CHAPTER 1

INTRODUCTION

1.1 Some Aspects on Modern Manufacturing System

Progress and development of manufacturing methods in metal cutting depend directly and uniquely on the development of machine tools and cutting tools. The search is going on for maximum obtainable reduction in machining cost and time with improved accuracy and good surface finish in machining. The demand for higher productivity leads to the development of high production machine tools like multispindle automatics, special-purpose machine tools and transfer machines. Though these machines are intended for mass production, batch production on these machines can be undertaken with the help of group technology. To reduce production time and to assure high accuracies of machined components, versatile ' machining centres' have been developed. For small batch or job production, computer aided flexible machining systems are used to integrate the various functions.

Computer has become the prime agent in controlling machine tools and manufacturing processes. Process parameters can be easily selected through computerized optimization and can be used for on-line monitoring through adaptive control. Machine utilization is the crucial requirement of expensive machine tools. With the development of on-line diagonistics to find the tool wear, it is possible to reduce the total tool resetting and tool changing time. This reduces the idle time and increases machine utilisation.

In an automated production it is quite general to use multi-tool operated machine tools, where a number of tools of varying types operate simultaneously. In such cases, tool failures will boost up the manufacturing cost by increasing the associated cost of tool replacements along with noncutting time cost. Peter[1] analyzed the production time in a factory, that accounts for noncutting time and the actual machining time during manufacturing as shown in Fig. 1.1. To quote Peter, "........... the problem here is an organisational one, no machine should stay idle, the working time at the different workstations must be balanced for all pieces, a computer program is required for that; maintenance and tool breakage problems must be handled properly and ' by passes' foreseen ".

1.2 Factors Influencing Machining Time

The concept of machining economics is gradually changing. The idea that machining time is the prime factor of machining economics requires rethinking. Machine tools have traditionally been improved and changed. Increase in rigidity and power have been achieved in order to meet the challanges of the improved cutting tool materials. To minimise product cost or to maximise profit rate, the usual practice is to optimize the machining parameters like speed and feed to reduce machining cost or production time. But the production time of a product is influenced by several other activities like mounting, setting, monitoring and changing of cutting tools, loading and unloading the work, delay in tool work movements etc. apart from actual machining time. Therefore, attention should be focussed to machine tool time-utilization which will do more for reducing production cost. Unfortunately there are very little literature which sensitizes us to the total time utilization of machine tools and the relative importance of machining time.

Machining time of a product on multispindle automatic lathe is influenced by the following factors :

a) Machine tool characteristics, N_f

b) Process planning and tooling arrangements, n_f

c) Optimizing parameters, O_P which again have subsets as :

i) Process parameters, O_N e.g., feed, speed, depth of cut

ii) product parameters, O_L e.g., size, shape, hardness of the component machined etc.

iii) tool parameters, O_T e.g., tool material, tool geometry, tool life etc.

iv) tool resetting and tool changing policies, O_R e.g., appropriate strategy for tool resetting considering dimensional accuracy of the component and also tool replacement for a group of tools having varying tool lives.

These factors can be represented with a Block-diagram as shown in Fig. 1.2.

Mathematically these can be expressed as

$$t_m \, \alpha \, \frac{n_f,\ O_L,\ O_R}{N_f,\ O_N,\ O_T} \qquad (1.1)$$

The domain of Machine tool characteristics, N_f includes:

i) number of working stations i.e. single spindle or, multistation(multispindle automatic lathes multispindle drilling, transfer machines),

ii) available tool slides for each station for fascilitating combined operations,

iii) power capacity for increasing process parameters,

iv) rigidity and process capability for maintaining desired physical characteristics of the components, e.g., dimensional accuracy and surface finish.

From the expression 1.1, it follows that the machining time, t_m and related cost can be reduced by the following ways:

a) Raising the value of factor, N_f
   (i) utilising more number of working stations or number of tool slides per station of the machine tool,
   (ii) utilizing the available power,
   (iii) increasing the rigidity and process capability of the machine tool
   (iv) combining the above factors.

b) Control of the factor, n_f by selecting optimum machining parameters through:
   (i) economical combination of operations for multi-tooling arrangement
   (ii) economical grouping of operations
   (iii) optimum sequencing of the operations

c) Raising the value of the factor, O_N by optimizing speed, feed and depth of cut.

d) Reducing the value of factor, O_L by:
   (i) decreasing the length of machining per pass through multi-tool operations
   (ii) judicious grouping of operations to obtain maximum volume of metal removal in one cut.

e) Increasing the value of the factor, O_T through:
   (i) improvement in tool materials and tool geometry with the aim of increasing cutting parameters as well as tool lives.