Coop/Intern Report

Cleveland State University
Washkewicz College of Engineering
Mechanical Engineering

Submitted in Partial Fulfillment
of the Requirements of
ESC 400

Employed By

Swagelok Company
Solon, Ohio
May 12, 2014- August 21, 2014

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July 28, 2014

Approval for Public Release:

Signature: _____ Date: 8/15/2014
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I. General Information

This summer I had the privilege of interning at Swagelok Company in Solon, Ohio. I worked in the Valve Services Group at the Order Fulfillment Center (OFC) in the Process Excellence Team with four other engineering interns and our mentor, Matthew Chan. Swagelok is a large company that produces valves, fittings, and other fluids related products and has a large presence in the petroleum industry as well as the chemical, alternative fuel, power, semiconductor, and nuclear industries. Swagelok was started in 1947 by Fred A. Lennon and has continued to grow since then as a very successful private company. At Swagelok, high value is put on the quality of our products and an even higher value on the quality of our people, which are referred to as associates, not employees. While it is headquartered in Solon and has its main facilities in northeast Ohio, Swagelok has a global presence in 70 countries on six continents and sells to companies all over the world. As of 2014, Swagelok has sales of $1.8 billion a year.

As an engineering intern at Swagelok, I was given projects that were not only beneficial to the company, but in many cases also a necessity. I had a chance to work with product engineers, quality engineers, assembly engineers, technicians, shop floor associates, manufacturing engineers, and engineering managers. I was given five projects for this summer, which are as follows:

1. Mill-turn machine tool chain optimization
2. Catalog, consolidate, and redesign assembly tooling
3. Update and convert critical engineering and material documentation
4. Update assembly specifications
5. Design test fittings for high pressure valve testing

II. Objectives

Listed below are the objectives I set for my summer at Swagelok, all of which I believe I have achieved. My objectives were aimed at better developing myself as an engineer and a professional and at strengthening my technical, leadership, and communication skills.

Professional Experience Objectives:

A. Improve communication skills in a team setting and in presentations.

B. Increase my teamwork skills and be a team leader to help reach company goals and personal career goals.

C. Develop strong networking relations.

Technical Objectives:

A. Significantly increase SolidWorks proficiency and further develop design skills.

B. Better understand engineering and manufacturing processes and how to increase their efficiency.

C. Learn more about machining operations and their impact on process time and engineering design.

Personal Objectives:

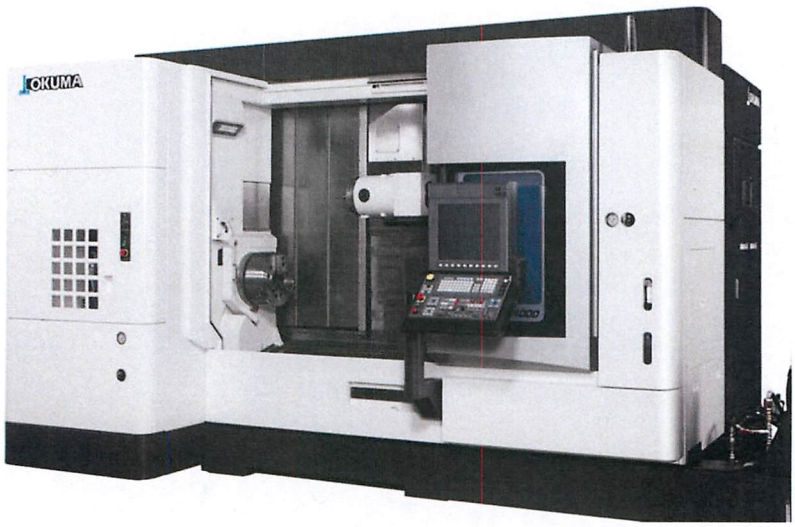
A. Gain a broader understanding of the different type of work, processes, and individuals required to successfully run a large manufacturing organization.

B. Continue to evaluate and learn more about the different professional and leadership opportunities for engineers.

C. Learn about newer, innovative company projects, perhaps offer assistance, and develop relationships with coworkers in the process.

III. Technical Details

My tool chain optimization project involved redesigning the tooling layout in one of Swagelok's mill-turn machines. In a mill-turn machine, such as the one shown below, there is a front and a back tool chain which can each hold about 50 different tools for machining different products. However, it takes the machine longer to retrieve a tool from the back chain because it requires the tool to be transferred to the front chain then taken to the turret to perform the necessary operations. The majority of the tooling used on this particular mill-turn machine were in the back tool chain which caused an unnecessary loss of cycle time when the machine was waiting between operations for those tools to come up.



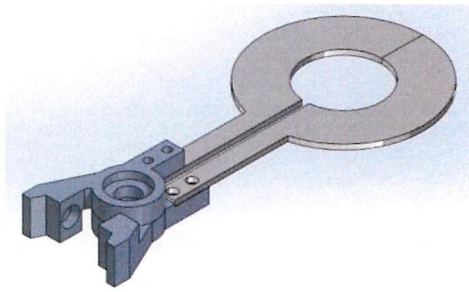
My objective was to relocate the tooling in the machine in order that all the main tools used would be on the front chain so that cycle time could be reduced. I first performed a few time studies on the machine, recording the cycle times with the current tool layout for one of the larger parts produced on this machine and one of the smaller parts. I then recorded the cycle times for a new layout where all the tooling would be on the front chain for the same two parts. I found that a new tool layout where almost all the tooling would be on the front chain would save about 3% of total cycle time on this mill-turn machine, a savings of about 1.5 minutes per cycle.

With the over 6,000 parts produced on this machine every year, that adds up to 160 hours of saved cycle time per year. Due to the reorganization of the tools, the associates working with the machine will no longer need as much set up time before starting an order. Set up time will therefore be cut in half, reduced by about 750 hours a year. These time savings combined give us an estimated savings of $40,000 per year.

After going through all the tooling necessary to produce all the parts run on this mill-turn machine, we were able to reorganize the tool chain to include all the main tools on the front chain and only about twenty rarely used tools on the back chain. After finalizing the tool descriptions and new positions, I updated 130 CNC programs that the machine utilizes to produce the 330 different products made on it. I also updated 130 set up sheets for the machine operator to be aware of the new tool locations and the required tool inserts based on the material of the product being manufactured. Finally, in the span of a few days when orders were put on hold, a couple of the technicians, operators, and myself made the physical change of the tooling in the machine. This concluded my project which increased the manufacturing efficiency of this CNC machine by cutting down cycle times and set up times.

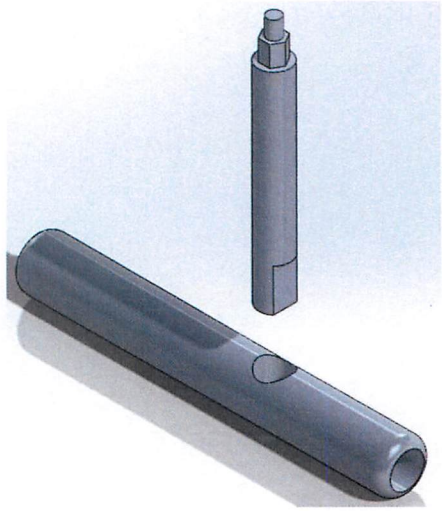
Another project I had involved cataloging all the assembly tools used at the OFC. Each work cell at Swagelok has a very unique assembly process that requires custom tooling. An assembly engineer or two is in charge of each department to ensure that the assembly process is continuing smoothly. However, due to this need for there to not be many lapses in the assembly process, the engineer designing a new tool often keeps the model and drawing at their own desk. When he/she moves on to a different role, the engineer taking their place is left with the task of finding tool drawings or redesigning tools from scratch. This causes the engineering department to lose about four to ten hours per week redesigning tooling that has already been designed by

another engineer in the past. My objective was to find/create drawings for all the tools used on the OFC shop floor so that new tools can be ordered when needed and engineers would not be recreating a tool every few months or years. I also cataloged all the tooling into an excel spreadsheet sorted by department, work cell, and part number/description.



My intern partner and I went through each work cell in a department and first learned the assembly process and how all the tooling is used. We then reviewed these processes and the tooling with the respective assembly engineer who helped us better understand the needs of that work center and where some tool drawings could be found. After finding all the existing drawings of the tooling at the work cell, we reverse engineered the rest of the tools into well-organized SolidWorks drawings so that replacements can be order when needed. We also ensured that all the tools had official part numbers at Swagelok so that they can be tracked and kept in order.

A large aspect of this project was not simply drawing tooling, but redesigning and consolidating tools that performed similar functions into one multi-purpose tool. This required us to evaluate each tool individually and speak with the shop floor associates to determine whether or not a tool was properly performing the task at hand and whether a new design seemed easy enough to use on a continuous basis. The more we consolidated and organized tools, the more



the efficiency of a work cell could increase, clutter could decrease, material costs could be reduced, and the cell would become more lean. Some examples of tooling we drew or redesigned are shown above. This summer we were able to catalog and find/create drawings for 500 tools in 16 work cells which contain the majority of the tooling at the OFC.

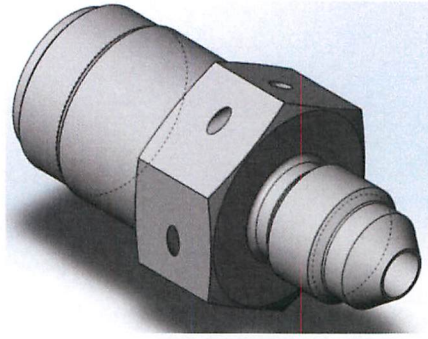
Two of my projects involved updating engineering and assembly documents. The first of these projects involved Swagelok's companywide conversion to a computer system known as SAP. This new system requires all documentation to be in a specific format and have a specific numbering system. I was given the task to update several engineering documents and obsolete or replace others. I had the opportunity to meet with product and quality engineers and also speak with the metallurgy and supplier development departments to discuss any special requirements for the documents, which documents were no longer needed, and which ones could be replaced with currently existing documents.

For the project involving assembly documents, I updated eleven documents used by the shop floor associates for valves, handles, and actuators to reflect current requirements in the assembly. Many of these requirements were undocumented procedures that the associates were taught by word of mouth. Swagelok puts a large emphasis on clarity, organization, and having all processes documented for consistency and in order to ensure the quality of our products.

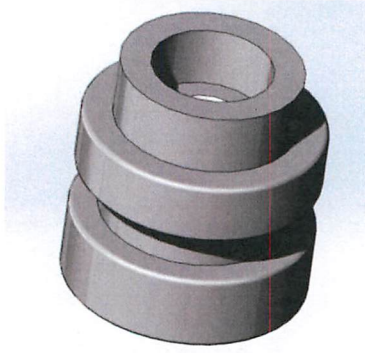
My final project involved designing test fittings for one of our ball valves. These particular valves were ordered by a customer twice, requesting that we test them to customer specifications rather than standard factory testing. Our test fittings (which are used to hold and align the valve to the test apparatus) for that particular end connection are used for testing at 1,000 psi so we asked the customer to allow us to perform our standard

pressure testing in order to not increase our turnover time for their orders. However, the customer ordered the same valve a third time, requesting their specified pressure testing again, so it was crucial for us to meet this goal. This ensures that we are providing quality products for our customers and helps Swagelok meet its goal of Zero Customer Disappointments. I was given the task of redesigning the test fittings for these valves in order to withstand up to 3,000 psi without damaging the end connections on the valves. Below are isometric views of the end screw used on the valve, the old test fitting, and my new design.

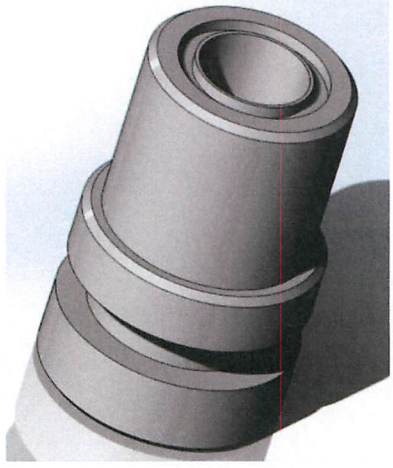
End Screw



Old Test Fitting

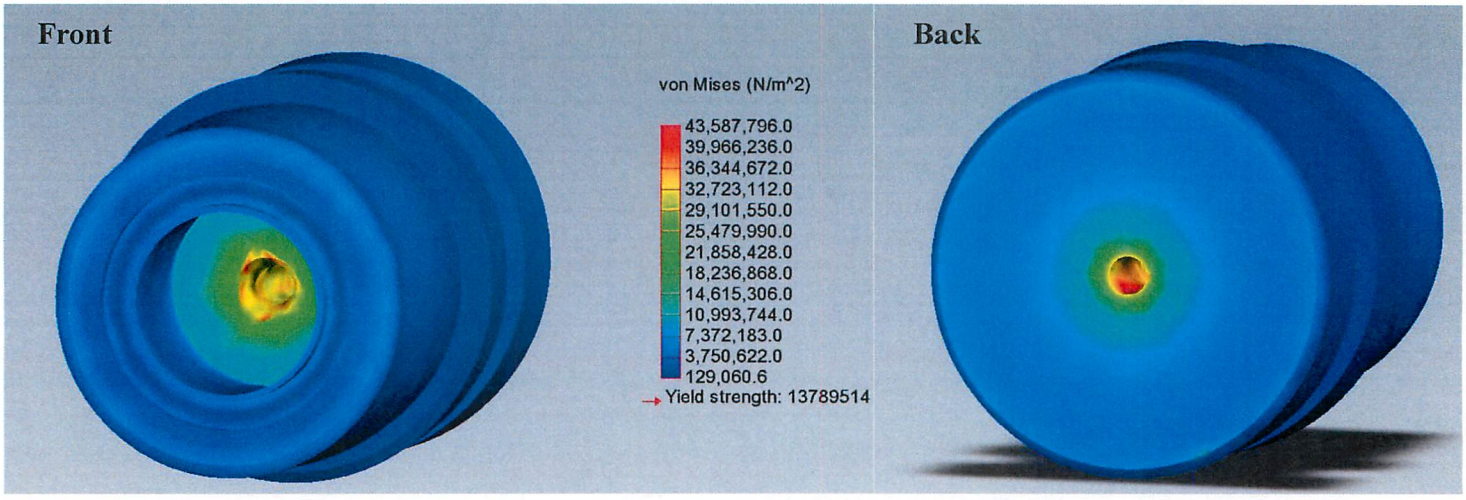


New Test Fitting



The old fitting sealed up against the taper on the end screw, because of which it was made out of plastic in order to not damage the end connection. This design and material are suitable to tests up to 1,000 psi but cannot withstand high pressure testing at 3,000 psi. I redesigned the test fitting so that it would fully enclose the end screw and seal up against the hex wall of the end screw with an o-ring. The fitting could now be made out of stainless steel instead of plastic to give it even more durability without damaging the end screw. This new design would provide a better seal and a stronger material to properly function in high pressure testing.

Before testing the new design, I ran a SolidWorks FEA to ensure that the fittings would meet our expectations. Based on the von Mises stress test performed by SolidWorks, these fittings could be tested at 3,000 psi.



I then took six of the new test fittings with three ball valves to the test lab at Swagelok and, with the help of an associate, we tested the fittings at 3,000 psi for 10 to 15 minutes each to ensure that it meets specifications. The fittings performed as expected and were deemed ready to be used for high pressure testing of our ball valves. To conclude this project, I held a meeting with the assembly engineers working in the respective department to inform them of the new test

fittings available and to give them a chance to bring up any concerns they may have with the new design.

IV. Development of Professional Skills

My time at Swagelok helped me develop myself both as a professional and as a future engineer and also gave me the chance to apply classroom knowledge to the real world. I used SolidWorks on a daily basis to complete my project of designing test fittings and that of cataloging the assembly tooling, greatly increasing my CAD proficiency. I also used my knowledge of manufacturing tools and processes from my college classes to help me complete my tool chain optimization project for the mill-turn machine.

From an engineering standpoint, I was able to learn about a wide array of assembly and manufacturing processes and realized how every detail in a process and every second in a cycle matter to their efficiency, quality, and cost. From a document and administrative standpoint, I saw the importance of uniformity and clarity in communication, documentation, and all systems in a company to ensure that everyone in the company is properly and efficiently working together to achieve the same goal.

I was also able to grow professionally and increase my leadership and communication skills while at Swagelok. I met with my project partners, engineers, technicians, and shop floor associates on a daily basis and had to effectively communicate the progress of my projects and the next steps that needed to be taken. We also had weekly team meetings and bi-monthly one-on-one meetings with our intern supervisor where I was given the chance to present the status of my projects, talk about my development and my competencies, and discuss the projects of the other interns as well.

I was also given tours of many of Swagelok's facilities in Solon and Highland Heights, which allowed me to gain a broader understanding of all the departments at Swagelok and how all of them work together to produce our high quality fluid products.

V. Discussion and Conclusion

After thirteen weeks at a company like Swagelok, I can certainly say that I have achieved all of my objectives. The experiences I had taught me a lot about engineering, fluids, business, leadership, and myself. Swagelok is a very professional, shirt-and-tie environment (which is an environment in which I thrive) but it is also full of wonderful, encouraging people who are always ready to help you learn and be successful at whatever you are doing.

My internship at Swagelok has helped me shape my career goals for the future as well. It has first deepened my desire to get an MBA later in my career and go into management. After learning about the Career Development Program at Swagelok, I am also very interested in pursuing a position in the Leadership Development Program there or a similar program elsewhere. I would like to thank everyone at Swagelok for a wonderful, educational summer and I sincerely hope to return for another internship next year!