

Purpose

The goal this semester is to:

- Create a procedure that can call the attention to a technician when a carbide insert breaks off the face mill during operation.
- Stop the mill before anymore cutting inserts break.

Background

- 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.
- Processes 100,000 tons of steel each year.
- These products are distributed domestically and to more than 18 countries worldwide.

Ethics

Cost Implications:

- Reduction in human error would increase productivity.
- Finkl has asked IIT to help them with this problem and this IPRO will conduct this project solely with Finkl.
- Finkl has promised IIT that they will not terminate any positions with the successful automation of this process improvement plan.



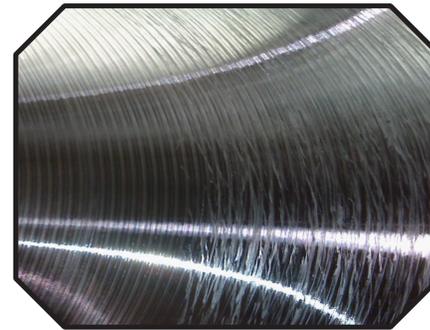
IPRO It takes a team!
INTERPROFESSIONAL
PROJECTS PROGRAM

IPRO 304:

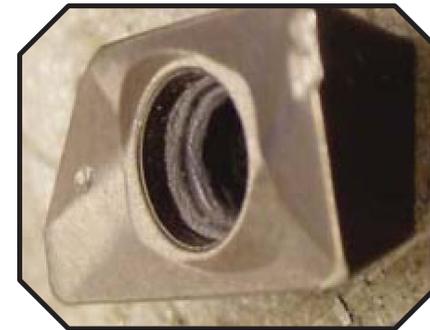
Integration of Process Improvements



Technician Changing broken Inserts



Surface after Broken Inserts



Broken Insert



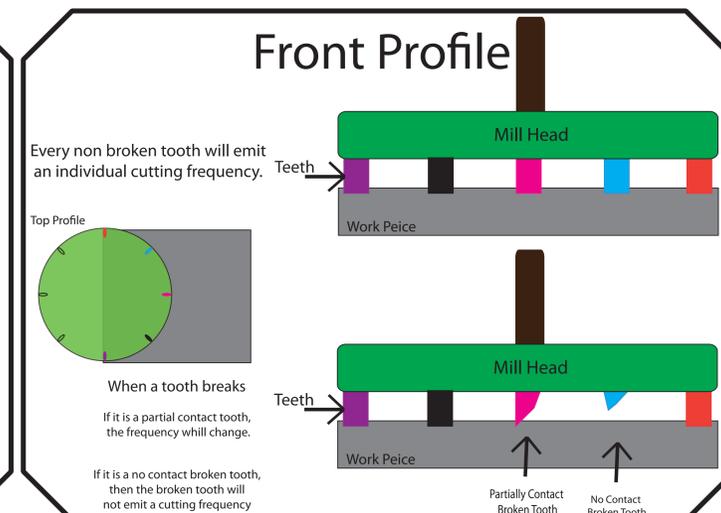
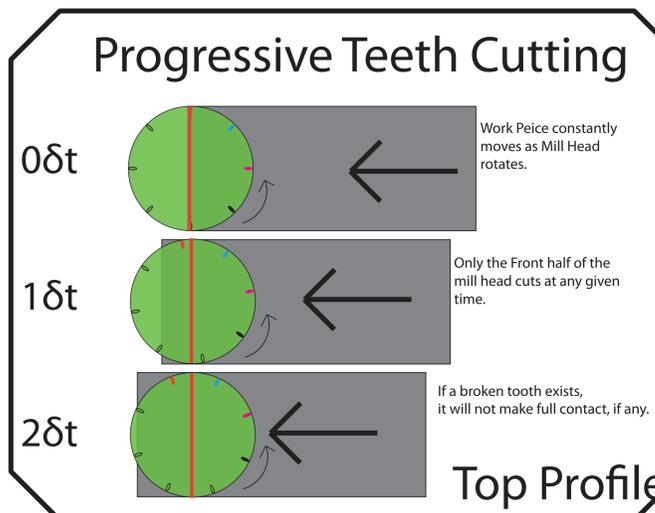
HAAS CNC Mill from laboratory



Tachometer



Finkl Mill with Accelerometer Attached underneath



Mechanical Failure

- One of the machines takes the top layer off of the metal using an 18-inch faceplate with 18 carbide inserts.
- 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.
- Technician does not realize right away that the carbide insert is broken.
- Steel cut with broken insert will need to be reprocessed as a result because the non-uniform surface finish casts doubt about steel's quality.
- Technicians have to wait on the steel going through the machine.
- Wasted man hours watching the metal go through, company loses productivity.

Objective

- Create a test plan that determines when a tooth breaks.
- Implement an automatic stop program for when a tooth breaks.

Organization

Mechanical Testing Team

- Collect data from the HAAS CNC machine & from the milling machine at Finkl.

Analysis Team

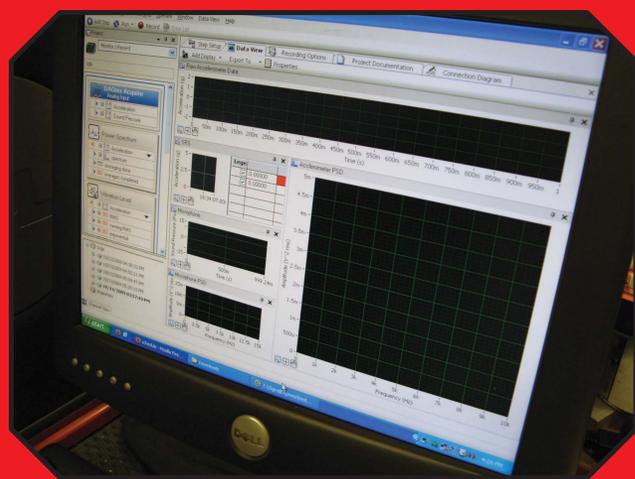
- Analyze data using sophisticated software such as Labview or Matlab.



ILLINOIS INSTITUTE
OF TECHNOLOGY

Test Plan

- Attach 3-D accelerometer (equipment that measures acceleration in the x,y,z planes) to measure the change in the amplitude of certain frequencies as a function of time .
- A tachometer (a laser that measures rotations per minute) will also be used to synchronize the cutting inserts with the observed frequency signal profile.
- When the amplitude changes from broken tooth the machine will be stopped by a computer command, and the carbide insert will be replaced.
- The frequency drop will be low enough to show when the insert breaks.
- Correlate when a carbide insert has broken off of a face mill to the frequency vs. time data output.
- A second method to discover broken teeth is to measure the temperature of the metal shards being discarded.
- With no broken teeth, the cutting will be done at a certain temperature
- If a tooth breaks, there will be a higher stress on the remaining teeth.
- This added stress should increase the cutting temperature, which could be correlated to the number of broken teeth.
- Method proved unsuccessful.



LabView Collecting Data



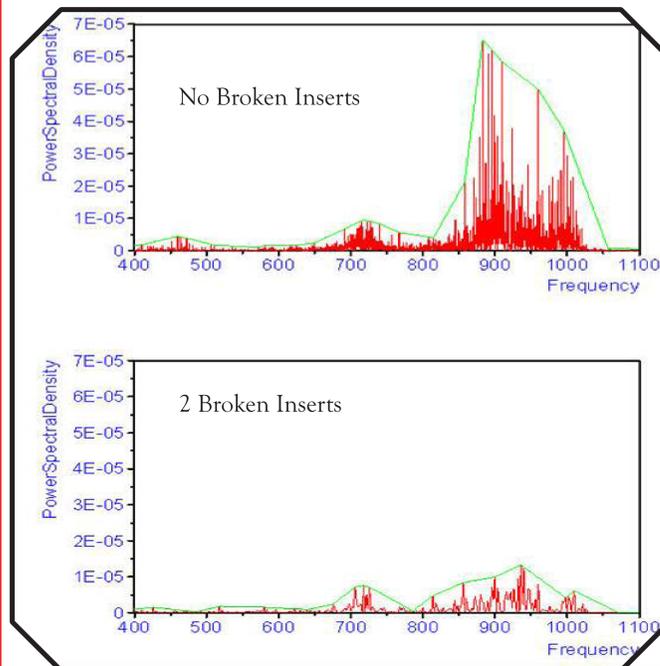
IPRO It takes a team!
INTERPROFESSIONAL
PROJECTS PROGRAM

IPRO 304:

Integration of Process Improvements

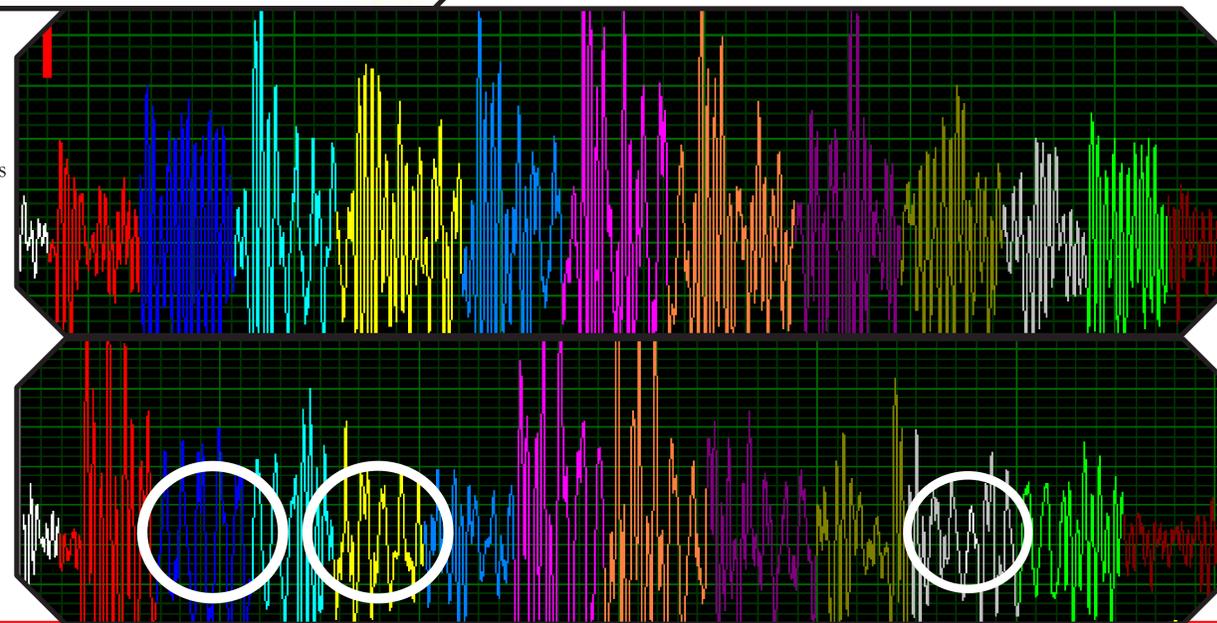
Analysis

Power Spectral Density



- An analysis of the power carried in the cutting frequencies that have shown considerable promise.
- Able to identify the presence of broken inserts.
- When all good inserts are present, all cutting frequencies have a certain overall power spectrum called a power spectral density.
- One block of time with the previous block for a change in power spectral density over a certain threshold should allow for effective breakage detection.
- Looking at the results, there is a huge power spectral density drop when going from no broken teeth to two broken teeth.
- A program can be set up to stop the milling machine after a threshold level is crossed.

No Broken Inserts



3 Broken Inserts

Conclusion

- After the power spectral density is obtained the peaks are connected.
- The connected peaks reveal a line of which the integral can be taken to give the area under the curve.
- It is the change in the area under the curve which is compared.
- The power spectral density can monitor gradual tooth breakage.
- A trigger system that will capture catastrophic tooth breakage.
- It may be possible to monitor if the machine is being abused or not.

Next Step

- Attempt to recreate the lab results at Finkl.
- Testing will be more difficult due to the fact that the mills are alot larger, and the machine noise is compounded by other machines in the room emmiting their own frequencies.
- Results are yet to come.

Acknowledgements

Team Roster

- Emmanuel Flores
- Corey Hawker
- Charles Loeppert
- Ryan Marx
- Ricardo Rodriguez
- David Snyder
- Stefan Stevanovic
- Joshua Willet

Advisors

- Prof. W. Maurer
- Prof. S. Mostovoy

Sponsor



ILLINOIS INSTITUTE
OF TECHNOLOGY