Installation, validation, and development of a vibration monitoring system for optimising machining parameters – Group P2

Aim of the Project

To investigate the resonances and vibrations experienced during machining with the intent to optimize machining parameters.

Background

Vibration analysis is used in industry to refine machining processes and the machines themselves. Analysis can help detect developing faults in machinery long before they would be noticed naturally. This can help prevent machine failure before it happens, giving maintenance teams a chance to perform repairs. The ability to detect these developing faults and rectify them before failure reduces machine downtime, allowing the production line to stay operational. This increases productivity, saving time and also lowering maintenance costs. Fixing smaller faults before they become worse helps avoid more costly repairs and machine replacement.

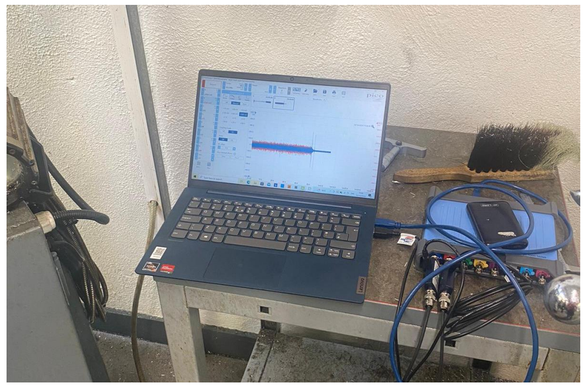
Machining parameters can be optimised by monitoring specific elements such as speeds, feeds, and depth of cut. By observing the changes in vibration through the adjustment of these elements, one can adjust all future operations to sit within the upper and lower limits of the cutting tool to minimise vibration, leading to more accurately machined components.

Testing equipment

The equipment used to perform this experiment are as follows:

- PicoScope 4824A
- TA487 Signal Conditioner
- TA095 Single-Axis IEPE Accelerometer
- PicoScope Software

The Picoscope 4824A is an 8-channel oscilloscope primarily used for diagnosis in the automotive space. In this experiment it was used to read the signals generated from the TA095 accelerometers. These generate an analog voltage signal based on the acceleration induced in the sensor. In this case the acceleration was the vibrations induced during the process of machining. The TA487 signal conditioner is the final crucial in the set of equipment. It is used to smooth out & boost the signal being generated from the accelerometer.



Testing

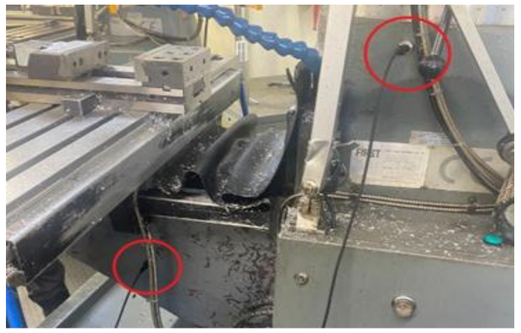
A number of preliminary tests were conducted on the manual lathe & mill, the CNC Router and the Cincinnati Dart. The purpose of these tests was to determine the upper and lower limits for speeds, feeds and depth of cut. These tests were also used to learn more about the software used for these experiments and to monitor the effects from adjusting those 3 factors on the machines used in these experiments.

Testing

Manual mill

During this experiment, it was discovered that the auto-feed on the manual mill was inoperable, as a result it had to be operated manually. Throughout the test it was apparent that the table movement created too much noise to collect useful data.

Due to excess noise on the mill, it was determined that the results could not be used, and further testing would be performed on the Cincinnati Dart CNC Mill.



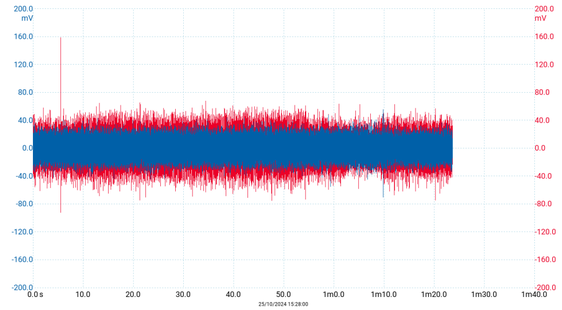
Manual lathe

The tests performed on the lathe revealed that the gearbox produced too much noise during the machining process. This meant that the results gathered could not be used. A higher speed and feed rate were chosen in an attempt to create some useful data however there was no notable difference compared to the initial testing.

Results

The ultimate goal of the experimentation was to complete a design of experiments. This would yield a statistical model that would be able to predict the surface finish a machine would yield based on different settings. Although this was not achieved, other goals were completed.

The team was able to create a standard operating procedure for setting up the equipment, positioning sensors, reading wave forms & gathering data for the picoscope equipment used in the project. As well as this the team determined how to conduct a design of experiments, what factors to use & what limits to use.



Changes & Considerations

In an ideal scenario, with enough time, multiple design of experiments should be completed. There should be screening experiments done to determine which factors have an influence on the data gathered. Multiple main designs should be done too to refine the statistical model as much as possible.

It was also determined that this set of equipment should be focused onto direct drive machines. This is because machines with gearboxes tend to generate too much residual vibration to yield useful results.