2015	$24,239.00	$51,775.64	$5,836.67	$12,760.03	$440,708.46
FY16Q1	10/1/2015	12/31/2015	$24,239.00	$34,899.16	$5,836.67	$0.00	$475,607.62
FY16Q2	1/1/2016	3/31/2016	$24,239.00	$27,704.78	$5,836.67	$0.00	$503,312.40
FY16Q3	3/31/2016	4/30/2016	$8,081.77	$11,032.28	$1,945.57	$0.00	$514,344.68
Totals			**$420,151.00**	**$405,642.78**	**$105,227.00**	**$108,701.90**	
Approved Budget			$420,151.00		$105,227.00		**$525,378.00**

Table 4a - Project Spend Plan

The final cost share percentage for the activity was 21.134%.

APPENDIX – Process Heat Analysis Excerpts

Batch Process Oven Losses

A thermal picture can provide insight into potential inefficiencies of each of the ovens, in addition to providing insight into the maintenance required for optimal operation. The batch process oven thermal picture is shown below (see Figure 2). The lower left picture shows a hot spot at the rear of the oven, and may indicate a need for insulation replacement or repair. The lower right picture shows heat loss around the door seals, which is expected to a limited extent, however the hot spot at the top of the oven, along the side indicates a compromised seal, or insulation. In addition to the loss of process efficiency and control, then temperature differential of over 100 degrees indicated a loss of 1800 BTU/hr/ft^2. A conservative estimate, based upon the thermal images, is a loss of 18000 BTU/hr/ft^2, over an estimated 10 ft^2 of area which equates to \$0.05/hr. for natural gas or \$0.35/hr. for electricity.

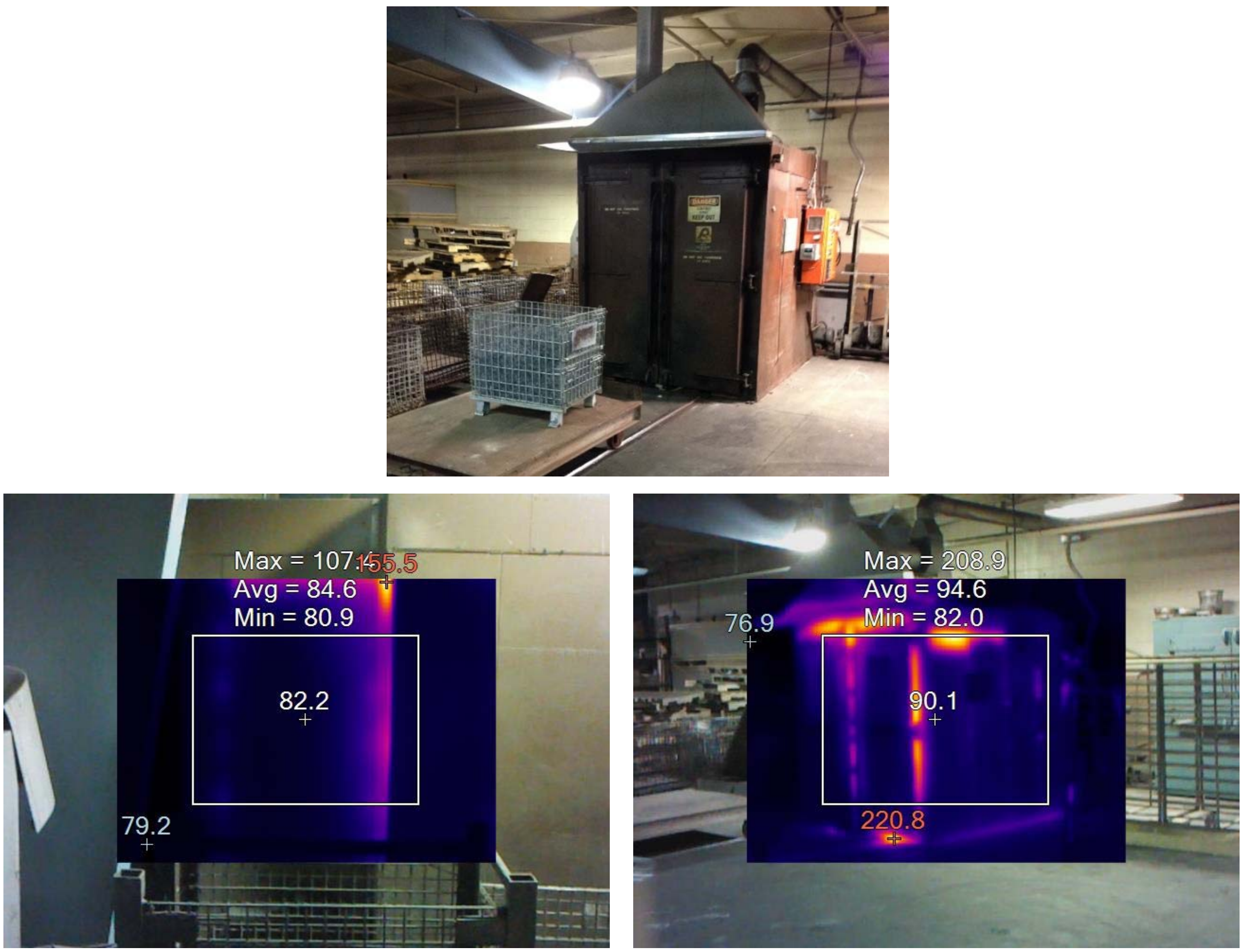


Figure 2 – Gas Fired Batch Heat Treat Oven

Stationary Gas Conveyor Oven (Hades) – Temperature Gradient

The large stationary heat conveyor oven, nicknamed "Hades", was found to have a temperature gradient within the furnace of approximately 90 °F or 12.1% (see Figure 3). This difference can cause insufficient heat treating along the length, or width of a part; which, if realized, may create

Figure 3 - "Hades" gas fired conveyor oven

a need to re-run the parts through the oven, resulting in twice the amount of energy to be used for any given part. Discussions regarding burner upgrades and optimization, and oven upgrades should be had with the current company that maintains the ovens due to the lack of information available regarding the manufacturer of the oven.

For all of the gas fired ovens, the availability of regenerative burners, high velocity burners, the addition of insulation, and oxygen enrichment, etc., are upgrades that could potentially reduce the energy use of the oven. Also, the addition of a flue gas reclamation system, to preheat the incoming parts and combustion air would reduce the thermal loading within the oven and reduce the energy required to maintain the oven temperature. In addition to the burner upgrades, and flue gas reclamation, the installation of process curtains will also increase the efficiency, and reduce the energy required to maintain process temperature.

Conveyor Oven Curtains

The smaller inline conveyor ovens, both electric and gas powered, utilize mesh curtains to minimize temperature loss and assist with maintaining process temperature within the ovens. The thermal curtains (see Figure 4), are showing wear associated with years of service and can be seen as a jagged "hot-spot". Replacement of these curtains will allow more efficient heat treating, and reduced energy required for maintaining temperature.

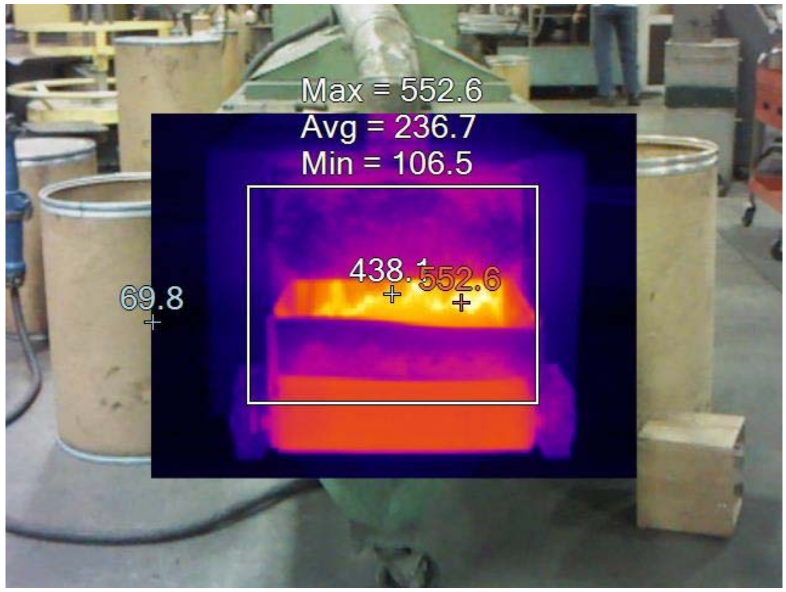


Figure 4 - Conveyor Oven Curtains

APPENDIX – HVAC Analysis Excerpts

<u>Thermal Analysis – Building Envelope</u>

The external (outdoor) temperature at the time of the thermal analysis was approximately 60degrees Fahrenheit. Areas including block walls without insulation, air infiltration around door seals, and transformer heat, were all observed, and are typical for a manufacturing facility. All of the thermal pictures taken during the site-assessment are located in the appendices.

Uninsulated Block Walls

Typical insulating value of concrete block walls is R1.1. Typical building codes call for a minimum of R13 in walls for this area, and the cost savings associated with the upgrade can be seen in Figure 1 below. The savings was calculated for 1000 sq-ft of exterior wall, utilizing the average cost per therm of natural gas from 2014. (Energy Models, 2015) The savings per year, per 1000sq-ft of exterior wall could be over $2000.00/yr. However, this cost does not take into consideration the heat being generated, and added by the production equipment adding to the facility heat.

Enter Values Below			
Area to be upgraded	1000	Square Feet	Enter the surface area of the space where insulation is to be upgraded.
Heating Degree Days	7000	HDD (Fahrenheit)	Help on finding Heating Degree Days for your area
Current R Value	1.1	US R Value	Help on looking up R values
New Total R Value	13	US R Value	Help on looking up R values
Pick your fuel type below -- Then, correct fuel cost and furnace efficiency if desired			
Natural Gas (selected) Fuel Oil Propane Electricity	1.168	$'s Per Therm	80 Percent
Calculate	Click Calculate button to update fuel saving		
$ Saving per year	2041.14	Dollars	The dollar saving in fuel cost for the first year.
$ Saving for 10 years	32530.53	Dollars	The dollar saving in fuel costs for the first 10 years, assuming a10% increase in fuel cost each year.
Greenhouse Gas Reduction	20971	lbs per year	If electricity is the fuel, it is assumed it is generated in a coal fired power plant.

Figure 5 - Wall upgrade from R1.1 to R13

Air Infiltration

The air infiltration around the exterior doors was seen in the personnel entry doors, and the garage doors (see Figure 2). A temperature differential of over ten (10) degrees was observed, this was also the difference between the interior and exterior temperatures, which would lead one to believe the air infiltration path is a direct route to the exterior, and that the temperature differential could be much greater in the winter months, with a differential of up to 80 degrees. This air infiltration would greatly increase the heating and cooling cost, and would well surpass the costs incurred due to the uninsulated block walls.

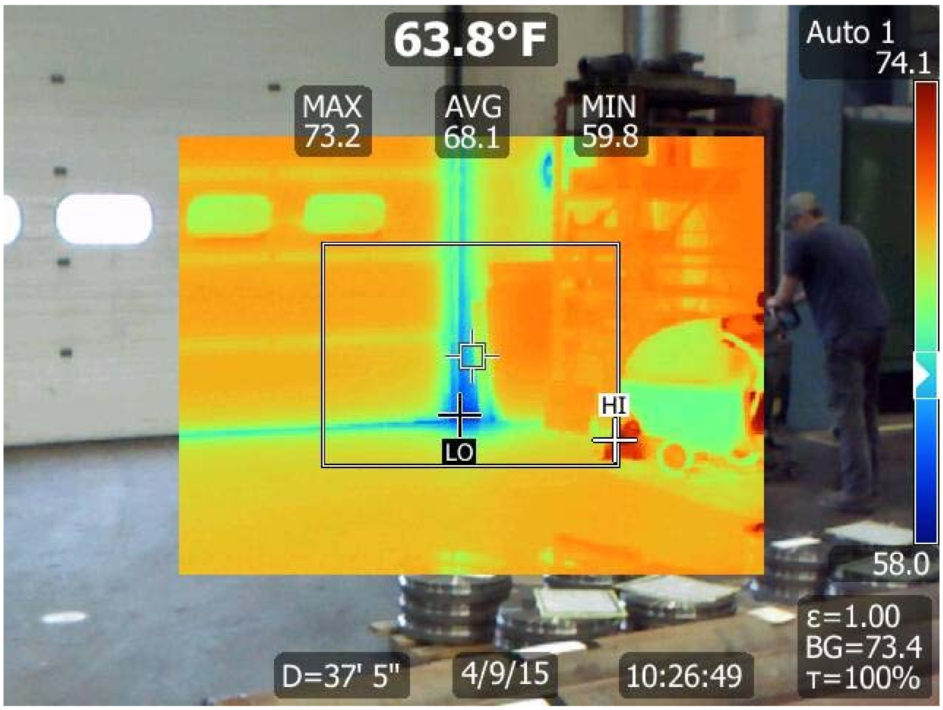


Figure 6 - Air Infiltration around Garage Door Seal

APPENDIX - Welding Processes Recommendation Example

Information Provided By Marc Purslow – EWI

To recap what we spoke about, there are a great number of ways to increase the efficiency of consumable-electrode arc welding processes. Generally speaking, SMAW (stick) isn't very efficient, and produces quite a bit of waste in the form of stubs (the unused portion of the electrodes) and in the slag that must be cleaned off between passes. To increase the overall efficiency of the welding approach, the following could be done:

1. Eliminate unnecessary voltage drops by minimizing cable lengths and checking the integrity of all electrical connections in the welding circuit (especially ground cables).
2. Be sure to use a power supply with a maximum rating appropriately close to the typical operating parameters. As we discussed, power supplies are the most efficient when they are run closest to their max rating. When they are only run at a small fraction of this maximum rating they are far less efficient. As shown below, a power supply that is marketed as 81% efficient must be operated at 75 to 100% of its rated load to get the full benefit. At on 25% of the rated load, the efficiency drops to 64%.

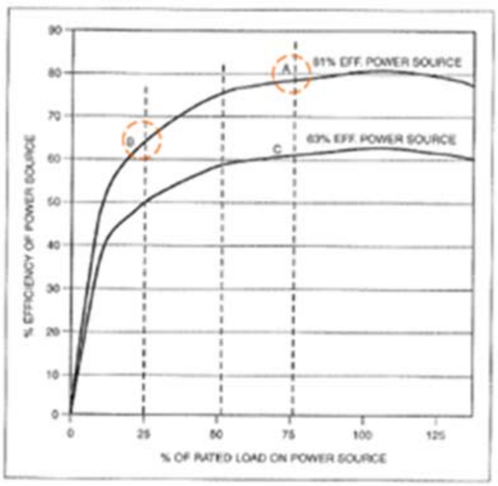
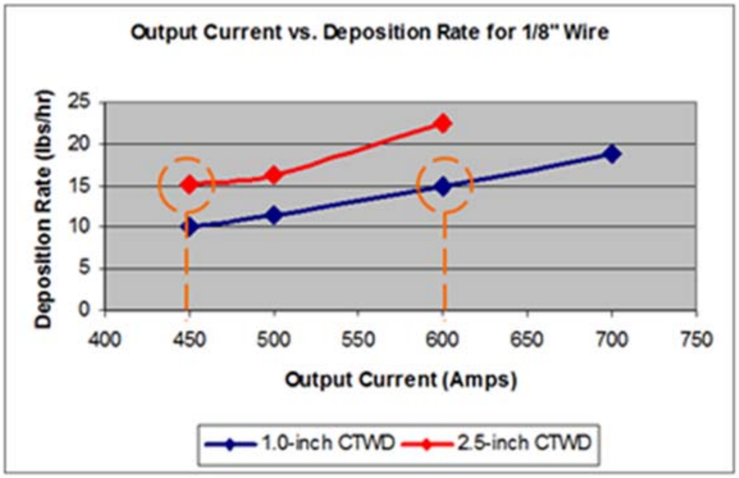


Figure 1.39-Efficiency Versus Output Load for Welding Power Sources

3. Go to a (manually-applied) semi-automatic process such as flux cored arc welding (FCAW) (although this would still require the cleaning of slag) or gas metal arc welding (GMAW). When we do this we can start to take advantage of the effects of resistive heating to increase efficiency. We can also go to pulsed GMAW, which will further increase the deposition rate at a current power output.
4. If we can manipulate the part to put in in the flat position, we can start to look into optimizing the GMAW parameters farther or can go to submerged arc welding (SAW) to significantly increase the deposition rate and take real advantage of resistive heating by using non-conductive tip extensions. The graph below illustrates how significant this benefit can be:



5. For heavy deposition-rate applications, we can introduce a second, non-electrified electrode into the SAW process to significantly increase the deposition rate without any energy "penalty."

There are, of course, other techniques to look at, but hopefully this gives you some ideas of how we could make a significant impact. I published an article in the AWS Journal on this topic. Here's a link so you can have a look:

https://app.aws.org/wemco/docs/winter13/WEMCO_1.pdf

I hope this info will be helpful for your meeting. Please don't hesitate to ring me if I can be of assistance during your discussions and let me know how I can help in the future.

Thanks,

Marc Purslow
Applications Engineer
EWI, Arc Welding
1250 Arthur E. Adams Drive., Columbus, Ohio, 43221
614.688.5150
www.ewi.org

APPENDIX – Company Assessment Details Summary

Company A - Quality Mould, 197 Arnold Palmer Dr, Latrobe, PA 15650, Westmoreland County / 110 Dill Lane, Latrobe, PA 15650, Westmoreland County (old location)

Site Walkthrough

Results from the walkthrough assessment performed at Company A, the following areas were identified as potential project areas, providing the greatest potential for savings of energy, money and resources:

Compressed Air System

- The greatest potential for savings within the compressed air system is the identification and repair of leaks, the identification and correction of false demand, and determining overall system health.

Lighting

- The transition to higher efficiency lighting has been started, this transition should be completed. Also, floor coating of a lighter color would also increase the amount of reflected/ambient light which would brighten the work areas. However, this may be cost and coating prohibitive.

Machining and Process

- Streetlight Lens Mold Creation
  Energy use may be improved through programming evaluation, and lights-out manufacturing. This part creation process would also be a candidate for energy monitoring, and tooling evaluation.
- Floodlight Lens Mold Stippling
  The manual process of stippling can be automated, reducing time and manpower impact for the entire facility. In addition to the time savings, a direct drive electric tool would be more efficient than the air tool currently in use.
- Floodlight Body Mold Polishing
  Automation of this process should be investigated. Automating this process would also reduce time and manpower impact for the entire facility. Elimination of the air tool currently utilized would also provide an energy savings.
- 6101AL Blank Creation and Material Use
  Near net shapes, or distributor cutting of the raw material into blanks, would eliminate 8 man/hours from the overall creation of this part.

Waste Stream

- Coolant Use
  A centralized coolant system, or “mobile” coolant recycling unit could be implemented to reduce coolant use and recycling needs. This device would also reduce the time and manpower required for coolant change in the machines. An investigation into coolant leaks would also have a positive benefit on coolant use.
- Housekeeping Projects (5S)
  Housekeeping projects would increase the safety and productivity of the workforce. Proper housekeeping has a positive effect on the bottom line through waste elimination, increased worker safety, and reduced space requirements for inventory and processes. Waste will be

eliminated through the identification of multiple hidden inventories (visual inventory management), and increasing the ability to find inventory. Worker safety will be increased through the elimination of slip and fall hazards such as adsorbents and debris. The elimination of space used for the storage of debris, will allow it to be utilized for processes, or inventory storage.

General

- The power distribution to the plant is reaching its full capacity. This is not an area of potential improvement for the current facility, it would be cost prohibitive. However, this should be one point to consider as criteria for future site selection.
- A preventative maintenance plan should be developed for the entire facility; enforcement is the key to its success.

Site Assessments

The processes chosen for follow-on activity, and based upon the initial walkthrough were machining, part sanding/finishing, and compressed air.

The machining examination centered on the optimization of one of the family of common parts. Once this type of part is optimized, the same methodology can be proliferated through the entire family of parts. The optimization includes tooling selection, machining path improvements, and consolidation of operations. Through the optimization of the part examined, an over 50% reduction in cycle time can be realized, which provides one half of a day’s production capacity availability on this machine. For example, selection of a tool that combines several operations provides cycle time and energy use improvements. The combination of a hole drilling, chamfering and tapping operation through the use of a thread mill eliminates two tool changes. Also, through the optimization of speeds and feeds of the tool, feature creation times can be reduced by up to 50%. The utilization of a back facing tool, to debur and chamfer the back of a feature eliminates the need to flip the part, further reducing cycle and set-up times.

The part finishing, which is a pneumatic sanding operation completed on a lathe, required 9.882 KW. The proposed improvement is the installation of a dedicated sanding operation, which would reduce the one hour operation to under ten (10) minutes, and eliminate the pneumatic sander. Calculated savings would be 7.12KW for the elimination of the pneumatic sanding, which is a 72% reduction without considering the 80% reduction in cycle time.

Since the walkthrough assessment was performed, the compressor for the facility has been upgraded. This provided the opportunity to compare the old compressor energy consumption to the calculated consumption given from the new compressor provider. Utilizing the logged compressor information, and the calculated consumption of the current system, a 46% energy consumption has been realized. Equating an approximate savings of $7000.00 per year at their current electricity rates. See the following table for areas identified, and projected savings for upgrades.

Implementation and Validation

Machine Tool Paths and Process Optimization

Early on in the AIM grant activities, *Company A* made changes to their facility based upon recommendations provided in the walkthrough site visit. The compressor at the facility was upgraded, and has provided a 16% savings to the facility's entire electricity use. The average electricity use for the entire facility was used for calculation purposes, due to the lack of benchmark energy consumption data for the old compressor.

Additional changes implemented, after the site assessment report was submitted to the company, has resulted in a material savings of over 42%, a process time savings of 29%, and an average energy reduction of 55%, has been realized for one of their part families. The facility has "virtually" increased their square footage, or production capacity, due to the 29% time savings obtained.

The material savings of over 42% was obtained through the use of round material blanks which are closer to the finished size and shape of the part, as opposed to the square material blanks being utilized for the creation of a round flat plate. The blanks are mill cut, and utilized in an "as received" condition, further reducing the overall time required to create the finished part, increasing inventory turns, and reducing the space requirements for inventory.

The process time savings of 29% was obtained through the optimization of machine movement, with no change to the machine tools utilized. Through the implementation of optimized tooling paths, with optimized speeds, feeds, and material removal rates, a no-cost-to-implement solution provided the stated results. The total cycle time, for all machines involved in the creation of the selected part, was measured prior to, and after, process optimization.

The average energy reduction of 55% was obtained through the modification of the processing methods utilized, and is a direct result of the time saved through the implementation of optimized machine movement. The savings was validated through the comparison of energy use, for the creation of the same part, on the same machine, before and after the changes were made. This was accomplished through the use of energy logging equipment attached to the machine creating the part(s).

<u>Company A (new location)</u>
An analysis of the following was suggested.

- compressed air use at the system and process levels
- building thermal properties
- lighting technologies
- energy use comparison of new machine technology vs. current equipment (this analysis would be most beneficial with an understanding of perceived future business requirements)
- welding process optimization
- dust collection

Company A				
Areas Identified for Savings	Projected Net Energy Savings/yr	Realized Net Savings/ yr		
		Energy	Time	Material
Machining Optimization - Adapter Plate	51%	55%	29%	42%
Compressor - Savings is based upon plant energy use (gross), benchmarking data was not available	$6,739.20	17%*		
Power pole Processing	66%			
Thread Mill Implementation		6%	39%	

Company B - Kurt J. Lesker, 1925 Pennsylvania 51, Jefferson Hills, PA 15025-3681, Allegheny County

Site Walkthrough

Results from the preliminary assessment performed at Company B, the following areas were identified as potential project areas, providing the greatest potential for savings of energy, money and resources:

Machining and Process

- The monitoring of energy utilized by certain machining processes, in particular when utilizing older equipment provides an avenue for energy and time savings. Additionally, investigation into the machining tools and programming may provide insight into methods for process improvement; including tool selection and tool path optimization.
- The implementation of a tool dispensing system, in place of the current honor system method, will provide monetary, and production benefits. Investigation into management of this area by a tool vendor could also be a solution to this area of opportunity.

Compressed Air

- The greatest potential for savings within the compressed air system is the identification and repair of leaks, the identification and correction of false demand, and determining overall system health.

Site Assessments

No projects were ever scheduled for this participant, however, discussions were had with their new plant manager, and the report supplied from the initial visit has been utilized for project creation within their facility. In short, the areas identified for improvement during the first site walkthrough, are being improved. However, without baseline data, the improvements cannot be quantified. The most prominent area of improvement is in their compressed air system; the identification and repair of leaks.

Implementation and Validation

None

Company C - Cygnus Manufacturing, 491 Chantler Drive, Victory Road Business Park, Saxonburg, PA 16056, Butler County

Site Walkthrough

Results from the preliminary assessment performed at Company C, the following areas have been identified as potential project areas, providing the greatest potential for savings of energy, money and resources:

Compressed Air System

- Understanding and evaluation of compressed air use, and system pressure requirements of 125psi, at a process or machine level.

Lighting

- Lighting upgrades, and an investigation to address the durability/longevity concerns of typical lighting upgrades, in addition to investigating the energy use of the current fixtures.

Waste Stream

- Investigate the implementation of an on-site coolant recycling system to reduce or eliminate the 2500 gal per month waste-stream and cost associated with it.
- Reduction of wastewater, or implementation of an on-site treatment method, to reduce monetary outlays for treatment.

Machining and Process

- Machine efficiency evaluation of the current EMCO machines. These machines utilize compressed air for their main power source.
- Investigate the implementation of a combined drilling and tapping process to reduce cycle times.
- Evaluate methods for the creation of small holes to increase production speeds while maintaining hole quality.
- Knuckle and turret pre- and post-processing, and investigation into alternate methods. Extremely process and labor intense to provide the customer required finish.
- Long and short column sandblasting and investigation into alternate methods. The long and short column surface finish is created through sandblasting and then powder coating. Investigation into a powder coat finish, that is capable of providing the identical finish, is needed.

At Company C, a more in-depth understanding was needed for finished components, and their sandblasting and air sanding requirements. This will require investigation into alternate methods of finishing, air reduction methods for current finishing processes, and complete machining vs. current method of manufacture for knuckles and turrets. In more general terms, an evaluation of the processing, sandblasting, and processing rooms, and how to minimize their energy use, is required.

Site Assessments / Implementation and Validation

None

Company D - Westmoreland Advanced Materials, 110 Riverview Drive, Monessen, PA 15062, Westmoreland County

Site Walkthrough
This company, after an initial walkthrough, was found to be outside of the scope of this grant.

Site Assessments
Company D was evaluated, however, they are outside of the scope of this grant.

Implementation and Validation
None

Company E - Pace – Airo, 1004 Industrial Blvd. Loyalhanna, PA 15661, Westmoreland County

Site Walkthrough

Results from the preliminary assessment performed at Company E, the following areas have been identified as potential project areas, providing the greatest potential for savings of energy, money and resources:

Compressed Air System

- Investigation into the reduction of compressed air use through several methods; transition from air powered tools to electric direct-drive tools, creation of shut down procedures for machines, monitor of machine pressure settings to eliminate false demand, and the launch of a leak elimination project for the compressed air system.

Lighting

- Investigation into the transition from 400W metal halide fixtures to compact florescent for ambient lighting, and transition from T12 to T5 fixtures for task lighting.

Painting

- Investigation in the elimination of paint rework due to dirt or contaminant related paint imperfections.

Machining Processes

- Investigation into the efficiency of the current machining processes including, material use, material removal (speeds, feeds, and tool path optimization), and machine and tool use. A harmonic analysis of the thin section machining would also be beneficial to increase the efficiency and part quality.

Preventative Maintenance and Waste Stream

- Reduction of the waste stream from machining and casting operations requires investigation.

Furnaces / Material Melting

- Reduction, reclaim, reuse and optimization of process heat requires investigation and understanding related to:
  a. Preventative Maintenance Schedules
  b. Fuel and process optimization
  c. Fuel Delivery and Burner Optimization
  d. Reclamation or reuse of process heat for other applications such as; building heat, die pre-heating, etc.

Site Assessments

Follow-on assessment activities were scheduled with Company E soon after the initial pre-assessment report was circulated through, and digested by, upper management. This company is an aluminum die caster with secondary machining and finishing capabilities. Energy logging was performed on the machining cells, both automated and manual, in addition to the die heating process and lighting.

All of the machining performed at this facility is essentially performed on near net parts created in their die casting operations. Machining is utilized for the removal of casting flash, for the limited material removal required to create a gasket sealing surface, for the creation of an aesthetically pleasing surface, or in preparation for coating. Large amounts of material are not removed, however it was noticed that different tools are utilized for creation of the same feature. This disparity in tool selection was investigated, particularly the use of a 4" shell mill as opposed to a 2" shell mill to create an identical feature. It was found that the 4" shell mill consumed much more energy, a factor of almost nine (9) times more than the 2" shell mill. Energy logging conducted had shown that the 4" shell mill consumed 0.077 KW, as compared to the 2" shell mill which consumed 0.0009 KW of energy. This logging session was conducted as a comparison for only one similar feature, which was a run time of approximately ten (10) seconds, and if implemented across all machining operations, could provide a substantial energy and monetary savings. Prior to implementation, testing would be required to select optimized tooling materials and geometries, in addition to the sizing to realize the greatest monetary and energy savings.

One requirement for a casting die is the requirement that it be preheated prior to installation, or once installed, the die must be kept at a consistent temperature to maintain consistent part quality. Preheating is typically performed with an electric die heater. Therefore, one of the commonly used die heaters was logged for energy consumption. It was found that it consumed as much energy in one hour, as eighteen (18) machining cells in the same period of time. Implementation of gas die preheaters, based upon equivalent BTU output calculations, can potentially realize a 60% savings in energy cost due to the lower cost of natural gas, per BTU of heat output.

One circuit of lighting was logged for one hour. The energy consumed by the entire facility for lighting, was over 160 KW per hour. This equates to over $95,000 per year in energy costs. The installation of a higher efficiency fluorescent lighting can provide a 36% savings. See the following table for areas identified, and projected savings for upgrades.

Implementation and Validation

Company E, as identified in past reports, has identified their lighting system as an area of energy reduction, and solution implementation. However, due to the extensive cost of the upgrade to over 400 fixtures, the implementation is a capital expenditure, and had been delayed due to a lack of CAPEX funds.

Company E				
Areas Identified for Savings	Projected Net Energy Savings/yr	Realized Net Savings/ yr		
		Energy	Time	Material
Machining	TBD	n/a	n/a	n/a
Lighting	$32,167.89	n/a	n/a	n/a
Die Heating	$9,000.00	n/a	n/a	n/a

Company F - CK Composites, 361 Bridgeport Road, Mount Pleasant, PA 15666, Westmoreland County

<u>Site Walkthrough</u>
Results from the preliminary assessment performed at Company F, the following areas have been identified as potential project areas, providing the greatest potential for savings of energy, money and resources:

Compressed Air
- Understanding the impact of a transition from air powered equipment to electric powered equipment, in several locations; primarily the air powered gantry hoists.
- A general leak elimination project, and the development of shut-down procedures for idle equipment.

Preventative Maintenance and Waste Stream
- Development, documentation, and implementation of a preventative maintenance schedule. In particular, the hydraulic systems, in an effort to reduce leaks and losses associated with hydraulic fluid loss, and its impact upon the waste stream of the facility.

Lighting
- Investigation into energy and monetary savings associated with a lighting retrofit from metal halide to compact fluorescent, and conversion from T12 to T8 lighting should be undertaken.

Machining Processes
- Investigation into the efficiency of the current machining processes including, material use, material removal (speeds, feeds, and tool path optimization), and machine and tool use.

Process Heat
- Reuse, or reclamation of process heat to be utilized in additional process areas for part and mandrel (pre)heating, and part drying.
- Implementation of a process heat piping insulation replacement project to increase the efficiency of the process heat transfer to areas of use, and reduce the amount of energy required to maintain process temperatures.
- Implementation of an oven refurbishment program to update heating elements to the most efficient possible (electric, gas, other), and to replace worn or missing door seals to increase the control and efficiency of the process ovens.
- Investigation, and examination of the boiler and associated systems to determine current system (in)efficiencies, and determine replacement or refurbishment needs.

<u>Site Assessments</u>
The site walkthrough report has been submitted. However, the full site assessment has not been scheduled.

<u>Implementation and Validation</u>
None

Company G - Jennison Manufacturing, 54 Arch St, Carnegie, PA 15106, Allegheny County

Site Walkthrough

Results from the preliminary assessment performed at Company G, the following areas have been identified as potential project areas, providing the greatest potential for savings of energy, money and resources:

Lighting

- The current lighting is 400W/277V high bay lighting. Although typical for a manufacturing facility, a lighting change could provide a savings in energy, with a less frequent change interval due to the increased life of the bulb and the longevity of the light quality. A direct replacement fluorescent bulb has been shown to provide an energy savings in excess of 30% with a replacement interval of five (5) years and retaining lighting quality of 70%.

Heat Treating

- The heat treating ovens at Dura Metal are electric powered, 220V units, and could benefit from a simple retrofit to gas powered operation. Changeovers from electric to gas can provide up to a 50% cost savings. Investigation into the refractory condition and oven insulation could also be beneficial.

Old vs. New Equipment

- Due to the average age of equipment in the facility, and the opportunity to examine machines performing similar functions, a comparative study of the energy use of similar machines with manufacture dates of a decade or more could provide insight into machine routing opportunities. This study could also highlight machine upgrade opportunities to save energy and reduce the overhead costs of the facility.

Site Assessments

Areas identified for further investigation have been: analysis of production methods used for higher volume parts (> 100pcs) to increase throughput and reduce energy consumption, analysis of their older laser cutting equipment and compare it to newer laser technologies, compressed air investigation, and also provide insight into newer lighting technologies. Follow on activities have been scheduled and a site assessment will be completed during the next reporting period. See the table below for areas identified, and projected savings for upgrades.

High Volume Machining

Jennison Corporation is primarily a job shop with typical part quantities in the one (1) to fifty (50) range. However, one part in particular, the cam machining for Cutler-Hammer (see Figure 1), has a requirement of 300-400 parts per month. This part process was mapped, and the full manufacture of the part was understood from raw material to finished part. Initial discussions had centered on optimization of the profile machining, however, due to the limitations of the machine currently being utilized for this operation, and the lack of more ridged CNC machines, limited gains can be made in this area. Also, based upon the cycle times, the machining was found to be only 16%-18% of the processing time required to create the part. Upon review of the current cycle times of the processes, the process that is suggested for improvement would be the feature created by the EDM process, which requires approximately 50% of the machine cycle.

Old vs. New Equipment

One machine in particular, that provides manufacturing flexibility to Jennison- Corporation, and that may benefit from an upgrade to reduce energy and increase performance, is the Photon laser, Versa-Lase V500. An energy analysis of this machine may provide insight into the reduced energy consumption and increased production capability that could be gained through the introduction of new technology. Investigation into current laser cutting technology has shown that newer machines can provide equal performance to the Versa-Lase V500 (see Figure 4) utilizing up to 20% less energy (500W vs. 400W). Newer machines also provide a larger table area, up to 300% greater processing area, and take up floor-space equivalent to, or less than the current unit. The current unit, when logged for energy use, consumed 3.866KW in the hour logging session. This equates to $0.247 per hour of operation utilizing the current electric rate of $0.06387/KWh. A comparison of the energy use of the current laser cutting machine and a new laser cutting machine is shown in table 2. In addition to the energy savings, parts availability, and machine up-time will increase, as will process flexibility due to the increased cutting area available. The new laser also has a faster cut-time that has not been captured in the savings calculations.

Process	Logged Energy (KW)	Cost /hr ($)	Cost/yr ($) (250 days, 5hrs/day)	Cost/yr ($) (250 days, 3shifts)
Photon Laser	3.866	$ 0.247	$ 308.65	$ 1,481.53
New Laser Energy Use	3.093	$ 0.198	$ 246.92	$ 1,185.22
Savings	0.773	$ 0.05	$ 61.73	$ 296.31

Table 5 - Photon Laser Energy Use and Cost

Compressed Air

A quantified full system assessment was suggested. However, was never completed. The system was typical of a company that had expanded over the past thirty (30) years, and had added building space, and then tied into their current compressed air system. The inefficiencies were not quantified, but the piping routing alone indicates inefficiencies of 10-15%.

<u>Implementation and Validation</u>

None

Company G				
Areas Identified for Savings	Projected Net Energy Savings/yr	Realized Net Savings/ yr		
		Energy	Time	Material
High Volume Machining	5%	n/a	n/a	n/a
Old vs. New Equipment	20%	n/a	n/a	n/a
Compressed Air	10-15%	n/a	n/a	n/a

Company H - Dura-Metal, 1552 Arona Road, Irwin, PA, 15642, Westmoreland County

Site Walkthrough
Company H had no interest in activities past the initial site walkthrough. However, the areas identified for further investigation were:
Lighting
- The current lighting is 400W/277V high bay lighting. Although typical for a manufacturing facility, a lighting change could provide a savings in energy, with a less frequent change interval due to the increased life of the bulb and the longevity of the light quality. A direct replacement fluorescent bulb has been shown to provide an energy savings in excess of 30% with a replacement interval of five (5) years and retaining lighting quality of 70%.

Heat Treating
- The heat treating ovens at Company H are electric powered, 220V units, and could benefit from a simple retrofit to gas powered operation. Changeovers from electric to gas can provide up to a 50% cost savings. Investigation into the refractory condition and oven insulation could also be beneficial.

Old vs. New Equipment
- Due to the average age of equipment in the facility, and the opportunity to examine machines performing similar functions, a comparative study of the energy use of similar machines with manufacture dates of a decade or more could provide insight into machine routing opportunities. This study could also highlight machine upgrade opportunities to save energy and reduce the overhead costs of the facility.

Site Assessments
The site walkthrough report has been submitted. However, there has been no expressed interest in a full site assessment.

Implementation and Validation
None

Company I - JV Manufacturing, 1603 Burtner Road, Natrona Heights, PA, 15065, Allegheny County

Site Walkthrough
The site walkthrough for Company I was conducted in cooperation with an energy assessment subcontractor that was currently engaged in activities with Company I, and realized the specialized manufacturing energy assessment capabilities, provided by NCDMM, were a good fit for the company and their current activity. The areas identified in the walkthrough assessment, for further investigation, were:

Motors

- It was estimated that roughly 60% of all electrical consumption at Company I was driven by motor use. Replacement of the existing motors with high efficiency motors, or variable frequency drives, would reduce the energy consumption of the facility as a whole.

Electrical Infrastructure

- Inspection of electrical cabinets, utilizing a thermal camera, has shown hot spots indicating worn components, and/or faulty electrical connections. Elimination of these conditions increases efficiency and reduces the possibility of premature system failure.

Lighting

- Elimination of the 400W metal Halide fixtures, and replacing them with T5 high output fluorescent lighting would reduce energy consumed for lighting by over 50%.

Machining Processes

- Optimization of recurring machining operations would increase cycle times, tool life, and reduce energy consumption across the entire product family. Initial calculations indicate cycle time reduction of over 30%, and energy consumption reductions of over 50%.

Site **Assessments**
Company I is a stamping die manufacturer that also provides stamped parts for limited customers. Energy logging was conducted for the compressed air system, the 90-ton and 60 ton stamping presses, and the parts washer and drier. The lighting was not logged due to a recent lighting upgrade to more efficient T5 lighting. During the evaluation the team assessed the motors and drives used on the major press and mechanical systems and evaluated the electrical infrastructure and lighting across the entire facility. The assessment revealed that there are significant opportunities for upgrading a number of drive motors to variable drive motors as well as finishing the LED lighting conversion in the warehouse and offices. The assessment also uncovered that the main dust collection system motor was overheating, and near failure, and should be replaced with a new more efficient variable drive motor. The assessment team will be meeting with the management team to review our recommendations and determine the next steps. The expectation is that the company will move forward with a number of upgrades based on the on-site assessment. The team will develop a project plan, together with the manufacturer, with the expectation that we will be back on-site to validate the implemented improvements. See the table below for areas identified, and projected savings for upgrades.

Implementation and Validation

None

Company I				
Areas Identified for Savings	Projected Net Energy Savings/yr	Realized Net Savings/ yr		
		Energy	Time	Material
Compressed Air	$4,917.00	n/a	n/a	n/a
Washer Motor	$53.00	n/a	n/a	n/a
Electric Infrastructure	n/a	n/a	n/a	n/a
Lighting	$9,193.00	n/a	n/a	n/a
Machining	$330.00	n/a	n/a	n/a

Company J - Ace Wire Spring & Form, 1105 Thompson Ave, McKees Rocks, PA 15136, Allegheny County

Site Walkthrough

As a result of the preliminary assessment performed at Company J, the following areas had been identified as potential project areas, providing the greatest potential for savings of energy, money and resources:

Comparison of Electric vs. Gas Heating Processes

- Company J has internal heat treating capabilities for their spring products. Two different energy sources are utilized and an understanding of the optimal energy source, determined through an energy analysis, would be beneficial for process routing and increasing energy efficiency.

Thermal Analysis of the Heat Treating Furnaces and Transformers

- The larger batch heat treating ovens could benefit from a thermal analysis to determine the health of the seals and refractory linings, and to potentially develop a maintenance schedule to optimize the efficiency of these operations. An additional thermal analysis of the transformers throughout the facility would provide insight into potential maintenance requirements or inefficiencies introduced to the power distribution of the machines.

Old vs. New Equipment

- The average age of the wire turning equipment is approximately ten (10) years. However, there are newer and older machines that produce springs of similar materials, and configurations. An analysis of the energy use of newer machines as compared to older machines may provide insight into optimal machine routing and energy use.

Site Assessments

Company J is a privately owned wire spring manufacturer that has been serving customers for over thirty-five (35) years. The current president is the founder of the company, and was hesitant to provide a site walkthrough stating “I don’t think this is worth my time” due to the recent transition to their new building and location. However, this company has become one of the more proactive companies worked with to date, due primarily to the founders realization of the positive impact to his bottom line the identified upgrades can provide.

The areas found in the walkthrough, and that have been scheduled for follow-on activities, were: the analysis of their in-line and bulk heat treating operations; which are gas or electric powered. Lighting has also been discussed, and has been a commonly overlooked area at most facilities evaluated in this program. Additionally, an analysis of newer vs. older equipment that perform the identical manufacturing operation will be investigated. See the table below for areas identified, and projected savings for upgrades.

Implementation and Validation

Lighting

Although seemingly low hanging fruit, lighting upgrades can provide substantial economic benefit and energy reduction. The lighting at Company J was achieved through 250W metal-halide highbay lights. This is a common method of lighting a manufacturing facility, however several choices for upgrade were provided, with the cost, savings, and calculated ROI included. Although, a higher initial investment than a fluorescent upgrade, the LED option was selected. The LED chosen is 52W, and provides higher quality lighting than the current metal halides, with an energy savings of almost 73%. To avoid the capital expenditure required to retrofit the entire facility, the LED lighting will be implemented on an as-needed basis. Company J has taken the suggestions of the site-assessment to a new level, and has invited NCDMM to present to the production and management staff about energy consumption, best practices and implementation within their building.

Company J				
Areas Identified for Savings	Projected Net Energy Savings/yr	Realized Net Savings/ yr		
		Energy	Time	Material
Heat Treating Ovens	$3,300.00			
Lighting	60%	73%		
Process Improvements	$1,120.00			

Company K - EH Schwab, 1281 Lower Rodi Road, Turtle Creek, PA 15145, Allegheny County

Site Walkthrough

As a result of the preliminary assessment performed at Company J, the following areas had been identified as potential project areas, providing the greatest potential for savings of energy, money and resources:

Compressed Air

The current compressed air system at EH Schwab could benefit from a full analysis. Signs of false demand, and a less than optimized compressed air system were present during the site walkthrough. Understanding compressed air demand can reduce energy consumption for the system by 10% or more, which can provide hundreds of dollars of savings per month.

Old vs. New Equipment

The spinning machines varied in age from five (5) to fifteen (15) years, and could benefit from energy logging to validate the potential need for machine upgrades, or machine replacement. In addition to upgrade or replacement, understanding of energy use as related to machine capability can provide insight into methods to optimize energy use, through process routing.

Site Assessments

Company K is a precision metal spinning and forming company that provides spun metal parts primarily to power transmission and nuclear power manufacturers. The metal spinning process has evolved from a manual art form, to the current CNC controlled machines. The area for energy savings within the facility was minimal due to the relatively young, highly educated management team that has implemented energy savings throughout the facility on an ongoing yearly basis. However, the one area that had been overlooked through the years was the compressed air system. An outside contractor was utilized to provide an in-depth quantitative assessment of the facility compressed air system. Several areas of savings were identified, including the modification of the piping to create a "closed-loop" system that can provide more efficient volumes and pressures of compressed air to the facility processes. Energy savings estimates of 5% - 20% should be realized, however the greatest gains will be in the cycle time reductions and increased efficiency of the grinding and polishing equipment that are able to receive a greater volume of air and run at their optimum speed. See the table below for areas identified, and projected savings for upgrades.

Implementation and Validation

None

Company K				
Areas Identified for Savings	Projected Net Energy Savings/yr	Realized Net Savings/ yr		
		Energy	Time	Material
Compressed Air Upgrades - Piping Upgrades - Compressor Upgrade	$2,500.00			

Company L - Leese & Co., Inc., 768 Old State Rte 66 # 2, Greensburg, PA 15601, Westmoreland County

<u>Site Walkthrough</u>
As a result of the preliminary assessment performed at Company J, the following areas had been identified as potential project areas, providing the greatest potential for savings of energy, money and resources:

Machine Path and Capability Optimization
A further understanding of machine capability, tool and tool path optimization, and utilization of machine functionality would provide increased machine output, decreased cycle time, and would reduce the energy required to create parts. Optimized tooling and tool paths would increase "chip time" and material volume removal rates, increasing productivity and throughput. Understanding and utilizing all machine capabilities, such as live tooling, would provide an opportunity to reduce setups for parts, and reduce overall cycle time.

Old vs. New Equipment
The two machines utilized for deep drilling, whose manufacture dates are separated by 30yrs, should be analyzed to provide an understanding of energy consumption. Understanding the energy use of the two machines (older technology vs. newer technology) would potentially qualify the need for replacement or upgrade.

Compressed Air
There are three compressed air systems at Leese & Co., Inc., one for each manufacturing building. Each of the compressed air systems could benefit from a full evaluation, and in the case of the upgraded compressed air system in the main machining building, a system validation can be performed. Optimization of the compressed air system can provide significant reductions in energy consumption; greater than 10% is common.

Lighting
The current lighting is a mix of upgraded T5 and T8 fluorescent lighting. Although typical for a manufacturing facility, a conversion of the remaining T8 lighting to the more efficient T5 lighting will provide an energy savings, in addition to a higher quality light. Another upgrade that can be performed is the installation of cool white, as opposed to warm white fluorescent bulbs. This upgrade will not affect the energy use of the facility, however it will provide a whiter, more useful light.

Thermal Analysis
The welding building requires significant amounts of energy to heat in the winter months due to poor insulation, and non-optimal construction. An evaluation of heat loss from this building will provide insight into measures that can be taken to reduce heat loss, and energy consumption from this area.

<u>Site Assessments</u>
Company L is a job shop machine shop that has been in business for nearly 60 years, and specializes in deep hole drilling and the creation of copper heat exchangers. The assessment of

the facility had identified two areas that could easily provide energy savings to the facility. The first area identified for analysis was the building utilized for the welding and grinding operations; an uninsulated concrete block construction. The second was the analysis and optimization of the machining operation for one of the higher volume components, in this case 150 pieces per month. Areas typically identified as opportunities, during site assessments, had already been in the process of upgrade. For example, lighting and compressed air. In addition to the process and facility upgrades suggested, Company L had mentioned a need for an upgrade to their ERP, and more specifically their quoting process. Our AMJIAC partners were contacted, and are currently engaged in a project to assist with the improvement to their quoting process. See the table below for areas identified, and projected savings for upgrades.

Implementation and Validation

None

Company L				
Areas Identified for Savings	Projected Net Energy Savings/yr	Realized Net Savings/ yr		
		Energy	Time	Material
Building Insulation	$13,680.00	n/a	n/a	n/a
Machine Process and Tooling Optimization - machining time reduction	35.60%	n/a	n/a	n/a

Company M - E. R. Shaw Incorporated, 5312 Thoms Run Road, Bridgeville, PA 15017

Site Walkthrough

Company M is a contract manufacturer specializing in deep hole drilling, in particular replacement rifle barrels for the United States military, and is also involved in the complete manufacture of semi-custom bolt action sporting rifles. All of the locations combined provides approximately 30,000 sqft of manufacturing space, which utilizes approximately 30 employees. The average age of the equipment in all of the facilities combines was 35yrs. Areas for investigation, and areas for potential energy reductions, identified during the walkthrough were:

Compressed Air

Compressed Air is utilized within all of the facilities. Building one was the facility that could benefit the most from a compressed air analysis. Within several areas of building #1, audible air leaks and machine set points higher than factory specification were present. Each of these conditions unnecessarily increases the facility compressed air requirements. As a point of reference, to create one horsepower of compressed air it requires seven to eight electric horsepower. Significant savings of hundreds of dollars per month have been seen at other manufacturing facilities, through the execution of leak elimination projects. This no/low cost solution can provide measurable energy savings. The compressor may also be oversized due to this condition, requiring a higher horsepower compressor utilizing unnecessary energy.

Thermal Analysis

Several areas could benefit from thermal analysis. Each will be categorized below by building number. Although, in general, all of the buildings (#1, #2, and #3) could benefit from analysis of the exterior walls for the need for insulation upgrades. Insulation upgrades can provide thousands of dollars in reduced energy costs on an annual basis.

Building #1

Two areas of thermal investigation for building one, would be the transformer room, and bluing tank/process. Investigation into each one of these areas can provide insight into the reduction of energy consumption, or the improvement of process efficiency.

Building #2

The ceiling in building two appears to lack any insulation. Investigation into this condition will provide insight into potential upgrades that can be applied.

Coolant Recycling

Investigation into in-house coolant recycling can potentially reduce coolant use, improve part and process quality, and eliminate a waste stream.

Lighting

The lighting in building three was the newest, building two had a mix of metal halide and t8 lighting, and building one had a mix of t8 and t12 lighting. Investigation into upgraded lighting solutions for all buildings would be beneficial, but the greatest gains could be made in building one.

Old vs. New Equipment

A vast percentage of the equipment at ER Shaw are under ten years of age. However, the horizontal reamers are sixty+ years old. Typical of this era of equipment, they are robust, have flexible capability, and complete the desired task well. This equipment should be investigated for energy use, in particular the replacement of the 60+ year old electric motors. While they are only 3/4HP, there are a significant number present (20+).

Optimized Tooling

All of the tools utilized at ER Shaw are carbide. However, investigation and optimization into the tools selected for barrel manufacture, including program creation, tool selection, tool speeds and feeds, and edge preparation will provide useful insight into best practices. Optimized tools have shown to increase tool life, and reduce energy consumption at the process level, by up to 25%.

Manual Finishing Process

The manual finishing process could easily be transitioned to an automated, or semi-automated honing process. The elimination of multiple personnel performing the finish bore lapping, or burr removal, could reduce product cycle times, and shorten lead times, and virtually increase plant capacity. Implementation of this process could also potentially increase product consistency. The consolidation of this process may also provide an energy savings.

<u>Site Assessments</u>

No site assessment activities were conducted for this company.

<u>Implementation and Validation</u>

None

Company N - L&S Machine, 709 Donohoe Rd, Latrobe, PA 15650, Allegheny County

Site Walkthrough

Company N is a job shop contract manufacturer engaged primarily in the production of nuclear reactor components (approx. 80% of their production). The facility employs just over 100 employees in the location that was visited. The facility toured, which was one of two locations, was world class in its technical capability, including manufacturing, production, ERP and house-keeping measures. A vast majority of the part material is 300 Series stainless steels, and Inconel 718. Average machine age in the facility was five (5) yrs. However, several areas were identified as potential opportunities for energy reduction, and further investigation:

Thermal Analysis

One area that can be identified for investigation is the temperature control of the facility. Not necessarily the physical control systems, but the thermal properties of each area of the building.

Coolant Recycling

Investigation into in-house coolant recycling can potentially reduce coolant use, improve part and process quality, and eliminate a waste stream.

Lighting

The lighting in the building consists of T8 fixtures. This is a good example of optimized lighting solutions, however, within the past year, alternative lighting solutions, with lower energy consumption, have become more attractively priced.

Optimized Tooling – Tooling Paths

Tooling selection was shown to be an area that was progressive, and L&S machine is constantly upgrading and testing tooling. However, evaluation of tooling and toolpaths, and additional edge preparation to their existing tools may provide increased tool life, and reduce the cycle times and energy consumption in their machining processes. Testing would be required.

Site Assessments

Several areas were identified for energy savings, as shown above, however only a few of the suggested areas were evaluated during the site assessment at their Latrobe location. The following areas were assessed:

- Optimized Tooling and Tooling Paths
- Thermal Analysis

Tooling Optimization

Tooling and process optimization is paramount for an efficient machine shop. The optimization of tool geometries, and programming should be scrutinized. One scientific method of scrutinizing the tools, machines, and tool geometries used to create a part or feature, is harmonic analysis, in particular the BlueSwarf - MetalMax analysis kit. Through the analysis of the tooling, through the assessment, the following table detailing productivity increases and savings potentials. The decreases in MRR indicate that the tool is being run in a less than optimal range, and slowing the tool can improve surface finish and tool life.

Tool Description	Original	Optimized	MRR Change
5” Diameter Face Mill	250 RPM 8 IPM 0.020” DOC 5.0” WOC MRR = 0.8 in^3/min	525 RPM 17.6 IPM 0.020” DOC 5.0” WOC MRR = 1.8 in^3/min	125% increase
3/8” Diameter Endmill - Roughing	2000 RPM 5 IPM 0.600” DOC 0.375” WOC MRR = 1.1 in^3/min	3000 RPM 9.6 IPM 0.600” DOC 0.375” WOC MRR = 2.0 in^3/min	82% increase
3/8” Diameter Endmill – Contour Roughing	2000 RPM 20 IPM 0.600” DOC 0.030” WOC MRR = 0.4 in^3/min	3000 RPM 12 IPM 0.600” DOC 0.030” WOC MRR = 0.2 in^3/min	50% decrease
3/8” Diameter Endmill – Contour Finishing	4500 RPM 40 IPM 0.600” DOC 0.0025” WOC MRR = 0.8 in^3/min	3000 RPM 40.5 IPM 0.600” DOC 0.0025” WOC MRR = 0.1 in^3/min	88% decrease

MRR = Material Removal Rate, RPM = Revolutions Per Minute, IPM = Inches Per Minute, DOC = Depth of Cut, WOC = Width of Cut

Company N - MRR comparison before and after tooling analysis using BlueSwarf

Tooling Optimization

Thermal analysis iof the facility indicated a potential savings of $1.60 per square foot of exterior block wall. This is based upon calculations including heating degree days, heating type, and the R value of an uninsulated block wall as compared to a wall that meets new construction code minimums for exterior walls within the region (R13).

Implementation and Validation

None

Company O - Hamill Manufacturing, Co., 500 Pleasant Valley Rd, Trafford, PA 15085, Westmoreland County

Site Walkthrough

Company O is a job shop fabrication shop engaged primarily in the naval nuclear industry, specializing in exotic materials (Inconel, Monel, and Stainless Steels), and the creation of large machined parts, and weldments. The operations are performed in one facility approximately 60,000 sqft in size, utilizing approximately 120 employees. Typical large parts are in excess of 16tons, and large weldments can require up to forty (40) pounds of weld deposition for one weld seam. Average equipment age at this facility is fifteen (15) years of age. Areas identified for further investigation into energy utilization were:

Compressed Air

Compressed Air is utilized within the entire facility. Several areas had noticeable audible leaks. A common thought is that compressed air is a low cost power source, however, seven to eight electrical horsepower are required to create one horsepower of compressed air. A compressed air evaluation is warranted for this facility.

Thermal Analysis

Several areas could benefit from thermal analysis. The building is a concrete block construction, and at first view, has no additional insulation. Thousands of dollars per month could be eliminated from the heating and cooling of the air within the facility, in addition to providing a more comfortable work environment.

Coolant Recycling

Investigation into in-house coolant recycling can potentially reduce coolant use, improve part and process quality, and eliminate a waste stream. Past investigation by Hamill Manufacturing into coolants that provide the operating parameters and EHS compliance desired, have validated their selection of HOCUT 795 MP. However, the coolant is disposed when it is removed from the machine. Coolant recycling may provide cost and environmental benefits.

Lighting

The facility lighting was upgraded to T5 fixtures within the past several years. The lighting is adequate within the facility. However, investigation into LED lighting may provide additional cost and maintenance benefits.

Old vs. New Equipment

The average equipment age at Hamill Manufacturing is approximately fifteen years of age. There are a mix of new and older equipment. Investigation into energy use of the current older equipment vs. the newer equipment that can perform similar tasks, and newer technology equipment that can replace legacy machines, may provide additional data points that can improve energy consumption. Once energy consumption is understood, the consumption can be reduce through machine routing optimization, or using the most efficient machine for the process required.

Through the understanding of machine energy consumption, the inclusion of energy consumption parameters in the procurement of new equipment, can provide additional ROI through cost avoidance. Also, understanding new technology equipment with hand-off capability, and live tooling, can eliminate setups, and provide the capability for complex part creation at one machine with one set-up.

Optimized Tooling

There are a wide variety of machine tools utilized at Hamill manufacturing. However, investigation and optimization into the tools selected for feature creation, including program creation, tool selection, tool speeds, feeds, and edge preparation will provide useful insight into best practices. Optimized tools have shown to increase tool life, and reduce energy consumption at the process level, by up to 25%.

Machine Shut Down Procedures

Several of the machines in the facility, that were not running parts, had chip conveyors, hydraulic systems, and lighting running. While this may be perceived as a minimal savings, thousands of dollars per year can be save through the implementation of shut-down procedures for idle equipment. Additionally, the productive life of the machine can be extended, and maintenance requirements reduced, through the implementation and use of machine shutdown procedures.

Part Polishing

The polishing of part exteriors is accomplished with manually operated air driven tools. The elimination of air driven tools, and implementation of electric direct-drive tools, can provide a substantial savings through the elimination of compressed air demand for one of the most air intensive operations in a manufacturing facility.

Welding

A great deal of the parts manufactured by Hamill Manufacturing require tens of pounds of weld to be deposited. Investigation into a higher deposition consumables or welding processes, and/or automated, or semi-automated welding processes will provide a higher operating factor and higher deposition efficiency, resulting in shorter cycle times, with a potential reduction in energy consumed during the process.

Site Assessments

Several areas within Company O were identified as possible areas for energy savings during the initial walkthrough, however, only a few of the suggested areas were evaluated during the site assessment:

- energy requirements for current welding operations
- tooling and process technology
- compressed air use at the system and process levels
- energy consumption of idle machines
- coolant recycling
- building thermal properties

A summary of the potential energy/cost savings, based upon the suggestions are included in the following table. These figures are either estimates based upon tests conducted, or calculations completed based upon information obtained. One point of interest is that over half of the suggestions require a process change, or minimal cost to implement, to begin benefitting from reduced energy consumption.

Implementation and Validation
None

Company O				
Areas Identified for Savings	Projected Net Energy/Cost Savings/yr	Realized Net Savings/ yr		
		Energy	Time	Material
Welding	35%	n/a	n/a	n/a
Tooling	> 58%	n/a	n/a	n/a
Compressed Air (gross)	> 10%	n/a	n/a	n/a
Compressed Air Leak Elimination (gross)	> 10%	n/a	n/a	n/a
Shut Down Procedures	$21,600.00	n/a	n/a	n/a
Coolant Recycling	$12,000.00	n/a	n/a	n/a
Thermal Upgrades	$12,000.00	n/a	n/a	n/a

Company P - Pen-Dor Manufacturing, 1 Biddle Ave., P.O. Box 52, Westmoreland City, PA, 15692, Westmoreland County

Site Walkthrough

Company P is a small job shop, general machining shop contained within 8,000 sqft, utilizing eight (8) employees. The average age of the equipment within the facility was greater than fifteen (15) yrs. The following were machines or systems that could benefit from a more detailed energy use analysis:

Compressed Air

Compressed Air is utilized within the entire facility, and is provided by a 25hp scroll compressor. However, several areas had noticeable audible leaks that should be eliminated. Also, a common method in the facility for routing compressed air was through the utilization of hose, as opposed to pipe, this is another common practice that can introduce inefficiencies into the compressed air system. A common thought is that compressed air is a low cost power source, however, seven to eight electrical horsepower are required to create one horsepower of compressed air. A compressed air evaluation is warranted for this facility.

Thermal Analysis

The building is a concrete block construction, and at first view, has no additional insulation. Hundreds of dollars, and thousands of BTU's per month, could be eliminated from the heating and cooling of the air within the facility.
PenDor has taken ownership of their heating requirements and employs renewable energy for heating during the day, and maintains the facility temperature at night utilizing natural gas powered infrared heating circuits. However, in addition to the main building structure, several of the large doors utilized for raw material receiving, and finished part shipment, should be analyzed for their energy efficiency.

Coolant Recycling

Investigation into in-house coolant recycling can potentially reduce coolant use, improve part and process quality, and eliminate a waste stream. The coolant utilized within the facility (TRIM SOL) is disposed of when it is removed from the machines. Coolant recycling may provide cost and environmental benefits.

Lighting

The facility lighting is currently T8 fixtures throughout, with the exception of one T5 fixture. The lighting is adequate within the facility. However, investigation into LED lighting may provide additional cost and maintenance benefits.

Old vs. New Equipment

The average equipment age at PenDor is approximately fifteen years of age and greater. There are a mix of new (1999 era) and older equipment (1970's era) utilized within the facility. Investigation into energy use of the current older equipment vs. the newer equipment that can perform similar tasks, and newer technology equipment that can replace legacy machines, may provide additional data points that can improve energy consumption. Once energy consumption is understood, the consumption can be reduce through machine routing optimization, or using the most efficient machine for the process required. However, a majority of the equipment at the facility have unique characteristics, and duplicate or overlapping capability within the equipment appears to be uncommon.

Optimized Processes

There are a wide variety of machine tools utilized at PenDor manufacturing, and each of the parts created has a tooling package specific for its geometry and material. However, investigation and optimization of the tools selected for feature creation, including tool speeds, feeds, and edge preparation will provide useful insight into best practices. Optimized tools have shown to increase tool life, and reduce energy consumption at the process level, by up to 25%.

Additionally, investigation into offline programming and machine program optimization software, can also provide a cycle time savings, which translates directly to an energy and money savings.

Although PenDor is a typical job shop machine shop, creating a variety of low quantity parts (<10pcs per batch), there are two parts in particular that could be investigated for optimization. The bronze bushings created for CK Composites, and the large 17-4 stainless steel tubes. The bronze bushings are created in quantities of 250 pieces per month, where the 17-4 stainless part requires a 4” diameter hole to be drilled through the axis of an approximate 7” diameter piece of roundstock.

As seen above, a great deal of opportunities exist at this manufacturer, with regard to energy savings, and process improvement. The desire for upgrade exists, however the monies available for upgrade are limited.

Site Assessments

A walkthrough of this facility was conducted, and conversations about follow-on activity have occurred, however, no site assessment has been performed for this company to date, and there has been no interest in follow-on activity form this company, at this time.

Implementation and Validation

None

Company Q - Linear Machining Technology, LLP, 7485 Pennsylvania Ave, Irwin, PA 15642, Westmoreland County

Site Walkthrough

Company Q is a small contract machine shop, engaged primarily in the creation of general machine parts, and components for the pharmaceutical industry. Raw materials processed are stainless steel and aluminum. This company has expressed great interest in energy consumption reduction, due to their approximate 70% increase in electricity costs over the past several years. The facility is approximately 8,000 sqft and employs eight (8) individuals. The average equipment age within the facility is fifteen (15) years, however the average age of the equipment is due to the non-CNC equipment. The oldest CNC machine is six (6) years of age. Areas for further investigation, and optimization to reduce energy consumption include:

Compressed Air

Compressed Air is utilized within the entire facility, and is provided by a reciprocating compressor with a set-point of 150psi, another similar compressor is utilized as a backup. A common thought is that compressed air is a low cost power source, however, seven to eight electrical horsepower are required to create one horsepower of compressed air. A compressed air evaluation is warranted for this facility.

Thermal Analysis

The building is a concrete block construction, and at first view, has no additional insulation. Hundreds of dollars, and thousands of BTU's per month, could be eliminated from the heating and cooling of the air within the facility. Projects centered on reducing the cooling requirement have been executed in the past, whereas, the heating is less of a concern due to the natural gas well on the property that provides free natural gas.

Lighting

The facility lighting is currently T8 fixtures throughout. The lighting is adequate within the facility. However, investigation into LED lighting may provide additional cost, maintenance, and light quality benefits.

Optimized Processes

There are a wide variety of machine tools utilized at Linear Machining Technologies. The part programming is competed off-line utilizing MasterCAM. However, the machinists are responsible for tool selection and setup, including speed and feed inputs. Tool selection is based upon past experience and could benefit from optimization for the features being created, including tool speeds, feeds, geometry, and edge preparation. Optimized tools have shown to increase tool life, and reduce energy consumption at the process level, by up to 25%. Additionally, setup time could be reduced with the implementation of a tool pre-setter.

Although Linear Machining Technology is a typical job shop machine shop, creating a variety of low quantity parts (<10pcs per batch), there is one part in particular that could be investigated for optimization, the hydraulic bulkhead. The hydraulic bulkhead is made from 6061 aluminum in quantities of 700 pieces, this order is filled approximately twice a year.

Site Assessments

Several areas within Company Q were identified as possible areas for energy savings during the initial walkthrough, however, only a few of the suggested areas were evaluated during the site assessment:

- compressed air use at the system and process levels
- lighting technologies
- tooling and process technology optimization
- optimization of the aluminum hydraulic bulkhead

A summary of the potential energy/cost savings, based upon the suggestions are included in the table following. These figures are either estimates based upon tests conducted, or calculations completed based upon information obtained. One point of interest is that over half of the suggestions require a process change, or minimal cost to implement, to begin benefitting from reduced energy consumption.

Implementation and Validation

None

Company Q				
Areas Identified for Savings	Projected Net Energy/Cost Savings/yr	Realized Net Savings/ yr		
		Energy	Time	Material
Compressor	$500.00	n/a	n/a	n/a
Compressed Air Piping	$4,285.00	n/a	n/a	n/a
Lighting	$1,535.43	n/a	n/a	n/a
Tooling Optimization	$60.00	n/a	n/a	n/a
Thermal Optimization	$2,000.00	n/a	n/a	n/a

Company R - Spark Technologies, 150 Railroad Ave, Schenley, PA 15682, Armstrong County

Site Walkthrough

Company R is a job shop specialty EDM house, specializing in the creation of high tolerance, high surface finish parts for the stamping industry. The manufacturing utilizes one of the three floors of their location, or 14,000 sqft of their available 30,000 sqft, and employs approximately eighteen (18) individuals. The facility layout, and management's method of addressing opportunities are unique. For example, this company utilizes a rainwater collection system to replenish the water utilized in the EDM process. Not only does it provide the needed water, free of charge, it does not require any additional conditioning, as city water would. Also, the heating requirement for the facility is provided by the heat generated by the EDM machines. Areas identified for future investigation, and energy reduction, were:

HVAC

One primary system of concern was the HVAC. The age of the system, installed in 1992, warrants a complete analysis to provide an understanding of potential savings. These systems have been identified by Spark Technologies as areas of opportunity and are planning to upgrade through the next few years.

Thermal Analysis

The building is a poured structural concrete construction, 14" thick, and at first view, has no additional insulation. While this may seem to possess exceptional insulating properties, typical R-values for this thickness would be in the R2.0 - R6.0 range. Another point of interest, or most easily upgraded, is on the third floor, which is hollow terra-cotta block. Thousands of BTU's per month, could be eliminated from the heating and cooling of the air within the facility if either, or both of these areas were insulated.

Lighting

The facility lighting consists of 100 T12 fixtures throughout. The lighting is adequate within the facility. However, investigation into LED lighting, and lighting control systems, may provide additional cost, maintenance, and light quality benefits.

Optimized Systems

A majority of the machines within the facility are EDM machines. Each of the machines have several pumps required for cooling the process, and none were labeled as high efficiency. Replacement of these motors would provide an energy savings for these processes. Also, insulating the EDM machine cooling tanks, in the summer, would reduce the cooling load required for temperature control of the workspace.

One additional point of energy savings, revolving around process improvement, would be the institution of a four day equivalent workweek. This removes one start-up and shut-down cycle, in addition to the energy used by the facility equipment, for one day per week.

Site Assessments

Several areas within Company R were identified as possible areas for energy savings during the initial walkthrough, however, only a few of the suggested areas were evaluated during the site assessment:

- HVAC analysis
- building thermal properties
- lighting technologies

A summary of the potential energy/cost savings, based upon the suggestions are included in the table below. These figures are either estimates based upon tests conducted, or calculations completed based upon information obtained. One point of interest is that over half of the suggestions require a process change, or minimal cost to implement, to begin benefitting from reduced energy consumption. All of the suggestions were viewed as favorable, and the HVAC system upgrades are moving forward toward implementation. This will include the replacement of all five (5) HVAC units, and the re-plumbing of the delivery ducts to better accommodate their heating and cooling needs. The lighting is also being strongly considered, and may be implemented on a "rolling basis", as one fixture requires repair, it will be replaced with LED. Window films are being evaluated for the exterior windows, as are new windows.

<u>Implementation and Validation</u>
None

Company R				
Areas Identified for Savings	Projected Net Energy/Cost Savings/yr	Realized Net Savings/ yr		
		Energy	Time	Material
Heat Exchanger	90%	n/a	n/a	n/a
Exterior Windows (double pane)	120%	n/a	n/a	n/a
Exterior Windows (triple pane)	133%	n/a	n/a	n/a
Insulation Upgrades	$25,000.00	n/a	n/a	n/a
Lighting	$3,300.00	n/a	n/a	n/a

Company S - Standard Horse Nail, 1415 5th Avenue, New Brighton, PA 15066, Beaver County

Site Walkthrough

Company S is a manufacturer whose capacity if split evenly between job shop and production manufacturing, located in New Brighton, Beaver County, PA. They inhabit approximately 43,000 sq-ft of manufacturing space, within one 87,000 sq-ft facility, the excess is utilized for old equipment storage or as rental storage space. Their newest section of their building was built in 1906, and they employ 22 employees. The average age of the equipment within the facility is approximately fifty years, due to the manual nature of the creation of their production components, which utilizes swiss machines and internally designed and manufactured key profile cutting machines. Their business consists primarily of woodruff key and taper pin manufacturing, which utilize AISI 1035 cold drawn steel flat bar, and AISI 8630 steel flat bar. Areas identified for future investigation were:

Thermal Analysis

The largest overhead cost for the facility, as stated by Mr. Merrick, is heating, which was in excess of $50K for the previous year. The building is brick construction, and at first view, has no additional insulation. Hundreds of dollars, and thousands of BTU's per month, could be eliminated from the heating of the facility through investigation of insulation options. Also, different methods of heating, other than the natural gas blowers, could also be investigated to provide the most efficient heating, or temperature control solution for the facility.

Lighting

The lighting is currently being upgraded from T12 to LED, which will provide a significant energy savings. However, the lighting in the facility should be connected to motion sensors to provide light only when required. With 22 employees, inhabiting 43,000 sq-ft of manufacturing space, there are significant areas that do not require constant lighting. Investigation into lighting control solutions should be performed.

Optimized Tooling

The cutting tools utilized for the creation of woodruff keys is designed in house, and quite unique, however, new cutting tool geometry, and cutter edge preparation may be able to be applied to this process. Common gains when utilizing edge preparation for endmills are:

- Reduction in required cutting forces leading to reduced energy consumption and machine wear
- Increased surface finish
- 2-3X, or greater, increase in tool life

Motor Evaluation

A number of the machines in the facility were designed and built by Standard Horse Nail. A majority of the machines are powered with electric motors, larger than 5HP, and could benefit from an energy use evaluation, and comparison to newer high efficiency motors.

Site Assessments

Company S is a manufacturer whose capacity if split evenly between job shop and production manufacturing, located in New Brighton, Beaver County, PA. They inhabit approximately 43,000

sq-ft of manufacturing space, within one 87,000 sq-ft facility, the excess is utilized for old equipment storage or as rental storage space. Their newest section of their building was built in 1906, and they employ 22 employees. The average age of the equipment within the facility is approximately fifty years, due to the manual nature of the creation of their production components, which utilizes swiss machines and internally designed and manufactured key profile cutting machines. Their business consists primarily of woodruff key and taper pin manufacturing, which utilize AISI 1035 cold drawn steel flat bar, and AISI 8630 steel flat bar.

An site assessment of Company S was conducted and an analysis of the following were suggested, and performed:

- building thermal properties
- lighting technologies
- tooling technology optimization
- motor evaluation

A summary table of the savings suggestions, and their calculated savings can be seen in the table below. Implementation of all suggestions count reduce the yearly overhead cost of Company S $20,000 - $40,000 per year. Also, through the procurement and use of CNC equipment, and facility consolidation, further savings can be realized due to a smaller amount of required square footage.

Description	Savings%	Cost Savings	Time Period
Insulation Upgrade (per 1000 sq-ft of wall)	n/a	$1,633.96	per year
Heating Upgrade from forced air to IR	30-70%	$15,000 - $35,000	per year
Pilot Light Procedure	n/a	~$2000	per year
Lighting Upgrade	87%	$2,579.85	per year
Motion Sensors for Lighting*	25%	$700.00	per year
Motor Upgrade (savings per swiss machine)	40%	$570.00	per year

* cost savings based upon installation with non-upgraded lighting

Company S - Savings Summary Table

<u>Implementation and Validation</u>

None

Company T - FPD Technologies, 124 Hidden Valley Road, McMurray, PA 15317, Washington County

Site Walkthrough

Company T is a job shop specialty forging house, with heat treating, machining and grinding capabilities, located in McMurray, Washington County, PA. They inhabit approximately 60,000 sq-ft of manufacturing facility, with 119 employees. The average age of the equipment within the facility is approximately fifteen years, however there is currently an effort to replace ten machines with two newer technology machines. Additionally, an industry leading servo driven press is in the primary stages of procurement. The new press technology will reduce the energy consumption of the forging process by almost 70%, when compared to current hydraulic press technology.

An analysis of the following systems and processes were suggested:

Forging Press Changeover

One of the largest consumers of production time is forging die set-up. Initial estimates show that forging die setup consumes up to 50% of forging capacity (time). Investigation into quick change dies, or die designs should be investigated. Additionally, a more efficient method of forging die transport should be investigated as another approach to further reduce set-up time. Reducing the total setup time of new dies, reduces idle time, and therefore reduces non-value-add energy expenditure by the press.

Compressed Air

The compressed air system should be evaluated to provide an understanding of system routing, and demand vs. requirement. There were several areas within the facility with operational inefficiencies that would produce a false demand upon the system. Hose routing also contributes to system efficiency and should be reviewed. A point of note, a 2psi reduction in system pressure can result in a 1% reduction in compressed air energy required for the facility.

Coolant recycling / Scrap Material Handling

Investigation of a coolant recycling process can drastically reduce the cost associated with coolant disposal. In conjunction with the coolant recycling system, and machining scrap chip pucker can further reduce coolant loss, and also increase the value of machining scrap.

Nitrogen Pressure System

The forging press utilizes compressed nitrogen for its energy source. The pressure ramp up, and reclamation can take upwards of 2.5 hours per set-up, further increasing the idle time required between part runs.

Machine Upgrade and Consolidation

As mentioned previously, one area of the facility will be undergoing a machine upgrade. This upgrade will replace ten (10) machines, with two (2) machines, while maintaining the same capacity. Energy comparisons should be conducted between the old vs. new machines to provide an in depth understanding of comparative energy consumption with new machine technology.

Thermal Analysis

Building

The building is a common concrete block construction, which has a typical insulation value of R1.1. Thousands of BTU's per month could be eliminated from the heating and cooling of the air within the facility, if the insulation was upgraded to current code requirements of R13. Analysis of the current building envelope can provide information supporting this claim, and may highlight other building envelope problems such as water infiltration, compromised door seals, etc.

Chiller sizing for part cooling

The current process for part temperature reduction, is conducted with an in-house water bath dip-tank, referred to as the hillbilly hot tub. This is an open loop cooling system, and introduces fresh cooling water when the temperature of the water exceeds 70degrees F. Investigation into closed loop, part cooling methods should be investigated.

Die Preheat

Current die preheating is accomplished with open flame natural gas torches. Preheating methods should be investigated to optimize, and potentially reduce, the die preheat cycle.

Furnaces

An analysis of the thermal properties of the existing heat treating and vacuum furnaces should be conducted. The analysis can provide information about refractory condition, door seal integrity, and BTU loading and cooling tower requirements.

Machining Optimization

FPD has conducted harmonic tool analysis in the past, however, the process was not maintained. Reanalysis of the benefits of tooling harmonic analysis should be investigated, and implemented into the current tool management process. Energy consumption and cycle time reductions of 30% or greater are not uncommon, all while increasing tool life and machining quality.

Lighting

The facility lighting consists of metal halide fixtures, and/or T5 fixtures throughout. The lighting is adequate within the facility. However, investigation into LED lighting, and lighting control systems, may provide additional cost, maintenance, and light quality benefits.

Site Assessments

Company T is a job shop specialty forging house, with heat treating, machining and grinding capabilities, located in McMurray, Washington County, PA. They inhabit approximately 60,000 sq-ft of manufacturing facility, with 119 employees. The average age of the equipment within the facility is approximately fifteen years, however there is currently an effort to replace ten machines with two newer technology machines. Additionally, an industry leading servo driven press is in the primary stages of procurement. The new press technology would reduce the energy consumption of the forging process by almost 70%, when compared to current hydraulic press technology. However, the price and delivery required for a timely return on investment were found to be excessive, and the project was slated for future consideration.

Seven areas were identified for energy savings, analyzed, and recommendations for improvement were made:

- Forging press changeover process, in particular the die setup, design, and transport.
  - Several recommendations were made to improve the current process. These changes were difficult to quantify from an energy savings perspective, however, the potential productivity increases and increased worker safety are well worth the investment alone. Validation after implementation can provide insight into energy savings.
- Compressed air system evaluation and use.
  - The compressed air recommendations focused on system routing improvements and increased piping diameters to optimize tool performance and reduce system pressure and volume losses.
- Nitrogen pressure system, specifically system pressurizing and depressurization.
  - The pressurization of the nitrogen system utilized for the forging press operation required an excessive amount of time. Utilization of high pressure cradles (4600psi vs. 2400psi) were recommended to increase initial system pressure and reduce pressurization times.
- Machine upgrade and consolidation, in particular the energy savings of new machines vs. current machines.
  - Ten (10) 15+ year old machines were logged for energy use, and will be replaced by two (2) current technology multiple axis milling machines optimized for the creation of current production parts. Energy reductions of approximately 8X with a capacity increase are expected. Validation will provide exact energy reduction numbers.
- Thermal upgrades to the building, and furnaces in addition to process improvements to die preheating, and heat removal from parts.
  - Building insulation upgrades and furnace door seal replacement were suggested.
  - Transitioning the die preheating from natural gas to Infrared heating was recommended. Natural gas was also provided as an alternative and would provide a cost savings over their current propane fueled system, with no equipment or process changes required.
- Machining optimization, specifically, machining parameters, and tool selection and use.
  - Harmonic analysis of four (4) representative tools was conducted, showing that a 1.7 – 1.9X increase in material removal rate, with minimal energy consumption increase, can be realized due to tool parameter optimization (see table of optimized vs. optimized material removal rates).
- Investigation into optimized lighting solutions.
  - Changing the facility lighting from current metal halide or T5 lighting to LED lighting can provide energy reduction benefits. (see table "Investment Grade Opportunities")

The table below summarizes the recommendations for which we were able to calculate

Improvement Opportunity	kWH Saved	Cost Savings Estimate (annual savings due to KW reduction)
Lighting: High Bay to LED	208,829	$16,706.32
Lighting Low Bay Offices and Hallways to LED	62,448	$4,995.84
Medical Machines Upgrade & Consolidation	69,715	$5,577.18

Company T "Investment Grade" Opportunities "investment grade" savings estimates. That is the data we collected was sufficient and accurate enough to provide a reasonably accurate estimate suitable for making investment decisions. These include the lighting projects, and machine consolidation because of the data collected from logging equipment in the field. These projects along account for a 7% reduction in total electrical use, and an annual savings of about $27k, and would be eligible for about $17k in First Energy Rebates.

Improvement Opportunity	Cycle Reduction	Cost Savings Estimate (annual savings due to KW reduction)
Nitrogen System Upgrade (4600 psi cradle)	25%	
Die Preheat (IR Lamps)	30-90%	30-90%
Die Preheat (Propane to NG)		30%
Building Insulation		$2 / s.f. of exterior walls
HVAC Upgrades		30-70% (≈ $5k /year)
Air Compressor Upgrades		$4k - $9k / year

Company T – Savings Projections

Additionally, the other recommendations and best practices that will provide both energy and production efficiency consistent with Company T's goals. For these opportunities there are many factors, and precise estimates are not possible. However, reasonable estimates based on established methods and benchmarked projects have been provided and are summarized in the table below. Ultimately these should be adjusted based upon the actual numbers of systems, and/or combination of upgrades. Many of the production set-up changes would have to be analyzed after implementation to back-calculate the energy savings based upon the cycle time decrease.

	Current Theroetical MRR (in^3/min)	Optimized Theoretical MRR (in^3/min)	Increase (%)
¾" diameter carbide 5-flute endmill, on two different machines, custom ground			
o analysis #977445 conducted on asset #2007-15	0.27	0.8	196%
o analysis #119482 conducted on asset #2006-11	0.28	0.8	186%
2.0" diameter Crestcut Endmill, on two different machines			
o analysis #881181 conducted on asset #2007-15	0.4	1.19	198%
o analysis #147171 conducted on asset #2006-11	0.4	1.19	198%
½" diameter 5-flute carbide endmill, ONSRUD			
o analysis #395972 conducted on asset #2010-10	0.04	0.11	175%
½" diameter 7-flute carbide endmill, ONSRUD			
o analysis #783636 conducted on asset #2010-10	0.11	0.32	191%

Company T - Comparison of Optimized vs. Current Theoretical Material Removal Rates (MRR)

Implementation and Validation
None

Company U - Stellar Precision Components, Ltd., 1201 Rankin Ave., Jeannette, PA 15644, Westmoreland County

Site Walkthrough
Company U is an ISO 9001:2008 and AS9100 certified job shop machine shop, with machining and grinding capabilities, located in Jeannette, Westmoreland County, PA, inhabits approximately 17,000 sq-ft of manufacturing space and employs 60 people. The average age of the equipment within the facility is approximately five years. Their business consists primarily of high tolerance components for the aerospace and defense industry. Machined materials include a wide variety, including composites, phenolics, and metals, such as, Aluminum, numerous Low Carbon Alloys, Tool Steels, Stainless Steels (300, 400, 13-8, 15-5, 17-4 Precipitation Hardening Grades). SPC also has extensive experience with exotic metals, such Titanium, Maraging Steel, Nickel Alloys, Tungsten, and Copper/Bronze Alloys.

One point of interest is the coolant recovery/recycling system utilized. The system is well thought out, and reduces coolant related disposal to 10% of the volume prior to its installation. The areas identified for further analysis are:

Compressed Air
There is evidence of false compressed air demand developed by the elevated set points, and audible compressed air leaks throughout the facility. Also, the set-point for the compressor, at 130psi is a bit high for the processes and equipment found at SPC. The cast iron (black pipe) compressed air piping provides a low initial cost solution for air routing, however, the piping internals are susceptible to corrosion, resulting in reduced system performance. An evaluation of the compressed air system and line routing would provide insight into the system health, elimination of the false demand, and any system losses.

Thermal Analysis
The facility is an insulated metal building with a concrete block foundation. Typical R-values for the metal portion of the building is R10-13, however the several feet of concrete block at the base of the building, and the several exterior bare block walls do not appear to have any additional insulation, and would possess an insulation value of R1.1. Additionally, the ceiling of the facility has gaps in the insulating panels, or missing panels altogether. Thousands of BTU's per month, could be eliminated from the heating and cooling of the air within the facility if either, or both of these areas were better insulated.

Lighting
The facility lighting consists primarily of T8 fixtures, of which 60% are operational, and metal halide lighting in the highbay area housing the Haas VF6. The lighting is adequate within the facility. However, investigation into LED lighting, and potentially lighting control systems, will provide cost, maintenance, and light quality benefits.

Tool / Process Optimization
SPC can benefit from a deeper understanding of tooling technology, and machining optimization. For example, harmonic tool analysis can be conducted to optimize tool feeds and speeds, and tool edge preparation can be implemented, which allows increased speeds and feeds while increasing

tool life. New tool technology, thriller thread mills for example, can also provide reduced cycle times. Analysis of a milling process is recommended.

Site Assessments

Company U is an ISO 9001:2008 and AS9100 certified job shop machine shop, with machining and grinding capabilities, located in Jeannette, Westmoreland County, PA. SPC inhabits approximately 17,000 sq-ft of manufacturing space and employs 60 people. The average age of the equipment within the facility is approximately five years. Their business consists primarily of high tolerance components for the aerospace and defense industry. Machined materials include a wide variety, including composites, phenolics, and metals, such as, Aluminum, numerous Low Carbon Alloys, Tool Steels, and Stainless Steels (300, 400, 13-8, 15-5, 17-4 Precipitation Hardening Grades). SPC also has extensive experience with exotic metals, such Titanium, Maraging Steel, Nickel Alloys, Tungsten, and Copper/Bronze Alloys

One point of interest is the coolant recovery/recycling system utilized at SPC. The system is well thought out, and reduces coolant related disposal to 10% of the volume prior to its installation.

Several areas, shown below, were identified for energy savings at Company U, of which, all were evaluated:

- compressed air system evaluation
- building thermal properties
- lighting technologies
- tooling and milling optimization, in particular the "*Ram Block Aft Adapter*"

The table below summarizes the estimated savings based upon the suggestions provided in the site assessment. The actual savings should be adjusted based upon the actual numbers of systems, combination of upgrades, or system part upgrades.

	Net Savings (%)	Net Savings ($/yr)
Compressed Air Upgrade		
- Piping	>10%	>$2600
- Compressor	>30%	> $17,000
Lighting Upgrade	90%	$3,832.92
Tooling Optimization (based upon material removal rate (MRR))	64%	n/a
Thermal Optimization (per 1000 sqft or exterior wall)	unknown	$2,000.00

* energy savings does not include tool savings, or production capacity increase

Company U - Summary Savings Table

Implementation and Validation

None

Company V - Trico Welding, 140 McGrogan Road, RuffsDale, PA, 15679, Westmoreland County

Site Walkthrough

Company V is a job shop welding shop, with machining capabilities, located in Ruffs Dale, Westmoreland County, PA. They employ eight (8) welders, machininsts, and fabricators, and inhabit over 4000 sq-ft of manufacturing and office space in their main facility, and are geared toward creating high tolerance welded assemblies in any material, including various grades of stainless, copper, Inconel, and Stellite. Their main customers are those serving the nuclear industry. The average age of the welding machines within the facility is less than 10 years, however their machining equipment within the facility is greater than fifteen years. The following details systems, or processes that could benefit from a detailed analysis in an effort to reduce the energy required to operate the system or machine, and/or manufacture the component.

Areas identified for further investigation were:

Compressed Air

Compressed Air is utilized within the entire facility, and is provided by a reciprocating compressor. The current unit provides air to the facility, however, it may not be the most efficient method to do so. Also, a common method in the facility for routing compressed air was through the utilization of hose, as opposed to pipe, this is another common practice that can introduce inefficiencies into the compressed air system. A common thought is that compressed air is a low cost power source, however, seven to eight electrical horsepower are required to create one horsepower of compressed air. A compressed air evaluation is warranted for this facility.

Thermal Analysis

The building is a concrete block construction, and at first view, has no additional insulation. Thousands of BTU's per month, could be eliminated from the heating and cooling of the air within the facility. In addition to the main structure, the door seals and windows should be evaluated for energy efficiency.

Lighting

The facility lighting is currently a mix of T12, T8, and T5 fixtures throughout. The lighting is adequate within the facility. However, investigation into LED lighting may provide additional cost and maintenance benefits.

Old vs. New Equipment

The average age of the milling machines at Trico is approximately twenty (20) years of age and greater. There is an NC controlled machine, and several Bridgeport manual milling machines. These machines provide the flexibility required to create the myriad of parts in a typical job shop environment. However, the current machines lack the rigidity and spindle speeds to take advantage of new tooling technology that can reduce energy consumption and cycle times. Investigation into newer equipment technology is warranted for Trico Welding, and should be based upon Trico's vision for their future business.

Optimized Processes

Although there were no representative parts or assemblies available to be viewed during the initial walkthrough, an investigation into optimizing a manufacturing process for the creation of a representative assembly is warranted. There are a wide variety of machine tools utilized at Trico Welding, investigation and optimization of the tools selected for feature creation, including tool speeds, feeds, and edge preparation will provide useful insight into best practices. Optimized tools have shown to increase tool life, and reduce energy consumption at the process level, by up to 25%.

Although Trico is a typical job shop welding shop, creating a variety of low quantity parts (<50pcs per batch) investigation into the best methods for feature creation would be beneficial, and potentially allow Trico to become more competitive within their chosen market.

Site Assessments

None

Implementation and Validation

None

Company W - Sosko Manufacturing, 410 Unity St, Latrobe, PA 15650, Westmoreland County

Site Walkthrough

Company W is a job shop machine shop located in Westmoreland county, and employs 5 individuals and inhabits approximately 3000 sq-ft of manufacturing space. The average age of the machines within the facility is geater than 15 years. The following details systems, or processes that could benefit from a detailed analysis in an effort to reduce the energy required to operate the system or machine, and/or manufacture the component.

An analysis of the following were suggested:

Compressed Air

Compressed Air is utilized within the entire facility, and is provided by a reciprocating compressor. The current unit provides air to the facility, however, albeit new, it may not be the most efficient method to do so. Also, a common method in the facility for routing compressed air was through the utilization of hose, as opposed to pipe, this is another common practice that can introduce inefficiencies into the compressed air system. A common thought is that compressed air is a low cost power source, however, seven to eight electrical horsepower are required to create one horsepower of compressed air. A compressed air evaluation is warranted for this facility.

Thermal Analysis

The facility is an uninsulated metal building, and at first view, has no additional insulation. Thousands of BTU's per month, could be eliminated from the heating and cooling of the air within the facility. In addition to the main structure, the door seals and windows should be evaluated for energy efficiency.

Lighting

The facility lighting is currently a mix of operational and non-operating T12 fixtures throughout. The lighting is somewhat adequate within the facility. However, investigation into LED lighting may provide additional cost and maintenance benefits.

Old vs. New Equipment

As stated previously, the average age of the machines at Sosko Manufacturing, Inc. is approximately fifteen (15) years of age and greater. All of the machines are CNC controlled, and provide the flexibility required to create the myriad of parts in a typical job shop environment. However, the current machines may lack the rigidity and/or spindle speeds to take advantage of new tooling technology that can reduce energy consumption and cycle times. Investigation into newer equipment and tooling technology is warranted, and should be based upon Sosko Manufacturing's vision for their future business.

Optimized Processes

An investigation into optimizing the manufacturing processes required for the creation of a representative part, or family of parts, is warranted. There are a wide variety of machine tools utilized, investigation and optimization of the tools selected for feature creation, including tool speeds, feeds, and edge preparation will provide useful insight into best practices. Optimized tools have shown to increase tool life, and reduce energy consumption at the process level, by up to 25%.

Although Sosko Manufacturing is a typical job shop machine shop, creating a variety of low quantity parts (<10pcs per batch) investigation into the best methods for feature creation would be beneficial, and may potentially allow Sosko Manufacturing to become more competitive within their chosen market.

An additional area of investigation should be the purchase of material that is closer to the finished shape of the final part. This can be done with the use of nearer net raw materials, and potentially castings or supplier cut blanks. This will come at an increased cost, but may provide energy cost reductions in excess of these increases.

Site Assessments

No site assessment activity was conducted for this company.

Implementation and Validation

None

Company X - Boyle, Inc., 82 Main St, Freeport, PA 16229, Armstrong County

Site Walkthrough
Company X is a job shop machine shop, specializing in carbide machining for the creation of stamping dies for the electrical maunacturing industry, and are located in Armstrong county. Company X. employs 12 individuals, have been in business for over thirty years, and inhabit approximately 3000 sq-ft of manufacturing space. The average age of the machines within the facility is geater than 15 years. The following details systems, or processes that could benefit from a detailed analysis in an effort to reduce the energy required to operate the system or machine, and/or manufacture the component.

An analysis of the following were suggested:

Compressed Air
Compressed Air is utilized within the entire facility, and is provided by a reciprocating compressor. The current unit provides air to the facility, however, albeit new, it may not be the most efficient method to do so. Also, a common method in the facility for routing compressed air was through the utilization of hose, as opposed to pipe, this is another common practice that can introduce inefficiencies into the compressed air system. A common thought is that compressed air is a low cost power source, however, seven to eight electrical horsepower are required to create one horsepower of compressed air. A compressed air evaluation is warranted for this facility.

Thermal Analysis
The facility is an uninsulated block building, and at first view, has no additional insulation. Thousands of BTU's per month, could be eliminated from the heating and cooling of the air within the facility. In addition to the main structure, the door seals and windows should be evaluated for energy efficiency. Thermal stability within the manufacturing and inspection areas is paramount for the inspection and creation of the high tolerance parts made at Boyle, Inc.

Lighting
The facility lighting is currently achieved through a mix of T8 fixtures throughout. The lighting is somewhat adequate within the facility. However, investigation into alternate lighting technologies may provide additional energy, cost, and maintenance benefits.

Old vs. New Equipment
As stated previously, the average age of the machines at Boyle, Inc. is approximately fifteen (15) years of age and greater. A majority of the machines are manually controlled, and provide the flexibility required to create the myriad of parts in a typical job shop environment. However, a majority of the current machines lack the rigidity and spindle speeds to take advantage of new tooling technology that can reduce energy consumption and cycle times. Investigation into newer equipment technology is warranted for, and should be based upon the vision for future business at Boyle, Inc. Also, a comparison of the energy use of older technology machines vs. newer technology machines should be conducted. This analysis may provide justification for job routing through the facility, and potentially justification for new equipment with greater energy efficiency.

Optimized Processes

An investigation into optimizing the manufacturing processes required for the creation of a representative part, or family of parts, is warranted. There are a wide variety of machine tools utilized, investigation and optimization of the tools selected for feature creation, including tool speeds, feeds, and edge preparation will provide useful insight into best practices. Optimized tools have shown to increase tool life, and reduce energy consumption at the process level, by up to 25%.

Although Boyle, Inc. is a typical job shop machine shop, creating a variety of single, or low quantity parts, and engaging in prototyping activities, investigation into the best methods for feature creation would be beneficial, and may potentially allow Boyle, Inc. to become more competitive within their chosen market.

Another area of investigation is in the area of dust collection. There are several dust collectors that have been added through the years, and an analysis of the current system for efficiency would be beneficial.

Site Assessments

None

Implementation and Validation

None

Company Y - PBM Valve, 1070 Sandy Hill Rd, Irwin, PA, Westmoreland County

Site Walkthrough
Company Y is a specialty valve manufacturer that produces valves and valve components primarily for the pharmeceutical and food industries, and are located inWestmoreland county. Company Y employs approximately 100 individuals, has been in business for over fifty years, and inhabit approximately 25,000 sq-ft of manufacturing space. The average age of the machines within the facility is geater than 15 years. The following details systems, or processes that could benefit from a detailed analysis in an effort to reduce the energy required to operate the system or machine, and/or manufacture the component.

An analysis of the following were suggested:

Compressed Air
Compressed Air is utilized within the entire facility, and a common method in the facility for routing compressed air was through the utilization of hose, as opposed to pipe; this is a common practice that can introduce inefficiencies into the compressed air system. A common thought is that compressed air is a low cost power source, however, seven to eight electrical horsepower are required to create one horsepower of compressed air. A compressed air evaluation is warranted for this facility.

Thermal Analysis
The facility is a mix between insulated block, sheetmetal, and stucco facade. A thermal analysis of the facility, and understanding the areas that may require attention, may eliminate thousands of BTU's per month in energy required to heat and cool the facility. In addition to the main structure, the door seals and windows should be evaluated for energy efficiency.

Lighting
The facility lighting is currently achieved through a mix of T5 fixtures throughout. The lighting is adequate within the facility. However, investigation into alternate lighting technologies may provide additional energy, cost, and maintenance benefits.

Old vs. New Equipment
As stated previously, the average age of the machines at PBM Valve is approximately fifteen (15) years of age and greater. A majority of the machines are manually controlled, and provide the flexibility required to create the myriad of parts required for valve manufacture. However, a majority of the current machines lack the spindle speeds to take advantage of new tooling technology that can reduce energy consumption and cycle times. Investigation into newer equipment technology is warranted, and should be based upon the vision for future business at PBM Valve. Also, a comparison of the existing machine energy use of older technology machines vs. newer technology machines should be conducted. This analysis may provide justification for job routing through the facility, and potentially justification for new equipment with greater energy efficiency.

Optimized Processes

An investigation into optimizing the manufacturing processes required for the creation of a representative part, assembly, or family of parts, is warranted. There are a wide variety of machine tools utilized, investigation and optimization of the tools selected for feature creation, including tool speeds, feeds, and edge preparation will provide useful insight into best practices. Optimized tools have shown to increase tool life, and reduce energy consumption at the process level, by up to 25%. In addition to the optimization of machine tools, and machine use, the following areas should also be investigated for application at PBM Valve:

- Use of near net materials (raw materials closer to finished size), greater use of near net shapes (castings), and additive manufacturing.
- More efficient polishing of component exteriors and interiors.
- Optimized tooling (i.e., style, type, geometry, flutes, edge prep, etc.), and part fixturing (increase commonality of machine fixturing).
- Increased use of the Giddings and Lewis HMC 170, Semi-automatic Palletized Horizontal Milling Machine.
- Optimization of tool operating parameters (i.e., tool harmonic analysis and machine movement).
- Methods to reduce product development time (current time is approximately 2 years).

Site Assessments

None

Implementation and Validation

None