

I PRO 304:
Integration of Process Improvements

Fall 2009

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Sponsor: A. Finkl and Sons (Chicago, IL)

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I. Team Charter

A. Team Information

1. Team Member Roster and Team Member Strengths, Needs and Expectations

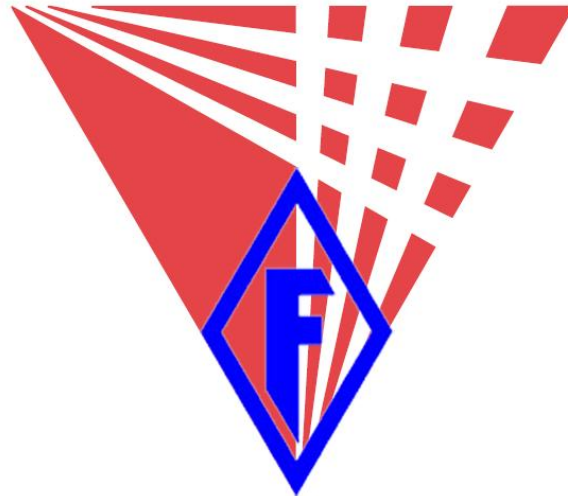
Name	Year	Major	Skills	What to Expect from IPRO	Team	Contact
Jessie Bauer	4th year	Electrical and Computer Engineering	Digital signal processing, IT networking, programming	I expect to experience real engineering.	Electrical Design Team Leader	jbauer5@iit.edu
Tony Bergeron	4 th Year	Computer Science	Programming, Have experience in LabView as well as last year's IPRO304 experience. I also handled all the material between groups and setup an FTP server for collecting all the data.	I expect to figure this problem out this year. We were close last year, we just needed more control.	Electrical Design	abergero@iit.edu
Matt Campen	4th year	Computer Engineering	Digital Signal Processing	I hope to learn signal processing (refresh my skills) and better transform my knowledge	Electrical Design	mcampen@iit.edu
Erik Gruchalski	3rd year	Mechanical Engineering	Machinist, Familiar with Mill, Lathe, Grinder, CNC programming, Wire EDM programming, Auto Cad, EZ Mill, Autodesk Inventor, Can Haggle and Bargain. Many contacts in manufacturing field. Experience in Manufacturing and design	Expect to get successful results	Machining Team Leader	gruceri@iit.edu
Tae Ki Choi	5th year	Architecture	Graphic Design, Architectural Rendering, and modeling	I want to learn how to work as a group. Whatever I am assigned to do, I will find a way to complete the teaks and get the projects done, that's all I want to learn from this IPRO	Machining	tchoi@iit.edu

Ryan Marx	4th year	Computer Science and Computer Engineering	Wireless Networking Experience, Programming Skills, Electrical Engineering Experience	Experience	Electrical Design	rmarx@iit.edu
Chaitanya Murti	4 th year	Electrical Engineering	Strong knowledge of MatLAB, D.S.P, speaking/presenting skills, and writing skills	I want to gain further experience in interdisciplinary teamwork. I also wish to apply my knowledge of electrical engineering to a real world problem. I believe that this IPRO will provide me with the opportunity to do some real design work.	Electrical Design	cmurti@iit.edu
Brian Robbins	4th year	Mechanical Engineering	Analysis and design of Experiments, Materials science, heat/mass transfer, fluid mechanics, mechanics of structures and AutoCAD design	I hope to learn more about working as a team and I hope to help solve the problems at hand for Finkl	Machining	brobbins@iit.edu
Atinder Pal Sohal	4th year	Electrical Engineering	Right now, I'm taking ECE 308, which is Signals and Systems and I'm taking ECE 408, which is an Introduction to computer networks. The knowledge in these courses will be helpful for this IPRO. Also I have some experience with some programming languages like Java, C#, C++, and Mat LAB. They can be helpful in reproducing the data on the computer	I hope to apply my classes to the project	Electrical Design	asohal@iit.edu
Amanda Stenson	4th year	Mechanical Engineering	Project management from previous internships, AutoCAD, mechanical analysis, engineering material design, manufacturing processes	I expect to better my skills of project management. I also expect to successfully finish this IPRO and please the sponsor	Project Manager	astenso1@iit.edu
Alejandro Taboada	4th year	Aerospace Engineering	Social, creative, and leadership.	I want to learn how to work with a real engineering problem, where multiple disciplines and input is required in order to solve it.	Machining	Taboale@iit.edu
Bingjian Zhang	4th year	Electrical Engineering	Signal Processing, Matlab programming	Teamwork skills, communication skills, and how to solve real world problems	Electrical Design	bzhang15@iit.edu

B. Team Identity:

The group's name will be **Shock Troopers**. The project uses amplitude to measure when the carbide inserts break, this is also known as a "shock". This IPRO is trying to find these "shocks", hence the group's name.

The group's logo combines IIT's logo and Finkl's. The group's logo will be:



The group's motto: *4th time is a charm.*

C. Team Purpose and Objectives

1. Team Purpose

The goal and mission this semester is to create a procedure that can show a technician when a carbide insert breaks off of a face mill during operation. Completing this task will increase productivity for A. Finkl and Sons.

2. Team Objectives

The objectives are to create a computer program, create a test plan, implement this procedure test plan in a lab and at Finkl, make the project cost-efficient, and ensure it is known when carbide inserts break off the face mill.

D. Background

1. Information About The Sponsor

A. Finkl & Sons Co. was founded in 1879. Finkl is the world's leading supplier of forging die steels, plastic mold steels, die casting tool steels and custom open-die forgings, processing 100,000 tons of steel each year. Since the 1800s, Finkl has maintained a commitment to manufacture 100 percent of its products in Chicago. These products are distributed domestically and to more than 18 countries worldwide. They sell their products to other manufacturers, like plastic processors, die casting companies and closed-die forging plants. With more than 100 patents to its credit, Finkl's steel formulations and steelmaking technologies set worldwide standards. Finkl's facilities are on the leading edge of technology, using the most automated processes in the world. In recognition of Finkl's product quality, Finkl was the first integrated steel manufacturer in America to receive ISO 9000 certification. Fun fact: they are the largest consumer of electricity in Illinois.

2. Information About the Mechanical Failure

Finkl has asked IIT to solve a mechanical failure for them. Since Finkl processes steel, they need quality control check each piece of steel. One of the machines takes the top layer off of the metal using an 18-inch faceplate with 18 carbide inserts. These carbide inserts take off $\frac{1}{4}$ inch of metal. Sometimes the carbide inserts break due to stress and the shape of the metal. Each machine has an assigned technician who will stop the machine and fix the carbide inserts. However, sometimes the technician does not realize right away that the carbide insert is broken. It may take three or four carbide inserts before it breaks when the technician replaces the broken carbide inserts. The steel that is going through will need to be reprocessed as a result. Another facet is that the technicians have to wait on the steel going through the machine. This means wasted man hours watching the metal go through, instead of doing something more productive for the company.

3. Information About the Technology Used

The machines that Finkl owns are not CNC, or computer-based machines. This means that a program cannot be simply made to fix this process.

This IPRO will be trying to solve the problem by using accelerometers in a non-conventional way. The group will also be creating a computer program that will analyze the data to fit the group's needs and the needs of the sponsor.

4. Historical Investigation of Machine Tool Failure

The first few IPROs were spent trying to diagnose the problem. Last semester was the closest this IPRO has come to solving the problem. A new method that will be tested this year may be able to measure when the carbide inserts break. The problem is that the tests at Finkl were conducted during work hours and there was no control over any aspect of the experiment. There were too many variables convoluting the data and the group could not replicate the results with every machine.

E. Ethical Issues

The cost implications are significant for this issue. This project aims to reduce human error which, in turn, would increase productivity. Finkl has asked IIT to help them with this problem and this IPRO will conduct this project solely with Finkl.

F. Business Costs of Problem

The costs associated with solving this problem are minuscule compared to the costs each year due to this problem. This method will be saving them money because instead of three or four carbide inserts breaking before finding the problem, only one carbide insert will break. Compared to other solutions like updating all of the machines to be computer based, which would fix the problem but cost as much a brand-new machine, the method is the most cost-efficient. The major cost will be buying accelerometers.

G. Practical Methodology

The approach to this project is to attach an accelerometer (an object that measures acceleration) and measure the change in the amplitude of certain frequencies as time progresses. When the amplitude changes, due to a broken carbide insert, the machine will be stopped the carbide insert will be replaced. The group anticipates that the frequency change will be great enough to show when the insert breaks.

H. Team Value Statements

1. Team Behavior

I PRO 304 believes that a code of ethics is fundamental to maintaining an honorable and respectable presence inside and outside of the classroom. Members of I PRO 304 shall conduct themselves in accordance with the ethics standards stated below.

- Conduct research and classroom discussion in a manner that is consistent with accepted honor and decency.
- Strive to maintain the highest standards of honesty and integrity in all endeavors associated with the I PRO.
- Be civil and respectful in professional and academic interactions, avoiding discrimination, based on race, religion, or age.
- Act for the school as faithful agents
- Treat other students, professors and host fairly.
- Be constructive without malice in evaluating the work of students.
- Encourage the free and open exchange of ideas and information without fear of retaliation.

2. Problems

The group will address conflicts by meeting with team leaders and advisors. If any problems arise, the team leader is responsible for making sure that it is solved. If anyone has problems with team leaders, then the advisors may step in and help find an agreement.

II. Project Methodology

A. Work Breakdown Structure

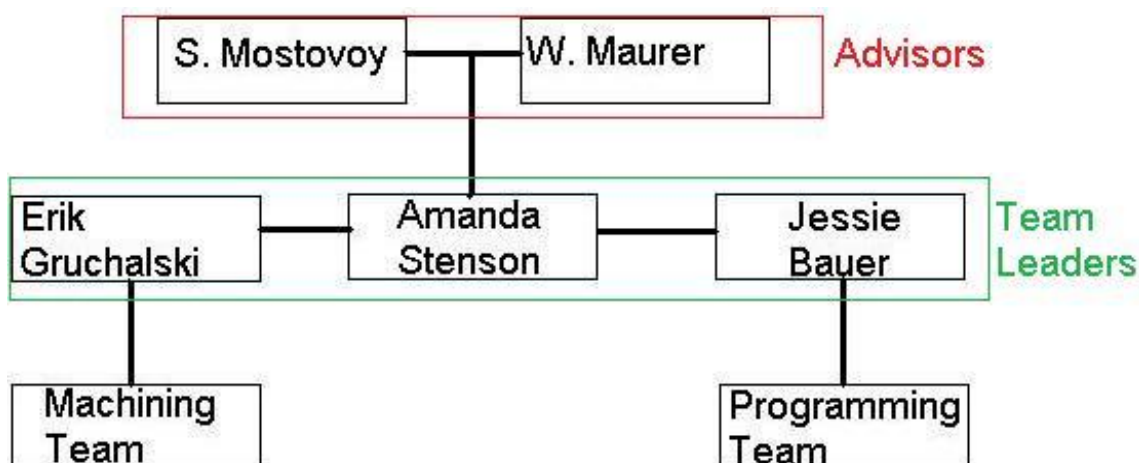
1. Problem Solving Techniques

The main focus will be to find out how to calculate when a carbide insert has broken off of a face mill. Other main tasks are finding out how to measure the frequency of the accelerometers and conducting the experiments. The group will first figure out the test plans for the Electrical Design group and for the machining group. Then the group will test the procedure and collect data. After analyzing the data, the group will know if the procedure and the instruments can identify the broken carbide insert. The solutions will be graphical, so it will be easy to find out if the broken carbide insert can be seen. It is very possible for the group to finish the tasks at hand and have results by IPRO day.

2. Team Structure

Team leaders are responsible for collecting data and presenting it to the other team leader and project manager. They are responsible for making schedules to go to lab and find materials. They are also ultimately responsible for any delays that occur in their group.

The Electrical Design team is responsible for creating the program, for setting up any computer-related operation with the experiment and analyzing the data. The machining team is responsible for getting the steel, calibrating the machines, and conducting the lab. The project manager is responsible for making sure the two teams stay on task, the deadlines are met and the advisors are aware of the progress.



3. Gantt Chart

ID	Task name	Duration	Start	Finish	Predecessors	Classification	Persons Involved	Hours needed
	<i>Project Organization</i>							
1	Find/Order Materials	7 days	9/7/2009	9/15/2009		Both Teams	Erik/Jessie	10 hours each
2	Test Procedure	7 days	9/16/2009	9/24/2009	1	Both Teams	Erik/Brian	5 hours each
3	Identify Stimuli	7 days	9/16/2009	9/24/2009	1	Electrical Design Team	Chaitanya	10 hours
4	Find range of values	7 days	9/16/2009	9/24/2009	1	Electrical Design Team	Matt	10 hours
5	Regulate depth of cut	7 days	9/16/2009	9/24/2009	1	Machining Team	Brian/Alejandro	1 hour each
6	Regulate speed	7 days	9/16/2009	9/24/2009	1	Machining Team	Tae Ki/Amanda	1 hour each
7	Run tests	14 days	9/25/2009	10/14/2009	2,3,4,5,6	Both Teams	All will be involved	Total: 300 hours
8	Finalize procedure	7 days	10/15/2009	10/23/2009	7	Machining Team	Erik	10 hours
	<i>Finkl Testing</i>							
12	Run tests at Finkl	21 days	11/5/2009	12/3/2009	13	Both Teams	All will be involved	Total: 300 hours
13	Set up tests at Finkl	7 days	10/27/2009	11/4/2009	9	Both Teams	All will be involved	Total: 5 hours
	<i>Presentations</i>							
9	Present to Finkl	1 day	10/26/2009	10/26/2009	8	Presentation	Amanda/Jessie	10 hours
10	Present to IPRO (midterms)	10 days	10/5/2009	10/16/2009		Presentation	Matt/Ryan	10 hours
11	Present to IPRO (IPRO day)	1 day	12/4/2009	12/4/2009		Presentation	Brian/Tony	10 hours
14	Present to Finkl	1 day	12/4/2009	12/4/2009	12	Presentation	Amanda/Jessie	10 hours

B. Anticipated Results

1. Details on Anticipated Activities

The group will experiment in a lab for the first half of the semester while they test the program to figure out if they can see when the carbide insert breaks. After the initial testing period, the group will finalize the results and present them to the sponsor. After the sponsor approves of the findings, the group will begin the testing phase at Finkl for three weeks. The group hopes to find that the accelerometers can also discern the frequency at which a carbide insert breaks off. If the group is successful, the next step is to present in front of Finkl again.

2. Anticipated Data and Testing

The group anticipates that the accelerometers will give information of the frequency of the spindle. The group anticipates that LabView will analyze this data from the accelerometers. From this data, the group hopes to conclude the frequency at which a carbide insert will break off of the face mill. The group will present the findings to Finkl. The group hopes to replicate the results on their machines. It is expected that the lab results will match the machinery results, as far as being able to see a frequency where the carbide insert breaks. The group will set this experiment up at each machine and run it for a few weeks while they make sure that the broken carbide inserts are found.

3. Potential Products

The group hopes to increase productivity from this experiment.

4. Potential Outputs from Each of the Project Tasks

The potential outputs from the first phase of testing are to create a test plan and have the analyzed data. The data will show the amplitudes of certain frequencies when the carbide inserts are broken. The output from the second phase of testing is to have Finkl's approval of the test plan and the analyzed data corresponding to the first phase testing.

5. Describe the Anticipated Results of Deliverables

The group anticipates the experiment, carried out on the milling machines at Finkl, to discern when the carbide inserts break on the machine.

6. Summarize the Challenges, Risks and Assumptions

In order to successfully determine a solution for the problem at hand, multiple challenges must be faced.

The first challenge is to find an appropriate accelerometer that can detect a difference in frequency output by the milling machine when varying quantities of cutting inserts are present in the machine. The desired accelerometer is to have a low sensor range and high bandwidth, which ultimately makes the given accelerometer a difficult measurement tool to locate.

The largest challenge that is to be dealt with is deciphering a difference in specific frequencies when a cutting insert is broken in the milling machine. The testing process of the accelerometers on a milling machine with varying quantities of cutting inserts leads to multiple risks, since a milling machine is to be used for testing.

The milling machine extends multiple safety risks that must be taken seriously in order to avoid injury during the testing process. Such safety risks include fragments of steel being ejected from the surface of the material being cut, cutting insert fragments being thrown from the milling machine face plate, and clothing getting caught in the machine face plate.

The current approach for detecting a broken cutting insert in the milling machine requires a large assumption dealing with the frequency output signal of the milling machine. The assumption is that a difference in frequencies as measured by the accelerometers will allow for the detection of when a cutting insert is broken in the milling machine.

G. How the expected results will be incorporated in a proposed solution

The first set of testing will be conducted at IIT using a scale milling set-up that is similar to that of the milling set-up at Finkl. The results provided by this testing will allow for a better understanding of the difference in frequency signals output by the milling machine with varying quantities of cutting inserts on the face plate. With this information, it can be determined whether the current approach is successful in determining when a cutting insert is broken by means of the output frequencies measured by the accelerometers.

If the results for the scale testing are found to be successful, testing will proceed at Finkl. Using the milling machines at the Finkl facility, the difference in frequency output of the milling machine for multiple quantities of cutting inserts will be measured to determine if the yielded difference in frequencies can be used to detect broken cutting inserts in the Finkl milling machines. Given that the results are conclusive with regards to detecting a broken cutting insert in the milling machine, a procedure and recommendation will be proposed to Finkl regarding the determined process and the desired equipment to perform the given process.

C. Project Budget

1. Budget

Item	Cost	Reason
Arbor (1)	\$40.00	Arbor mill
Carbide Inserts (45)	\$900.00	Inserts for the face mill
Face mill (10" dia 12 insert spaces)	\$600.00	Holds inserts and connects to spindle
Accelerometer (4)	\$900.00	Accelerometers measure the dependent variable
Travel (gas)	200 miles	Travel to and from Finkl Steel Factory
TOTAL:	\$2440.00	

D. Designation of Roles

1. Assigned roles

- **Team Leaders:**
 - Erik Gruchalski (Machining Team)
 - Jessie Bauer (Electrical Design Team)
 - Amanda Stenson (Project Management)
- **Electrical Design Team:**
 - Bingjian Zhang
 - Matthew Campen
 - Jessie Bauer, Ryan Marx
 - Tony Bergeron
 - Chaitanya Murti
 - Atinder Pal Sohal.

- **Machining Team:**
 - Brian Robbins
 - Tae Ki Choi
 - Alejandro Taboada
 - Amanda Stenson
 - Erik Gruchalski

- **Project Management:**
 - Amanda Stenson
 - Tony Bergeron
 - Brian Robbins

- **Minute Taker:**
 - Amanda Stenson

- **Agenda Maker:**
 - Matt Campen

- **Time Keeper:**
 - Tony Bergeron

- **iGroups Moderator:**
 - Tony Bergeron