# AN INVESTIGATION INTO CHATTER ARISING DURING THE TURNING PROCESS USING ACOUSTIC EMISSION

BY:

J. N. KERAITA

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# ABSTRACT

Chatter is the condition where unwanted vibrational motion exists between the cutting tool and the workpiece during machining. Chatter is highly undesirable because it severely affects the quality of machined surfaces and causes high rates of wear of cutting tools amongst other detrimental effects. Therefore, elimination of chatter would yield advantages such as reduced tooling costs, downtime and scrap generation. In this project, acoustic emission ( AE ) signals generated during turning in the lathe machine were sampled and analysed with the view to establishing the onset of chatter. The effects of chatter were also evaluated.

The signals were detected by a piezo-electric transducer mounted on the tool holder. They were sampled by a microcomputer via a pre-amplifier and filter and then stored in the hard disk. Signal analysis was carried out off-line after downloading the sampled data from the hard disk using floppy diskettes. Frequency analysis, count and amplitude distribution analysis as well as time series analysis were used to evaluate the AE signals.

It was established that the cutting speed, the feed rate, the depth of cut, the amount of the tool wear and the cutting geometry all influence the stability of the cutting process. Further, the changes occurring to AE signal parameters can be used to identify the onset of chatter and hence plot stability charts. Apart from showing the borderlines of stability, such charts help in identifying the changes required to eliminate chatter with minimum or no loss of production.

The sensitivity of AE signal parameters to the cutting conditions was maximum in the frequency range 100-500 kHz. AE mean intensity level and AE count rate (at a properly chosen threshold voltage ) increased almost linearly with the cutting speed, cutting depth, feed rate and tool wear up to the onset of chatter when the pattern was lost. During chatter the AE signal parameters fluctuated significantly. Higher statistical moments ( skew and kurtosis ) of the AE signals were found to be sensitive to tool wear and the subsequent chatter. In general, frequency techniques yielded better results compared to count techniques. The fractal order showed little correlation with the intensity of the cutting conditions. The fractal order failed to identify the onset of chatter.

Results of the principal component analysis conducted on a $20^{th}$ order auto-regressive ( AR ) time series model of the AE signals were found to be sensitive to the amount of tool wear. The first principal component showed a decreasing tendency with increase in flank wear. The tendency was lost at the onset of the chatter. A scattergram of the first two principal components showed outliers corresponding to adverse wear conditions, which were accompanied by chatter.

It was concluded that AE technique offers a good adaptive method for on-line monitoring of the cutting process since AE signal parameters are sensitive to the cutting conditions. It is recommended that this research should be extended to designing an on-line closed-loop system to monitor chatter and its effects.