Motivating Manufacturing Energy Efficiency: E2 Assessments & GreenLean℠ Training with Directed Implementation

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Table of Contents

List of Tables i
Executive Summary 1
Introduction/Background 4
Methodology 5
Results 10
Discussion of Results 14
Conclusions and Recommendations 16
Appendix A: Internship Process 19
Appendix B: Intern Program Schedule 22
Appendix C: Sample Promotional Materials 25
Appendix D: Intern Project Checklist 26
Appendix E: Intern Project Scoring Model 28
Appendix F: Intern Project Summaries 29

List of Tables

Table 1: Student Intern Academic Affiliation 7
Table 2: Lean Service Providers 10
Table 3: Recommended Savings 11
Table 4: Implemented Results 13
Table 5: Proposed and Implemented Results by Suggestion Type 15

Executive Summary

The Minnesota Technical Assistance Program (MnTAP) evaluated new tools to help Minnesota utilities conservation improvement programs (CIPs) meet their annual energy savings goals. MnTAP worked to incorporate energy assessment strategies and use of lean manufacturing tools into MnTAP-sponsored intern projects designed to provide Minnesota manufacturing companies with energy efficiency recommendations and direct implementation assistance.

Over the three-year program, MnTAP coordinated lean and energy projects at seven companies. For the seven projects, savings from identified energy conservation measures were estimated to total nearly 1,300,000 kWh of electricity use and 4,800 therms of natural gas use at the facilities. Total dollar value of savings from recommended energy conservation measures when combined with waste reduction and production improvements is approximately $730,000.

Significant learning from this project includes:

- Recruiting companies was most efficiently done by MnTAP and became more effective as case examples were developed; referrals from utilities and partners were limited.
- Funding stability allowed recruiting of high quality projects with significant energy conservation opportunity regardless of utility support, enabling program development.
- Adapting the basic program model was needed to attract suitable businesses to participate and accommodate individual business lean practices and needs.
- Coupling lean manufacturing tools with process energy assessments broadens the engagement across company staff and work functions.
- Incorporating lean tools with the MnTAP intern program resulted in identification of additional energy savings opportunities over standard assessments and intern projects.
- Training on lean manufacturing tools was needed for most student interns and could be effectively accomplished within the intern timeline.
- Adding additional short term engineering staff through the MnTAP intern program is a cost effective way to enable companies to develop and implement conservation plans faster than relying on internal staff time.

Recruiting Companies and Students

Recruiting companies to participate in the MnTAP intern program has been a successful, ongoing process for MnTAP staff members for thirty years. Project companies were identified and recruited through MnTAP's traditional intern project process with an additional focus on outreach with lean providers and utility representatives. Target outreach materials and case study examples were important resources to demonstrate project opportunity and engage companies in the second and third years of the project. Over three years, MnTAP coordinated lean and energy projects at seven companies.

- Schwing America, White Bear
- ST Specialty Foods, Brooklyn Park
- Uponor, Apple Valley
- MGK, Chaska

- Kemps, Rochester
- Lou Rich, Albert Lea
- Firmenich, New Ulm

Maintaining the timeline for the project required engaging at least two companies with the program each year. To accomplish this, MnTAP staff needed to recruited companies engaged with lean manufacturing through several lean service providers as well as those using lean resources internal to the companies. While the original plan for company applicants to complete a GreenLean℠ evaluation with Enterprise Minnesota as a starting point for the process, was effective and allowed the student to start with several lean targets, a broader pipeline of facility opportunities was needed to have companies ready to launch projects each May when the student interns were available. The stable funding offered through this pilot program allowed MnTAP staff the support needed to recruit companies and demonstrate the impact of the technical assistance offered through the MnTAP intern program.

Student interns were hired from high quality engineering programs. Some had lean concepts incorporated in their course work, and some did not. The engineering interns were all able to pick up lean concepts with some basic tutorials and on the job training.

Identifying and Implementing Opportunities

While some project data was usually available prior to the intern beginning work at each company, the lean training and assessments were often performed within the internship period, rather than beforehand. This allowed the interns to participate directly in the lean assessments, collect and analyze lean data as part of their project. In this way interns were deeply immersed in the both the identification of opportunities and developing viable solutions. This is not unusual for intern projects as the opportunities identified in these intensive projects tend to be more involved that a short-term single focus assessment. The team based nature of the lean training tended to result in more engagement by company employees that normally seen in a typical energy audit. This enhanced level of participation and project ownership encourages implementation.

Student recommendations often require additional planning time and capital to be implemented, so it is important to have continued interactions with project participants in order to verify implementation and actual savings. To accomplish this, MnTAP staff continue to follow up with intern host companies to encourage and provide support for implementation for two years after completion of the project. Implementation that occurs after the intern has completed their project can be documented through this process.

For the seven projects, savings from identified energy conservation measures are estimated to total nearly 1,300,000 kWh of electricity use and 4,800 therms of gas use at the facilities. Total dollar value of savings from recommended energy conservation measures when combined with waste reduction and production improvements is $730,000. As of May 31, 2016 implemented energy savings total 720,000 kWh of electricity and 3,700 therms of gas (approximate 55% of the potential electric use savings and 77% of potential natural gas use savings). Total dollar value of savings when combined with waste reduction and production improvements is over $325,000 (approximately 45% of the total potential dollar savings). Incorporating lean strategies into the

seven MnTAP intern projects has nearly doubled the identification of energy conservation opportunities compared with the typical energy conservation suggestions such as lighting, compressed gas and motor improvements. A high implementation rate of 52% of the recommendations was achieved.

Benefits of Intern Programs for Energy Efficiency

Utility CIPs can benefit from partnering with an intern provider such as MnTAP in order to achieve additional documented energy conservation. Interns working on lean projects helped companies justify investments in process improvements, aided staff in completion of energy efficiency utility rebate applications, and verified energy savings. Manufacturing companies are focused on production and often lack time to apply for utility rebates or to verify or document savings after projects are completed. Having an intern working on the project provides a cost effective way to assist facilities in collecting information on energy using equipment and processes, an interface with utility representatives to encourage project participation and needed follow-up with measurement and verification documentation.

The MnTAP intern program provides participating companies with a comprehensive report of analysis results and recommendations for future actions. These reports belong to the companies and are not public information and often provide guidance for future improvement planning. To allow a timely public reporting on results and recommended energy savings opportunities, MnTAP publishes *SOLUTIONS* to provide a summary of the projects at the end of each summer. Interns give public presentations on their work at the annual intern program symposium. Presentations and summaries are posted on the MnTAP website (www.mntap.umn.edu/intern/pastproj.htm)

Lean process improvements recommended and implemented through this pilot intern program helped companies reduce energy use per unit of production. Adding a lean component to the internship programs enhances the MnTAP intern program's ability to identify energy savings opportunities that get implemented. The program also enables partnerships with managers beyond the environmental or sustainability group that may not otherwise have considered energy saving modifications as part of their process improvements. Identifying a reliable source of funding lean and energy internships would enable investment of the time required to engage facilities that can most benefit from this type of services. Additionally, broad based funding would allow the program to extend beyond specific utilities that choose to adopt it. Lean and energy intern assistance offers a valuable implementation opportunity for the state to meet energy efficiency and climate change goals.

Introduction/Background

The overall goal of this project was to **provide new tools to help Minnesota utilities meet the 1.5% annual energy savings goal** by assisting Minnesota manufacturers with identifying and implementing opportunities to become more energy efficient. The MnTAP intern program originated from the pollution prevention efforts supported by the Minnesota Pollution Control Agency (MPCA). The program has always focused on source reduction of process wastes. Energy efficiency projects, also a form of process waste reduction, have been pursued on a case by case basis when funding support can be provided through grants or utility programs. In this project MnTAP explored a framework to incorporate energy assessment strategies and use of lean tools into MnTAP-sponsored intern projects. The advantage of this approach is that the intern is able to provide the extra engineering capacity companies need to both identify high energy savings opportunities and launch implementation.

MnTAP is an industrial outreach and assistance program at the University of Minnesota. The program, established in 1985, helps Minnesota businesses develop and implement industry-tailored solutions that prevent pollution at the source, maximize efficient use of resources, and reduce energy use and costs to improve public health and the environment. MnTAP has a reputation for developing solutions, building relationships, and assisting with implementation of technology solutions including collecting data and documenting results.

MnTAP's technical staff members have engineering and science backgrounds, including several Certified Energy Managers. In addition to MnTAP's staff members, an annual intern program coordinated by MnTAP places highly qualified technical students in facilities to lead energy efficiency and pollution prevention projects. Over the past thirty years, companies implementing energy efficiency solutions identified by MnTAP interns have reduced their energy use by 65 million kWh and 5 million therms recorded as first year savings. Annual cost savings for waste and energy reductions through these projects have totaled nearly $50 million in first year savings.

Enterprise Minnesota has been an important project partner who supported the original program concept and participated directly in two projects, providing lean training and assessments. Enterprise Minnesota is fee-for service 501(c)(3) non-profit business consulting organization that helps small and medium-sized Minnesota manufacturing companies take advantage of expert business solutions to compete and grow profitably. They are Minnesota's representative to the national Manufacturing Extension Partnership (MEP) network funded through the U.S. Department of Commerce's national Institute of Standards and Technology (NIST). Enterprise Minnesota was chosen to partner with MnTAP in this project because of their GreenLean℠ process, which ties traditional lean improvement tools to "green" business practices. GreenLean℠ implementation has led to increases in efficiency, reduced waste (both energy and material), improved productivity, and reduced costs for practicing businesses.

Methodology

Project Identification

In the initial proposal, this project was envisioned with MnTAP partnering with one lean provider, Enterprise Minnesota, to support Minnesota manufacturers with GreenLean℠ training, which would include value stream mapping and possible follow up kaizen events. These lean process assessment tools would be followed by and energy efficiency assessments and hands-on implementation assistance through the MnTAP-sponsored intern. Once the project was underway, it became clear that engagement of more companies than could be referred was necessary to have high quality projects available at a point where they could take full advantage of the interns who are able to work from May through August.

MnTAP approached Division of Energy Resouces (DER) to request a modification to the program to allow companies to participate who had a lean culture, internal lean expertise or were working with any lean provider. This request was approved. Opening the process to companies engaged with other lean service providers, including lean resources internal to the company, allowed more companies to engage with the program and increased the quality of the resulting projects.

Project companies were identified and recruited through MnTAP's standard intern project identification methods with an additional focus on outreach with lean providers. In addition to outreach to companies with prior MnTAP working relationships, the new intern project opportunities were announced through press releases, MnTAP and partner websites, newsletters, direct outreach, presentations at events and association meetings, and fliers. See Appendix A, Appendix B and Appendix C for details on the intern process, planning, and promotional materials.

MnTAP staff score all applications and rank projects based on criteria such as: likelihood of success, presence of company champion, impact on the environment, applicability to other businesses, and safety of the work environment. See Appendix D and Appendix E for intern project checklist and scoring model. All companies that applied for a MnTAP intern received a site visit from MnTAP staff to scope the project idea and confirm business commitment to support the project.

Identifying companies to host projects with lean engineering focus takes more time in order to identify and assess the potential impact of project scope. Companies can be referred to the program through their lean providers or their utility representatives or they can self-nominate and apply as described above. Most often, companies are identified through MnTAP staff interactions with company representatives at industry specific meetings, at training events, or through other technical assistance requests. The projects require more MnTAP staff time to develop than standard intern projects. Several department representatives often need to be engaged in the assessment and opportunity identification process, informed regarding the potential of the company

hosting a MnTAP intern, and involved in developing the scope of the more complex projects.

A major advantage of this project was the availability of reliable funding over the extended grant period that could be applied to companies across the state to support intern projects. Because of the assured funding MnTAP staff members were able to target facilities with high energy efficiency and process improvement opportunity to improve production throughput per unit energy. While MnTAP currently recruits and receives applications from many companies interested in energy efficiency projects, we need to request funding from utility providers to support the project. Some utilities are able and willing to support this type of programing to capture the energy conservation value, however, many do not. If projects that are not supported by utilities do not fit into a current MnTAP grant profile, we cannot service the project, even if there is a high energy improvement potential. The extended funding offered through this grant allowed MnTAP to refine the process through high quality projects across the state without limitations imposed by specific utility CIP programs.

Year one projects were the most challenging to identify. There was a very limited time to recruit facilities due to grant timing. Two projects were identified. One project was conducted during the normal summer intern program. The other was conducted during the Fall 2013 academic semester. Successful case studies for these two projects helped MnTAP recruit additional projects for year 2 and 3 of the program. By year 3, the companies and partners were more aware of the program and, because MnTAP had been careful with project costs, we were able to expand the number of supported projects to three to accommodate additional business applications.

Intern Hiring

There are several programs in Minnesota that offer training in lean concepts to engineering students. University of Minnesota, Duluth (UMD), St. Thomas University and St. Cloud State University all have undergraduate engineering students with some course work options in lean principals. University of Minnesota, Twin Cities (UMN TC) has both an undergraduate and graduate industrial and systems engineering program. Most students do not have a background of both engineering and lean manufacturing concepts due to time constraints of current curriculum and department organization. For all students, especially those who had no formal course work in lean concepts, MnTAP staff recommended educational tools, resources and webinar training materials to develop a basic understanding of lean principles.

Students were hired from the programs at UMD, St. Thomas and both the undergraduate and graduate programs at UMN TC Industrial and Systems Engineering. Once identified, these same programs were contacted directly in subsequent years of the project. This allowed direct outreach to engineering students who have some exposure to lean principals concerning internship opportunities to enhance their educational experience. From the work on this project, it appears that MnTAP can identify and attract engineering students with an aptitude for lean methodologies. Engineering students without lean exposure were also considered and several placed with project

companies. These students were paired with companies that had in-house lean expertise where possible so the student could learn how to use the lean tools on the job. We learned that with proper support, good engineering students are able to quickly understand lean concepts and become proficient at using lean tools. Therefore, a good match between a student's engineering skills and project needs was felt to be more important than extensive lean training or experience. Table 1 lists student intern affiliation for the seven projects conducted in this work.

Table 1: Student Intern Academic Affiliation

Year	Company	Student Affiliation
2013	Schwing America	Mechanical Engineering , UMD
	ST Specialty Foods	Industrial and Systems Engineering, UMTC
2014	Uponor	Mechanical Engineering, University of St. Thomas
	MGK	Industrial and Systems Engineering, UMTC
2015	Firmenich	Chemical Engineering, UMTC
	Kemps Ice Cream	Chemical Engineering, UMTC
	Lou-Rich	Mechanical Engineering, University of St. Thomas

Project Implementation

All seven of the projects were received enthusiastically by the companies involved. The students were successful in identifying both lean and energy related opportunities for improvement.

MnTAP interns have a successful history of analyzing energy-consuming processes in the manufacturing sector and making recommendations for conservation projects to companies. As part of this project, the interns were able to provide the detailed study of energy efficiency opportunities and/or analyze data gathered from external assessments to facilitate prioritization and implementation of those opportunities. Direct energy reductions can be gained through recommendations for:

- variable frequency drive (VFD) opportunities
- process optimization such as temperature or pressure settings
- motor inventories
- establishing/following maintenance schedules for energy consuming equipment
- lighting upgrades
- elimination of compressed air leaks

MnTAP encouraged utility participation in the on-site projects by connecting directly with utility representatives while the intern was on site. This may have required making connections between company staff and the utility representatives if these relationships were not already present and consulting with utility representative on proposed project opportunities to assess which might have rebate opportunity. In many cases, the intern is able to complete rebate applications. These connections help the utility be more aware of site opportunity potential as well as encourage the project companies to take full advantage of existing CIP and rebate programs.

In addition to conservation projects, focusing on lean opportunities can help identify process areas that have high energy intensity through value stream mapping. Increasing throughput for a unit operation when integrated into the process may allow more production per unit energy. Such efforts include:

- optimizing work flow
- streamlining process set up to decrease down time
- eliminating off-specification product or wasted raw material

These latter opportunities may be more complex, difficult to implement and quantify the impact of changes. MnTAP interns and staff have encouraged companies to benchmark production energy consumption per unit of production in order to apply for custom energy rebates from utilities. Projects where the lean assessments are done early in the intern project or prior to the intern start allow more opportunity for the intern to measure the process energy, material and cost impacts of process changes. MnTAP internships are only 12 weeks long, which requires a high degree of planning and organization for the student to identify direct conservation and process throughput energy opportunities and implement the recommendations. However, engaging the intern in the lean assessment allows them to set up the changes at the facility. Analysis of the outcomes can rely on project follow up to capture the impacts. A team approach is often helpful in managing the projects start to finish. The most successful implementation of energy efficiency recommendations occurs when there are multiple long-term employees involved with the project. It is especially helpful to have a project manager onsite who is knowledgeable about energy consumption and costs.

Based on experience gained in this program, MnTAP learned that keeping projects aligned with the current MnTAP summer intern schedule and timeline facilitates identification of the best projects, makes it easier to hire highly qualified students and makes the most efficient use of MnTAP intern and staff time. One of the program internships was scheduled in the fall semester. This project ended up with an extra time challenge due to end of year holiday and vacation schedules of key facility staff members, end of year business shutdowns and maintenance scheduling.

MnTAP believes that for the lean and energy project to work well, the companies need to demonstrate some commitment to establishing a lean culture. This can be through contracting experienced consultants or training internal staff. The companies selected to participate in the program had varying levels of lean manufacturing skills. Some worked with external consultants, some worked in peer training teams and others had strong internal expertise. Depending on the needs of the facility, a variety of lean tools were emphasized beyond value stream mapping and kaizen events. Examples of lean tools used to complete the projects include 5S, gemba walks, spaghetti diagrams, standard work, cellular manufacturing layout, and setup/changeover reduction.

Project Reporting

The MnTAP intern program has a history of leaving the participating companies with a comprehensive report summarizing analysis results and recommendation for future actions. These reports belong to the companies and are not public information. To allow a timely public reporting on results and recommendations, MnTAP launched a publication called *SOLUTIONS* to provide a summary of the projects at the end of the summer. This summary serves as a way to convey the value of the projects to key stakeholders as well as promote the opportunities to other companies. The lean and energy intern summaries have been provided to DER as part of the reporting requirement (see Appendix F.) Interns gave public presentations on their work at the annual intern program symposium. Project companies, DER staff and utility representatives were all invited to attend the symposium to become more familiar with the project opportunities and the energy conservation potential. Attending this presentation event was an important link in promoting the program opportunity to utilities as part of the CARD deliverables.

Results

MnTAP successfully completed seven intern projects that aimed to reduce energy usage using lean tools and methodologies, over the course of three summers, 2013-2015. Two of these incorporated lean services provided by Enterprise Minnesota, while the other five used internal or MnTAP lean resources to provide the lean component of the project (Table 2).

Table 2: Lean Service Providers

Year	Company	Service Providers
2013	Schwing America	Enterprise Minnesota
	ST Specialty Foods	Internal
2014	Uponor	Enterprise Minnesota
	MGK	Internal
2015	Firmenich	Internal
	Kemps Ice Cream	MnTAP
	Lou-Rich	Internal

The total annual energy savings identified by the interns was 1,264,100 kWh electricity and 4,800 therms of gas energy, both natural gas and propane. Of these recommendations, 720,000 kWh and 3,700 therms of reductions have been implemented as of May 2016.

Depending on the availability of capital for making improvements or production scheduling for modifying processes or equipment, many intern recommendations are not immediately implemented. Intern project companies understand that MnTAP advisors will continue assisting them after the intern completes their report. MnTAP follows-up on the projects for at least two years from the completion of the intern's work. As a result, MnTAP anticipates additional implementation of intern recommendations over the coming two years, especially for the three 2015 projects.

In addition to energy savings, the interns also identified opportunities for saving 156,500 gallons of water, 27,600 lbs. of solvent, 173 million cubic feet of Nitrogen gas, 7,200 lbs. of cleaning chemicals, 112,000 lbs. of raw material, and reclaimed 47,200 lbs. of finished product.

Suggested lean improvements have identified time savings of 2100 hours, and 128,000 lbs. of production gain. These efficiency improvements would allow the companies to make more product while using approximately the same amount of energy, or to reduce the number of extra shifts needed. These enhanced efficiencies may not result in direct decrease of current energy use, however, they contribute to decreasing the energy intensity of the business production.

Total potential cost savings from the recommendations made by the interns over the course of this work is estimated at $725,800, of which $325,000, or about 45%, has been realized so far.

Table 3 on the next page shows the suggested improvements and their associated annual savings for each company. Table 4 shows the actual annual savings for those suggestions that have been implemented as of May 2016. Copies of company-approved summaries of each project are shown in Appendix F.

Table 3: Recommended Savings

Year	Company	Suggestion	Potential Production Gains	Potential Annual Electricity Reduction (kWh)	Potential Annual Gas Reduction (therms)	Other Potential Annual Reduction	Potential Annual Savings
2013	Schwing America	Optimize paint booth loading patterns		24,200	2500		$4,600
		Repair compressed air leaks		21,000			$2,100
		Reduce forklift travel			100		$1000
	ST Specialty Foods	Upgrade exterior lighting		11,000			$1,300
		Inspect for air leaks		42,500			$3,800
		Install zero-leak drain system		18,000			$1,600
		Implement lean operations initiatives	800 hrs				$50,000
2014	MGK	Modify tank rinse procedures				27,600 lbs solvent	$21,000
		Repair leaks/ maintain compressed gas systems		122,400			$10,000
		Install VFDs		177,400			$16,000
	Uponor	Optimize curing process		553,000			$55,300
		Switch from nitrogen to compressed air				86,400 $ft^3/hr\ N_2$	$1,300
		Insulate extruder barrel		26,000			$2,600
		Remove redundant blower		6,500			$600

2015	Firmenich	Add an operator	320 hrs 53,000 lb				$100,000
		Add sensory controls	14 hrs			80,000 gallons	$9,000
		Increase feed solids	>75,000 lb		2,200	28,000 gallons	$337,500
		Recover product solids				47,200 lb solids	$15,300
	Kemps	Add sugar pump in the truck bay				112,000 lb liquid sugars	$22,600
		Replace air compressor drains with zero-loss drains		256,000			$24,300
	Lou-Rich	Purchase new washer	280 hrs			29,300 gallons	$12,300
		Implement standard work	420 hrs	4,800			$11,900
		Remove coil washer		1,300		19,200 gallons 7,200 lbs chemicals	$13,200
		Lean layout with conveyors	260 hrs				$7,100
		Implement supermarkets	50 hrs				$1,400
Total			**2100 hrs** **128,000 lbs**	**1,264,100**	**4,812**		**$725,800**

Table 4: Implemented Results

Year	Company	Suggestion	Implemented Production Gains	Implemented Electricity Reduction (kWh)	Implemented Gas Reduction (therms)	Other Implemented Reduction	Implemented Savings
2013	Schwing America	Optimize paint booth loading patterns		24,200	2500		$4600
		Repair compressed air leaks		23,200			$2,400
		Reduce forklift travel			100		$200
	ST Specialty Foods	Upgrade exterior lighting		11,000			$1,300
		Inspect for air leaks		42,500			$3,800
		Install zero-leak drain system		18,000			$1,600
		Implement lean operations initiatives	800 hrs				$50,000
2014	MGK	Modify tank rinse procedures				17,500 lbs solvent	$31,000
		Repair leaks/ maintain compressed gas systems		120,400			$10,000
		Install VFDs		42,300			$3,800
	Uponor	Optimize curing process		434,500			$43,400
		Insulate extruder barrel		3,900			$3,900
2015	Firmenich	Increase feed solids	38,000 lbs		1,100	14,000 gallons	$169,000
	Kemps	Follow-up in progress					
	Lou-Rich	Follow-up in progress					
Total			**800 hrs 38,000 lbs**	**720,000**	**3,700**		**$325,000**

Discussion of Results

Over the course of the "Motivating Manufacturing Energy Efficiency: E2 Assessments and GreenLean℠ Training with Directed Implementation Assistance" effort 25 recommendations were made at seven businesses in reports developed by MnTAP interns working at their facilities. As of May 2016, thirteen of these recommendations have been at least partially implemented for an implementation rate of 52%, which is high for technical assistance suggestions based on our experience. A typical implementation rate is more like 30% for energy efficiency recommendations.

Compressed air system improvements such as fixing leaks and installing zero loss air drains were the most common savings opportunities identified over all projects. Since many utilities offer rebates for compressed air upgrades, this is also an opportunity for utilities to document reductions toward their CIP goals. Most interns who had compressed air or lighting activities in their projects did take advantage of these utility rebate programs.

Seven recommendations made during this program were related to traditional energy efficiency opportunities, which included compressed air systems, lighting, and addition of VFDs. These recommendations totaled 648,300 kWh electric energy, with the potential to save $59,100. As of May 2016 six of these recommendations have been implemented totaling 257,400 kWh electric energy, saving $22,900.

An additional seven recommendations made during this program were lean specific changes related to implementing standard work procedures, changeover reduction, and/or improved flow and transport through the process. These recommendations would lead to direct energy reductions of 29,000 kWh electric energy and 2,600 therms of propane gas. In addition, these recommendations, when implemented, would enable an increase of 53,000 lbs. of production with little or no additional energy use, and they would free up 1,850 production hours which could either save energy by idling un-necessary equipment, or allow further production increases with little to no additional energy use. As of May 2016, three of these recommendations have been implemented totaling 24,200 kWh electric energy, 2,600 therms, and $54,800 in savings. These implemented changes have resulted in approximately 800 hours of production gain. These lean specific opportunities likely would not have been identified during a standard MnTAP internship or assessment without the application of lean tools.

A total of 11 recommendations were made focused on process and equipment improvements identified through the use of lean tools such as value stream mapping and kaizen events. These recommendations totaled 586,800 kWh electric energy, 2,200 therms of heat energy with the potential to save $490,700. When implemented, they also enabled 294 hours of production saved and an increase of 75,000 lbs of product with little to no additional energy. As of May 2016, four of these recommendations have been implemented totaling 438,400 kWh electric energy and $247,300 savings.

Over these seven projects, the use of lean tools resulted in nearly doubling the electrical savings (615,000 kWh) and identifying more than ten times the potential dollar savings ($666,700) compared to the traditional energy efficiency opportunities alone (648,300 kWh and $59,100). Implemented savings attributed to the incorporation of lean tools were 462,600 kWh and

$302,100 versus 257,400 kWh and $22,900 for traditional energy opportunities alone. Opportunities identified using lean tools tended to have large dollar impacts. Since they often required more significant upfront costs and/or process disruptions, these opportunities had a lower implementation rate of 39% compared to 86% implementation for the traditional energy opportunities. This is still a very good rate of implementation, which can be attributed to the follow up of interns and MnTAP staff. It should be noted that some areas of traditional energy efficiency, such as motors and heating, could not be addressed as fully during these projects due to the time spent on lean tools. Table 5 is a summary of proposed and implemented measures by type of recommendation.

Table 5: Proposed and Implemented Results by Suggestion Type

Suggestion Type		Production gains	annual electricity reductions (kWh)	annual gas reductions (therms)	other annual reductions	annual savings
Compressed Air	proposed		459,900			$41,800
	implemented		204,100			$17,800
Equipment	proposed	280 hrs			112,000 lb liquid sugars 29,300 gallons H_2O	$34,900
	implemented					
Lean	proposed	1,850 hrs 53,000 lbs	29,000	2,612		$176,000
	implemented	800 hrs	24,200	2,612		$54,800
Lighting	proposed		11,000			$1,300
	implemented		11,000			$1,300
Process	proposed	14 hrs 75,000 lbs	586,800	2,200	27,600 lbs solvent 127,200 gallons H_2O 47,200 lb solids 112,000 lb liquid sugars 7,200 lbs chemicals	$455,800
	implemented	38,000 lbs	438,400		11,500 lbs solvent 14,000 gallons H_2O	$247,300
VFDs	proposed		177,400			$16,000
	implemented		42,300			$3,800

Conclusions and Recommendations

MnTAP internships are an excellent way to facilitate the identification and implementation of energy efficiency projects and aid utilities in meeting energy conservation goals. The interns are able to make suggestions that when implemented improve efficiency, save money, reduce waste and material usage and in some cases decrease regulatory burden. Through the MnTAP Intern program, businesses are able to bring in highly qualified technical resources to address waste reduction and energy efficiency projects sooner and faster than relying only on their internal staff. This is primarily because an intern has the time and technical skills to research alternative equipment, procedures, process layout, chemicals and raw materials. Additionally, MnTAP intern projects have been scoped in advance to ensure the intern is working on a project with a good opportunity for the company. MnTAP staff members provide experience and resources to help the students succeed. Because the interns have an extended time on the client site, many interns are able to start implementation of recommendations they make. This attention to project scope and implementation results in increased engagement from the company staff, more thorough vetting of project potential and improved focus on the most important aspects of the project. The extended time the intern spends on site supports implementation of more complex projects.

Applying lean tools to MnTAP intern projects has been demonstrated in this work to uncover additional energy efficiency opportunity beyond that identified in traditional assessments. Tools such as value stream mapping of industrial processes enable a facility to identify high-energy intensity areas of the operation. The use of lean manufacturing tools on these seven projects allowed interns to nearly double the amount of potential electrical energy savings identified. An intern can follow up with these results to analyze options for improving the efficiency of high-energy intensity processes and develop implementation strategies. In addition, lean production tools primarily focus on opportunities to reduce wasted time in processes and increase throughput for unit operations. When integrated into an energy consuming process, this increased efficiency may allow more production per unit energy. The use of lean manufacturing practices often resulted in greater production with the same energy input, rather than actual lower energy consumption. Once the opportunities for increased efficiency are identified, the short-term addition of the technically trained MnTAP intern allows the company to focus on implementation strategies. This helps the company drive toward implementation faster than relying on internal company staff members who are primarily focused on production related issues and have limited time to focus on improvement opportunities.

The offering of lean tools was also found to be an incentive to encourage intern project applications from companies who might otherwise not have an interest in hosting a standard pollution prevention or energy efficiency intern. The addition of lean manufacturing methods to the successful MnTAP intern program increases program interest by reaching multiple decision makers within companies beyond the traditional environmental, health and safety personnel. Lean manufacturing projects are often raised to the level of the operations manager or continuous improvement manager who may not have previously considered energy and environmental improvement internships.

Utility Opportunity

Engage Industrial Facilities in New Ways

Typical utility programs often involve site assessments that are designed to be short-term interactions with facilities to identify energy efficiency opportunities and motivate implementation by emphasizing cost effective investments. Some utility programs encourage account representatives to build longer-term relationships with facilities through frequent visits or energy team participation. This is an effective strategy for increasing utility awareness of energy saving projects companies are considering but are limited by the facility staff time availability to work on the projects. A MnTAP intern project integrates both the direct opportunity identification of the site assessments and the partnership building aspects of the energy teams with the additional support of supplying short term, cost effective engineering resources the companies needs to identify energy efficiency opportunities, scope cost effective solutions and launch implementation to capture the energy savings without having to divert company staff resources from their primary activities. Solid relationships develop between the company champion, the utility key account representative, the MnTAP advisor and the MnTAP intern. These relationships facilitate moving projects toward implementation and verified energy savings.

Capture Additional Energy Efficiency Opportunity

MnTAP internships are an effective way to identify and encourage implementation of energy reduction opportunities. Intern assessments and projects that include lean manufacturing tools are an additional method to achieve this. MnTAP believes that for the lean and energy project to work well, the companies needs to demonstrate some commitment to establishing a lean culture. This can be through contracting experienced consultants or training internal staff. Results from this pilot project indicate additional energy efficiency opportunity can be identified by using process and value stream mapping to focus energy efficiency investments where they will make the biggest impact. In addition to specific energy efficiency opportunity identification, traditional benefits of lean such as increasing throughput and/or decreasing time required for various operations contribute to overall decrease in energy intensity of the product output. In some cases this decreased energy intensity may be realized as a decrease in operating hours allowing equipment to be idled.

Motivate Implementation

A MnTAP intern working at a facility provides the highly trained staffing needed to collect information on energy consuming equipment or operations. This additional resource is critical when large amounts of data need to be gathered and analyzed in a timely manner to generate project opportunities for management consideration. This was certainly true in this program with motor inventories and compressed gas audits as well as benchmarking production energy consumption per unit production. Interns have worked with vendors and other host partners to scope capital investment requirements and calculated achievable cost savings and project payback opportunities. Completion of these tasks may delay projects if internal staff members are required to add them to their daily activities. The timely generation of high quality test

results along with project scoping and documentation build the internal support and momentum needed to launch implementation. The data gathered by the MnTAP interns has often been used to support both prescriptive and custom rebate applications for utility providers. Application of these rebates also provides motivation for facilities to implement energy efficiency measures.

Measure and Verify Energy Savings

Manufacturing companies are focused on production and often lack time to verify or document savings after projects are completed. Having an intern working on the projects allows the companies to measure the resulting energy conservation achieved from project implementation and verify the impact of the investment. The additional staff time the intern provides is often used to complete utility rebate documentation for energy efficiency projects which helps utilities document reductions that count toward CIP savings. The in-depth knowledge of the process recommendations enables MnTAP staff to follow up with companies to measure success and verify the actual savings achieved for projects that may be implemented after the intern has completed their project. This follow up encourages companies to implement recommended improvements. The opportunity to measure and verify the results helps both the company and the utilities have higher confidence in the quality of the recommendations and the achievable energy and cost savings resulting from the program.

Appendix A: MnTAP Internship Process

Company Recruiting

We recruit companies to participate in the intern program from October 15 through February 1. We do this in a number of ways.

Interest tracking

All inquiries are tracked in the MnTAP contact management database. Companies expressing interest over the year are reminded of project application deadlines during the open application period. They may receive monthly e-newsletters from MnTAP, reminder e-mails, and/or personal phone calls from MnTAP staff.

Targeted Emails

Specific groups are often targeted for solicitation into the intern program such as companies that participated in the water conservation project. These e-mails highlight the benefits of participation, remind them of the application deadline and link them to the MnTAP website for success stories and the intern company application.

Fliers

Fliers have been created for various industries or focuses. In each flier, there are company examples.
Fliers were mail in the Chemical Coaters Association Winter newsletter and distributed at the January Manufacturer's Alliance monthly meeting and at various events that MnTAP's booth was displayed.

Letters

A number of personalized letters are sent each year:

1. Letters to interested parties: those companies that applied last year
2. Letters to companies that expressed interest but didn't apply
3. Letters to county waste coordinators
4. Letters to others as TA staff request it

Press releases

Press releases are sent to the MnTAP media list. This list includes media, consulting organizations, associations, partners, and some media outlets.

Presentations

MnTAP staff includes information about internships in presentations to various organizations throughout the year. Audiences and/or presentation locations include: CISSR, MPCA, county meetings, association meetings, and others.

Checklist

Companies are often recruited through standard TA work. A check-list has been developed to help the TA staff work with the company on developing an intern project.

Selection

MnTAP staff score all applications and rank projects based on criteria such as: likelihood of success, impact on the environment, applicability to other businesses, and safety of the work environment.

Project Agreements

MnTAP drafts the project agreement specific to each company and forwards documentation to project advisors, managers and University administration for signatures.

Student Intern Recruiting and Hiring

As the TA staff members develop projects with companies, the intern coordinator begins recruiting students.

General Flier

This flier can be used throughout the year when working with student groups or professors. It is also handed out at career fairs.

Career Fairs

MnTAP participates in three career fairs. The U of M Environmental Career Fair on St. Paul Campus, the U of M College of Science and Engineering Career Fair in Minneapolis, and the MN Private College and University Career Fair at the Minneapolis Convention Center. A promotional bookmark was printed and distributed to students at these events.

Job Advertisements

The job advertisement is created using the list of deliverables provided by the TA staff member and company. The ad is posted with the U of M job placement services, other colleges in MN, WI, IA, ND & SD, and on the MnTAP website.

Email job ad

The email job ad was sent to contacts within appropriate departments such as the Department of Mechanical and Industrial Engineering at UMD, St. Cloud State University's Mechanical and Manufacturing Engineering Department and the Department of Industrial & Systems Engineering at the U of M.

Applications

Applications are accepted year-round for the program. Applications include unofficial transcript, resume, and cover letter. They are then evaluated based on qualifications. Students should be a junior or senior or have significant coursework in the area of the internship. Additionally, a student must have at least a 3.0. We occasionally hire graduate students.

Interviews

On campus interviews are conducted at MnTAP in March/April. Out of state students are either interviewed on the phone or via video teleconference.

Hiring

Students are offered positions, confirmation meetings set up with companies, and employment paperwork and background checks completed by the University. Occasionally students are required by companies to be screened for drugs as a condition of their internship.

Training

A two day orientation and training is held at MnTAP at the beginning of the project – usually the third week of May. The company directs any on-site training when the intern reports to the company on the first day.

Appendix B: Intern Program Schedule

Date / Month	Activity	Documents	Lead
October	Kick-off meeting	Kick-off mtg agenda *(Intern Program\Advisors\Kick Off)*	Coordinator
October - February 1	Company Recruiting	Emails & fliers (industry specific) Letters to past interested parties & TA contacts Press Releases & presentations *(Intern Program\Company Recruiting_Selection\Outreach)* Recruiting via technical assistance (use check-list) *(Intern Program\Company Recruiting_Selection\Application Process)*	Coordinator TA Staff
February 1	Applications Due	Application form & proposal tracking *(Intern Program\Company Recruiting_Selection\Application Process)*	Coordinator
February 15	Application Scoring & Selection	Scoring model (filled out for each project) *(Intern Program\Company Recruiting_Selection\Project Scoring)*	TA / Coordinator
February 15 – March 1	Project Description w/ Deliverables	Work with company to determine deliverables Submit to Coordinator for contracts / job ads	TA
March 1	Project Selection	Agreement w/ confidentiality statement Pre-project checklist	Coordinator

Date / Month	Activity	Documents	Lead
		(Intern Program\Company Recruiting_Selection\Agreement)	
January 1 – May 1	Student Recruiting	Intern flier & email Job ads & interviews *(Intern Program\Student Recruiting_Selection\Recruiting)*	Coordinator
March 1 – May 1	Student Hiring	Offer letters, emails U online application *(Intern Program\Student Recruiting_Selection\Hiring)* Student confirmation interview	Coordinator Company
~May 20	Project Timeline	Timeline *(Intern Program\Company Recruiting_Selection\Project Planning)*	TA
~May 20	Student Training	Presentation and manual *(Intern Program\Student Supervision\Training)* Hiring paperwork	Coordinator
May 20 – Aug 25	Student Supervision	Timesheets, contact information, photos, media, etc. Supervisor meetings (monthly)	Coordinator / TA
June 15	Cost-share	Cost share letters and invoices *(Intern Program\Company Summer Contact\Cost Share)*	Coordinator

Date / Month	Activity	Documents	Lead
August 25	Final Presentations	Presentations Student Wrap-Up *(Intern Program\Student Supervision\WrapUp)*	Coordinator
September 15	Company follow-up	Ensure company has all information needed Prepare MMF disbursement for students	Coordinator
September 20	Wrap up	Meeting with supervisors	Coordinator / TA

Appendix C: Sample Promotional Materials

Tap into the benefits of a MnTAP intern

Get solutions for your pollution prevention, energy efficieny, or lean manufacturing projects

Interns with the Minnesota Technical Assistance Program (MnTAP) can research conservation opportunities in your facility, perform assessments, and provide concrete recommendations to improve process, material, and energy efficiency. This hands-on assistance can help your company move from recommendation to implementation. Companies that participated in the MnTAP intern program in 2013 have the potential to realize reductions of over 522,570 pounds of waste, 2.2 million kWh and 317,327 therms of energy, and could conserve over 5.4 million gallons of water. These potential reductions can save these companies $872,200 annually!

A Focus on Lean

A recent study has shown that incorporating a sustainability element into a Lean Manufacturing project can result in an additional 30% reduction in costs. With this in mind, MnTAP is partnering with lean service providers to help implement lean manufacturing principles, energy efficiency, and waste reduction at business with the goal of reducing waste across their facility. Schwing America and ST Specialty Foods were two of the 2013 intern projects focusing on lean manufacturing. These projects are supported through a Minnesota Department of Commerce, Division of Energy Resources Conservation Applied Research and Development (CARD) grant.

"With the help of our MNTAP intern, Schwing America was able to facilitate valuable lean manufacturing changes on the production floor."

- Mark Moschkau

Director of Operations, Schwing America

At Schwing America, opportunities were identified to optimize work cells using the 5S method and improve the efficiency of the busy assembly workers. Outcomes included clearly lined floors, removal of clutter, and tools and materials placed in standardized locations. Other solutions identified included:

- Optimizing paint booth loading patterns to minimize energy usage, which can result in thousands of dollars per year of energy savings.
- Recommending air leak testing that will save 21,000 kWh and $2,000/year.
- Constructing a spaghetti diagram resulting in a staging area that reduces forklift travel, saving 390 gallons of fuel and nearly $1,000/year.

At ST Specialty Foods, lean manufacturing initiatives were employed to improve efficiency, reduce waste, and eliminate unnecessary processing. Downtime associated with line changeovers was one of the biggest concerns for the plant. Recommendations included:

- Utilizing 5S methods to standardize work areas, developing standard operating procedures, and color-coding tooling to expedite set-up time which could save 14 minutes per line and up to $50,000/year.
- Repairing air leaks identified by a compressed air audit and installing a mist eliminator and zero loss drain valves to improve system efficiency. Energy savings and utility rebate are anticipated.

www.mntap.umn.edu/intern/pdf/2013Solutions.pdf • 612.624.1300 • 800.247.0015

Appendix D: Intern Project Checklist

Use this checklist when working with companies to scope the potential intern project. Remember: a facility walk through is required to evaluate projects for acceptance.

1. Waste Reduction Potential

Where is this project on the waste hierarchy?

Is the potential for waste reduction significant for the company?

How do you intend to quantify savings/reductions?

2. Company Interest and Commitment

Why is the company interested in this project?

Is there a company champion? Would he/she be involved in the project? How?

Is there management support? What is the evidence of this?

Has the company undergone P2/E2 efforts in the past? Are they committed to lessening their environmental impact?

Will the company contribute cost-share?

Is the company committed to implementation? What is the company's maximum payback for capital projects?

What is the economic status of the industry? Is this important to the project?

3. Application to other businesses

Is this a common waste issue in the industry?

Is there a significant number of similar companies in Minnesota that would benefit from the project?

Can the technology be transferred to businesses in other sectors?

Would others be interested (i.e.; utilities)?

4. Work Site Quality

What safety training is the company willing to offer the intern?

Are there safety issues/hazards that might make this an unsafe workplace? If yes, what?

Is there facility information we should be sharing with students during the interview (i.e.; heat, fire, cold, etc.)?

5. Other

Is this a new sector or entirely new information? What value is there in working in this sector?

Is there enough for a student to do in 536 hours? If yes, is it too much? If no, what other projects could a student tackle?

Is there an opportunity to involve a professor or employee health issues in this project?

Would this project be of interest to a utility or vendor for funding?

Is there anything else that would help you make the argument for/against this project for consideration?

Appendix E: Intern Project Scoring Model

Company _____ MnTAP Staff _____ Date _____

Section 1 – Circle **one** score from each column (30 points possible).

Waste Hierarchy		New Information		Application to Other Businesses	
Pts.	Criteria	Pts.	Criteria	Pts.	Criteria
10	Waste source reduction or process energy reduction	10	Completely new information	10	Many similar businesses in MN
		8	Information new to Minnesota	8	Many businesses with similar processes
6	In-house recycling or building envelope (HVAC) energy reduction	6	Information new to MnTAP / No MnTAP expertise	6	Several businesses with same waste stream
		5	Applying previous success to different industry	5	Limited MN transferability
4	Off-site recycling or energy study	4	Repeat project from different company	4	No transferability

Totals	
Section 1 Total	
Section 2 Total	
Project Total	

Section 2 – Circle **all** scores that apply in each column (70 points possible).

Company Champion		Management Support		Cost		Other Change Drivers		Company Culture		Project Specific		Funding		Business / Industry Health	
Pts	Criteria	Pts	Criteria	Pts	Criteria	Pts	Criteria	Pts	Criteria	Pts	Criteria	Pts	Criteria	Pts	Criteria
4	Student reports to champion	4	Active support	4	New high cost if project not completed	4	Regulatory	3	Evidence that company is willing to change	3	Potential solutions identified prior to project start	3	Project fits company payback period	2	Business sector in stable state
3	Champion's work ties to core business functions	3	Management reduction goal	3	Potential savings is greater than student cost	3	Organization interested in change	2	Broad internal awareness of project	2	Decisions can be made quickly	2	Meets company's other criteria for funding	1	Business has positive cash flow
2	Has decision making power in company (status)	2	Willingness to dedicate resources	2	Implementation cost / payback aligned with expectations	2	Significant opportunity exists now	2	Good management / employee relations	1	Some unidentified aspects to allow for innovation	1	Amount of capital company is willing to invest		Miscellaneous
1	Able to influence company (status)	1	Environmental / Energy Management Policy	1	Potential savings	1	Employee health concerns	1	Good number of employees assisting student	1	Reasonable likelihood of success	1	Funds are accounted for in budget	2	Priority / Grant Specific / Funding Partner
		1	Willing to cost share			1	External/ community recognition	1	The right thing to do attitude						
Totals															

Add comments to clarify project and/or scoring

Appendix F: Intern Project Summaries

2013 INTERN PROJECT SUMMARY #1

ST Specialty Foods
Brooklyn Park, MN

Rahul Dhuria
Master's in Industrial Engineering, University of Minnesota

Company Background
ST Specialty Foods was formed as an entrepreneurial startup company in 1992. The company has an exclusive niche in the value-added dinner and side-dish segment of center store retail. The 100-employee Brooklyn Park manufacturing facility mainly produces packaged pasta products such as macaroni & cheese. The company also produces boxed potatoes, prepared

dinners, meal cups, noodles and sauce, skillet dinner mixes, and instant rice and rice mixes.

Project Background

ST Specialty Foods is a growing low-cost pasta producer that must be sustainable and low-waste in order to maintain its competitive position in the industry. The executive team has identified lean manufacturing improvements as a priority for this site in particular. Project successes will enable the company to grow while reducing waste and improving energy efficiency.

Incentives to Change

S.T. Specialty Foods anticipated a 10-15% increase in sales, which would require extended operation hours and thus a substantial increase in energy costs. There were also concerns that cross-contamination of separated food wastes would risk rejection by the hauler and lead to increased disposal costs. Management was striving to implement a lean manufacturing program focused on setup time reduction, process control, and the “5S” principles: sort, straighten, shine, standardize, and sustain.

Recommendations and Results

Energy Efficiency

Upgrade Exterior Lighting: The plant replaced ten 250-watt outdoor lighting wall packs with ten 50-watt LED fixtures and replaced two 400 watt flood fixtures with two 80 watt LED flood fixtures. Xcel Energy provided a rebate of $750 and estimated an annual electricity savings of 11,000 kWh or $1,300. The LED fixtures have provided equivalent light output at about one-fourth the energy cost. The new fixtures are expected to last five times longer and provide more consistent lighting levels over time.

Inspect for Air Leaks: The intern worked with an outside contractor to audit the compressed air system. Sixteen leaks of varying size were revealed and repaired. Xcel Energy rebated the cost of the audit, and repairing the leaks will save the company 42,500 kWh or $3,800 annually.

Install Zero-Loss Drain and Mist Eliminators in Compressed Air System: Installation of a zero loss drain improves energy efficiency by allowing condensate to be drained from the air

system without allowing compressed air to escape and be wasted. Two mist eliminators were installed to improve the efficiency of the compressed air system by removing particulates, food grade oils, and condensate. Xcel provided a rebate of $2,400 for the mist eliminators and $200 for the zero-loss drain, which will save the plant an estimated 18,000 kWh or $1,600 in electricity annually in addition to reduced maintenance costs.

Lean Operations

Standardize Operating Procedures: Several areas in the plant were evaluated for methods to improve and standardize operating procedures. The intern worked with employees to create written standards that provide important knowledge for both production and maintenance staff in order to speed equipment setup and keep production parameters within specifications.

Coded Set-up Markings: In order to allow all employees to set up machines quickly and accurately, machine setup locations were color-coded and setup sheets were created. This improved the accuracy of the equipment setup, minimized product and packaging losses, and reduced the time needed to start a new production run.

Organize Waste Bins: Waste bins were color-coded with blue for glue, yellow for food scraps (hog feed), red for trash, and gray for recyclable cardboard. This reduces the potential for contamination among bins. Proper segregation of materials allows for donation of materials suitable as animal feed for beneficial reuse and lower waste management costs.

Install Shadow Boards and Line Maps: The intern ordered, installed, and organized shadow boards for tools and striped the floor to map the locations of color-coded containers in each production area. These improvements allow for easier access to tools and equipment and improve employee efficiency. Checklists were also created for line operators to keep equipment clean and operational, which will reduce downtime for maintenance issues.

By implementing these lean operational solutions, ST Specialty foods is well on its way to minimizing downtime between product changeover and improving overall plant efficiency. It is estimated that these changes can save 14 minutes of time on each production line each day, which will save the company $50,000 per year. Six months after the intern project, ST Specialty foods is successfully continuing their lean efforts and seeing continued increases in production efficiency.

Recommendation	Reduction	Annual Savings	Status
Upgrade exterior lighting	11,000 kWh	$1,300	Implemented
Inspect for air leaks	42,500 kWh ~33 CFM	$3,800	Implemented
Install zero-leak drain system	18,000 kWh	$1,600	Implemented
Implement lean operations initiatives	14 minutes/line/day	$50,000	In Progress

2013 INTERN PROJECT SUMMARY#2

Schwing America
White Bear Lake, MN

Paul Senne
Mechanical Engineering, UMD

"The best part of the internship was the positive reaction to the recommendations I made and seeing some of the recommendations get implemented." ~ Paul Senne

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Company Background

Schwing America is a member of the Schwing Group, a worldwide designer, manufacturer and distributor of premium concrete production and handling equipment, headquartered in Herne, Germany. Schwing America's 400,000 square foot manufacturing plant in White Bear, Minnesota, one of seven production facilities in the global Schwing Group, produces concrete pumps, truck mixers, batch plants, reclaimers and genuine parts for distribution throughout the world. Established in 1974, Schwing employs a staff of approximately 200 full time employees.

Project Background

The objective of this project was to help facilitate a lean manufacturing approach to the production process in a way that consciously links the goals of reducing waste from the lean perspective with environmental sustainability goals such as materials and energy efficiency. The lean manufacturing principles naturally lead to sustainability improvements both in the form of energy, water, and materials use reduction and in terms of decreasing energy intensity of a product when production rates increase. Lean manufacturing typically uses a host of process analysis and improvement methods to classify and minimize non-value added steps and processing and resource usage. Schwing engaged with Enterprise Minnesota, the NIST Manufacturing Extension Partner for Minnesota, to provide training to employees in GreenLean® methodology. This training enabled everyone – from the executive sponsor to the assembly workers – to work together to identify, communicate, and quantify opportunities for improvement and implementation.

Incentives to Change

Due to significant swings in the construction market, Schwing has seen a fluctuation in its business over the past five years but is now growing at a fast pace to serve the recovery of that sector. This growth positions its manufacturing centers to re-examine and optimize their layout and procedures in light of a growing and changing business. Through lean manufacturing analysis, a broad range of opportunities were found to improve the manufacturing process. Organization of work cells was found to be a priority that could improve the efficiency of the increasingly busy assembly workers. This included defining work spaces, providing visual clarity and standardization to where products, tools and parts belong, and organizing small parts into kits for each product, thereby minimizing mistakes and unnecessary movement of people and materials. Once a job on the Schwing assembly floor begins, the goal is to have all required tools and materials accessible by the assembler within 30 seconds instead of minutes.

Solutions

Optimize Work Cells : Using the 5S method, an array of work cells across one of the production buildings was optimized so that the floors were clearly lined, clutter was removed, and all tools and materials were placed in standardized locations. This enabled the floor to be fully utilized and prevented the potential for work spaces to be underutilized due to sprawling jobs. Travel times for assemblers were minimized which increased their production efficiency by eliminating confusion about parts needed and time searching for parts. The method of using bulk parts bins was re-examined and it was recommended that kits be assembled for each bill of material to minimize potential for small part spillage and incorrect part selection. As part of this process, the bills of material were audited and updated as required. This suggestion actually highlighted the importance of applying lean as part of a supply chain philosophy as in some cases, it was found that vendors had the capability of providing the required pre-assembled kits, allowing Schwing staff to focus on higher value activity.

Root Cause Analysis: By observing the assembly process, Paul found that defects that resulted in rework occurred. He used root cause analysis to research any patterns in the defects and to identify the appropriate changes that could be implemented. Paul's work in analyzing the quality problems that resulted in rework and materials waste was recognized by management during his summer internship. His analysis enabled the production floor supervisor to accurately determine what portion of quality improvement they could implement by changes within the production cell and to what degree communication with the design staff or sub-assembly suppliers was necessary in order to gain improved quality and minimize time and materials spent on rework.

Optimize Paint Booth Loading Patterns: Another project focus area was energy savings in the paint room due to the significant energy required to maintain clean air within the building and the air exchange required to heat and cure the product. By analyzing the energy use in paint booths at multiple Schwing production sites, Paul was able to quantify and recommend loading patterns between paint booths that would minimize unnecessary energy usage. This recommendation could result in thousands of dollars of electrical and gas savings annually.

Repair Compressed Air Leaks: A system air leak analysis was performed in the areas utilizing significant amounts of compressed air. Paul worked with maintenance to recommend a regular testing method as well as to repair existing leaks. This was conservatively estimated to save over $2000 per year in electrical costs.

Reduce Forklift Travel: Paul constructed a spaghetti diagram of forklift travel to examine travel patterns and load utilization of forklifts between areas in the facility and to identify areas where one-way loads were common. This enabled Paul to recommend a staging area system that would reduce forklift travel. The new system could save over 390 gallons per year of propane fuel and reduce wear and tear on the equipment.

Recommendation	Environmental Impact	Annual Savings	Status
Optimize paint booth loading patterns	24,200 kWh/yr	$2,600	Under Review
	2,500 Therms/yr	$2,000	
Repair compressed air leaks	21,000 kWh/yr	$2,100	In progress
Reduce Forklift travel	390 gallons propane/yr	$1000	In progress

2014 INTERN PROJECT SUMMARY #1

Uponor
Apple Valley, MN

Christopher Lanari
Mechanical Engineering, University of St. Thomas

"Working with MnTAP was a fantastic way to gain engineering and project management experience. Learning about Lean manufacturing principles was also a huge benefit to me, since the ideas of continuous improvement and eliminating wasted time and work can be applied to any job." ~ Christopher Lanari

Company Background

Uponor Corporation provides plumbing, radiant heating, and fire suppression solutions to both residential and commercial markets internationally through the use of extruded cross-linked polyethylene pipe (PEX). Wirsbo Company was founded in Sweden as a high-quality steel company in 1620. Uponor acquired Wirsbo in 1988 and the name changed to Uponor North America in 2006. Uponor North America employs approximately 500 employees and is a major player in the PEX extrusion industry. Their products may be used commercially or residentially for plumbing, in-floor radiant heating, and fire suppression infrastructure, in NPS sizes from 1/2-in to 4-in. Uponor also offers pre-insulated piping solutions for long-distance and/or exterior-run pipe.

Project Background

The overarching project goal was to optimize Uponor's next generation cross-linked polyethylene (PEX) extrusion process in order to bring down operation costs while conserving energy and natural resources. Using lean and green tools to improve the new process that is still in test mode, the intern managed projects to improve the overall process. In particular, the intern focused on tracing out all air, nitrogen, water, and electrical inputs, quantifying the amounts needed per hour and per kg of material consumed. The intern also investigated energy efficiency opportunities not currently part of the line and presented options to the technology and process engineering groups for review. Since this new process is the future technology, the opportunity to provide viable system improvements to future lines is significant.

Incentives to Change

Uponor is finalizing development of a new extrusion process. The major selling point of this new system is greatly increased extrusion output. However, corresponding increases in energy use and operating cost resulted in no net gain of performance versus operating price. The incentive for Uponor to improve energy, water, and other inputs is to lower the operating cost of the new process in order to widen the profit margin of their PEX pipe production.

Recommendations and Results

Optimize Curing Process: One opportunity for optimization is to adjust the curing process to its lowest possible setting while maintaining product cross-linking specifications. The process was designed with all settings at 100% during extrusion operation. Optimization experiments revealed that all settings could be reduced to 70% while still meeting product specifications.

Switch from Nitrogen to Compressed Air: The extrusion system was designed to use nitrogen as the injected gas that prevents the hot extruded pipe from collapsing after leaving the die. Using Uponor's compressed air system, it is possible to replace nitrogen with compressed air. Compressed air generated in-house is much less expensive than purchasing 100% pure nitrogen.

Insulate Extruder Barrel: Insulating the extruder barrel is another possible improvement that would lower energy costs. An insulation blanket with an aerogel core, which possesses an extremely small conductive heat transfer coefficient, was recommended that will be custom-fitted to the extruder barrel. This will greatly reduce the costs associated with start-up and production, since much less heat will escape from the extruder barrel to the production floor via natural convection. Safety will also be improved by protecting employees from the hot extruder barrel.

Remove Redundant Blower: Another improvement opportunity would be to rearrange process steps to eliminate unneeded operations. As the extruded pipe passes through the cooling tanks, it is blown dry with an air wipe station twice in order to be measured at two separate locations. The first time is between the second and third cooling tanks, where cross-linking is measured. The second time is at the very end of the process, where the outer diameter of the pipe is measured just before coiling occurs. The recommended solution is to put both of the required-dry measurement machines at the very end of the process, removing the need for multiple air wipes and thus conserving electricity.

Recommendation	Environmental Impact	Annual Savings	Status
Optimize Curing Process	76.8 kWh	$55,300	In progress
Switch from nitrogen to compressed air	12 ft^3/hr N_2	$1,300	In progress
Insulate extruder barrel	3.6 kWh	$2,600	In progress
Remove redundant Blower	0.9 kWh	$600	In progress

2014 INTERN PROJECT SUMMARY #2

MGK
Chaska, MN

Neil Peterson
Industrial & Systems Engineering, University of MN

"The MnTAP internship program was an invaluable opportunity to gain experience and build confidence in working in industry. It was challenging, engaging, and rewarding to be able to lead a project that would bring real benefit to my company." ~ Neil Peterson

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Company Background

McLaughlin, Gormley, and King (MGK) is a chemical manufacturer specializing in insect control solutions. MGK employs over 100 people, with 35 employees working at its manufacturing facility in Chaska. Originally founded in 1902 with a focus on botanicals and food spices, MGK evolved its talents, knowledge and business into a respected manufacturer of insect control solutions. Their first insecticide product was launched in 1927 and was based on pyrethrum, a natural insecticide found in a species of the chrysanthemum plant. Years of meticulous research, commitment to continuous improvement, and a focus on customer needs have grown MGK into a company with over 300 registered formulations. Each product seeks to provide a responsible and sustainable solution to help protect people and their environments from the impacts of insects.

Project Background

This lean manufacturing project is focused on optimizing the use of solvent for production tank rinsing. Between production runs, tanks are cleaned with a triple rinse of solvent to avoid contamination, comply with industrial regulations, and exceed customer expectations. The current tank cleaning procedure has been in place for over two decades and has been successful; however, increasing customer demand and industry requirements suggest it would be prudent to validate its efficacy. By monitoring the rinse cycles, taking samples of solvent after each rinse, and analyzing the data, I will help MGK better quantify and understand its rinsing protocols and provide opportunities to reduce solvent use and update their standard operation procedures. Other elements of my project involve taking inventory of all facility motors, evaluating motor system energy conservation opportunities and suggesting improvements in the compressed gas systems.

Incentives to Change

MGK is poised for additional growth, having recently acquired an industry competitor. To comfortably meet the demands of the future, MGK will need to expand its production process expertise. Throughout the years, MGK leadership has fostered a spirit of continuous improvement. Leaders empower their teams to deploy lean methodologies to solve problems and exploit opportunities, with a focus on improvement to process areas. By focusing on eliminating wastes within processes, MGK can continue to thrive in the insecticide market and stay resilient to competition. With the reduction of solvent use, MGK can show good environmental stewardship and support its corporate sustainability goal of reducing natural resource use.

Recommendations and Results

Modify Tank Rinse Procedures:

Option 1 - Double Rinse Tanks When Applicable:

I worked with the MGK quality team to set a tank cleanliness target in the formulating area with quantitative and qualitative elements. Data collected over the summer indicated that the triple rinse system is often more than sufficient in meeting the current tank cleanliness target. If products are broken down into categories based on active ingredient level, then different cleaning procedures can be in place for different types of products. Data analysis showed that products with an active ingredient level of less than 20% were consistently clean after two rinses. Implementing a double rinse cleaning procedure for these products would reduce the yearly amount of solvent used for tank cleaning by at least 5% and bring at least $4,000 in annual savings.

Option 2 - Shorten Cycle Time of Third Rinse: While a cleaning process consisting of two rinses is not adequate in certain cases, there is opportunity for reducing the amount of solvent used in the third rinse. The mechanics of the current rinse pumping and piping system are such that the third rinse is generally the heaviest in a tank cleaning process. By the second rinse, the majority of the residue has already been removed from the sides of the tank. Therefore, it is a form of extra processing waste to allow the most solvent to be used in the final rinse. If the rinse system is modified so that the cycle time of the last rinse is halved, solvent waste generated from tank cleaning would be decreased by at least 10% for approximately $10,000 in annual savings.

Option 3 - Reinstate the Recycle Solvent Program: The solvent drained after the third rinse could be reused as the first rinse in a subsequent tank cleaning. This procedure was in place at one time at MGK, but has since lost momentum due to efficiency setbacks. Continued investigation and improved recycle rinsing procedures would bring significant savings, and is an excellent way to make use of what would otherwise be disposed of as hazardous waste. This has the potential of cutting solvent usage for tank cleaning by 1/3 and saving an estimated $21,000 annually.

Repair Leaks and Maintain Compressed Gas Systems: MGK uses compressed air and nitrogen in several processes and to power certain equipment. Leaks in systems such as these often go unnoticed since many are not audible or are overpowered by equipment noise. Compressed air and nitrogen leaks around the facility make the systems less efficient and waste electricity. Additional energy is required to compensate for what is lost through the leak. By fixing the leaks and improving the system maintenance program, there is a potential savings of $10,000/year.

Install Variable Frequency Drives (VFDs): Certain motors in the facility would benefit from the implementation of a VFD, which adjusts the speed of a motor relative to the amount of power that a system calls for. In the facility, several motors run at full capacity and have long run times though the system has variable requirements. Installation of a variable frequency drive on various motors in the MGK facility would bolster the electrical efficiency of the facility. An initial evaluation of VFD implementations shows an annual savings of $16,000.

Recommendation	Environmental Impact	Annual Savings	Status
Modify tank rinse procedures	27,600 lbs. solvent reduced	$21,000	In progress
Repair leaks/maintain compressed gas systems	122,400 kWh	$10,000	In progress
Install VFDs	177,400 kWh	$16,000	Under review

2015 INTERN PROJECT SUMMARY #1

Lou-Rich
Albert Lea, MN

Carter Tollefson
Mechanical Engineering, University of St. Thomas

"I really enjoyed this internship because it enabled me to use the skills I have gained through my coursework and apply them to a project that really had a positive impact on the company. I particularly liked learning about lean manufacturing principals because the idea of eliminating sources of waste through continuous improvement is something that can be applied in any industrial setting." ~ Carter Tollefson

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Company Background

Lou-Rich, Inc. is a contract manufacturing and engineering company based in Albert Lea. The company manufactures complete products, weldments, engineering components, and high level assemblies. It provides customers with help in quality assurance, material sourcing, and design of products. Other services include machining, fabricating, finishing, welding, painting, wiring, assembling, testing, and packaging. It provides services to original equipment manufacturers (OEMs) in the agricultural, construction, food service, industrial, medical device and medical equipment markets.

Project Background

Lou-Rich has been manufacturing freezer assemblies since 1989. Over the years, the types and designs of freezers have changed and many have been removed or added on to the line. The production area size has been gradually reduced and its location and work cell layouts have changed many times. It was moved to its current location in 2012 and the work cells were compacted into an area that was much smaller than it was previously. The goal of this project was to determine and reduce sources of waste in this production line by optimizing product flow and implementing lean manufacturing solutions to ensure the best use out of the remaining space for the process.

Incentives to Change

Lou-Rich, Inc. is committed to reducing waste and continuous process improvement through the use of lean manufacturing principles. Current analysis of the freezer line where this project is focused shows that there is an opportunity to reduce many different kinds of waste such as motion, inventory, chemicals, idle time, transportation, and water. The creation of a system that will process materials more efficiently will reduce these wastes. This will save the company money in operator time and associated production costs. It will also reduce the production lead time for freezers and will allow increased production and profit for the company during the year.

Recommendations and Results

Purchase new washer and place in freezer area: The current washer used to clean components in the freezer area is located about 350 feet away from the line. This causes operators to spend a lot of time taking parts to the washer and back. This waste reduction opportunity is estimated to save 280 hours per year or about $7,700 in operator time.

Operators must be paid to run the washer and load and unload parts, and reassigning them to other areas could save about $2,550 per year. Forklifts must be used to transport parts to and

from the washer and then back to the freezer line; this time reduction equates to a savings of $1,750 per year. The new design of the washer is estimated to save 29,300 gallons of water per year. By combining all of these savings together, new washer implementation would save approximately $12,200 per year.

Implement standard work at foaming and coiling operations: Through lean analysis, it was determined that production processes in the foaming and coiling operations could be accelerated by making simple changes in operating procedures. By implementing standard work in the coiling and foaming processes, it could save operators 420 hours per year where they could be assigned to other work areas. This equates to about $11,550 per year in operator time. There are also energy savings associated with not having to heat the foam molds which equal $370 per year.

Remove current coil washer: The current coil washer is believed to be unnecessary to meet customer requirements. During foaming, an air hose is applied to each freezer that blows out any debris that may be in the coil. This combined with the new washer implementation, is expected to provide the required cleaning. If approved by the customer, this could save $13,200 per year in chemical, water, and power savings.

Rearrange layout and implement conveyor system: The current layout and equipment are not optimized, and require operators to move excessively in their work cells and they require a lot of operator time handling part containers. I suggested that a new layout be implemented to reduce operator movement, and that a conveyor system be implemented to reduce time spent by operators to move parts to and from the work cells. Implementing a conveyor system would clear room on the factory floor and eliminate time handling parts containers. These changes are estimated to save operators 260 hours in handling time per year or $7,100 per year. Furthermore, these changes will help balance process flow and organize the work place.

Implement finished good and component supermarket: Due to continuous changes in order sizes by the customer, I suggested that a finished goods supermarket be installed. The supermarket would implement a pull system that would enable the line to only make parts as the customer needs them. This is different from the push system used that relies on predictions of customer demand that is hard to do with fluctuating order sizes. This would help buffer against the order fluctuations, prevent against excess material handling, and lower the amount of components in work cells.

The current component storage areas are located far away from the welding and soldering areas where all components are combined together. The new supermarket will be located closer to those areas with less movement to and from storage area. This solution can save operators approximately 50 hours per year or $1,400 in operator time. It will also allow parts to be shipped to customers faster and create a more structured, organized work environment.

Recommendation	Annual Reduction	Annual Time Savings (hours)	Annual Savings	Status
Purchase New Washer	29,300 gallons	280	$12,200	Proposed
Implement Standard Work	4800 kWh	420	$11,900	Implementing
Remove Coil Washer	19,200 gallons 7,200 lbs. chemicals 1,300 kWh	0	$13,200	Proposed
Lean Layout with Conveyors	0	260	$7,100	Proposed
Implement Supermarkets	0	50	$1,400	Proposed

2015 INTERN PROJECT SUMMARY #2

Kemps Ice Cream
Rochester, MN

Anne Hunter
Chemical Engineering, University of Minnesota

"This was my first real world engineering experience and it was fascinating for me to see how I learned to thrive in an industrial environment. After coming up with my own experiments to collect data and to test my theories throughout the plant, I now have a new appreciation for complex piping systems - and for the ice cream I purchase at the store!" ~ Anne Hunter

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Company Background

Kemps LLC is a dairy manufacturing company that was founded in 1914 and is known for making high quality dairy products. The ice cream plant, located in Rochester, MN, employs 180 people and produces 700,000 gallons of ice cream, frozen yogurt, and frozen novelties per week. The plant brings in ingredients such as sugar and cream from suppliers in the upper Midwest which are then made into ice cream and inspected to ensure they meet high quality standards before being shipped out for distribution. Despite increased competition from national brands, Kemps remains a top dairy brand in the Minneapolis- St. Paul metropolitan area, as well as in other areas of the upper Midwest.

Project Background

The purpose of this internship was to study the ice cream making process to determine the main causes of waste in the plant and to make process change recommendations in order to reduce the waste going down the drain. Recommendations were made to improve the company's product yield, which also helps to reduce its impact on the environment. Cost-benefit analyses were also done to determine the impact of each recommended process change.

Incentives to Change

One area of focus at the Kemps ice cream plant is the amount of ice cream mix that goes down the drain as waste. This waste represents a loss for the company on three levels – lost revenue from product that could be sold, labor costs, and increased wastewater treatment fees resulting from dairy product going down the drain.

Over the years, Kemps ice cream plant has experienced high Biochemical Oxygen Demand (BOD) levels in its wastewater, prompting the wastewater treatment facility in the city of Rochester to impose fines in response to the increased load on the facility. By being able to determine the main causes of this waste, Kemps can explore options to reduce it, thereby increasing product yield and revenue while minimizing wastewater fees and environmental impact.

Recommendations and Results

Addition of a Sugar Pump in the Raw Receiving Area: Liquid sugars such as corn syrup, fructose, and liquid sucrose are unloaded and brought into the receiving tanks by a pump located on the back of each sugar truck. This pump is about four feet above the ground and pumps sugars through a 20 ft. receiving hose before they reach the 11 ft. vertical sugar receiving lines. Once the truck is empty, sugar remains in the receiving hose that cannot be pumped into the receiving lines. Water cannot be used to rinse the sugar down because it promotes bacterial growth so the sugar in the hose is washed down and goes to waste. By installing a new sugar pump in the receiving bay, approximately 10 gallons of sugar product will be saved from each sugar shipment by eliminating the need for a receiving hose at the bottom of the unloading process. In the new process, the hose connecting the truck to the pump can be physically lifted, allowing the entirety of the sugar load to enter the system piping and eventually make its way into the sugar receiving tanks.

Replace Compressed Air Drains with Zero-Loss Drains: Currently, the plant uses four types of drains to remove moisture from the compressed air system. These include float drains, timed drains, continuously open drains, and a manually opened drain. The float drains are a basic type of zero-loss drain since they use a level sensor to ensure that only water is released from the drains. The other drains all release some amount of compressed air which takes electricity to produce. If this compressed air is not being used to do useful work in the plant and instead leaks out of an open drain, it represents a loss in the system. Therefore, it is recommended that all drains, except for the two float drains, should be replaced with zero-loss air drains.

Calibrate Flow Meters and Tank Gauges:
Of all of the tanks and silos in the ice cream plant, only the two main blend tanks and the three flow meters leading to them are consistently calibrated. The gauges on the raw tanks, pasteurized tanks, and vat pasteurizers and the other flow meters are not regularly calibrated,

while the flavor tanks do not have any gauges. This creates a problem for the company because the tank inventories taken on a daily basis are based on unreliable information.

Therefore, it is recommended to continue to calibrate tank gauges and flow meters and to set up a schedule for an annual calibration. Though a full economic analysis of the benefits of tank and meter calibration is not possible, the data collected from correctly calibrated equipment is useful to the plant in multiple ways. First, data collected for loss reports and product reports will be more accurate, allowing company resources to be used more efficiently. Additionally, the plant will be able to use the tank inventory values to double-check the amounts of product brought in by trucks, ensuring the company only pays for the amount of product that is actually received.

Recommendation	Reduction	Annual Savings	Status
Addition of Sugar Pump in the Truck Bay	112,000 lbs. of liquid sugars	$22,600	Recommended
Replace Air Compressor Drains with Zero-Loss Drains	256,000 kWh	$24,300	Recommended
Calibrate Tank Gauges and Flow Meters	Unknown	Unknown	Recommended

2015 INTERN PROJECT SUMMARY #3

Firmenich, Inc.
New Ulm, MN

Sushruth Venkatesh
Chemical Engineering, University of Minnesota

"Lean manufacturing is all about value creation; I don't think there is any greater professional satisfaction than helping create products that many people consume, while doing so more efficiently and by using fewer resources. This internship has given me a chance to apply the most abstract of chemical engineering concepts to a practical setting. I will no doubt use the project management & communication skills I've picked up here in the rest of my professional career." ~ Sushruth Venkatesh

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Company Background

Started in 1895, Firmenich, Inc. is the world's largest privately owned company in the flavors and fragrances business. Firmenich has a strong presence in 64 different countries across the globe, and has 26 manufacturing sites and 56 operational facilities. At its facility in New Ulm, MN (FIRULM), Firmenich makes over 900 different types of spray-dried, dry-blended, paste, and liquid flavors. It has a high standard of excellence that is characterized by its strict adherence to safety and quality control. Well known among New Ulm residents as a responsible neighbor, FIRULM strives to improve sustainability while expanding & becoming more efficient.

Project Background

Approximately 40% of FIRULM's products are spray-dried products. This makes the spray drying operation a critical component of the company's operation. FIRULM would like to optimize this drying process to improve performance. Furthermore, FIRULM desires to increase capacity to meet increased customer demands.

The Clean-In-Place (CIP) cycle is a step that immediately follows spray drying. FIRULM's strict adherence to quality control ensures that no contamination occurs across different product batches. The company wishes to reduce (and perhaps even reuse) the water and chemicals used during this step (while maintaining quality levels) to utilize their resources in a responsible manner, keeping in line with sustainability goals.

Incentives to Change

FIRULM is a practitioner of lean manufacturing principles, and strives to increase productivity and to eliminate the seven wastes associated with manufacturing. Doing this has helped reduce costs and increase profitability. FIRULM wishes to continue doing this through the help of a MnTAP intern, who would bring a fresh pair of eyes to observe the processes at the facility, as well as additional engineering expertise. FIRULM is also on the path of continuous improvement, not only in manufacturing, but also in safety and quality. Finally, FIRULM would like to lead Firmenich's global sustainability efforts by improving resource utilization.

Recommendations and Results

Add an Operator: One of the spray dryers at FIRULM currently has only one operator to prepare each batch, run the dryer, and run the CIP process. He has to shut down the equipment after every spray drying batch, run cleaning water and chemicals through the spray dryer, take down and manually clean equipment, and then reassemble the equipment. Adding another operator to this dryer would increase throughput. Working alongside the operator, the intern found that a total of 320 hours of production could be gained per year, which translates to a potential production increase of 53,000 lb. and annual income of $100,000.

Add Sensory Controls: Currently, operators at FIRULM use either a visual inspection or a timer based system to control rinse cycles in the CIP process. To ensure more precision and enable the operators to concentrate on other important things, the intern recommended automation of these processes through the use of turbidity and/or conductivity meters. This way, the operator would be able to tell when to stop a particular rinse, saving precious water and chemicals in the process. Hand held conductivity meter readings provided initial water saving estimates of 80,000 gallons per year on one of the dryers, with an accompanied 14 hours of time that could go towards production, resulting in increased annual income of $9,000.

Increase Feed Solids: The concentration of feed solids in the slurries fed to the spray dryer play a crucial role in the process. Since the primary function of a spray dryer is to evaporate water, reducing the amount of this water leads to a higher production rate. Since there is less water to evaporate, there is a decrease in energy consumption as well. The intern was able to implement a project for increasing the feed content, a move that has the potential to increase production capacity by over 75,000 lbs. per year

Recover Product Solids: The current CIP process at FIRULM is designed to flush out any solids left in the spray dryers and associated components (screw conveyors) into the drain during washing. The intern suggested recovering this product to reduce TSS & BOD costs associated with these discharges. Multiple methods of product recovery were considered. The best option is the use of a pigging device which is expected to prevent over 47,200 lb. of product a year from going down the drain, and save over $15,300/year as a result.

Recommendation	Production Gains	Reduction	Annual income/Savings	Status
Add an Operator	320 hours 53,000 lbs.	-	$100,000	Testing
Add Sensory Controls	14 hours	80,000 gallons water	$9,000	Recommended
Increase Feed Solids	>75,000 lbs.	2,200 therms 28,000 gallons water	$337,500	Testing
Recover Product Solids	-	47,200 lbs. solids	$15,300	Recommended