

HIGHER TECHNICAL INSTITUTE

MECHANICAL ENGINEERING DEPARTMENT

DIPLOMA PROJECT

INVESTIGATION OF ACOUSTIC EMISSION
FOR THE PREDICTION OF TOOL WEAR
DURING VERTICAL MILLING

M / 1036

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INVESTIGATION OF ACOUSTIC EMISSION

FORT THE PREDICTION OF TOOL WEAR DURING

VERTICAL MILLING

BY

ZAKOU MARIOS

PROJECT

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**HIGHER TECHNICAL INSTITUTE
NICOSIA – CYPRUS
MECHANICAL ENGINEERING DEPARTMENT**

DIPLOMA PROJECT 2006/2007

Project Number: M/1036

Title: “Investigation of Acoustic Emission for the Prediction of Tool Wear during Vertical Milling.”

Objectives:

1. Investigate on various condition monitoring techniques in monitoring tool wear during metal cutting (milling).
2. Study the applications of Acoustic Emission in tool wear monitoring and the advantages and disadvantages offered over other conventional condition monitoring techniques.
3. Study on background theory of Acoustic Emission.
4. Present a data acquisition system for Acoustic Emission signal.
5. Study on signal analysis techniques used with Acoustic Emission
6. Use the available research equipment on Acoustic emission to reproduce or prove the usefulness or not of Acoustic Emission as a tool wear monitoring technique with vertical milling.
7. Present results in an easy understandable form and derive necessary conclusion on the condition of the vertical milling cutters monitored during the cutting process.

Terms and Conditions:

1. Sources of information and references should be quoted accordingly.
2. Presentation of results should be as much as possible in the same form as in literature for easiness of comparison.
3. General report presentation should be according to HTI regulations, for final year project report presentation.

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Supervisor : Dr Vassilios Messaritis

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LIST OF CONTENTS

	<u>Page</u>
List of contents	i
List of figures	vi
List of tables	xi
Acknowledgements	xii
Author's Declaration	xiii
Supervisor's Statement	xiv
Synopsis	xv

CHAPTER 1: Review of tool wear monitoring techniques during metal cutting

1.0	Identification of the need	1
1.1	Direct measurement methods	4
1.1.1	Optical (Light reflection, Fiber optics) sensors	4
1.1.2	Electrical resistance sensors	5
1.1.3	The radioactive sensor	6
1.1.4	Pneumatic sensors	6
1.2	Indirect measurement methods	6
1.2.1	Monitoring cutting forces	7
1.2.2	Vibration and sonic analysis (Noise)	9
1.2.3	Roughness of machined surfaces	9
1.2.4	Work-piece dimensions change	10
1.2.5	Distance between tool post and the work-piece	10
1.2.6	Temperature and thermoelectric effects	11
1.2.7	Energy input to the system	12
1.2.8	Acoustic Emission signal analysis	12

CHAPTER 2: Acoustic Emission in tool wear monitoring

2.1	Advantages and disadvantages of Acoustic Emission	14
2.2	Acoustic Emission in Turning	16
2.3	Acoustic Emission in Milling	20
2.4	Acoustic Emission in Grinding	22
2.5	Acoustic Emission in Drilling	25

CHAPTER 3: Metal Cutting – Cutting Tool – Tool Wear

3.1	Basic metal cutting theory	26
3.1.1	Tool angles	27
3.1.2	Orthogonal and oblique cutting	28
3.1.3	Chip formation and chip breaker	30
3.1.4	Cutting parameters in turning	31
3.1.5	Cutting parameters in milling	32
3.2	Cutting tools	33
3.2.1	Tool life	33
3.2.2	Cutting tools for turning	33
3.2.3	Operations carried out on a lathe	35
3.2.4	Cutting tools for horizontal milling	36
3.2.5	Cutting tools for vertical milling	37
3.2.6	Operations carried out on a milling machine	38
3.2.7	Characteristics of tool material	40
3.3	Tool wear mechanisms during metal cutting	41
3.3.1	Types of tool wear during metal cutting	43
3.4	Tool wear in turning	44
3.5	Tool wear in milling	46

CHAPTER 4: Acoustic Emission theory

4.1	Definition of Acoustic Emission	49
4.2	Sources of Acoustic Emission	49
4.2.1	Plastic deformation (slip and twinning)	50
4.2.2	Fracture, Crack initiation, crack growth and vacancy coalescence	54
4.2.3	Basic mechanisms of Acoustic Emission generated during plastic deformation	54
4.2.4	Plastic work of deformation and Acoustic Emission generation	55
4.2.5	Martensitic phase transformation and Acoustic Emission generation	57
4.3	Transmission and propagation of Acoustic Emission	59
4.3.1	Wave propagation in isotropic unbounded elastic media	59
4.3.2	Wave propagation in isotropic bounded elastic media	61
4.4	Detection of Acoustic Emission activity	65
4.4.1	Piezoelectric Acoustic Emission transducers	65
4.4.2	Capacitive transducers	68
4.5	Factors affecting Acoustic Emission and sources of Acoustic Emission during metal cutting	69

CHAPTER 5: Data acquisition system for Acoustic Emission signal at HTI

5.1	Experimental equipment and instrumentation	71
5.1.1	CNC Milling machine	74
5.1.2	Acoustic Emission detection equipment	75
5.1.3	Data acquisition equipment	80

CHAPTER 6: Signal analysis techniques used with Acoustic Emission

6.1	Acoustic Emission signal characteristics	84
6.2	Event counting and ring down counting	86
6.3	Amplitude distribution	87
6.4	Spectral analysis of the Acoustic Emission signal	88
6.5	Autocorrelation function	90
6.5.1	Mathematical procedure in performing the autocorrelation function	91
6.6	RMS level and distribution moments	92
6.7	Correlation of chip breaking rate with burst emission rate	93
6.8	Signal analysis using wavelet packets	94

CHAPTER 7: Acoustic Emission varying the cutting conditions

7.1	Depth of cut and cutting speed constant, varying feed rate	98
7.2	Feed rate and cutting speed constant, varying depth of cut	105
7.3	Depth of cut and feed rate constant, varying cutting speed	111
7.4	Examining the influence of machining time on the Acoustic Emission signal	118
7.5	Examining the influence of Material Removal rate on the Acoustic Emission signal	125
7.6	Examining the variation of the Acoustic Emission Signal, during cutting with sharp and worn tools.	127

CHAPTER 8: Observations – Comments – Conclusions

8.1	Flank wear formation	134
8.2	Influence of feed rate on the AE generation	138
8.3	Influence of depth of cut on the AE generation	140
8.4	Influence of cutting speed on the AE generation	141
8.5	Influence of machining time on the AE generation	143
8.6	Influence of MRR on the AE generation	145
8.7	AE generated during cutting with sharp and worn tools	148
8.8	General comments - Future work	149

APPENDICES	152
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REFERENCES	156
-------------------	------------

LIST OF FIGURES

CHAPTER 1: Review of tool wear monitoring techniques during metal cutting

		<u>Page</u>
Figure 1.1	The journey to operational excellence	2
Figure 1.2	Photo of a multi-beam optical sensor	4
Figure 1.3	Force monitoring sensor during a turning operation	8
Figure 1.4	Photo of a displacement sensor	11
Figure 1.5	The tool-workpiece thermocouple method	12

CHAPTER 3: Metal Cutting – Cutting Tool – Tool Wear

Figure 3.1	Basic metal cutting theory 1	26
Figure 3.2	Main features of a single point cutting tool	27
Figure 3.3	Basic metal cutting theory 2	28
Figure 3.4	Orthogonal cutting	29
Figure 3.5	Oblique cutting	29
Figure 3.6	Continuous chip	30
Figure 3.7	Discontinuous chip	30
Figure 3.8	Continuous chip with built-up-edge	31
Figure 3.9	Types of cutting tools	34
Figure 3.10a	Producing a cylindrical surface	35
Figure 3.10b	Producing a flat surface	35
Figure 3.10c	Taper turning	35
Figure 3.10d	Parting-off	35

Figure 3.10e	Radius turning	35
Figure 3.10f	Drilling	35
Figure 3.11	Slab mill	36
Figure 3.12	Side and face cutter	36
Figure 3.13	Slitting saw	37
Figure 3.14	End mill	37
Figure 3.15	Rough cut end mill	37
Figure 3.16	Slot drill	38
Figure 3.17	Face mill	38
Figure 3.18	Plain milling	38
Figure 3.19	End milling	39
Figure 3.20	Gang milling	39
Figure 3.21	Straddle milling	40
Figure 3.22	Crater wear	43
Figure 3.23	Flank wear	43
Figure 3.24	Notch wear	44
Figure 3.25	Carbide insert used in a face milling operation showing the parallel land (b_s)	48

CHAPTER 4: Acoustic Emission theory

Figure 4.1	Burst and continuous type signals	50
Figure 4.2a	BCC lattice structure	51
Figure 4.2b	FCC lattice structure	51
Figure 4.2c	CPH lattice structure	51
Figure 4.3a	Slip in BCC lattice structure	52
Figure 4.3b	Slip in FCC lattice structure	52
Figure 4.4	The stages of the twinning process	53
Figure 4.5	Martensitic transformation	58

Figure 4.6	Rayleigh wave	60
Figure 4.7	Longitudinal wave	62
Figure 4.8	Torsional wave	62
Figure 4.9	Example of dispersion	63
Figure 4.10	Second order damped spring mass system	66
Figure 4.11	A piezoelectric transducer	67
Figure 4.12	A capacitive displacement transducer	68

CHAPTER 5: Data acquisition system for Acoustic Emission signal at HTI

Figure 5.1	Photo of the CNC milling machine used in which the cutter and the preamplifier with the sensor are clearly seen	71
Figure 5.2	Photo in which the power supply, the RMS-DC converter and the two digital storage oscilloscopes used for the purposes of this research are clearly seen	72
Figure 5.3	Photo in which the desktop computer used for the purposes of this research can be seen	72
Figure 5.4	Schematic diagram of the experimental arrangement	73
Figure 5.5	Photo in which the Bridgeport Interact Mk2 vertical milling machine together with the controller can be seen	74
Figure 5.6a	The AEP4-1S pre-amplifier	76
Figure 5.6b	The AEP3 pre-amplifier	76
Figure 5.7	Characteristic frequency response curve for the VS150-M transducer	77

Figure 5.8	Characteristic frequency response curve for the VS900-M transducer	78
Figure 5.9	Characteristic frequency response curve for the VS45-H transducer	79
Figure 5.10	The GDS-806C digital storage oscilloscope	80
Figure 5.11	The ADC-212 Pico digital oscilloscope	81
Figure 5.12	Circuit of combined AE signal decoupling and RMS converter	83

CHAPTER 6: Signal analysis techniques used with Acoustic Emission

Figure 6.1	A typical Acoustic Emission signal	84
Figure 6.2	Acoustic Emission signal with processing terminology	85
Figure 6.3	Acoustic Emission signal in which events and ring-down counts are clearly seen	86
Figure 6.4	Short time Fourier transform analysis of an Acoustic Emission signal	90

CHAPTER 7: Acoustic Emission varying the cutting conditions

Figure 7.1	Photo of the 60 mm face cutter used	96
Figure 7.2	Photo of the 14 mm slot drill cutters used	97
Figure 7.3	Photo of the 18 mm slot drill cutters used	97
Figure 7.4	AE signal at 10 mm/min feed rate	99
Figure 7.5	AE signal at 20 mm/min feed rate	100
Figure 7.6	AE signal at 30 mm/min feed rate	101
Figure 7.7	AE signal at 40 mm/min feed rate	102

Figure 7.8	AE signal at 50 mm/min feed rate	103
Figure 7.9	Graph of RMS Vs Feed rate	104
Figure 7.10	AE signal at 1 mm depth of cut	106
Figure 7.11	AE signal at 2 mm depth of cut	107
Figure 7.12	AE signal at 3 mm depth of cut	108
Figure 7.13	AE signal at 4 mm depth of cut	109
Figure 7.14	Graph of RMS Vs Depth of cut	110
Figure 7.15	AE signal at 100 rpm cutting speed	112
Figure 7.16	AE signal at 200 rpm cutting speed	113
Figure 7.17	AE signal at 300 rpm cutting speed	114
Figure 7.18	AE signal at 400 rpm cutting speed	115
Figure 7.19	AE signal at 500 rpm cutting speed	116
Figure 7.20	Graph of RMS Vs Cutting speed	117
Figure 7.21	AE signal at 24 minutes machining time	120
Figure 7.22	AE signal at 37 minutes machining time	121
Figure 7.23	AE signal at 51 minutes machining time	122
Figure 7.24	AE signal at 68 minutes machining time	123
Figure 7.25	Graph of RMS Vs Machining time	124
Figure 7.26	Graph of RMS Vs Material removal rate	126
Figure 7.27	AE signal for the 14 mm sharp cutter	129
Figure 7.28	AE signal for the 14 mm worn cutter	130
Figure 7.29	AE signal for the 18 mm sharp cutter	131
Figure 7.30	AE signal for the first 18 mm worn cutter	132
Figure 7.31	AE signal for the second 18 mm worn cutter	133

CHAPTER 8: Observations – Comments – Conclusions

Figure 8.1	The 60 mm cutter used on which the various values of flank wear are shown.	135
Figure 8.2	AE signal on which some basics are explained	137

LIST OF TABLES

CHAPTER 7: Acoustic Emission varying the cutting conditions

Table 7.1	Cutting conditions during the test of varying the feed rate	98
Table 7.2	Table in which 3 RMS values for each individual feed rate are shown together with an average value of RMS	98
Table 7.3	Cutting conditions during the test of varying the depth of cut	105
Table 7.4	Table in which 3 RMS values for each individual depth of cut are shown together with an average value of RMS	105
Table 7.5	Cutting conditions during the test of varying the cutting speed	111
Table 7.6	Table in which 3 RMS values for each individual cutting speed are shown together with an average value of RMS	111
Table 7.7	Cutting conditions for the different machining Times at which signals were selected	119
Table 7.8	Table in which 3 RMS values for each individual machining time are shown together with an average value of RMS	119
Table 7.9	Table in which the calculated MRR together with an average value of RMS value for each case are shown	125
Table 7.10	Cutting conditions during the test for examining the AE during cutting with sharp and worn tools	127

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Finally, I am forever indebted to my mother for her understanding, endless patience and encouragement when this, was most required.

AUTHOR'S DECLARATION

I hereby declare that the project submitted for the diploma of the technician engineer to the Cyprus Higher Technical Institute, apart from the help recognized, is my own work and has not formerly submitted to another University or Institute for a degree.

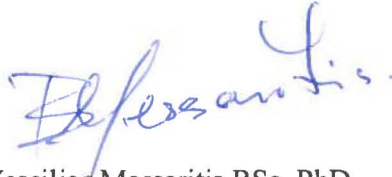
Marios Zakou

.....

SUPERVISOR'S STATEMENT

This is to certify that Mr. Marios Zakou has prosecuted research work under my supervision and he has fulfilled the conditions for of the Ordinances and Regulations of the final year project for the Higher Technical Institute.

21 May 2007

A handwritten signature in blue ink, appearing to read 'Vassilios Messaritis', is written over a faint, illegible stamp.

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SYNOPSIS

The purpose of this work was the investigation of Acoustic Emission (AE) as a method for predicting tool wear during vertical milling. This work was born near last December. To tell you the truth if someone before December came to ask the author what Acoustic Emission is all about his answer would surely be... "WHAT?" The reason for choosing to study the specific subject was the need of meeting something new and the specific work was offered for this purpose.

This work has started by first starting to know what Condition Monitoring (CM) and furthermore what Acoustic Emission (AE) is all about. After this preliminary research the next step was to get "In-Line", meaning that the next step was to start the preliminary work in order for the various tests for investigating the purpose of this work to begin. Tests could not start immediately due to the fact that some preliminary testing in order to establish the appropriate equipment which would be used during the work should be carried out. This preliminary testing turned out to be the most difficult part of the whole work due to the fact that several problems with the initial equipment and instrumentation had occurred. At the beginning problems with the oscilloscope had occurred due to the fact that the specific oscilloscope GDS-806C was not able to provide with data for future analysis but only with jpeg and bitmap images of frozen screen, so for this reason the use of the Pico digital oscilloscope has been decided for the purposes of the specific work. Another problem which has occurred of vital importance was the fact that the preamplifier AEP3 which was first used was providing no amplification to the generated AE signal, so the AEP4-1S preamplifier was adopted.

When the proper equipment has been chosen, various tests have taken place. The first part of the experiment included tests which included the variation of the cutting conditions during machining for a 60 mm face cutter and the second part had as purpose the

investigation of the variation of the AE generated during cutting with sharp and worn tools and for this purpose cutters of 14 and 18 mm of the slot drill type sharp and worn have been used.

As far as the first part of the experiment is concerned, the one with the 60 mm face cutter, tests of examining the AE generated during varying the depth of cut, feed rate, and cutting speed were conducted. In each test, two of the above said cutting conditions were kept steady while the third was varied. After capturing the AE signals generated during these tests several conclusions have been extracted and a quite detailed discussion is presented in chapter 8 for each case.

As far as the second part of the experiment is concerned, the results were quite clear from the point of view that during the examination of the signals captured, the difference in the RMS background level of the AE generated during cutting with sharp tools and the AE generated during cutting with worn tools has presented a difference which could be translated that it is due to the tool wear formation. Although in the specific tests the RMS background level was quite low this could not stop the extraction of the very useful conclusion which states that the AE generated during cutting with sharp and the AE generated during cutting with worn tools presents a difference.

A strong effort has taken place in order to present results in an easy understandable form in order to provide an easiness of comparison with results stated from other researchers. For each test, cutting conditions, RMS background levels of the AE signal generated, and also a typical signal for each case are presented. More signals could not be shown due to lack of space. As far as the conclusions and comments is concerned, for each test separately, a discussion has taken place trying to explain what was possible to be explained.

So, by concluding it must be said that a great amount of work has been done during the last months and several hours were dedicated on this work. One of the most important conclusions of this work was the fact that future work is a "must". Future work on the subject on which

this work is all about, must take place in order to get into further depth and study how the AE generated responds under a larger variety of cutting conditions, tool diameters and workpiece materials. In our belief, a lot of things have been earned from this work and as far as the subject of Acoustic Emission (AE) is concerned, it proved to be a quite interesting subject which must be and will be, further studied in the future.