

I²PRO 304

Integration of Process Improvements Project Plan

Sponsored by A. Finkl & Sons Co.

Team Charter

Name	Major	Email	Cell
Tom Kozmel	Materials Science Engineer	tkozmel@iit.edu	████████
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Greg Tatkowski	Mechanical Engineering	gtatkows@iit.edu	████████
Tomasz Chojnacki	Mechanical / Materials Science Engineering	tchojnac@iit.edu	████████
Jaimin Ray	Industrial Technology & Management	jray2@iit.edu	████████
Gregory Sparks	Materials Science Engineer	gsparks@iit.edu	████████
Michael Regacho	Mechanical Engineering	mregacho@iit.edu	████████
YuBo Diao	Aeronautical Engineering	ydiao1@iit.edu	████████
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Alex Szalko	Business / Marketing	aszalko@iit.edu	████████
Suk Won Kim	Electrical Engineering	skim46@iit.edu	████████

Team purpose and objectives

During the milling operations at A. Finkl & Sons (an industrial steel producer), a substantial amount of time and money is lost when cutting inserts break without warning. Because of this loss in time and money, the goal of IPRO 304 has been and will continue to be to devise an effective means by which a broken cutting insert can be quickly and reliably detected, minimizing damage to the finished steel to the other cutting inserts in operation.

By developing this solution, A. Finkl & Sons will be able to reduce the amount of workers necessary to monitor the machines and also improve the efficiency of their operations. Ultimately, our solution has the potential to reduce A. Finkl & Sons' labor and production costs.

In order to accomplish our goal, we will have to automate a process by which cutting insert breaks are reported to the machine operator the instant they occur. To accomplish this, our team will need to isolate a profile of the behavior of each cutting insert on the milling head, establish consistent breakage conditions, identify breakage detection criteria, and produce digital algorithms by which those breaks can be reliably detected. With consistently reliable detection parameters, the team will then need to produce a computer interface or A/V alarm by which a technician can be alerted to the breakage.

Team values statement

Due to the value of our solution to A. Finkl & Sons and IIT, efficient teamwork, wholehearted effort and unwavering dedication will be absolutely crucial to the success and implementation of our solution. As such, there are guidelines we will follow to ensure that our time is spent in the most ethical, productive and efficient way possible:

- All members are to report to class on-time and prepared for the agendas created by the IPRO professors and team coordinators
- All members are to report their progress to ensure that work is being divided equally and that all members are participating
- All members are expected to be respectful and accepting of the strengths and weaknesses of other team members

Conflict resolution will be addressed in a respectful manner to prevent negative feelings and attitudes in the group and will be assessed on an individual basis.

Team strengths, needs and expectations

Name	Strengths	Skills to develop	Expectations
Tom Kozmel	Organization, coordination, labs and reports, Materials Science & Engineering	FFT, PSD, LabView, diaDEM, hands-on machinery work	Being able to identify the signal for a break in a bit and be able to create an alert system to solve A. Finkl & Sons' problem.
Dorothy Collins	Mathematics and Data Analysis	Computer programming	Solve or significantly advance the solution to the problem at hand.
Bill Watts	Mechanics, solid mechanics, thermodynamics, materials	Signal Analysis & programming	Allowing the team to divide the work equally
Greg Tatkowski	Engineering knowledge, dedication, leadership	Scheduling & organization	Develop something that detects tool breakage consistently at a high confidence.
Tomasz Chojnacki	Teamwork, hard work, drive	Coding in LabView, signal analysis	To expand my engineering knowledge
Jaimin Ray	Teamwork, Six Sigma, Hardworking,	Data Analyst, More Mechanical manufacturing Experience, Communication.	Expanding Knowledge in different engineering field with management skills. As well to get success in Project.
	Skill in Different Project management software's.		
Gregory Sparks	Computer work and coding experience. Quick learner	Evening out workload, LabView, diaDEM	To develop my programming skills and use them to solve A Finkl & Sons' problem
Michael Regacho	AutoCad, ProEngineer	Coding and Programming	To gain teamwork and programming experience and to solve a real world issue
YuBo Diao	Knowledge/experience in machines and structures	Electronics	
Claudius Kuzmicki	Circuitry, Math, Quick Learner, Good at working with groups, Always have a solution, Never give up on a problem, Most topics that fall under "Electronics"	Computer Programming in more detail, Speaking in front of "higher" individuals (also in front of many people) confidently.	To gain a feel on how the "real world" works and to solve problems for a real life problem instead of my typical book questions. Also, solve the main problem for Finkl.
Paul Gal	Hands on machinery work, Mathamatics, Computer programing and operation, Electronics	Signal analysis, FFT, PSD	To analyze the signal and decipher between random vibrations and a broken bit

Background Information

Sponsor Information

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 including plastic processors, die casting companies and closed-die forging plants. With more than 100 patents to its credit, Finkl's steel formulations and steel-making 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.

User problem information

As Finkl machines the steel during a milling operation, they rely heavily on the performance of the mill. Each milling machine has an eighteen inch diameter faceplate with eighteen tungsten carbide cutting inserts. The hardness of the steel being milled causes cutting inserts to chip, wear, or at times fail catastrophically. As a result, the surface finish of the steel can be substandard, and more stress will be placed on the remaining cutting inserts to make up for the broken one, making a systemic failure of all inserts highly probable. This poor surface finish also often forces Finkl to re-machine the part to meet customer specifications, wasting time and raising production costs.

Information about the technology or science behind the solution

The milling machines operated and owned by Finkl are manually operated. There are no computer based components of the machine; therefore, the solution will have to be implemented externally. Accelerometers (devices which measure acceleration) have been shown to be useful in the isolation of each cutting insert of a milling machine. With a known RPM of the milling machine, software can be designed to isolate each cutting insert from the accelerometer output. The software can be designed to record the history of each insert. In theory, a cutting insert's acceleration or the cutting head's vibrations will differ if it becomes broken or chipped, allowing the software to display the insert failure to the milling machine operator.

Previous attempts to solve the problem

The previous IPROs were able to isolate individual cutting inserts through accelerometer output. With an established baseline of performance with no broken cutting inserts, the IPRO members were able to see higher amplitude of acceleration when broken inserts were detected. However, the isolation and detection did not occur in real-time; it was only possible when analyzing the accelerometer data after collection.

Societal and business cost of the problem

Finkl must replace cutting inserts when they break, increasing production costs of the finished product. The annual cost of replacing these cutting heads has yet to be determined but has been previously estimated at being around several hundred thousand dollars. In addition to the cost of replacing cutting heads, a solution to Finkl's problem has the possibility of reducing the quantity of workers required for operations. Assuming a solution alerting workers on shift of a broken cutting insert was made, the quantity of workers on shift operating the machines could be reduced, lowering labor costs. Overall, a solution to A. Finkl & Sons problem could save them time and money while increasing the productivity and efficiency of their operations.

Ethical Issues associated with the problem

This project aims to reduce human error during the machining process which, in turn, would increase productivity. In other words, a solution to this problem could lead to a reduction of Finkl's workforce as they would become unnecessary. Because of this, A. Finkl & Sons could experience scrutiny and backlash from its employees.

Finkl has asked IIT to find a reasonable solution to this problem and this team will conduct its research under Finkl's discretion. As sponsor of this project, Finkl rightfully holds that the team's findings are not intended to

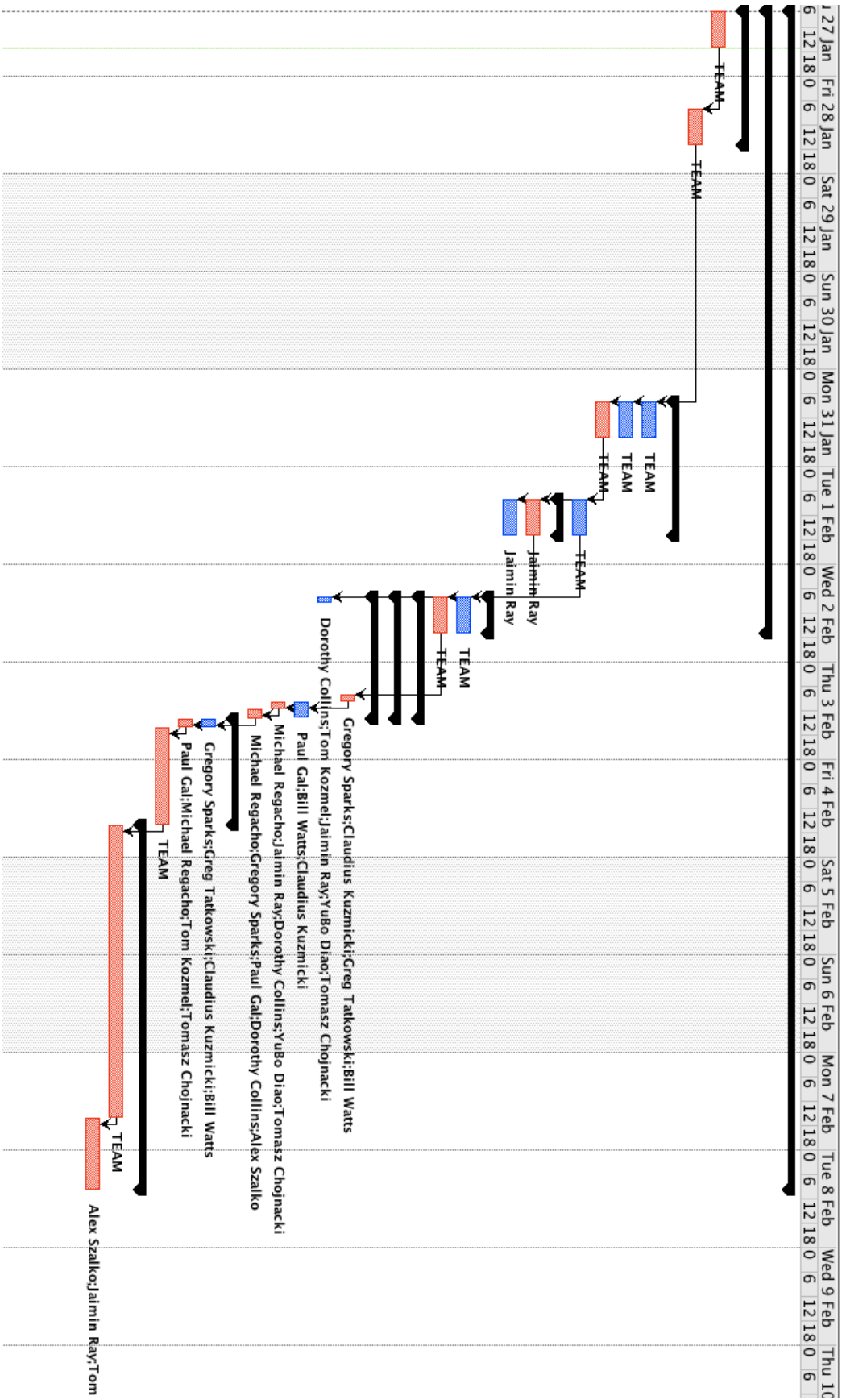
A. Finkl & Sons

be shared outside of the IPRO setting, and any company methodologies or technical communications shared will be held in strict confidence.

Proposed implementation outline

(See Gantt Chart below)

	Name	Duration	Start	Finish	Pred...	Resource Names
1	<input type="checkbox"/> Identifying the purpose of breaking Tools	8.233...	1/27/11 8:00...	2/8/11 9:52...		
2	<input type="checkbox"/> Define	5 days?	1/27/11 8:00...	2/2/11 5:00 PM		
3	<input type="checkbox"/> Identifying Purpose of Project	2 days?	1/27/11 8:00...	1/28/11 5:00...		
4	Meeting with Team members	1 day?	1/27/11 8:00...	1/27/11 5:00...		TEAM
5	Brainstorm on scope of Project	1 day?	1/28/11 8:00...	1/28/11 5:00...	4	TEAM
6	<input type="checkbox"/> Create Charter and Roster	2 days?	1/31/11 8:00...	2/1/11 5:00 PM		
7	Set the Goals	1 day?	1/31/11 8:00...	1/31/11 5:00...	5	TEAM
8	Define Finkl requirements	1 day?	1/31/11 8:00...	1/31/11 5:00...	5	TEAM
9	Create new ideas and management plan	1 day?	1/31/11 8:00...	1/31/11 5:00...	5	TEAM
10	Meeting with stake holders	1 day?	2/1/11 8:00...	2/1/11 5:00 PM	9	TEAM
11	<input type="checkbox"/> Create Project Plan	1 day?	2/1/11 8:00...	2/1/11 5:00 PM		
12	Create Gantt chart	1 day?	2/1/11 8:00...	2/1/11 5:00 PM	9	Jaimin Ray
13	Create PERT Chart/CPM Chart	1 day?	2/1/11 8:00...	2/1/11 5:00 PM	9	Jaimin Ray
14	<input type="checkbox"/> Prepare Plan	1 day?	2/2/11 8:00...	2/2/11 5:00 PM		
15	Involvement Matrix	1 day?	2/2/11 8:00...	2/2/11 5:00 PM	12	TEAM
16	Communication Plan	1 day?	2/2/11 8:00...	2/2/11 5:00 PM	12	TEAM
17	<input type="checkbox"/> Measure	1.65 d...	2/2/11 8:00...	2/3/11 2:12 PM		
18	<input type="checkbox"/> Team Meeting	1.65 d...	2/2/11 8:00...	2/3/11 2:12 PM		
19	<input type="checkbox"/> Finalizing Accelerometer	1.65 d...	2/2/11 8:00...	2/3/11 2:12 PM		
20	Knowledge in Labview and Diadem	0.25 d...	2/3/11 8:00...	2/3/11 10:00...	16	Gregory Sparks;Claudius Kuznicki;Greg Tatkowski;Bill Watts
21	Meet with Finkl and Collect Data for Machine	0.2 da...	2/2/11 8:00...	2/2/11 9:36 AM	10	Dorothy Collins;Tom Kozmel;Jaimin Ray;Yubo Diao;Tomasz Chojnacki
22	Devise Testing Strategy/Code Logic	0.333...	2/3/11 10:00...	2/3/11 1:40 PM	20	Paul Gal;Bill Watts;Claudius Kuznicki
23	Install Accelerometer	0.2 da...	2/3/11 10:00...	2/3/11 11:36...	20	Michael Regacho;Jaimin Ray;Dorothy Collins;Yubo Diao;Tomasz Chojnacki
24	Collect Data/Reading	0.2 da...	2/3/11 11:00...	2/3/11 2:12 PM	23	Michael Regacho;Gregory Sparks;Paul Gal;Dorothy Collins;Alex Szalko
25	<input type="checkbox"/> Analyze	1.25 d...	2/3/11 2:1...	2/4/11 4:12 PM		
26	Start Writing Code	0.25 d...	2/3/11 2:1...	2/3/11 4:12 PM	24	Gregory Sparks;Greg Tatkowski;Claudius Kuznicki;Bill Watts
27	Analyze collected Data/Reading	0.25 d...	2/3/11 2:1...	2/3/11 4:12 PM	24	Paul Gal;Michael Regacho;Tom Kozmel;Tomasz Chojnacki
28	Finalizing Design of Code	1 day?	2/3/11 4:1...	2/4/11 4:12 PM	27	TEAM
29	<input type="checkbox"/> Deliverables	1.333...	2/4/11 4:1...	2/8/11 9:52...		
30	Compile semester	1 day?	2/4/11 4:1...	2/7/11 4:12 PM	28	TEAM
31	Make Report and Presentation	0.333...	2/7/11 4:1...	2/8/11 9:52 AM	30	Alex Szalko;Jaimin Ray;Tom Kozmel



Project Methodology

Work Breakdown Structure

To solve our problem, we will direct our efforts in phases (or milestones as described in the project plan guidelines) similar to the Fall 2010 semester:

1. Purchase triaxial accelerometer, develop background information and experience in LabView and diaDEM software programs
2. Meet with Finkl to view machines and become acquainted with their work and processes
3. Devise testing strategy and code logic for our developed software
4. Install Accelerometer, collect data on multiple visits and begin developing code
5. Analyze collected data and finish design of code
6. Test reliability of our software and solution
7. Compile semester work and present our findings to A. Finkl & Sons

After interviewing team members from Fall 2010, it seems entirely plausible that our team could test and analyze the data from a triaxial accelerometer during the coming months. Our solution will be objectively analyzed through data analysis software and through testing at A. Finkl & Sons facilities.

Developing software that can detect a broken cutting insert may prove to be our most difficult task as it requires team members to become acquainted with LabView and diaDEM which is uncharted territory for some. LabVIEW is a graphical programming environment used by millions of engineers and scientists to develop sophisticated measurement, test, and control systems using intuitive graphical icons and wires that resemble a flowchart (National Instruments). diaDEM is software specifically designed to help engineers and scientists quickly locate, inspect, analyze, and report on measurement data using one software tool (National Instruments).

The fast Fourier transform (FFT) is an equation that relates the amplitude, or strength, of an electrical signal as a function of frequency, instead of as a function of time. It is also one of the core analytical tools of signal processing.

Power Spectral Density (PSD) is the frequency response of a random or periodic signal. It tells us where the average power is distributed as a function of frequency.

Team Structure

Our team structure this semester will be broken down into three main groups with subgroups underneath them:

Data Collection Group

- Accelerometer purchase, installation & modification (Michael Regacho & YuBo Diao)
- Trip Planning (Tom Kozmel)
- Mounting Scheme / Data Collecting (Dorothy Collins, Yubo Diao, Jaimin Ray, Tom Kozmel, Tomasz Chojnacki)

Data Analysis & Software Development Group

- Labview / Diadem analysis (Greg Sparks, Claudius Kuzmicki, Greg Tatkowski, Bill Watts)
- Software Logic Development (Paul Gal, Claudius Kuzmicki, Bill Watts)
- Software Writing (Greg Sparks, Sukwon Kim)

Deliverable Creation, Presentations and Project Leaders

- Business, Financial & Marketing Analysis (Alex Szalko & Tom Kozmel)

The group names define what the members in said group will be responsible for. Alex and Tom will serve as the project leaders and will guide the project, maintain relationships with employees and update Professor Maurer and Dr. Mostovoy on the group's progress. We have decided against making any additional leaders for this IPRO as responsibilities may change as new challenges present themselves.

Expected Results

Expected Activities and Tasks

This semester, our plan will be completed in seven general phases (time estimates and subtasks on the Gantt Chart):

1. Purchase Accelerometer and develop experience in diaDEM and LabView
2. Visit the A. Finkl & Sons facility to assess the problem
3. Devise the testing strategy and develop the code logic for our software
4. Install the accelerometer, collect data and begin writing software code
5. Analyze the collected data and finalize the design of the software code
6. Test the reliability of the software at A. Finkl & Sons
7. Compile semester and present findings to Finkl executives

Expected Data

We expect data from our analysis to show that a triaxial accelerometer can accurately detect when a cutting insert breaks through FFT and PSD analysis. From this data, we will be able to develop software with the capability to detect this change immediately and notify the operator on duty.

Final and Potential Products from Research and Testing

Our research and testing will lead to a program that will allow a triaxial accelerometer mounted on the milling spindle to detect when a cutting insert has been broken. This program will then notify the operator on-duty that a break occurred.

Challenges, risks and assumptions

We will utilize many assumptions from last semester on the efficacy of accelerometers when detecting broken cutting inserts on Finkl's milling machine. No research exists on this topic as this problem has yet to be solved by anyone else in the industry. Because of this, the entire success of our project is based from our own primary research (hence our lack of previous citations)

Project Budget

For this project, we will require a triaxial accelerometer and licenses to diaDEM and LabView. The cost of the accelerometer will be covered by A. Finkl & Sons and the diaDEM and LabView programs can be utilized for free at IIT. Because of this, IPRO 304 will not require any funding to complete

Designation of Roles (Minute taker, Agenda maker, Timekeeper, iGroups Moderator)

- Minute taker - Tom Kozmel
- Agenda maker - Bill Watts
- Timekeeper - Dorothy Collins
- iGroups Moderator - Alex Szalko