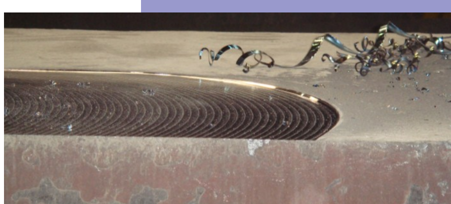
Background Information: A. Finkl and Sons

Information about the Sponsor

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. 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.

Information about the Problem

As Finkl machines the steel during a milling operation, they rely heavily on the performance of the mill. 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, making a systemic failure of all inserts highly probable. This poor surface finish also often forces Finkl to remachine the part to meet customer specifications, and this leads to the loss of significant amounts of otherwise productive time.



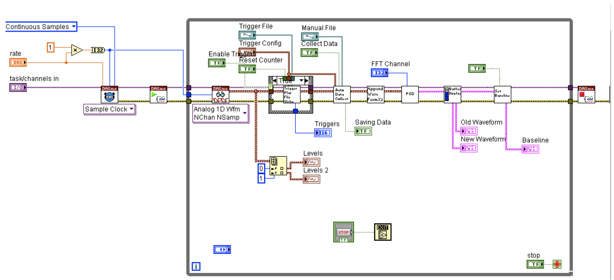
"Our sponsor **A. Finkl and Sons** *is not only our client, but also our dedicated and helpful partner. Our group has worked together with* **A. Finkl and Sons** *staff towards success."*

Results and Conclusion

In analyzing the data, we have found possible indications for when a tool insert is broken. However, our results were never consistent when we acquire new data for analysis. The problem we encountered stems from the acquisition of the data for analysis. Each time we collect data, the placement of our accelerometer is different each time.

Permanently fixing the accelerometer in a constant placement on the milling machine is the required next step. This will eliminate the variable of the accelerometers placement and orientation, making it into a constant. This would provide us more consistent data for analysis and make the detection software less complex.

Other future work necessary to continues with the next semester team members using our data and knowledge in LabView programming to begin developing a program to incorporate this new method into an automated system.



Acknowledgements

We would like to thank the following parties for helping us with any of our questions and giving us advice on how to approach this problem. Since this is our 5th semester, this list continues to grow, so in addition to the following people, we would like to extend our thanks to anyone who has helped us and is not listed below.

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- Ray DeBooth
- Jennifer Keplinger
- Dave Snyder
- Keith Crawford
- Craig and Russ from IIT Machine Shop

Integration of Process Improvements

Advisors: Professor W. Maurer and Professor S. Mostovoy

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

Fall 2010 IPRO-304

Team Members

- Alexander Derdelakos
- Amar Rana
- Francis Gotanko
- Jon Perry
- Kyle
- Gillmeister
- Robert Hill
- Mike Sullins

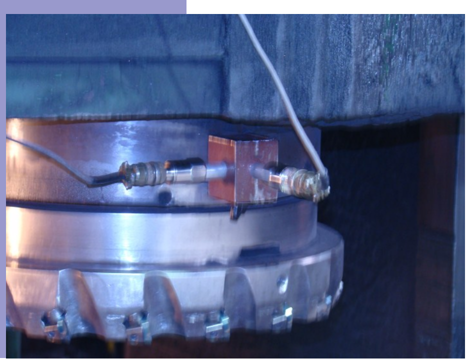
The Problem

A. Finkl and Sons’ steel formulations and steelmaking technologies set worldwide standards. An industry-wide problem is the performance of the mill. Each milling machine has eighteen tungsten carbide cutting inserts. The hardness of the steel being milled causes cutting inserts to chip, wear, or at times fail catastrophically. Finkl’s money and reputation is sacrificed to purchase new cutting inserts and correct milling errors. If a solution is created to detect when an insert fails, the insert can be replaced immediately, reducing the risk of a systemic failure of other inserts.

Objective

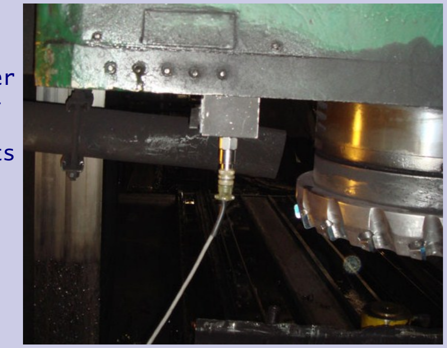
The previous IPROs were able to isolate individual cutting inserts through accelerometer output. With an established baseline of performance with no broken cutting inserts. However, the isolation and detection did not occur in real-time.

Thus, this semester, our main objective stemmed from their research. The idea of using the accelerometer to monitor the vibrations of the machine in order to recognize subtle variations produced when an insert is damaged or broken was continued. And unique and step-by-step methodology was drawn up to extract the largest amount of success for our sponsor



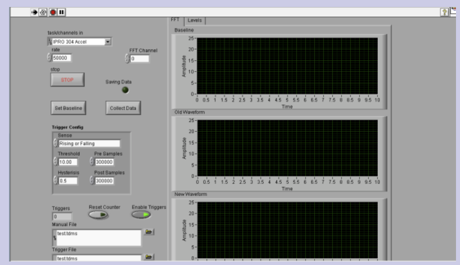
Methodology

The Strategy



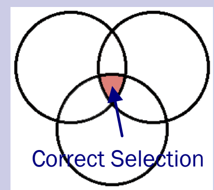
A single-axis accelerometer is used to monitor the vibrations produced by the machine and milling inserts with the steel being machined.

The accelerometer data is collected in LabView; a data acquisition program that monitors and records data based on a set of parameters determined by its programmer.



The data collected in our trials is then evaluated in DIAdem, a data analysis program that processes and extracts information for use by the team to determine the most distinguishable properties for the detection of insert damage and breakage.

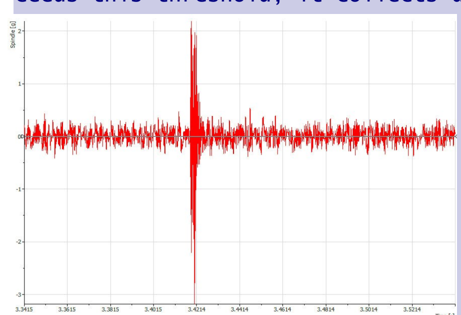
The Implementation



It has been determined that the most effective way to reach our goal in such a vibratory environment is to have a series of several checks so as to avoid false alarms.

-> Check 1: The Trigger

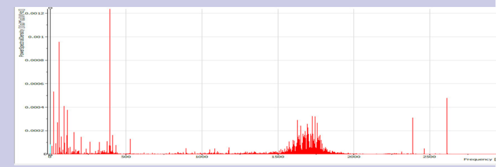
It is understood that in a typical scenario when an insert fails, it fails catastrophically. This destruction of a carbide insert results in a significant shock to the system that is easily identified by the monitoring program. When the program encounters a spike in activity that exceeds this threshold, it collects data before and after the trigger.



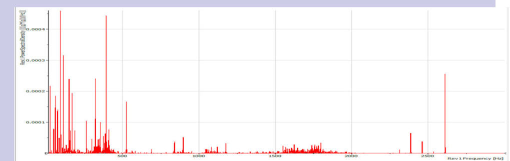
-> Check 2: Pre / Post Trigger waveform analysis

Reacting to a trigger the program saves a predetermined amount of data from before and after the event. This data is split into full rotational increments; these increments are then integrated to produce the Power Spectrum Density (PSD) for analysis.

Data is then split into full rotation increments for analysis. A Fast Fourier Transform (FFT) is performed upon each increment, that results of which can be used to produce a graph of the Power Spectral Density (PSD) for the time necessary to perform one rotation.



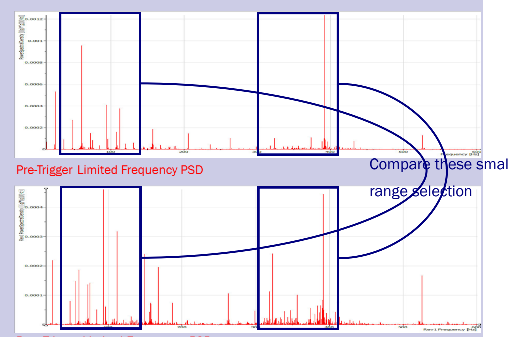
Pre-Trigger PSD



Post-Trigger PSD

-> Check 3: Limited Frequency PSD

By zeroing in on specific frequencies we can be more assured that the changes are attributed to the actual milling process rather than fluctuations from the environment or machine. This last check will insure that the differences found in the PSDs from before and after the trigger are concentrated in this area. This way, a missing insert is known to be the cause of the shock to the system and the redistribution of power across the spectrum rather than a change in the machine’s performance.



Pre-Trigger Limited Frequency PSD

Post-Trigger Limited Frequency PSD