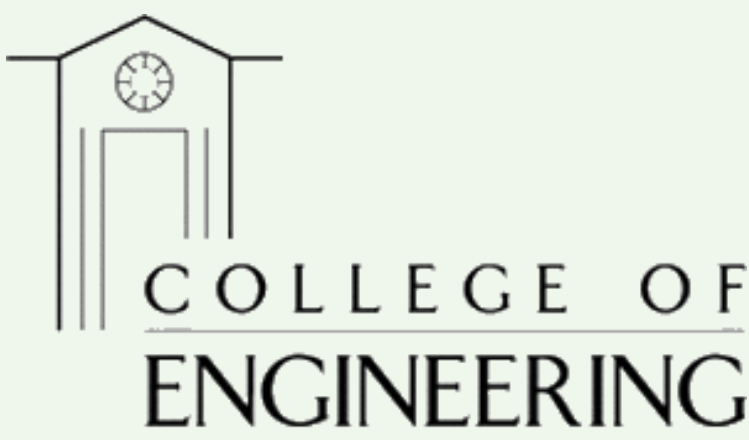


TOOL CONDITION MONITORING SYSTEM

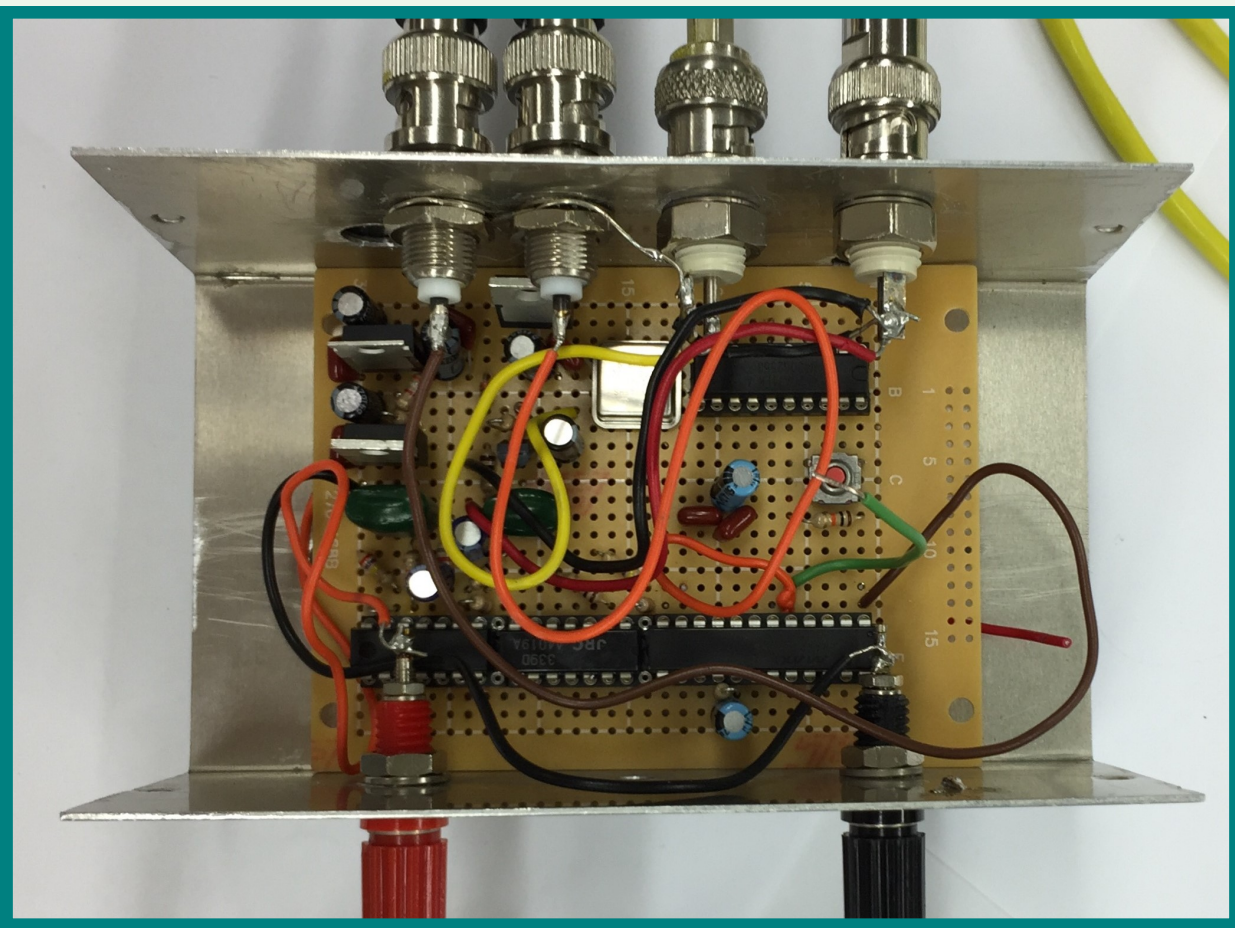
Ali ElSeddik - Rick Skrbina - Caitlin Slicker - Kyle Burgess - Chris Vogler



Background

Great Lakes Controls and Engineering has identified the problem of monitoring the wear of cutting tools on a multi-spindle automatic screw machine.

Faulty parts are produced when cutting tools begin to dull or spindle bearings wear beyond nominal limits. Team 10 has been tasked with creating a system to monitor tool life and identify dull tools before they begin producing faulty parts.



Design Requirements

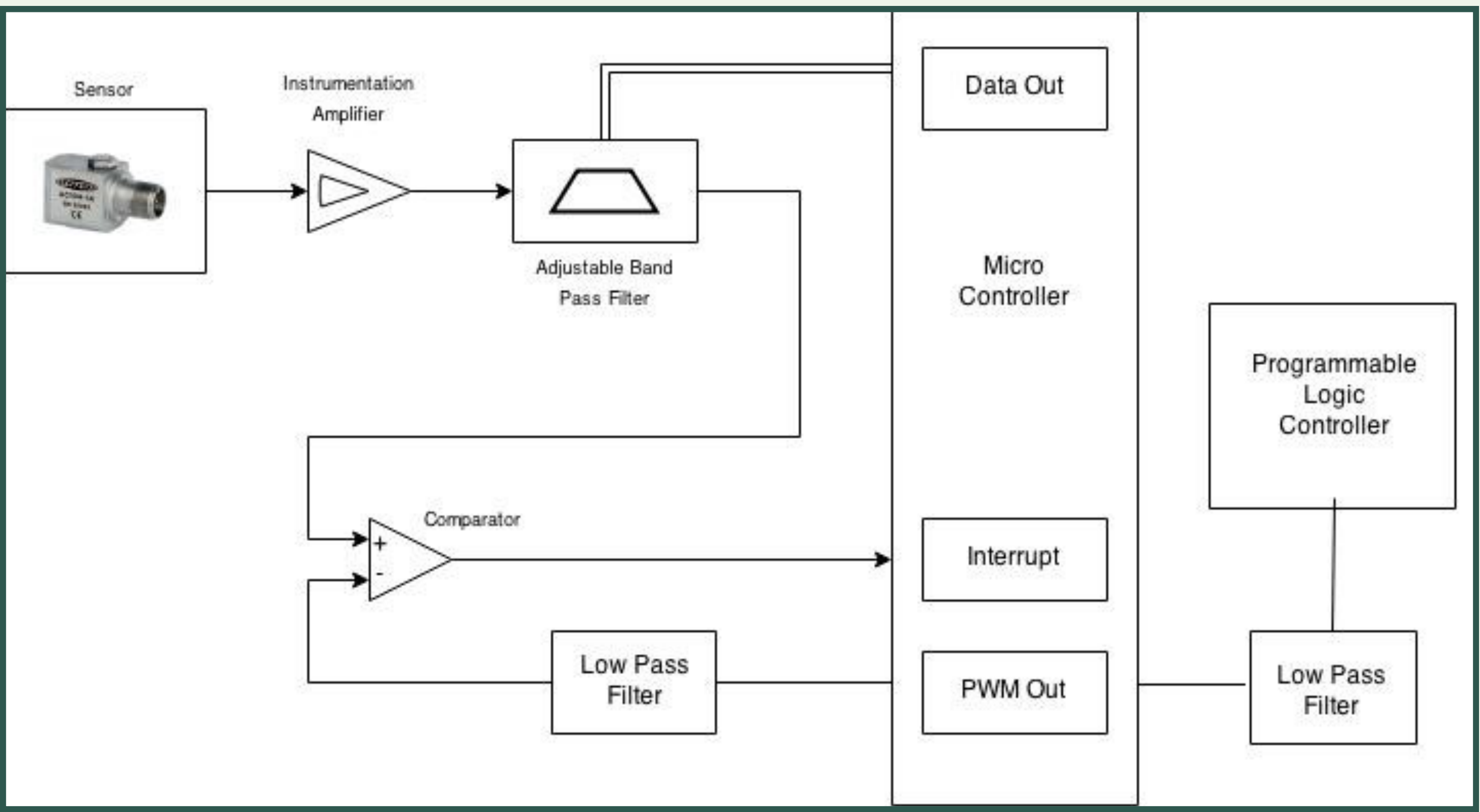
- Sensor must only read one tool operation
 - Ability to eliminate background noise and focus on one tool
- While cutting operation not in progress, system must have ability to monitor spindle bearings of machine
- Output a 0 to 10 volt analog signal of the tool life to the Programmable Logic Controller (PLC) of the machine
 - Map signal to 0 -100% of tool life remaining.
- Run off supplied 24V DC
 - 4-pin control cable connector ran from PLC to device for power and analog signal
- Device must be compact to fit inside machine without interrupting process and withstand harsh environment
 - Size should be less than 2" x 2" x 2"
- \$250 budget for multiple units made

Design Approach

The system is comprised primarily of an industrial accelerometer, an adjustable band-pass filter IC, and a microcontroller. The accelerometer outputs voltage over time that represents changes in acceleration; these small changes in acceleration are caused by the mechanical resistance experienced by the cutting tool as it operates on the work piece. The data from the sensor is then analyzed by filtering out frequencies that are significant to tool life by using the adjustable band-pass filter. The magnitude of the recovered signal is read by the microcontroller, which determines where the tool was new or dull. The system then produces an output signal to the machine's Programmable Logic Controller (PLC) to notify the operator.

Future Improvements

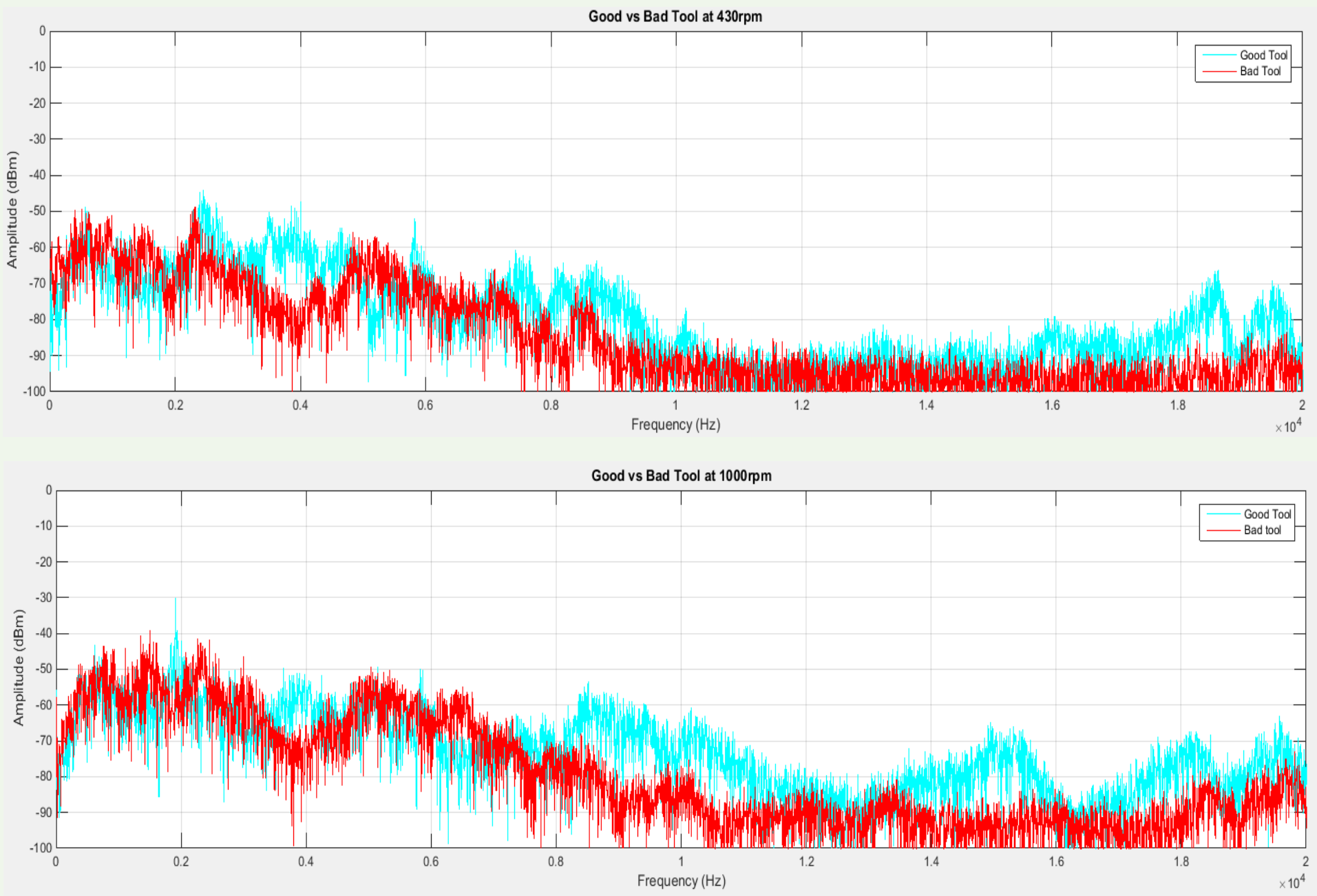
The sensor used in the current design is a general purpose accelerometer. The output voltage of the accelerometer is too small, and the noise in the circuit is too high to make accurate distinctions. This could be improved by using a higher sensitivity accelerometer with a built-in pre-amplifier; it would increase the signal-to-noise ratio and make changes in the output voltage's amplitude more significant.



RESULTS

This project provided the perfect platform for an initial design upon which further development could be made. Within the time and budgets constraints of this project, the team developed a system for a new method to monitor tool condition on metalworking lathe machines .

To the right, the differences between the good (cyan) and bad (red) tools could be seen at frequencies of 4 kHz and 9 kHz at both low and high speeds.



BUDGET

Component	Quantity	Price	Subtotal
MSP430 Microcontroller	1	\$0.00	\$0.00
MAX262 Programmable Filter	4	\$16.48	\$66.58
CTC AC130 Accelerometer	1	\$150.00	\$150.00
Accelerometer shielded cable	1	\$57.50	\$57.50
Accelerometer mounting disk	1	\$6.50	\$6.50
20 pin SIL socket	4	\$1.89	\$7.56
Miscellaneous Circuit Components	-	\$0.00	\$0.00
Shipping	-	\$13.52	13.52
Total			\$301.66

Special thanks:

Justin Walz - Great Lakes Control and Engineering
Dr. Joydeep Mitra - Project Facilitator

