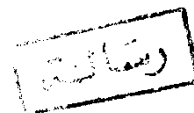


AIN SHAMS UNIVERSITY  
FACULTY OF ENGINEERING

AN INVESTIGATION INTO THE OPTIMUM  
SELECTION OF MACHINE TOOLS  
BY THE AID OF COMPUTERS

A Thesis submitted in partial fulfillment  
of the degree of M.Sc  
in Mechanical Engineering  
(Production Engineering)



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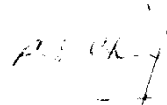
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## S T A T E M E N T

This dissertation is submitted to Ain Shams University for the degree of master in mechanical engineering.

The work included in this thesis was carried out by the author in the Department of Design & Production, Ain Shams Univresity, from 1988 to 1992.

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

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## S U M M A R Y

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The investments consumed in the purchasing of new machines and equipment represent a considerable percentage of the national expenditures, of which machine tools and the associated equipment represent a great portion, which makes the study of the most appropriate methods of buying such machines very necessary.

The main objective of the purchasing process of new machine tools should be to obtain the most appropriate machines from both technical and economical sides which satisfy the needs and fulfill the required specifications that should be governed by the components they have to produce.

However, deviations may occur, where machine tools which are unnecessary or unsuitable for the purpose and / or do not satisfy the best economical conditions may be purchased.

In order to improve the output of the purchasing process i.e obtaining the most suitable machine tools with minimum investments the following methodology has been suggested in the present work :

- 1) Improving the accuracy of the determination of the required machine tool specifications, by formulating the suitable relationships between the machine tool specifications and the workpiece features, using the computer to speed up the specification process.

The program (OPTIMACH.S2) have been prepared for this purpose covering :

- Center lathe specifications (conventional and CNC )
- Milling machine specifications (conventional and CNC )

2) Because of the high investments needed to purchase CNC machine tools and in order to utilize their potential economic benefits, only those parts which are appropriate for CNC machine tools must be processed on them. A decision making procedure to determine whether to load the machined parts on a CNC or on a conventional machine tool is introduced. This procedure depends on a scoring system related to the complexity features of the workpiece and other production features of the work place.

The computer program (OPTIMACH.S1) has been prepared to speed up this process.

3) In order to assist the machine tool selection process, a point system for weighing the main features of the required machine tools is introduced, and is used as a selection criterion to evaluate the machines offered from different suppliers, where a computer program "OPTIMACH.S3", is prepared to speed up the selection process.

The previous suggested procedures have been applied to some practical case studies selected from practice. The results proved the success and time saving of the developed procedures.

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**CONCLUSIONS**

**REFERENCES**

**ARABIC SUMMARY**

## N O M E N C L A T U R E

Symbol	Units	Description
A	mm	Cutter approach ( milling )
$A_d$	mm	Allowance in diameter
$A_l$	mm	Allowance in length
$A_v$	mm	Allowance in width
a	mm	Depth of cut
Bpy		Batches per year
Bsz		Batch size
$C_v$		Cutting speed constant
$D_o$	mm	Workpiece diameter
DOB	mm	Maximum bar diameter
$D_{max}$	mm	Maximum workpiece diameter
$D_{min}$	mm	Minimum workpiece diameter
D	mm	Cutter diameter
E		Feed exponent
$F_a$	N	Axial or feed force component
$F_c$	N	Main Cutting force
$F_r$	N	Radial force component
G		Tool life exponent
H	mm	Height of tool cross section
$K_c$	$N/mm^2$	Workpiece material factor
$K_{s11}$	$N/mm^2$	Specific cutting pressure
$K_\chi$		Plan approach angle factor
$K_\gamma$		Rake angle factor
$K_t$		Tool material factor
$K_f$		Cutting fluid factor
$K_v$		Tool wear factor
L	mm	Table length (milling machine)
LCD	mm	Maximum distance between centers
$L_t$	mm	Maximum bore length
$L_o$	mm	Workpiece length
$L_t$	mm	Tool overhang

$L_x$	mm	Transverse stroke
$L_z$	mm	Longitudinal stroke
$M$	mm	Cutter shift from workpiece center
$M_t$	N.m	Torque
$n$	rpm	Spindle speed
$P_f$	kw	Feed power
$P_c$	kw	Cutting power
$R$		Spindle speed range ratio
$R_a$	$\mu m$	Surface roughness
$R_i$	mm	Free distance after clamp
$R_{in}$	mm	Run in
$R_{out}$	mm	Run out
$RVFi$		Required value of feature (i)
$R_z$	$\mu m$	Average peak to valley roughness
$r$	mm	Tool nose radius
$S$	mm/rev	Feed per revolution
$SCR_{in}$		Score of feature number (i)
$SOS$	mm	Swing over slide
$SOB$	mm	Swing over bed
$SVnFi$		Supplier value of feature (i)
$S_z$	mm/tooth	Feed per tooth
$T$	minute	Tool life
$U$	mm/min	Feed rate
$v$	m/min	Cutting speed
$V_r$	$mm^3/min$	Stock removal rate
$W$	mm	Table Width
$W_o$	mm	Workpiece width
$W_i$		Weight of feature number (i)
$W_M$		Correction factor
$X_R$	mm	Longitudinal stroke of table
$X_{vp}$	mm	Milling distance in X direction
$Y_R$	mm	Transverse stroke of table
$Y_{vp}$	mm	Milling distance in Y direction
$Z$		Number of teeth of milling cutter
$z$		Number of speed steps in gearbox

$Z_R$	mm	Vertical stroke of table
$Z_{vp}$	mm	Milling distance in the vertical direction
$\eta$	%	Overall mechanical efficiency
$\phi$		Progression ratio in speed gearbox

## CHAPTER I

### INTRODUCTORY CHAPTER

Metallic parts are initially manufactured as semi finished products by casting, forging, rolling or extrusion. Due to the nature of such processes the products have relatively large dimensional, geometrical and surface deviations. In order to manufacture finished products with a specified quality, machining processes have to be usually carried out on the semi finished products on proper machine tools.

The part to be machined has several surfaces, which should be machined to attain the specified quality which is given by:

- Dimensions and dimensional accuracy.
- Form and form accuracy.
- Surface quality.

In fact these items are determined by the interaction between the cutting process and the MFTW\* system, in which the machine tool usually plays a great role. Moreover the rate of production and hence the manufacturing cost of a product are mainly affected by the machine tool on which it is produced.

The great influence of the machine tool on both technical and economical manufacturing aspects of the machined parts, implies a careful selection of the appropriate machine tool on a techno-economical scientific basis.

In order to manufacture a part with the required shape and size on a machine tool, certain coordinated motions must be

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\*.Machine, fixture, tool, workpiece

imparted, which are either primary or auxiliary. Primary motions include the principal or cutting movement and the feed movements, which serve the purpose of removing metal from the workpiece. Auxiliary motions are those required for the proper setting of the tool with respect to the workpiece to ensure the successive machining of several surfaces of one workpiece or similar surfaces of different workpieces. They are performed either manually on conventional machine tools or automatically as appropriate movements in accordance with the machining cycle on automatic machine tools.

### 1.1-Classification of manufacturing operations

All operations in machining a workpiece on a metal cutting machine tool are classified as either processing or handling operations. Processing operations are those in which the actual cutting process or chip removal takes place. The rest are handling operations and include loading and clamping the work, advancing and withdrawing the cutting tools, releasing and unloading the work, checking the size of the workpiece, etc.

In up-to-date machine tools, the processing operations are performed by the operative mechanisms of the machine tool. Handling operations are performed in various ways in different machine tools. A part or even all of the handling operations are performed in certain cases by corresponding mechanisms. The operator of other types of machine tools performs the handling operations by himself.

The faster the working and handling operations are performed in a machine tool, the less time will be required to produce a workpiece and the more workpieces can be produced in the same period of time by a given machine tool [1].