Final Report:

# Analyzing the Cost of Norton Saint-Gobain Super Abrasive Grinding Wheels

A Major Qualifying Project
Submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
In partial fulfillment of the requirements of the
Degree of Bachelor of Science

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30 March 2020

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# Abstract

Saint-Gobain, a grinding wheel manufacturing plant in Worcester, MA, sponsored this project with the overall goal of closely observing the operations of one of their highly specialized grinding wheels. During the project, the team completed time studies for each grinding wheel process, validated the components of the product cost structure, and edited the cost structure when needed. The team also identified several opportunities to reduce costs at specific process steps and developed and evaluated three improvement ideas.

# Acknowledgements

We would like to thank the following individuals and organizations who contributed to the overall success of our project.

Tom Moll and Marc Lamoureux, our project sponsors and liaisons at Saint-Gobain for providing us with support and insight into the company. We appreciate their invaluable help, which was critical for the success of the project.

The operators and engineers at Saint-Gobain for taking the time to talk with us, helping us understand all the processes in our project, and allowing us to observe them at work and complete time studies. Their insight helped us identify process problems and solutions that helped us in our final recommendations.

Finally, we would like to acknowledge Worcester Polytechnic Institute for providing us with the opportunity to complete this project and specifically, Professor Sharon Johnson, for her guidance and support throughout this project.

# Leadership Statement

This project was completed by a group of five students: Michael Gake, Alex Johnson, Alyssa Mesaros, Kevin O'Driscoll, and Rachel Quinlivan. The time studies and process observations were designed and completed primarily by Michael, Alyssa, and Rachel, with Alex participating. The data analysis was led by Alex, with Alyssa completing a large part. Alex, Kevin, and Alyssa researched and developed the final three improvement ideas, including contacting companies and conducting cost analyses. The entire team worked on the introduction, background, and first draft of the methodology. Michael and Rachel completed a second draft of the methodology and results and the entire team edited the final versions of the paper. Alyssa and Rachel organized and carried out administrative tasks, such as setting agendas, note-taking, and contact with our sponsor.

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# Chapter 1: Introduction

Norton Saint-Gobain is a grinding wheel manufacturer that has been operating in Worcester, Massachusetts since 1885. The company produces grinding wheels for a wide variety of customers, including car, aerospace, and software companies. Although technology has changed over time, their manufacturing processes have remained relatively unchanged. Approximately 97% of their products are custom-made based on customer specifications. These specifications include determining the type of abrasive, bonding material, shape, size, and tolerance level of the grinding wheel. Similarly, the grinding wheel market is mature and has remained stable over the years. Most customers in need of a grinding wheel have previously purchased one and have an existing supplier, so the price of products is an important differentiator for targeted customers.

Norton Saint-Gobain Superabrasives offers a highly specialized product: the GPK grinding wheel. Superabrasives are tools used in precision grinding and are considered "super" due to their extraordinary hardness, unparalleled performance, and longevity (Carel, 2017). The GPK wheel is a large grinding wheel made up of small, individual grinding pieces adhered onto a base up to eight feet in diameter. They are made of two components: abrasives and bonding materials. The abrasive materials are bonded together and formed into the shape of a wheel, varying in terms of shape, size, and type of abrasive and bonding materials. The system needed to make these wheels relies heavily on operators and manual work. Time improvements can be made, but Saint-Gobain requires a positive cost-benefit analysis to upgrade their machines or systems (T. Moll, personal communication, September 10, 2019). There are several cost estimation techniques that could prove beneficial if used, but the first goal must be validating the cost sheets their production system is based on. Saint-Gobain's cost sheets rely on the measurement of setup time, machine time, and labor time, and the associated variable and fixed costs for each GPK wheel.

Norton Saint-Gobain seeks to improve their processes to be more cost-competitive by conducting studies of their current process, analyzing the results, and implementing changes based on the findings. Their goal is to maintain a competitive profit margin but identifying possible improvements has been an ongoing challenge. The application of analytical studies, such as value-stream mapping and time-studies, have helped Saint-Gobain understand where changes in their system can be made.

This goal of the project was to validate current data for the GPK wheel and to develop improvements in the super abrasive manufacturing process to reduce product cost by 30 percent. We developed four project objectives to accomplish our goal:

- Process familiarization
- Validation of the current standard costs of products
- Developing and evaluating cost reduction ideas
- Selecting and developing improvements.

The team utilized a DMAIC problem-solving approach in order to improve, optimize, and stabilize the business processes of Saint-Gobain (ASQ, 2020). During the initial weeks, our team worked with Saint-Gobain managers and operators to familiarize ourselves with the process by observing and understanding the layout and standards of the plant. We then worked closely with the operators on the manufacturing floor and our project sponsors to validate the current standard costs of products. This involved the use of cost cakes, created with Excel, and time and observational studies. Based on our cost validations, we identified costs in the process that could potentially be reduced. Following this work, we developed and evaluated the feasibility of cost reduction ideas with the use of a PICK chart, a Lean Six Sigma tool used to categorize process improvement ideas (VERTEX42), and an estimated comparison to their current processes. We then selected and developed ideas for several improvements to the production system with Saint-Gobain's approval, ultimately seeking future reductions in their product costing.

The report first provides a background on Saint-Gobain, grinding wheel production and markets, and information about product costing and process observations. We then discuss the objectives and methodology we followed to complete our project goals. The next section describes the results of this work. Finally, we present our conclusions from the project and recommendations for how Saint-Gobain can move forward.

# Chapter 2: Background

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# Chapter 3: Methodology

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# Chapter 4: Results

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# Chapter 5: Conclusions and Recommendations

The overall goal of this project was to closely observe the manufacturing process of Saint-Gobain's GPK wheel and to reduce costs where necessary. In order to achieve such a large goal, objectives were created. After revisiting data, we accomplished the overall objectives set out in section 3.1 within our SMART Chart. We now provide general conclusions and other recommendations for Saint-Gobain to consider.

## 5.1 Conclusions

Through time studies conducted on the manufacturing process, updating process costs in the Bill of Materials, and cost analysis, this project allowed us to prioritize the steps in the process that had potential for improvement by analyzing what was most costly. Through brainstorming and consulting with our sponsors and advisor, we developed four improvements that can be considered for implementation. For each improvement, we evaluated operational, organizational, and financial feasibility and generated a PDSA to follow in order to see potential impactful changes. Our updated costs would reduce the total process cost by 33%, which exceeds our initial goal of reducing costs by 30%. Any additional implementation of our improvements can further reduce the process cost.

As Industrial Engineering students on the verge of graduation, we were presented with an invaluable opportunity to grow our skill sets in areas of potential future pursuit. Saint-Gobain Super abrasives was willing to sponsor a student-led project on their manufacturing floor, offering us their time, resources, and commitment. This opportunity allowed us to gain first-hand experience conducting studies and analyses, communicating with operators, collaborating with higher level management, and several other activities that we will continue to utilize throughout our careers and lifetimes.

## 5.2 Recommendations

We recommend Saint-Gobain to manufacture their wheels through only fabrication method 1. We concluded that it is 26% more cost efficient to manufacture utilizing fabrication method 1 as opposed to fabrication method 2 for the GPK wheels and changing from the current production method to fabrication method 1, will reduce the total costs by close to 12%. The reduction of savings from the initial 26% when simply comparing the variable costs of the different fabrication methods can be attributed to the large, unchanged fixed costs throughout the manufacturing process.

We also recommend that Saint-Gobain further investigate the sifting machine. Through our analysis, the sifting machine can further reduce costs by $145 per wheel. However, the total savings across the company would be even higher as the machine can be used for all the wheels that they produce. We recommend that Saint-Gobain complete further analysis by considering all their production and use our completed PDSA to control the implementation of this machine.

The particular wb machine the team investigated was deemed insufficient since it does not run powders well. In other words, when the hoppers of the machine open and close, fine particulars are sent airborne. For Saint-Gobain's abrasive mix, this would result in a lot of lost product and therefore may not be exactly what they are looking for. With the machine, wb will be automated, so the current amount of time it takes to wb fabrication method 2 can be eliminated, but 15% will need to be added to the molding time if the operator is multitasking. We recommend Saint-Gobain to take a deeper look into a similar product and simulate how the machine will change their manufacturing process due to the potential impact.

Our recommendation for the graphite aerosol spray is to implement it into Saint-Gobain's process as soon as possible. We found it saves approximately four minutes in the inspection process. This change is easy to implement, and our testing found that it does not affect the material of the grinding piece or its adherence to the base.

## 5.3 Reflections

Following the completion of our MQP project, our team responded to reflection prompts that touched upon our experiences with design, constraints, knowledge acquisition, and teamwork. We provided thorough and honest responses in this section.

### *Design Aspect of the Project*

The engineering design process consists of several steps. Examples we have worked with from courses here at WPI include but are not limited to Ask, Research, Imagine, Plan, Create, Test, and Improve. Ask requires participants, or us in this case, to identify the at hand needs and constraints. We were actively asking throughout the duration of our project to fully understand what the company wanted to improve and what would be possible within our allotted time. Research includes compiling details pertaining to the problem. Specifically, we observed each process to identify where the problem was or where there was opportunity for improvement. The information needed for Imagine can be found in Appendix B, in which we brainstormed possible solutions for each of the processes. Plan was completed when we all completed our respective PDSA documents for each recommendation/idea. Create, or creating a prototype, was done either through purchasing the necessary item or reaching out to companies for quotes and details for existing machines. Testing was done through physical testing for the spray and, for other recommendations, through thorough analytical predictions. Improvement of the entire process is something that we hope Saint-Gobain will continue to implement given our specific recommendations.

### *Constraints in the Project*

Economic, health and safety, and manufacturability were the most important constraints that we considered during our project. Economic constraints included the size of the grinding wheel market and the stage it is at, as well as the constraints of the company. We had to consider the amount of sales that Saint-Gobain has in a year and the cost of any improvements that we were considering. Health and safety of the employees is a major concern for any company, especially in the manufacturing industry. We listened to concerns that some operators had about the processes they were involved in and made sure any improvement ideas we considered would not be a detriment to their safety. As a manufacturing company, the ability to continuously improve the manufacturing process was imperative to our goals and methodology. Any ideas and designs we recommended need to be replicable by the company and positively impact their manufacturing process. Our sponsors wanted any improvement suggestions that involved existing machines, so they could easily work it into their current process. Our project might have an economic impact on the grinding wheel market, because reducing costs at Saint-Gobain will force other companies to reduce their costs and lower their time constraints.

### *Experience in Acquiring and Applying Knowledge*

Our project can be divided into two areas when discussing how we acquired knowledge: primary research and secondary research. A large aspect of our report needed to be conducted through secondary research. We took advantage of the academic journals, articles, and papers available through the databases provided by WPI. There was a lot our group didn't fully understand, given our coursework doesn't cover all the intricacies of manufacturing and grinding wheels, specifically. To gain an initial understanding of the project ahead of us, we needed to read through the available material online. We developed a basic understanding through this research.

This project also provided an opportunity for us to work outside of the classroom on a real manufacturing floor, and it gave us the chance to understand the processes through first-hand experience and communication with professionals. We worked very closely with our project sponsors to understand their process from beginning to end, as well as to gain a more detailed understanding of the grinding wheels we were studying. Furthermore, the floor operators that work on these products every day were great resources for insight that wasn't available through researched sources. Through these conversations, presentations we gave, and instruction from sponsors, we developed a rich understanding of the industry that we can take with us into future jobs.

### *Teamwork in the Project*

Working in a team of five WPI students, we each understood the importance of communication and commitment in working to complete a successful and timely MQP project. A key first step was identifying each of our strengths and weaknesses in an honest manner. We discussed how each of us could most effectively contribute given our major, presentation skills, writing skills, etc. Having everyone on the same page ensured that we all felt comfortable contributing in meetings and expressing concerns as the project moved along. This comfort continued through the entirety of the project, as every team member felt that their opinions, recommendations, and ideas were heard and considered fairly. We encouraged open meetings that allowed for everyone to speak and help with each aspect of the project that arose. Another key measure our group took was to have everyone go on visits to the Saint-Gobain manufacturing floor as often as they could. We wanted everyone to be actively interacting with sponsors and participating in the studies and analysis we were conducting on-site. Lastly, we utilized weekly meetings at regular times to discuss goals for the week and progress on long-term deliverables, as well as to plan for future meetings with sponsors. By defining what needed to be completed each week or over the course of a month, each team member was aware of deadlines and expectations. This also meant each of us had ample time to ask questions or ask for help, when needed.

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## Appendix A: Saint-Gobain Bill of Materials

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## Appendix B: Full Calculation Results

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## Appendix C: Full Calculation Formulas

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## Appendix D: Preliminary Brainstorming Results

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## Appendix E: PDSA Recommendation 1

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## Appendix F: PDSA Recommendation 2

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## Appendix G: PDSA Recommendation 3

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## Appendix H: Recommendation 4 Quote

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