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A COMPUTERIZED MACHINING INFORMATION CENTRE FOR TURNING

By

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بسم الله الرحمن الرحيم

STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Ph. D. in Mechanical Engineering.

The work included in this thesis was carried out by the author in the department of Production Engineering, Ain Shams University, from 10-11-1986 to 11-10-1990.

No part of this thesis has been submitted for a degree or a qualification at any other University or Institute.

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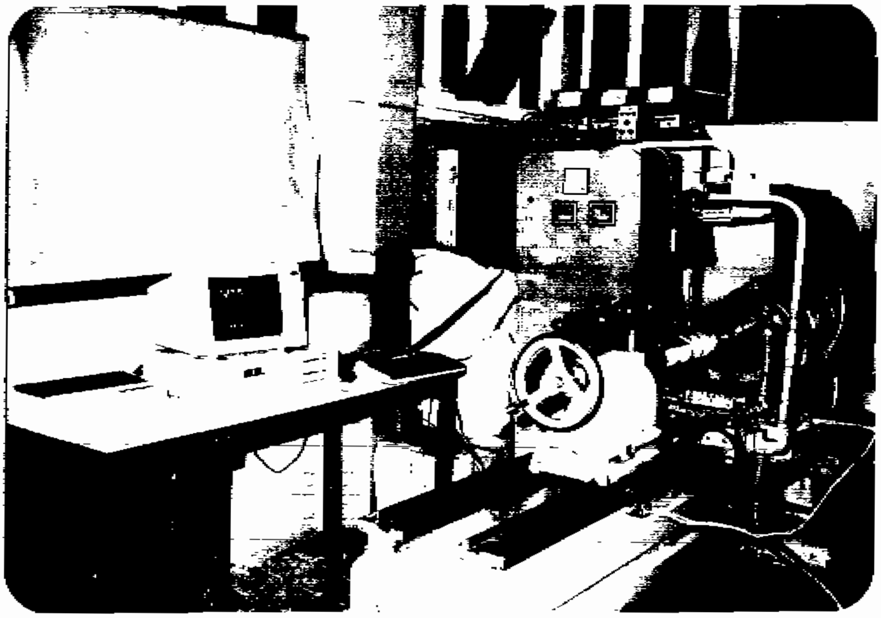

THE MACHINING INFORMATION CENTRE (MIC)

ABSTRACT

The application of computer automated manufacturing systems is rapidly increasing to follow the needs of industry. The speed of information flow in highly automated systems is extremely important as they are critically dependent on the amount of fresh information supplied to them. In the present work, a complete design, implementation, and testing of a computerized *Machining Information Center (MIC)* is carried out to meet the needs for automatic machinability testing that would overcome the difficulties and expenses of conventional machinability testing methods. MIC consists mainly of a master computer that controls a slave computer, which, in turn, controls an *Automated Machinability Testing Unit (AMTU)*. The system is protected against unintended events by including a closed loop emergency-detection system. The MIC remarkably decreases the testing time, cost and effort, material and tooling cost, as well as the experimental errors resulting from the unpredicted variation of machining conditions and from human interference. The MIC is recommended for the solution of machining problems, comparative evaluation of different workpiece and tool materials, machine tools, cutting fluids, ... etc. Moreover, it can be used as an experimental test rig for advanced machinability testing research.

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NOMENCLATURE

SYMBOL	UNITS	DEFINITION
A	mm	machining allowance.
a	mm	depth of cut.
b	mm	width of cut.
b_1	mm	limiting width of cut.
B	mm	flank wear land width.
C1	L.E.	machine cost constant.
C2	L.E.	tooling cost constant.
Cv	---	tool life coefficient.
C_θ	---	cutting temperature coefficient.
D	mm	average workpiece diameter.
D1	mm	initial workpiece diameter.
D2	mm	final workpiece diameter.
Dc	mm	chucked workpiece diameter.
e	---	efficiency of the main drive.
ef	---	efficiency of the feed drive.
Fa	N	axial cutting force component.
Fc	N	tangential cutting force component.
Fr	N	radial cutting force component.
G	---	operational amplifier gain.
I	Amp	electrical current.
Ksa	N/mm^2	specific cutting pressure due to Fa.
Ksc	N/mm^2	specific cutting pressure due to Fc.

Ksr	N/mm^2	specific cutting pressure due to Fr.
K_l	L.E./hr	labour hour rate.
K_m	L.E./hr	machine cost per hour.
K_{TP}	L.E.	tool capital cost.
K_{TC}	L.E.	tool change cost.
K_{TR}	L.E.	tool regrind cost.
L	mm	workpiece length.
m	---	tool life exponent.
ma	---	axial force exponent.
mc	---	tangetial force exponent.
mr	---	radial force exponent.
n	rpm	spindle rotational speed.
P	KW	power consumed.
Pm	KW	motor rated power.
r	mm	tool nose radius.
s	mm/rev	feed.
T	min	tool life.
v	m/min	cutting speed.
Vm	volt	mean voltage.
V_t	volt	tacho generator voltage.
Vs	volt	output servo voltage.
V_r	volt	computer reference voltage.
α	degree	clearance angle.
β	degree	tool wedge angle.
γ	degree	rake angle.
$\emptyset$	degree	firing angle.
δ	---	system damping factor.

θ	°C	cutting temperature.
[illegible]	degree	plan approach angle.
μ	---	coefficient of friction.

INTRODUCTION

The introduction of the recent advances in machining technology necessitates the best utilization of machine tools through the use of the optimum cutting conditions, thus leading to maximum productivity and minimum manufacturing cost. The optimum values for the machining variables of a given workpiece material with different delivery conditions cannot be established without the provision of detailed machinability information about this specific workpiece material. This can be achieved only by performing a series of machinability tests on this material, processing the obtained data and converting them into useful cutting information. Using conventional methods of machinability testing requires considerable effort, time, and cost. Besides, considerable amount of workpiece and tool materials are consumed in the tests. Accordingly, conventional machinability testing is therefore reduced to one or two tests carried out on selected groups of workpiece and tool materials. This results in insufficient information about the given material which limits the effectiveness of the obtained results.

The present work presents a computerized Machining Information Center [MIC] comprising a computer automated machinability test equipment and a data bank which enables automated machinability testing, machinability data handling and interactive machining problem solving.

Several machining parameters such as the cutting force components, the cutting temperature, the tool life, vibrations, ... etc. are to be simultaneously measured by means of proper transducers which enable the on-line measurement of such parameters. They are then processed to obtain the related machinability data and saved into the machinability data bank. MIC results in considerable savings in the amount of time, effort and cost as compared with conventional machinability testing methods.