International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 03 | Mar 2019 www.irjet.net p-ISSN: 2395-0072

Study and Analysis of Time Factor in the Utilization Process

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Abstract - *Manufacturing Engineering evolves under the category of time, precision, rate of production and most importantly costs over the different era of the history. The terms that are engaged can be collect, interpolate, and analyses for the deep knowledge of actual working of the specific process if any interests. Although the collection of information is not easy as it sounds and it requires keen observations and in-depth process view. As the process continues with interpolation cycle. They in turn needs accurate and reliable past record data's for precise tracking of processed information in real. With correct information in your hands through above two process, we can assure that the obtained statistical figures can be reliable and also decisions can be made with respect to figures. In general, collection of correct information is challenging work which has several different techniques and procedures to go for, and selection of apt technique with company's structure and policy, made us stood aside from others.*

Key Words: **Hob travel time calculation, Tool touch time, Data interpolation, statistical analysis, Time factor, Increase utilization**

1. Introduction

Today, all the manufacturing companies share a common motto of satisfying their customers by delivering right product at right time with right quality. While companies were concentrating on these factors, many constraints will come to the account of manufacturer when they look into the manufacturing process. Those constraints also contain non value adding elements which has to be eliminated for efficient operation of the industry. The report is organized as follows by covering about brief explanation about factors in gear manufacturing, selection criteria of the data, way to collect the data and to track the actual tooth touch time, overall time consumed for the process.

1.1 PROBLEM STATEMENT

Gear manufacturing industry is one of the crucial and a most important sector among all industrial product manufacturing industries. As gears plays a major role in industrial sectors like Cement industries, Steel industries even they are also been used in various defense organizations where dimensional precisions plays a major role.

The main market driver globally are Oil and Gas Industries where there is a huge demand for Gear Manufacturers. Because of the innovative advances, the reception of robots and modern computerization is picking up unmistakable quality. Computerization and robots are generally embraced in every single mechanical part, principally in fast and tedious undertakings. Finally, complete content and organizational editing before formatting.

1.2 OBJECTIVE

The objective of this study is to track actual time for production of products irrespective of time that datasheets tell. It also focus on techniques to undergo, resources, strategies to collect the required information. This study helps the organisation to identify and eliminate the non-value adding process form their procedure and addition of value-adding process for effective usage of resource and time. As efficiency of the particular process hikes, if all the above mentioned steps were taken into account. There is no place for false data inside the data pool, once the system is adopted to modern upgrades.

2. Methodology

It explains about the various steps and procedure to be accomplished for successive application of data under the guidance of data processing technique. It also describes about the various terms and condition for the introduction of new term or parameter to the operating system for enhancement of system efficiency. Shewale et al [1] discussed about the hob tool efficiency on basis of their statement the dimensions noted from the hob are revaluated after the particular period of time.

2.1. Data Processing Technique:

In this data processing technique, various processes and steps to achieve effective data are discussed below. These steps has to be followed to get an accurate and reliable data which can be used to calculate precise calculation over the tool touch time.

The most general and basic structure was described in figure 2.1.

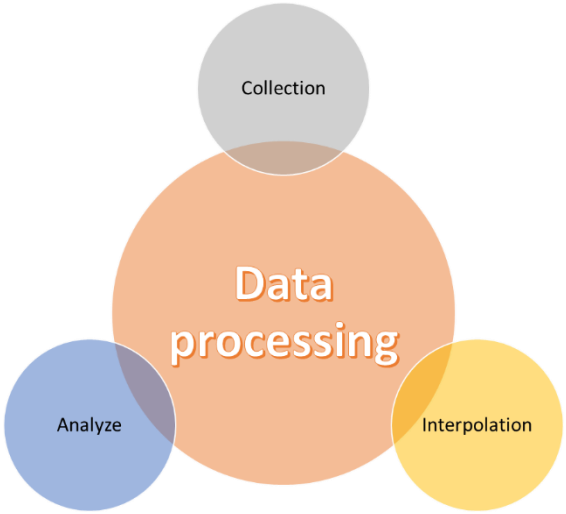

Fig 2.1 Steps in Data processing

This diagram indicates the basic working levels in the technique. First, we collect information about product like customer, specifications, model no, drawing no, etc. The information can be aggregated or obtained from trusted source like data receiver, data storage unit or may also from Department managers, Process head officer, Employees which has lot more possibilities of error or foul play. Once the way of collecting information is decided, then the next step is to be categorization or interpolate them with required parameter figures, etc. As the second part over, the final is to compare the data with previously collected data for ensuring that there is a steep of increase curve over period of time. Also, the changes made in the system have some payback which has to be viewed in the positive manner. So ultimately, the purpose of implementation of technique to system, is to achieve details of positive and real numbers that are in the play rather than expected or false numbers that are not actually exists.

2.2. Data collection – Standard Method

The standard procedure of collecting data differs from company to company. In general, it has some basics sections which has to be fulfilled by any company who is keen on their data value. The main scope of this method is to provide information about the actual time taken for the process. Some of the key terms are as follows,

i. Collection of data

a) Cutting speed section

The cutting speed section comprises details of running machine like speed of rotation (RPM), feed (f), etc. The section may also contain extra information like no of starts, etc in some special cases.

This information and data collected will be helpful in

- Formula used for time calculation
- Comparison of speeds between successive months
- Comparison of speeds between jobs

b) Time section

Time section consists of data related to time respect to job, specification, customer, etc. They can be modified as per comfort of company's structure without lack of information. The categorization and framework for this section will be done by managers, as they are responsible for decision-making and thus, this section also plays major role in management perspective too.

c) Overhead section

The section acts as a hub for many parameters which are inter-related and collected under single cottage. As our manufacturing minds greatly focused on time, this section compel all time affecting data other than in time section. The reason for proposal of this section is **"track time affecting parameters due to unexpected and unavoidable circumstances "**is held. Some of the parameters can be listed as

- Job change time
- Job setting time
- Machine Idle time
- Planned breakdown , etc

ii. Interpolation of data

Here, the collected data which is in huge amount will be segregated into small groups by eliminating unnecessary data. As the company has prior vision over focused areas, they collect data and information related to that particular areas. So overall quantity of data will be reduced and can be processed much faster and accurately.

For instance, a company can foresee

- Monthly production volumes
- Total number of products produced over month periods
- Time taken for standard products in different time periods.

By having precise and actual value in hands, helps firms and high profile workers greatly to pursue any decisions or make any change. It is very important to cross-check the interpolation more than once, for any foul play in the firm that may affect firm dramatically.

iii. Analysis of data

The obtained information through above sections will be validated and put through analysis for the detailed study and

knowledge. Generally, the analysis can be carried out for different scenario depend upon company's focus areas. This helps company and its managers to know

- What to focus on?
- Where to focus?
- Where does extra supervision is needed?
- Which parameter limits the profit scale?

In detail, analysis shows visual and reliable results which can be useful in case of decisions made for the upcoming future. As if any change error in analysis will cause catastrophic effect on company in the future. So managers visualize the reports more often and made any alteration if necessary to run the process smoothly.

2.3 Data collection – Advanced Method

In order to eliminate any discrepancy in the quality of data collection, several theories and fundamentals can added to the system to make them more vulnerable to them. Since the introduction of this concepts is optional as they require extra time and manpower to implement into the system. Once it is introduced to the system, they can operate and regulate with less manpower and time. One of the fundamentals, we are going to see is mostly opt for manufacturing industry and also be used for other industries too but with little modification.

In our discussion, we are basically following **"time"** as our focus area since it plays most crucial role, particularly in manufacturing industry. So here, there are some additional information we require to make data, more accurate and precise.

Some of them include

- Approach
- Over run
- Face width
- Hob travel

Ultimately from which we can calculate,

- Theoretical time taken
- Actual time taken

i. Approach

Hob approach is the distance from the point of initial contact between hob and gear blank to the point where the hob reaches full depth of cut. The approach length is a function of hob diameter, gear outside diameter, depth of cut and gear helix angle.

In general, approach can be calculated either by manual using formulae or by CNC machine itself. The manual method require greater knowledge in both field of work and practical appliance. In other dimension, values provide by CNC is based on technology and make of the machine itself. As the technology and measuring systems get upgraded, the values can be more reliable and used without any doubts. It represent the movement of the tool as it also calculate the clearance value of height for the tool. Also approach has its value to contribute to the minimization of utilization of the process.

The formula for calculation of approach is given as,

a) Helical gear :

$$Approach = \sqrt{w * \left(\frac{D + G - W}{COS^2(H)}\right) - G} \quad [3]$$

Where,

W= Depth of cut (inch)
D = Hob outside diameter
G = Gear outside diameter
H = Gear helix angle

b) Spur gear :

Since helix angle for spur gear is either 0 or 1, equation is simplified as

$$Approach = \sqrt{W * (D - W)} \quad [3]$$

ii. Over-run

Hob overrun is the linear hob travel beyond full cutting depth required to complete generation of the gear teeth. It plays important role in precision of teeth depth and alignment. In general, over run can be automatically measured by digital measuring system in CNC machines. But in other cases, the formula used for calculation is

$$Over\ run = \frac{S * \cos(H) * \tan(SA)}{\tan(PA)} \quad [3]$$

Where,

S = addendum of gear in inches
H = Gear helix angle
SA = hob head swivel angle
PA = gear pressure angle

iii. Face width

The face width of a gear is the length of teeth in an axial plane as in case of double helical, it does not include the gap.

When the face width is too small, the gear has poor capacity to absorb the shock loads and vibrations.

In practice, the optimum range of the face width is in between 8 and 10 modules. The face width can also be obtained from CNC along with approach, over run, etc.

The dimension of face width of gear is an important aspect in the design of gears. If the face width is too large, there is a possibility of concentration of load at one end of the gear tooth.

iv. Hob travel

The hob travel length consists of three elements,

- Gear face width
- Hob approach
- Hob over run

The gear face width is also indicated on the part print as the width of the gear blank. When more than one part is loaded per cycle, the total gear width must be taken into account. Hob travel provides information about movement of job and cutter which is very useful in terms of calculation of actual time of the job.

v. Theoretical time calculation

The theoretical time is the time taken by the process found by using formula and theorems. But in general, theoretical time cannot be achieved as there is always error in every process which make the output lower than theoretical value. In our case, theoretical time can be calculated using formula

$$Theoretical\ time = \frac{Z * L}{N * K * F} \quad [3]$$

By substituting all the factor value required in the formula, theoretical time for the corresponding process can be identified.

The most important thing to focus is to substitute values in their appropriate units because small error in their units can leads to wrong value in overall calculation and also in process view. So it is important to apply corresponding units for values associated with it.

In general, the factors in the formula can be easily obtained from the CNC machine and convert them to corresponding units is the only work to do. For clear understanding, the factors along with their units are listed below

Table 2.3 Factors and their units

Factors	Description	Units
Z	Number of teeth	-
L	Hob travel	Inch
N	Cutter speed	Revolution per minute (RPM)
f	Feed	Inch / RPM
i	Number of starts in hob cutter	-

vi. Actual time calculation

The actual time calculation is the actual time during which a process occurs or complete. It is always lower than the calculated theoretical time due to many error/reasons. By comparing the both time values, deviance occurred can be classified and categorized into groups that can be minimized or eliminated in the upcoming cycles. The actual time calculation is carried out by using formula

$$Actual\ time = \frac{Z * L}{N * K * F} \quad [3]$$

The difference between two formulas other than their names is

- In theoretical time formula, speed and feed rate will be the assigned values for the process by either machine suppliers or R&D engineers.
- In actual time formula, speed and feed rate will be the values entered by operators at the time of process
- In both formula, factors like "**Z, i**" are constant as denote standard job and cutter values.
- Also, factor **"L"** will be varying for every jobs.

3. Result Comparison

3.1 Introduction

When the number of factor increases, the quality of result is also increase significantly. Also increase in factor relating time will provide accurate information that can give solutions to long term problems. Based on the company's structure and finance, application and maintenance of fundamentals can be varied and their results may also be deviated. At the end, results can be reliable by company, once they carried out all other steps with great care and interest.

Let us consider that a Gear manufacturing company is implementing the technique and will study the effect of technique over the company's performance. Jelena R. Jovanovic et al [2] have discussed about several factors for

manufacturing time duration on basis of their paper the table is made and the data collection is done.

3.2 Result with standard data collection method

In this method, general procedures are followed in order to calculate the overall or general parameter which is **"Total time "**in this case. Also through this method only the value or number of parameter can be identified not the cause. This may lead to poor understanding of process, may be ended up in poor decision too. To understand both the concepts, let us consider a real world examples of batch products with all necessary parameters. At first, we can see an example for the standard data collection method for gear manufacturing company as per our assumption.

Table 3.2 Report of batch product using standard data collection method

OD	Cutting speed	Feed rate	Hob travel	Total time (hrs)
110	40	0.6	129.4	3.4
106	80	0.6	127.65	0.8
140	35	0.75	352	2.6
169	40	0.75	158	3.7
158	35	0.6	215	1.9
130.8	50	0.75	155.2	3.4

3.3 Result with customized data collection method

In this method, additional information collected from both supplier and machine itself, should be processed and has to be categorized based up on their groups. By sorting them into groups, it is easy for processing the data. The results are quite promising than the standard data collection method. From this type of analyzing, you can see the deviance in the time respective between real time and theoretical time.

In order to visualize the effect of time factor in the production management, example was given with comparison between standard or present method and advanced or prescribed method with same set of data. Let us see the detailed report using our suggested data collection methods for the gear manufacturing company as we discussed earlier in this chapter

Table 3.2 Report of batch product using Advance data collection method

OD	Cutting speed	Feed rate	Hob travel	Theoretical time (hrs)
110	40	0.6	129.4	1.59
106	80	0.6	127.65	0.66
140	35	0.75	352	1.92
169	40	0.75	158	1.60
158	35	0.6	215	1.50
130.8	50	0.75	155.2	1.33

3.4 Various time factors comparison

It is essential to understand all types of strategies that are helpful to us. By studying the techniques and strategies, we can able to select the one which is apt for our need and apply them. So in terms of application, both of them has specific advantages of their own but for time management application, it is wise to choose one that manages time as primary source.

In order to provide broad over view, selection of technique always depend on process and parameter that need to be monitored. Once the types of techniques were shortlisted, it is manager's work to choose the best suitable one for the application into the working system. As for as our example, list of advantages that make the suggested method stood ahead are as follows,

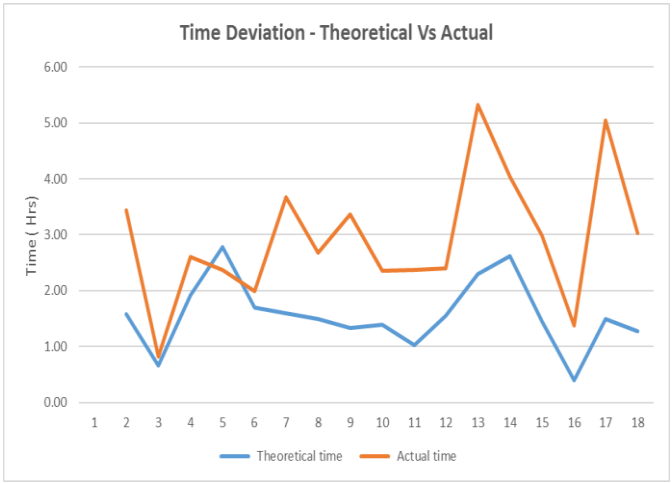

Figure 3.4 Comparison between standard and customized data collection

4. CONCLUSIONS

Time management is the most potential part in development stage of an organisation as laid the foundation of successive firms and organisation. It is very useful and prominently used in many type of industries like manufacturing, automation, etc. As the task of collecting data, interpolating with required fields and analysis it for further study or usage is general for all types of firms.

In specific, it will help in analysis and study of time management in new process, detailed study of ongoing process, collect report of customizable parameters for specific areas of focus. Since industrial revolution made it possible through lots of new proposal and rules to monitor. In fact it also offer industrialists to learn and know about new concepts and prototype so that they can make new development over the others.

There is also other literatures that share the benefits of method in whole another perspective view. Also, there are other methods that contribute more to firms which will eventually consume lots of time, manpower, and knowledge to procure best results compared to others.

5. SCOPE FOR FUTURE WORK

- This paper mainly focused on time monitoring behaviour of process, there are also other problems like inventory maintenance, proper machine utilization, etc.
- In this work, only specific approach method has been discussed so that in future other methods related to eliminate same problem can be addressed.

In this work, time management is focused by using factors, formula and concepts. In future number of factors affecting can be increased based on the situation of application of method.

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