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THE ROLE OF MACHINE LAYOUT ON REDUCTION OF THROUGH PUT TIME FOR GEAR MANUFACTURING

(CASE STUDY ON HIBRET MANUFACTURING AND MACHINE BUILDING INDUSTRY)

A THESIS SUBMITTED FOR THE PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER BUSINESS ADMINISTRATION (MBA)

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CERTIFICATE OF ORIGINALITY

This is to certify that the project title THE ROLE OF MACHINE LAYOUT ON REDUCTION OF THROUGH PUT TIME FOR GEAR MANUFACTURING is an original work of the student and is being submitted in partial fulfillment for the award of the Master's Degree in Business Administration of Indira Gandhi National Open University. This report has not been submitted earlier either to this University or to any other University/Institution for the fulfillment of the requirement of a course of study.

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First , I would like to extend deepest gratitude to my all family, for their endless , inspirations, understanding encouragement, moral and emotional support they have showered me all the past years of my study.

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To Metec and HMMBI, I am most thankful for providing me all the resources required to finish my research work successfully in its overall arrangements .To all respondents who were willing and kind to answer all the questions.

DECLARATION

I Asefa Kassa declare that this research paper done on the topic **"THE ROLE OF MACHINE LAYOUT ON REDUCTION OF THROUGH PUT TIME FOR GEAR MANUFACTURING"** is produced with my own effort. It has not been submitted anywhere else. It is submitted as a partial fulfillment of the requirement of the degree of masters in Business Administration.

ACRONYMS

HMMBI- Hibret manufacturing and machine building industry

PPC -production planning and controlling

MTTP - manufacturing throughput time per part

M/C - machine

C/grinding - cylindrical grinding

S/grinding -surface grinding

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CHAPTER I

INTRODUCTION

1. Background of the study:-

The placement of the facilities in the plant area, often referred to as "facility layout problem", is known to have significant impact upon manufacturing costs, work in process, lead times and productivity. A good placement of facilities contributes to the overall efficiency of operations and can reduce until 50% the total operating expenses (Tompkins et al., 1996). Simulation studies are often used to measure the benefits and performance of given layouts (Aleisa & Lin, 2005). Unfortunately, layout problems are known to be complex and are generally NP-Hard (Garey & Johnson, 1979). As a consequence, a tremendous amount of research has been carried out in this area during the last decades. A few surveys have been published to review the different trends and research directions in this area. However, these surveys are either not recent (Hassan, 1994; Kusiak & Heragu, 1987; Levary & Kalchik, 1985), or focus on a very specic aspect of layout design, such as loop layouts (Asef-Vaziri & Laporte, 2005), dynamic problems (Balakrishnan & Cheng, 1998) and design through evolutionary approaches (Pierreval, Caux, Paris, & Viguier, 2003). Benjaafar, Heragu, and Irani (2002) conducted a prospective analysis and suggested research directions. Our conclusion will show that several of their research propositions remain valid but other issues can also be raised.

Many research worked out with associate the machine layout and through put time reduction. Manufacturing through put time reduction can be vital
According Danny J.Johanson College of Business, lowa state university amps lowa USA, manufacturing through put time is determine as the length of time between the release of an order to the factory floor and its receiptling finished goods inventory or its shipment to the customer. Proper machine layout for gear manufacturing can help on reduction of through put time.

The important step in the design of a cellular manufacturing (CM) system is to identify the part families and machine groups and consequently to form manufacturing cells. The scope of this article is to formulate a multivariate approach based on a correlation analysis for solving cell formation problem. (Burgess morgan & vollmamn 1993 For processing time consideration a simple manufacturing system consisting of two work stations (a work stations is either amchine or a work bench where aworker performs the job (cox and black stone 1998 that manufacturs parts x and y .both parts must first go through work station 1 and then through work station 2.

Having the above issues I select project proposal to study the role of machine layout on reduction of throughput time for gear manufacturing of one industry named Hibret Manufacturing & Machine Building Industry(HMMBI.

Hibret Manufacturing & Machine Building Industry is one of the industry in Metal and Engineering Corporation of Federal Democratic Republic of Ethiopia. The industry is engaged on manufacturing of different spare parts and machines. Customers for this industry are Textile Industry, Leather Industry, Sugar Industry, Construction Machinery, Automotive Industry, Cement Industry and other private sector. To accomplish its task the industry has different type of machinery which can used for spare part manufacturing

Hibret Manufacturing & Machine Building Industry produces different type of spare parts for different sectors. The industry has different factories. Those are conventional Manufacturing Factory, Precision Manufacturing Factory, Machine Building Factory and Material Treatment & Engineering Factory. The above factories have different type of machineries Like Lathe machine, Milling machine, Grinding machine, CNC Lathe machine, CNC Vertical machine center, WEDM, EDW, boring and other machines which are useful for production of spare parts. The main streams of spare parts are Shafts, Gears, Pin Bushing, and Coupling Bolt & Nut. To produce those part the factories has functional organization approach of machine layout. In functional approach type of machines layout similar machines are organized in one shop like Lathe shop, Milling shop and grinding shop.

Statement of the problem:-

Usually, in all manufacturing or process company there must be problems that emerge from small problem until the big problem. Even in a small shop there's still has its own problem. Usually, the problems face by the company such as low production, the quality is not satisfied, waste of time in each process and high cost production. In the shop itself also exist this problem, but it maybe because of the plant layout of the shop that is the base for the shop.

Besides that, these problems occur because of the machine used for the process. Hence, machine or tools used must have maintenance or updated within the period of time. This may cause the failure of the machine or tools. In other case, some company used completely man power without machine but tools are also used.

But remind that, human also can be the source of the problem, usually in case of wasting time and quality. Hence to increase the productivity, all these problems must be reduced as lower as could. If it cannot be fix but at least to reduce or improve it.

The important thing is to keep the process or working flow on schedule with out idle time and delay process. Some of the things to be measure in the plant layout are the arrangement of the machine used. The path use to travel.

In manufacturing one among the most core issue in productivity is layout. Machine layout mainly concern with flow of material, motion of worker and utilization of Jig & Fixtures. In Hibret Manufacturing and Machine Building Industry there is lack of meeting customer delivery time. If a customer is not getting its ordered on time it affects the cost & time of operation. One of the reasons for delivery on time is manufacturing process is long for some parts. If we take gear the process passes through different shops and the location of those shops is not near by and most of non value added activity like transportation of the semi finished blank from one operation to other operation take time. By applying the correct machine lay out we can meet customers need.
Different type of spare parts needs different machine. To see the rationale of the study we can take one product of the industry which have more customers and applicable for different sectors that is gear. To produce gear it passes through different shops. Like Lathe shop gear hobber shop, Heat treatment shop and grinding shop. So as the industry follow functional approach of machine layout. To produce a gear it needs time to transfer from

one shop to other shop. So to meet customers delivery time the layout of machines should be studied weather it is appropriate or not.

2. Basic Research Questions:-

1 What type of layout is currently used to manufacture gear?

2 What is the average through put time for gear i.e. the time from customer order to deliver the gear?

3 To what extent machine lay out affects the deliver time?

4 What type of machine are engaged on manufacture of gear?

5 How the machine should arrange or what is the proper layout of the machines?

6 What is the process to manufacture gear?

7 How many customer orders in gear fulfill delivery time?

3. Objective of the study:-

3.1 General Objective:-

The general objective of this study is to assess the current machine layout used in HMMBI and to assess the proper machine layout in order to enhance production of gear manufacture.

3.2 Specific object:-

The main objective of the study is asses the problem of productivity associated with machine layout and to suggest better organizational structure & machine lay out utilization and to develop the knowledge of process flow and effect on productivity especially on gear manufacturing.

1. To examine the existing machine lay out of HMMBI
2. To investigate the non value activity in gear manufacturing process
3. To make appropriate suggestion of machine lay out for gear manufacturing process

1.5 Significance of the study:-

When an organization comes into operation among the main concerns machine lay out take great considerate because lay out directly relates with motion of man power and transportation and flow of materials. Those issues are directly related to time and then to cost. The main significant of the study is to get the exact & proper layout of machines.

4. Research methodology

The methodologies that are going to be used in this term paper are as follows :

6.1 *POPULATION*

In this study the population for research is three type. The first and most population is customer of HMMBI. Has engaged on manufacturing of different spare parts and machine tools and it has different customers from governmental organization and private sector .A s the scope of the study is the role of machine lay out on reduction of through put time in gear manufacturing ,the customer are selected who give an order of gear to HMMBI. The second population of the study are members of marketing department of HMMBI. Because they are on the front to the customer. The third population is production planning & controlling member and work shop managers of HMMBI. Because the face the problem of delaying the delivery time and machine lay out problems.

6.2 *SAMPLE SIZE and SAMPLING* TECHNIQUES

6.2.1 SAMPLE SIZE

From the above three category of population I selected from different customers 20 companies who give an order to HmmB1 for the past three years. 10 member from marketing department and 20 members from production planning & controlling and

workshop mangers.

6.2.2 *SAMPLING* TECHNIQUES

In order to determine the sampling techniques for this study, I considered the nature of management research studies of mixed approach. Furthermore, the experiences others who have dealt with research studies of similar machine lay out case and research design. case study approach have been addressed. In this regard, to select the sample in this research because of its qualitative nature customers are selected according their frequency of order. from HMMBI the reason to selected marketing , production planning and controlling members and workshop ,mangers rather than from other department ,is their interaction with gear manufacturing and machine lay out .

6.3 **DATA TYPE AND DATA COLLECTION TECHNIQUES**

The study has two type of data those are , primary and secondary data . A search of books, magazine, articles internet resources took place to organize the study as conceptual base for machine lay out and through put time. And this enhance learning of the experiences of industries and organizations.

Primary data were collected from customer of HMMBI, members of production planning and controlling of HMMBI, work shop managers and members of marketing department of HMMBI through 2 Questionnaire.

The study also applied observation through direct visiting in manufacturing process of gear in different fealties of HMMBI.

6.4 DATA ANALYSIS & PRESENTATION

the data collected by Questionnaires from the three categories of population were analyzed with the help of conceptual knowledge and informational from primary source and tabulated as of their category that is customer, members of production planning and controlling and work shop manager and it is analyzed as of percentage for each Questionnaires responses.

5. Limitation and scope of the study:-

Hibret Manufacturing & Machine Building Industry is not specialized on produce some spare parts. It manufactures different categories of spare parts. And most orders are customs base. So it is difficult to organize the machines on item base. But for gear manufacturing most of the process & machine need to produce it is known. So the scope of this study is to asset the proper machine layout to manufacture gear because gear is applicable in every mechanism and it has high demand & order.

6. Organization of the study:-

The research has four chapters. Chapter one will be encompassed the background, the rational of the study the statement of problem, the objective the scope, methodology, samples ion sampling technique and methodology of analysis. and the significance & limits. Chapter two contains the literature review. Chapter three presents results and discussion of the study Chapter four indicates the conclusion and recommendations of the study.

CHAPTER II:

REVIEW OF RELATED LITERATURE

2.1 Introduction

Manufacturing throughput time is defined as the length of time between the release of an order to the factory floor and its receipt into finished goods inventory or its shipment to the customer. Reductions in manufacturing throughput time can generate numerous benefits, including lower work-in-process and finished goods inventory levels, improved quality, lower costs, and less fore- casting error (because forecasts are for shorter time horizons). More importantly, reductions in manufacturing throughput time increase flexibility and reduce the time required to respond to customer orders. This can be vital to the survival and profitability of numerous firms, especially those experiencing increased market pressures for shorter delivery lead times of customized product.

Many firms are struggling in their attempts to re- duce manufacturing throughput time, and the factor changes that can reduce manufacturing throughput time are not always understood

(Suri etal.1996). While manufacturing throughput time reduction can indeed be a daunting task due to the many factors that influence it and their complex interactions, there are basic principles that, when applied correctly, can be used to reduce manufacturing throughput time.

To apply the principles correctly, the basic factors that determine manufacturing throughput time must be clearly understood. This paper first uses a simple hypothetical manufacturing system to illustrate the basic factors that determine manufacturing through- put time and explain why each factor occurs. This tutorial could be used to train workers in these basic concepts. The paper then presents a conceptual framework that illustrates the factors that influence manufacturing throughput time, the actions that can be taken to alter each factor, and their interactions. Because customers are concerned about the response time to their order and because the minimum order size can be for a single part/product, the focus throughput this paper will be on the manufacturing throughput time per part (MTTP).

Information obtained from case studies of lead time reduction efforts at four different plants (see Johnson and Wemmerlöv 1998 and Johnson 1999 for published versions of two of the case studies), previous research on throughput time reduction factors (see *Table 1*), and queuing theory principles were used to construct the framework. The frame- work is detailed enough to provide guidance to the industry practitioner on how to reduce MTTP while being general enough to apply to most manufacturing situations.

The tutorial on factors contributing to MTTP is presented next. The MTTP reduction framework is then presented, and the factor changes that will re- duce each component of MTTP are discussed. The paper concludes with some general guidelines on focusing efforts to reduce MTTP.

The main aim of any industry is to increase the profit by maximum utilization of resources.

Industries develop and adopt new technologies and new designs to improve their productivity by considering their various limitations such as workers, machine utilization, etc. Productivity is a ratio of production output to the resources required to produce it (inputs). The measure of productivity is defined as a total output per one unit of a total input. Productivity can be increased by reducing non value adding process which can be identified through seven wastes (defects, inventory, motion, waiting, over processing, overproduction, transportation) and through work study. (Work study is a scientific analysis and improvement of work in all its aspects and is a very useful technique of increasing productivity. Work study results in improvements in plant layout, material handling system, process design and standardization, working conditions, etc.) These in turn help to minimize defective work and waste.

One of the most important factors to consider in designing the manufacturing facilities is finding an effective layout. Laying out a factory involves deciding where to put all the facilities, machines, equipment and staff in the manufacturing operation. Layout determines the way in which materials and other inputs (like people and information) flow through the operation. Relatively small changes in the position of a machine in a factory can affect the flow of materials considerably. This in turn can affect the costs and effectiveness of the overall manufacturing operation. Getting it wrong can lead to inefficiency. Inflexibility, large volumes of inventory and work in progress, high costs and unhappy customers.

A layout essentially refers to the arranging & grouping of machines which are meant to produce goods.

2.2 Understanding the Factors Determining MTTP

2.2.1 Processing Time

Consider a simple manufacturing system consisting of two workstations (a workstation is either a machine or a workbench where a worker performs the job, Cox and Blackstone 1998) that manufacture parts X and Y. Both parts must first go through workstation 1 (WS-1) and then through workstation 2 (WS-2). The processing time per part is 10 minutes at each workstation, move time between stations is instantaneous, parts arrive one at a time to the workstation, and no variability in arrival rates or processing time exists. Under these conditions, it would be possible to sequence the arrivals to the workstation so the next part doesn't arrive until the current part is finished. As *Figure 1a* illustrates, if X and Y are processed consecutively, the MTTP for each part type is the sum of the processing times at each station for a total of 20 minutes. Given the current state of technology used to produce the parts, 20 minutes is the minimum MTTP possible, and it is a perfect system.

Any increase in the processing time per part would increase the MTTP by the same amount.

2.2.2 Production and Transfer Batch Sizes

Production batch sizes (that is, the number of parts of the same type processed before the workstation is set up to process a different part) and transfer batch sizes (the number of parts moved at the same time to the next workstation) of one unit are often unrealistic due to machine setup times and material handling constraints, respectively. Further realism can thus be incorporated into the example by first increasing both the production and transfer batch size for each part to 10 units. Under these conditions, each part spends 100 minutes at each station for a total MTTP of 200 minutes (see *Figure 1b*). Each part incurs only 20 minutes of actual processing time. The remaining 180 minutes is either time a part spends waiting for its turn to be processed at a workstation, or time the part spends waiting for the remaining parts in the batch to be processed so the batch can be moved. These wait times are sometimes referred to as wait- in-batch and wait-to-batch times, respectively (Hopp and Spearman 2001), or collectively as the wait-for- lot time (MPX 1996). The wait-for-lot time incurred by each part in this case is linearly related to the size of the production and transfer batches used. This causes MTTP to also increase in a linear fashion as production and transfer batch sizes increase.

2.2.3 Setup and Move Time

Further realism can be entered into the hypothetical system by requiring a setup time of 40 minutes before each batch is processed and including a 15 minute batch move time between machines. If no other changes are made to the process, MTTP in- creases by 95 minutes, causing the total MTTP to increase to 295 minutes (see *Figure 1c*). Any further increases in setup and move time would directly in- crease MTTP by the same amount.

2.2.4 Variability

Assuming the same production cycle continuously repeats in the examples shown in *Figures 1a*, *1b*, and *1c*, no idle time will exist at either station once the system fills with work (that is, once WS-2 starts processing the first part), causing the steady-state utilization to be 100%. This can only happen in a system with no variability. Because such systems don’t exist in reality, variability is introduced and examined in the hypothetical system.

Variability can be a result of either controllable or random variation (Hopp and Spearman 2001). Controllable variation is a result of decisions made and includes such things as differences in the processing time of different parts due to design differences, differences in wait-for-batch time due to production and transfer batch size decisions, and so on. In contrast, random variation is a result of events beyond our immediate control. This includes such things as natural variation in process time for the same type of part due to unplanned machine downtime or differences in machines, operators, or material; variation in the time between arrivals to each work- station, etc. Regardless of the type, variability generates the possibility that a batch of parts arriving to the workstation will find the workstation still busy processing a previous batch. When this happens, the new batch must join the queue and wait its turn for processing.

For example, suppose in *Figure 1c* that variability caused the processing time for the batch of X at WS- 1 to be 110 minutes instead of 100 minutes, and at WS-2 to be 90 minutes instead of 100 minutes. In addition, the batch of Y arrives at WS-1 at 130 minutes, which is 10 minutes earlier than planned. The impact on MTTP is shown in *Figure 1d*. The early arrival of the batch of Y to WS-1 coupled with the extended batch processing time of X at WS-1 caused an initial wait time of 20 minutes for the batch of Y at WS-1. This wait time is called queue time. The extended batch processing time of X at WS-1 also delayed the arrival of the batch of Y to WS-2 by 10 minutes (when compared to *Figure 1c*), which caused 10 minutes of idle time between the completion of X at WS-2 and the start of Y. The net result is an MTTP for X that is the same as in *Figure 1c* (i.e., 295 minutes), but an MTTP for Y that is 20 minutes longer than in *Figure 1c* (i.e., 315 minutes instead of 295 minutes).

Increases in variability cause queue size and its associated queue time to increase. For example, sup- pose variability caused the batch of Y to arrive at the same time as the batch of X, but all other conditions are the same as in *Figure 1d*. As *Figure 1e* shows, the MTTP for X remains unchanged at 295 minutes, but the MTTP for Y has now increased by the additional 130 minutes of queue time for a total MTTP of 445 minutes. When variability of all kinds is considered, queuing theory indicates that queue size and its corresponding queue time increases at an increasing rate as the standard deviation or coefficient of variation of interracial and/or processing time in- creases (see *Figure 2*).

In assembly or joining operations, variability can also cause a part to arrive at a workstation before its mate(s). When this happens, wait time can occur, even though the workstation is available for setup and processing of the part. Although this waiting time is often included as part of queue time, it is also some- times referred to as wait-to-match time (Hopp and Spearman 2001).

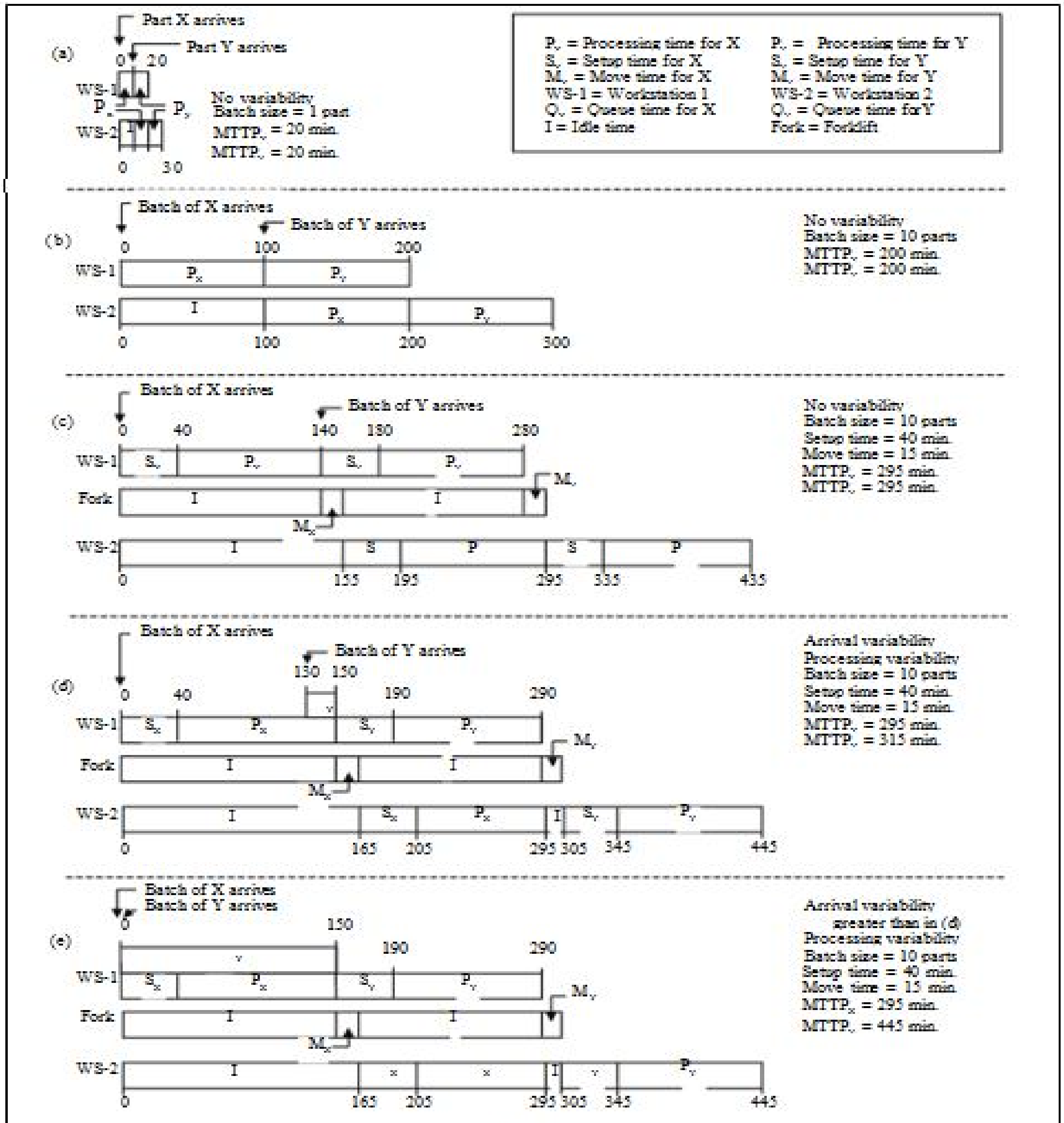

Figure 3
Impact of Batch Size, Setup Time, Move Time, and Variability on MTTP

2.2.5 Utilization

Variability has less impact on queue time when workstation utilization is low than when workstation utilization is high. When utilization is low and significant slack workstation capacity exists, it is fairly easy for a batch to arrive when the workstation is idle and be processed immediately. However, as utilization increases and less slack capacity is avail- able, it becomes more difficult for a batch to arrive when the workstation is idle. This increases the probability that the batch must join the queue, resulting in longer queue times and MTTP.

For example, suppose batches of parts arrive to a single workstation on average every 10 hours, each batch contains 10 parts, and the average batch processing time is 6 hours. However, due to variability, the actual interracial and processing times deviate from the average. The actual interracial and processing times for four batches of different parts arriving to this workstation are shown in *Figure 3a*. In this case, the workstation is idle when each batch arrived, the average utilization is 60%, and the average MTTP is 6 hours. In *Figures 3b*, *3c*, and *3d*, the average utilization of the workstation is increased to 70%, 80%, and 90%, respectively, by decreasing the average time between batch arrivals to 8.6, 7.5 hours, and 6.7 hours, respectively, while simultaneously keeping the absolute deviations from the average interracial time for each batch the same as in *Figure 3a*. As shown, the increases in utilization caused the batch of X to incur queue time of 0.4 hours in *Figure 3b*; batches of X and Y to incur queue times of 1.5 and 1.0 hours, respectively, in *Figure 3c*; and batches of X and Y to incur queue times of 2.3 and 2.6 hours, respectively, in *Figure 3d*. If each part cannot leave the station until the entire batch has been processed, these queue times caused the average MTTP to increase at an increasing rate with successive increases in utilization. The magnitude of the impact that utilization and variability have on MTTP will vary from system to system. However, queuing theory indicates the general pattern of results shown in *Figure 3* holds for all systems, namely that queue time and its associated MTTP increase at an increasing rate as utilization increases (see *Figure 4*). Furthermore, queue time and MTTP at a workstation with high variability will increase faster as utilization in- creases than will queue time and MTTP at a work- station with low variability.

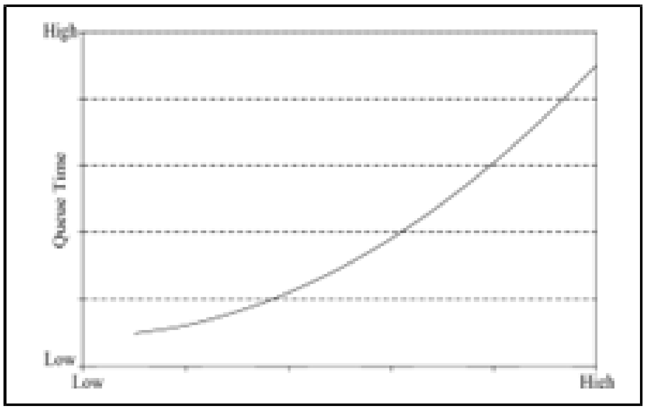

Figure 2
Queue Time vs. Interarrival and Process Time Coefficient of Variation. Note: Graph constructed using GI/G/M queuing formula in Whitt (1983).

2.2.6 Factor Interactions

The preceding discussion indicates that MTTP is equal to the sum of the processing, setup, move, queue, wait-in-batch, wait-to-batch, and wait-to- match times. Because queue, wait-in-batch, wait- to-batch, and wait-to-match times all involve waiting, and because actions to reduce one type of waiting may also reduce other forms of waiting, they are collectively referred to as waiting time in the MTTP reduction framework. Reductions in MTTP thus require reductions in one or more of these components. While setup time, processing time per part, and move time are independent of each other (i.e., a reduction in move time does not affect setup time or processing time per part, and so on), changes in any of these three components can affect waiting time (Hyer and Wemmerlöv 2002). Consequently, one way to re- duce waiting time is to manipulate the other three components of MTTP.

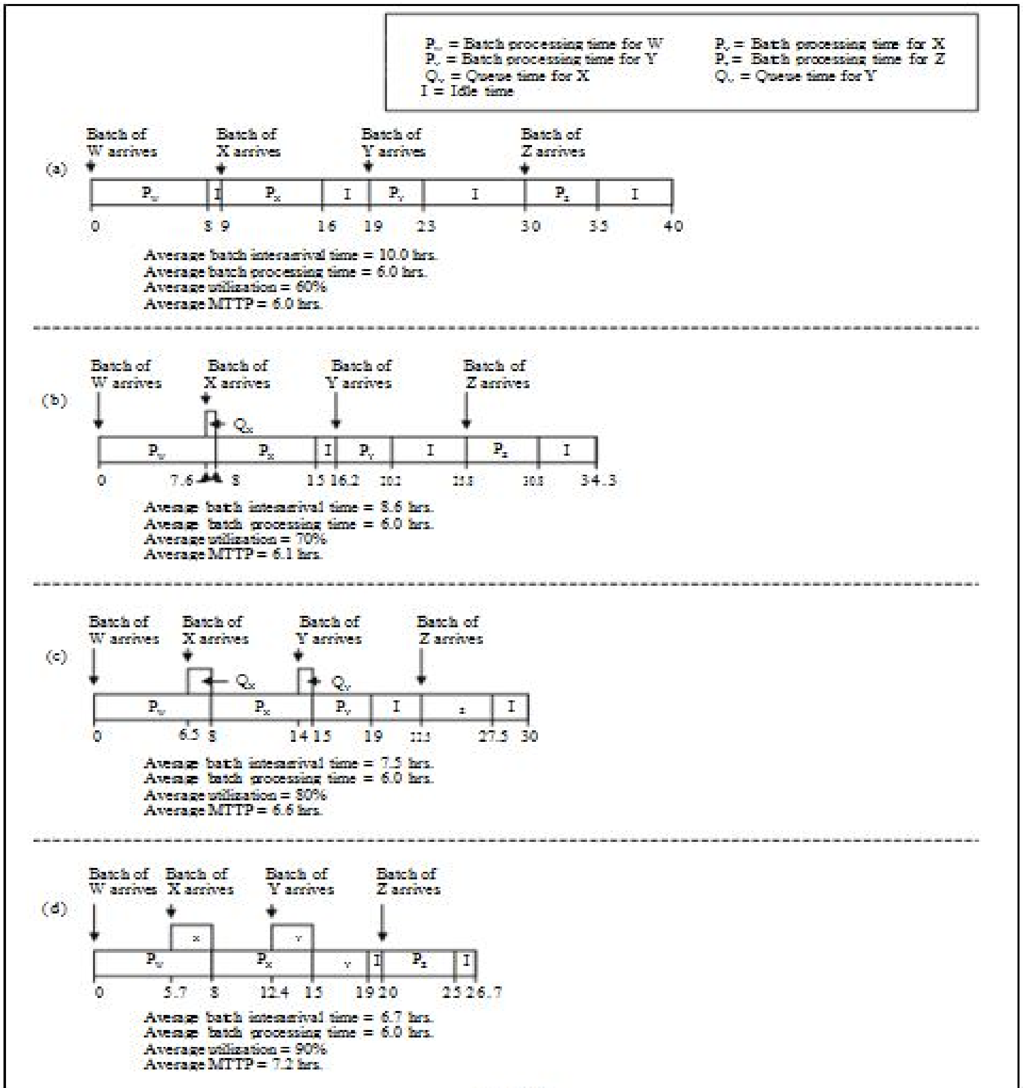

Figure 3
Impact of Utilization on MTTP

For example, if the average processing time per part is reduced to 5 minutes for each part type at each workstation in *Figure 1e* while all other conditions remain the same, Y would only wait 100 minutes at WS-1 and the MTTP would be 295 minutes (see *Figure 5*). Reducing batch processing time by 100 minutes for each part (i.e., 50 minutes at station 1 and 50 minutes at station 2) in this case actually caused a 150 minute reduction in MTTP for Y due to the additional impact on waiting time at WS-1.

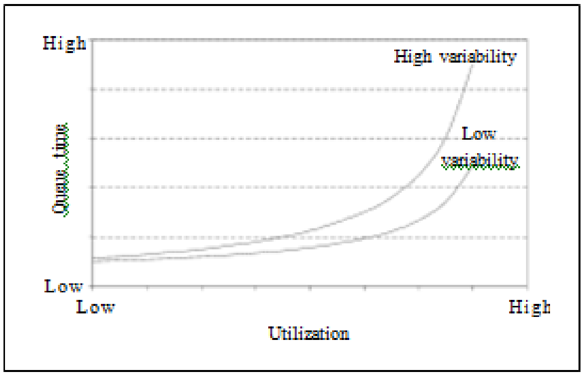

Figure 4
Queue Time vs. Utilization. Note: Graph constructed using GI/G/M queuing formula in Whitt (1983).

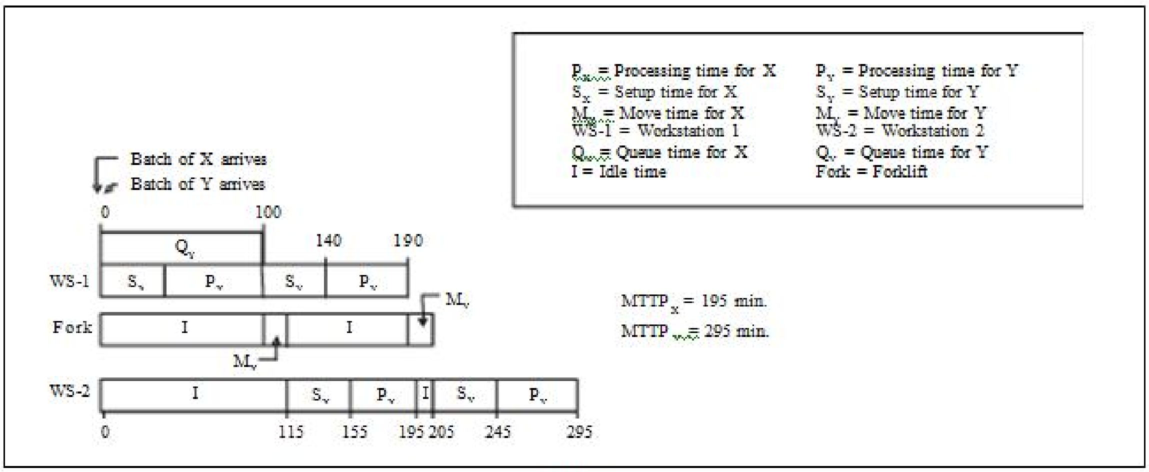

Figure 5
Impact of Processing Time per Part Reduction on MTTP Compared to *Figure 1e*

2.2.7 Manufacturing Throughput Time Reduction Framework

Overview of Framework

Figure 6 presents the MTTP reduction framework. The framework can be described as a flowchart with five columns. Column 1 lists the objective of the framework as the reduction in MTTP. Column 2 presents the components of MTTP. Setup time is the sum of the times spent setting up all workstations required to process the part through the production system. Processing time is the sum of the times spent processing a part at each workstation required in the production routing for the part. Move time is the sum of times spent moving a part between each workstation in the production routing for the part. Waiting time is the sum of the queue, wait-in-batch, wait-to- batch, and wait-to match times at all workstations in the production routing for the part. Waiting time is usually the largest of the four components, accounting for as much as 90% of manufacturing lead time in some systems (Houtzeel 1982). Column 3 illustrates the factors that will reduce each component. Column 4 specifies actions that will alter each factor shown in column 3, and column 5 presents important changes that might be required to enable some of the actions shown in column 4. The feasibility of accomplishing some of the actions and changes shown in columns 4 and 5 are directly related to the type of production layout used (i.e. job shop/functional layout, cellular layout, or product layout/assembly line). The issue of layout choice will be included in the following discussion where appropriate.

Based on these definitions, one or more of these four components must be reduced in order to re- duce MTTP; by following the flowchart from left to right, actions that will reduce each component can be identified. This flowchart is intended to provide a structured way to examine the types of actions that can be taken to reduce MTTP and the relationships between these actions. The following sections briefly discuss how to reduce each component of MTTP.

2.7.1 Setup Time Reduction

Column 3 of *Figure 6* indicates that setup time reductions can be accomplished by reducing the time per setup and/or the number of setups. Time per setup can be reduced by purchasing equipment with short setup times, improving setup procedures, dedicating workstations to families of parts with similar setup requirements so that common fixtures can be used and developed, and/or by using family scheduling to group batches that have common setup requirements. Workstation dedication and family scheduling can also reduce the number of setups required. Further information on improving setup procedures can be found in works by Steudel and Desruelle (1992) and Shingo (1985).

2.2.8 Processing Time per Part Reduction

Column 3 of *Figure 6* indicates that reductions in processing time per part can be accomplished by reducing the number of operations required, reducing the processing time per operation, and/or reducing scrap and rework. The number of operations per part may be reduced through the adoption of new technology that allows a single operation to do what was previously done by several operations, or by redesigning the part so that fewer operations are required. Processing time per operation can be reduced by redesigning the part to require less processing, incorporating faster technology to process the part (if available), or dedicating labor to a family of parts with similar processing requirements. Labor dedication allows the workers processing the parts to be- come more familiar with a smaller family of parts, thus potentially reducing the amount of time spent reading blueprints, setting machine speeds, performing quality inspections while the parts are on the machine, and so on.

The best way to reduce scrap and rework is to improve raw material quality to prevent defective material from entering the system, and to improve equipment capabilities, processes, and procedures to prevent scrap and rework from happening in the first place. Implementing poka-yoke (fail-safe) de- vices can be especially beneficial in this respect. Using one-piece flow (or very small transfer batches) can also reduce scrap and rework because defective parts can be quickly detected at the next operation. One-piece flow is often impractical in a job shop/ functional layout due to the increased material handling, production control, scheduling, and/or information systems requirements such a change would entail. In contrast, one-piece flow can often be used in a cellular or product-oriented layout with little impact on the same requirements. As a last resort, increased inspection of the parts to identify defective units and prevent them from being transferred to the next operation can be used to improve scrap and rework.

2.2.9 Move Time Reduction

Column 3 of *Figure 6* indicates that reductions in move time can be accomplished by reducing either the time required per move or the number of moves required. The time required per move can be reduced by increasing the speed of the material handling equipment (which may not be possible due to safety implications), or by reducing the move distance required. If the speed of the material handling system is increased through the installation of conveyors or other automated handling equipment, it is question- able how realistic this option would be when a job shop/functional layout is used. While move distance can sometimes be reduced by reorganizing the equipment to optimize the material handling between departments in a job shop/functional layout, the amount of reduction is greater if the equipment performing sequential operations on a part is grouped to form manufacturing cells.

If a job shop or functional layout is currently being used, the number of moves requiring material handling equipment can often be reduced by grouping workstations performing sequential operations into manufacturing cells. In some cases, technological improvements that allow more sequential operations to be done by a single machine can achieve the same result (for example, a CNC milling ma- chine is used to perform the operations previously done by several machines)

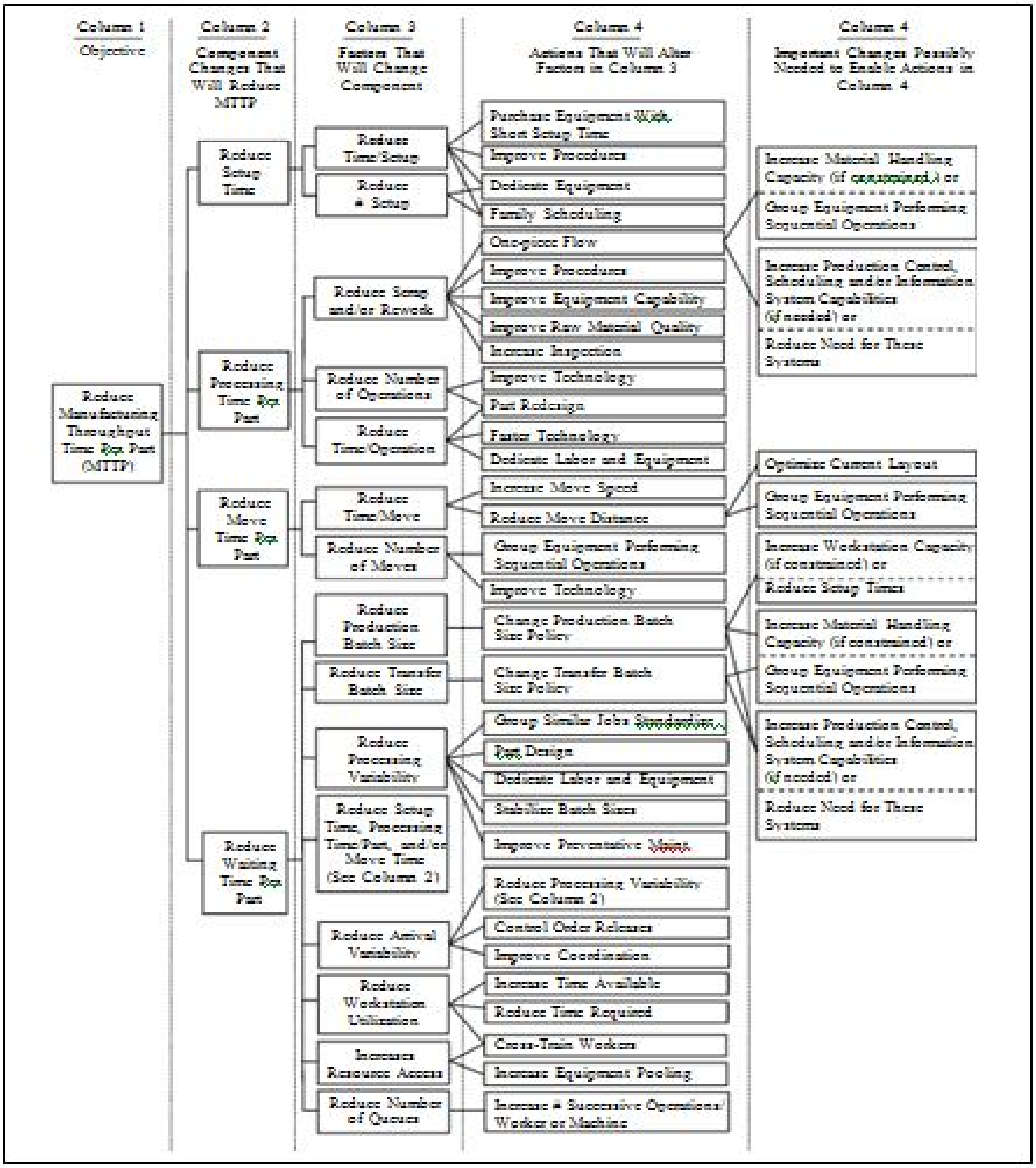

Figure 6
Manufacturing Throughput Time per Part (MTTP) Reduction Framework

2.2.10 Waiting Time Reduction Overview

Column 3 of *Figure 6* indicates that reductions in waiting time can be accomplished by reducing setup time, processing time per part, move time, production batch sizes, transfer batch sizes, processing time variability, arrival variability, resource utilization, and/or the number of queues. It can also be reduced by increasing access to resources. Reductions in setup time, processing time per part, and move time have already been discussed. The remaining factor changes will be discussed in the following sections.

2.2.11 Production Batch Size Reduction

Production batch size reduction is often the easiest and most cost-effective way to reduce waiting time and MTTP in most plants. Not only does it re- duce the wait-for-lot time for the part in question, but it also reduces queuing time for parts in other batches as well. For instance, consider the example in *Figure 1e*. The average processing time per part for X is 110 / 10 = 11 minutes at WS-1 and 90 / 10 = 9 minutes at WS-2. Because only one part in the batch is processed at a time, 9 parts are always waiting, resulting in a wait-for-lot time of 11 * 9 = 99 minutes at WS-1 and 9 * 9 = 81 minutes at WS-2. The queue time for Y is 150 minutes at WS-1 and the wait-for-lot time at both WS-1 and WS-2 is (100/ 10) * 9 = 90 minutes. This produces a MTTP for X and Y of 295 minutes and 445 minutes, respectively. In contrast, if production and transfer batch sizes are reduced to 5 parts for both X and Y but all other conditions remained the same, the wait-for-lot time for X is reduced to 11 *4 = 44 minutes at WS-1 and 9 * 4 = 36 minutes at WS-2 (see *Figure 7*). Queue time for Y drops to 95 minutes at WS-1 and the wait- for-lot time at both WS-1 and WS-2 drops to (50 / 5) * 4 = 40 minutes. The net result of the batch size reduction is that MTTP is reduced to 195 minutes for X and 290 minutes for Y.

To reduce batch sizes, the plant needs to implement a policy to schedule production of smaller batches. However, if demand stays constant, smaller batch sizes increase the number of setups required. As the number of setups increases and more of the available capacity is used for setups, workstation utilization increases, which causes queues to grow. Eventually, the increased queues negate any benefit to be obtained from batch size reduction and MTTP increases rapidly (see *Figure 8*). Reducing setup time would allow further batch size and MTTP reduction. When batches are transferred between workstations by forklift, handcart, or another similar conveyance device, batch size reduction also increases the number of trips required. The increased number of trips raises the utilization of the forklift, which causes increased queuing. If utilization increases enough, the increased queues counteract any benefit to be obtained from batch size reduction, and MTTP increases rapidly in the same manner as previously described for the impact of batch size reduction on setup time. Batch size reduction also increases the number of different batches of product on the shop floor at any one time, which may increase the load on the production control, scheduling, and/or information systems. Based on this discussion, if MTTP is to be reduced through batch size reduction, one or more of the following changes are often required (see Column 5 in *Figure 6*):

1. Workstation capacity must be increased (if capacity is constrained) or setup times reduced.
2. Material handling capacity must be increased (if capacity is constrained) or the workstations required to process a batch be consolidated so that material handling equipment is not needed as often.
3. The capabilities of the production control, scheduling, and/or information systems must be increased (which may included increases in both labor and computer capacity) to handle the increased requirements or the need for these systems reduced

If production is performed using a job shop/functional layout, the spatial separation of workstations and labor resources required to produce the batch of parts will likely require increases in workstation and material handling capacity and production control, scheduling, and/or information systems capabilities as batch sizes are reduced. In contrast, if cells are formed, workstations and labor are dedicated to families of parts and grouped in close proximity. This dedication and grouping reduces setup time and of- ten allows the parts to be transferred between work- stations by hand or by small conveyors, thus eliminating the need for forklifts and other material handling equipment. Cells reduce the amount of cen- tralized scheduling required because only the cell must be scheduled rather than each workstation. Tracking of parts is less because the parts are either in one of the cells or the order hasn't been started yet. Finally, reduced scheduling and tracking requirements may reduce the amount of computer information system capacity needed (if a computerized information system was used) and the amount of time needed to enter data, maintain the system, etc. Thus, converting a job shop/functional layout to a cellular layout would likely allow batch size reduction with- out corresponding increases in machine capacity, material handling, production control, scheduling, and information system capacity/capabilities. In fact, the use of cells may result in less need for these systems, even though batch sizes are reduced.

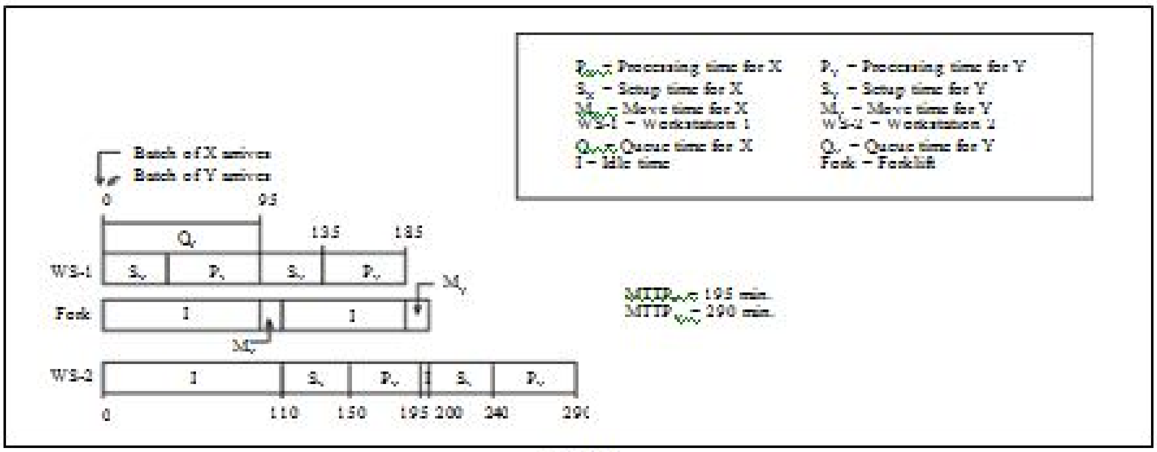

Figure 7
Impact of Batch Size Reduction on MTTP Compared to Figure 1e

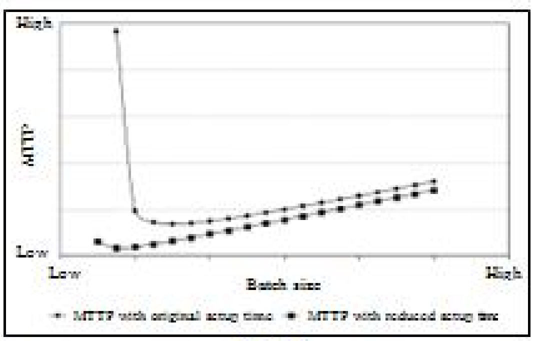

Figure 8
MTTP vs. Batch Size. Note: Graph constructed using standard queuing theory formulas.

2.2.12 Transfer Batch Size Reduction

If production batch sizes cannot be reduced, wait- ing time can still be reduced through the use of transfer batches smaller than the production batch size. For example, suppose in Figure 1e that setup times cannot be reduced below 40 minutes, which pre- vents production batch size reductions. However, material handling capacity is such that transfer batches of five parts could be used. The impact of this change is illustrated in Figure 9. As shown, the transfer batch size reduction reduced the wait-to- batch time for the first transfer batch of X and Y at WS-1 to 11 * 4 = 44 and 10 * 4 = 40 minutes, respectively. This allowed these transfer batches to be moved to WS-2 earlier than in Figure 1e, and be- cause WS-2 was idle, it could begin processing the transfer batches immediately. Thus, the first trans- fer batch of X was being processed at WS-2 at the

at same time as the second transfer batch for X was being processed at WS-1. Similar results occurred for Y. Even if both transfer batches must be combined before leaving WS-2, the net result is a reduction in MTTP for X of 295 – 240 = 55 minutes and for Y of 445 – 395 = 50 minutes when compared to *Figure 1e*.

Transfer batch size reduction has the same implications for material handling capacity, production control, scheduling, and information system capabilities as those previously discussed for batch size reduction, but it does not influence the number of setups required if all transfer batches of the same production batch are processed consecutively be- fore parts of a different type are processed. Transfer batch size reduction also has less impact on material handling capacity, production control, scheduling, and information system capacity if manufacturing cells are used versus a job shop layout.

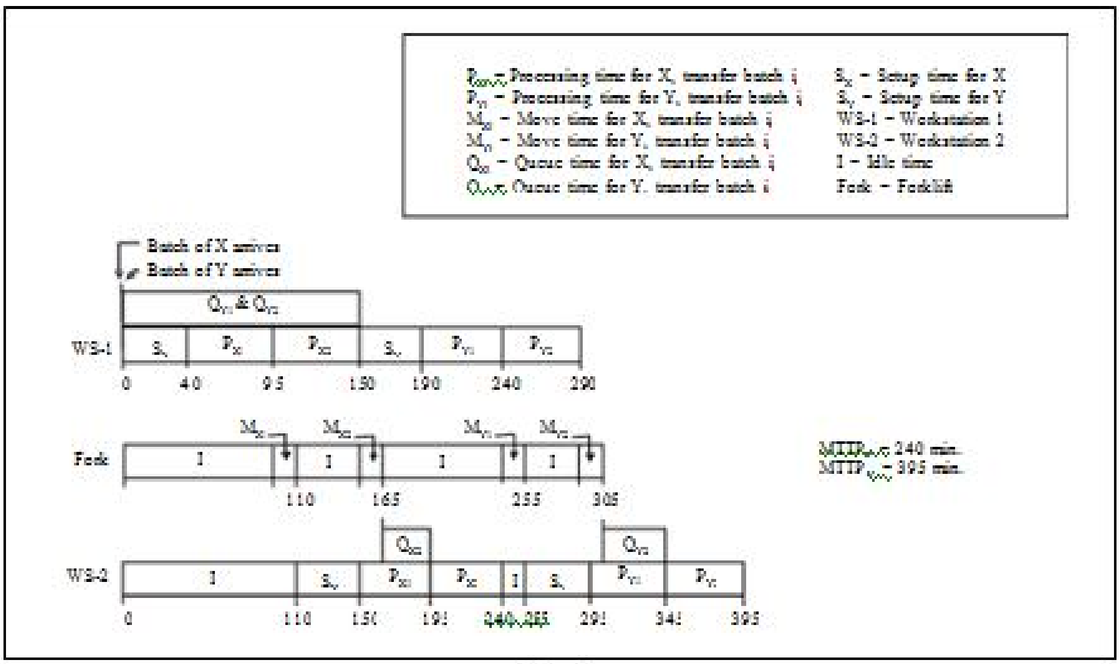

Figure 9
Impact of Transfer Batch Reduction on MTTP Compared to *Figure 1e*

2.2.13 Processing Time Variability Reduction

Variability in processing time comes from several sources: variance in setup time for a workstation, variance in the processing time per part, variance in the size of the batch processed, and variance due to unplanned downtime and repair of the workstation. Reducing any of these sources of variability will reduce processing time variability and, consequently, waiting time as well. Grouping similar jobs based on part family affiliation, dedicating equipment and labor to these part families, and/or standardizing part design will help reduce the variance associated with setup times and processing time per part. Stabilizing or establishing similar batch sizes for all jobs in the family will help reduce variance associated with batch size differences. Improvements in preventive maintenance will help reduce variance associated with unplanned downtime and repair of the workstation.

2.2.14 Arrival Variability Reduction

Reductions in arrival variability will also reduce waiting time. Arrival variability is more complex than processing variability and is dependent on the variability of new orders released directly to the work- station, as well as the departure variability from any upstream workstations that feed the station in question. When workstation utilization is high, each job is extremely likely to arrive when the workstation is busy and, consequently, is likely to have to join the queue. As a result, the departure variability from the workstation is primarily dependent on the processing variability at the station. In contrast, when work- station utilization is low, the workstation is idle a substantial portion of the time and each job arriving to the station is more likely to find the station idle. In this case, variability in the time between arrivals tends to directly impact departure variability. In addition, departure variability is reduced as the num- ber of identical copies of the resource at the station increase (Hopp and Spearman 2001, p263). This is a direct result of resource pooling. More will be said about this impact in section 3.5.7.

Regardless of the utilization level, any changes that reduce variability in the time between arrivals or in the actual processing at the workstation will reduce departure variability. Processing variability has already been discussed. Variability in the time between the arrivals of new orders can be reduced through the use of controlled order release mechanisms. Such mechanisms stabilize the production schedule by releasing new orders to the workstation when the queue reaches a set level. For assemblies that require two or more components to start production of the job, any changes in production control that improve the coordination of the arrival of the components will also reduce arrival variability.

2.2.15 Workstation Utilization Reduction

As discussed in section 2.5, wait time is heavily influenced by workstation utilization. Workstation utilization can be defined as “the total workstation time required per period divided by the total work- station time available per period.” In this framework, the total workstation time required per period is equal to the sum of the times spent setting up the workstation, processing parts, waiting for labor to become available, and waiting for the equipment to be re- paired. This is similar to the definition used in queuing packages like MPX (MPX 1996). The total workstation time available per period is equal to the sum of the times each identical unit of the resource at the workstation is available to be used. Thus, for example, if the workstation has two semi-automated machines operated by a single worker, each machine is available eight hours per day, and on average a total of two hours are spent setting up the machines, ten hours are spent processing parts, one hour is spent waiting for labor, and unplanned downtime equals one-half hour each day, the average workstation is primarily dependent on the processing variability at the station. In contrast, when work- station utilization is low, the workstation is idle a substantial portion of the time and each job arriving to the station is more likely to find the station idle. In this case, variability in the time between arrivals tends to directly impact departure variability. In addition, departure variability is reduced as the number of identical copies of the resource at the station increase (Hopp and Spearman 2001, p263). This is a direct result of resource pooling. More will be said about this impact in section 3.5.7.

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The time available per period can be increased by adding equipment if capacity is machined con- strained, adding workers (and possibly extra shifts) if capacity is worker constrained, and reducing absenteeism. The capacity or time required can be reduced by reducing the arrival rate of jobs to the workstation (which will reduce output), and/or by reducing setup time, processing time per part, equipment downtime, scrap and rework, and delays due to unavailability of workers. Reducing delays due to unavailability of workers may require adding additional workers (which also increases capacity), re- assigning worker responsibilities to better balance the load, or cross-training workers to handle multiple tasks. In the case of cross-training, workers can float to the workstation or resource experiencing the most delays. This will reduce the utilization of equipment, but it will not necessarily increase the overall average worker utilization because it may simply change when and which worker is idle, rather than the total amount of idle time. If this occurs, resource availability is increased without increasing utilization, and wait time goes down.

2.2.17 Increase Resource Access

Figure 6 indicates that waiting time can also be reduced by increasing access to resources. While resource access can be increased by purchasing equipment, hiring workers, working overtime, etc., the intent of this factor is to increase resource access without incurring these additional costs. Using cross- trained workers and increasing equipment pooling can sometimes accomplish both of these goals. Us- ing cross-trained workers has previously been discussed and will not be mentioned further.

To understand how equipment pooling can in- crease resource access and reduce waiting time, consider the case where parts A and B both require a milling operation (as well as other operations not requiring a mill) and this operation can be done on either Mill 1 or Mill 2. However, the two mills are currently located in different areas of the plant and Mill 1 is dedicated to the production of A and Mill 2 is dedicated to the production of B. While this may have its advantages, it does create the possibility that Mill 1 is starved for work due to variability in demand, variability in processing times at previous stations, workstation downtime at a previous station, etc., while Mill 2 has a queue of B waiting for processing. Thus, B incurs waiting time even though a mill with the required capabilities is currently sitting idle in another area of the plant. This would not hap- pen if the two mills were pooled (i.e., resource pooling is increased) by locating them in close proximity and feeding them with a common queue of work. Whenever a mill in the pool becomes idle, it would begin processing the next job in the queue. This can reduce waiting time and MTTP for A and B, *pro- vided the increase in equipment pooling doesn't in- crease setup times, processing times, move times, variability, etc., to the point where the impact of these increases overcomes any potential waiting time reduction resulting from the pooling increase.* Due to the complex interaction of such factor changes, queuing theory or simulation models are often required to determine if MTTP would be reduced through in- creases in equipment pooling.

2.2.18 Reduce Number of Queues

The final way to reduce waiting time is to reduce the number of queues by increasing the number of successive operations that the same worker or ma- chine performs. For example, suppose a metal part requires several different milling, drilling, and tap- ping operations and these operations are currently done on three different machines made specifically for that purpose. At each machine, the part may have to join a queue to wait its turn for processing. In contrast, if all these operations can be done on a CNC milling machine, the queues between operations are eliminated. The elimination of wait time will reduce MTTP, *provided any increase in setup and processing time resulting from the use of the CNC milling machine rather than the specialized equipment is less than the amount of time the part normally spends waiting*. Similarly, cross-training workers to perform multiple assembly tasks that were previously done by separate workers will reduce MTTP, provided any increase in task time resulting from the loss of specialization is less than the waiting time eliminated.

2.3 Type of lay out

Objectives of good machine\plant Layout:-

A well designed plant layout is one that can be beneficial in achieving the following objectives:

· Proper and efficient utilization of available floor space

· Transportation of work from one point to another point without any delay

· Proper utilization of production capacity.

· Reduce material handling costs

· Utilize labour efficiently

· Reduce accidents

· Provide for volume and product flexibility

· Provide ease of supervision and control

· Provide for employee safety and health

· Allow easy maintenance of machines and plant.

· Improve productivity

considering the above objectives the are five type of lay out as follows

2.3.1 PROCESS LAYOUT :-

Process layouts are found primarily in job shops, or firms that produce customized, low-volume products that may require different processing requirements and sequences of operations. Process layouts are facility configurations in which operations of a similar nature or function are grouped together. As such, they occasionally are referred to as functional layouts. Their purpose is to process goods or provide services that involve a variety of processing requirements. A manufacturing example would be a machine shop. A machine shop generally has separate departments where general-purpose machines are grouped together by function (e.g., milling, grinding, drilling, hydraulic presses, and lathes). Therefore, facilities that are configured according to individual functions or processes have a process layout. This type of layout gives the firm the flexibility needed to handle a variety of routes and process requirements. Services that utilize process layouts include hospitals, banks, auto repair, libraries, and universities.

Improving process layouts involves the minimization of transportation cost, distance, or time. To accomplish this some firms use what is known as a Muther grid, where subjective information is summarized on a grid displaying various combinations of department, work group, or machine pairs. Each combination (pair), represented by an intersection on the grid, is assigned a letter indicating the importance of the closeness of the two (A= absolutely necessary; E= very important; I= important; O= ordinary importance; U= unimportant; X= undesirable). Importance generally is based on the shared use of facilities, equipment, workers or records, work flow, communication requirements, or safety requirements. The departments and other elements are then assigned to clusters in order of importance.

Advantages of process layouts include:-

Flexibility:- The firm has the ability to handle a variety of processing requirements.

Cost:- Sometimes, the general-purpose equipment utilized may be less costly to purchase and less costly and easier to maintain than specialized equipment.

Motivation:- Employees in this type of layout will probably be able to perform a variety of tasks on multiple machines, as opposed to the boredom of performing a repetitive task on an assembly line. A process layout also allows the employer to use some type of individual incentive system.

System protection:- Since there are multiple machines available, process layouts are not particularly vulnerable to equipment failures.

Disadvantages of process layouts include:-

Utilization:- Equipment utilization rates in process layout are frequently very low, because machine usage is dependent upon a variety of output requirements.

Cost:- If batch processing is used, in-process inventory costs could be high. Lower volume means higher per-unit costs. More specialized attention is necessary for both products and customers. Setups are more frequent, hence higher setup costs. Material handling is slower and more inefficient. The span of supervision is small due to job complexities (routing, setups, etc.), so supervisory costs are higher. Additionally, in this type of layout accounting, inventory control, and purchasing usually are highly involved.

Confusion:- Constantly changing schedules and routings make juggling process requirements more difficult.

2.3.2 PRODUCT LAYOUT :-

Product layouts are found in flow shops (repetitive assembly and process or continuous flow industries). Flow shops produce high-volume, highly standardized products that require highly standardized, repetitive processes. In a product layout, resources are arranged sequentially, based on the routing of the products. In theory, this sequential layout allows the entire process to be laid out in a straight line, which at times may be totally dedicated to the production of only one product or product version. The flow of the line can then be subdivided so that labor and equipment are utilized smoothly throughout the operation.

Two types of lines are used in product layouts: paced and unpaced. Paced lines can use some sort of conveyor that moves output along at a continuous rate so that workers can perform operations on the product as it goes by. For longer operating times, the worker may have to walk alongside the work as it moves until he or she is finished and can walk back to the workstation to begin working on another part (this essentially is how automobile manufacturing works).

On an unpaced line, workers build up queues between workstations to allow a variable work pace. However, this type of line does not work well with large, bulky products because too much storage space may be required. Also, it is difficult to balance an extreme variety of output rates without significant idle time. A technique known as assembly-line balancing can be used to group the individual tasks performed into workstations so that there will be a reasonable balance of work among the workstations.

Product layout efficiency is often enhanced through the use of line balancing. Line balancing is the assignment of tasks to workstations in such a way that workstations have approximately equal time requirements. This minimizes the amount of time that some workstations are idle, due to waiting on parts from an upstream process or to avoid building up an inventory queue in front of a downstream process.

Advantages of product layouts include:-

Output:- Product layouts can generate a large volume of products in a short time.

Cost:- Unit cost is low as a result of the high volume. Labor specialization results in reduced training time and cost. A wider span of supervision also reduces labor costs. Accounting, purchasing, and inventory control are routine. Because routing is fixed, less attention is required.

Utilization:- There is a high degree of labor and equipment utilization.

Disadvantages of product layouts include:-

Motivation:- The system's inherent division of labor can result in dull, repetitive jobs that can prove to be quite stressful. Also, assembly-line layouts make it very hard to administer individual incentive plans.

Flexibility:- Product layouts are inflexible and cannot easily respond to required system changes—especially changes in product or process design.

System protection:- The system is at risk from equipment breakdown, absenteeism, and downtime due to preventive maintenance.

2.3.3 FIXED-POSITION LAYOUT:-

A fixed-position layout is appropriate for a product that is too large or too heavy to move. For example, battleships are not produced on an assembly line. For services, other reasons may dictate the fixed position (e.g., a hospital operating room where doctors, nurses, and medical equipment are brought to the patient). Other fixed-position layout examples include construction (e.g., buildings, dams, and electric or nuclear power plants), shipbuilding, aircraft, aerospace, farming, drilling for oil, home repair, and automated car washes. In order to make this work, required resources must be portable so that they can be taken to the job for "on the spot" performance.

Due to the nature of the product, the user has little choice in the use of a fixed-position layout.

Disadvantages include:-

Space:- For many fixed-position layouts, the work area may be crowded so that little storage space is available. This also can cause material handling problems.

Administration:- Oftentimes, the administrative burden is higher for fixed-position layouts. The span of control can be narrow, and coordination difficult.

2.3.4 COMBINATION LAYOUTS:-

Many situations call for a mixture of the three main layout types. These mixtures are commonly called combination or hybrid layouts. For example, one firm may utilize a process layout for the majority of its process along with an assembly in one area. Alternatively, a firm may utilize a fixed-position layout for the assembly of its final product, but use assembly lines to produce the components and subassemblies that make up the final product (e.g., aircraft).

2.3.5 CELLULAR LAYOUT:-

Cellular manufacturing is a type of layout where machines are grouped according to the process requirements for a set of similar items (part families) that require similar processing.

These groups are called cells. Therefore, a cellular layout is an equipment layout configured to support cellular manufacturing.

Processes are grouped into cells using a technique known as group technology (GT). Group technology involves identifying parts with similar design characteristics (size, shape, and function) and similar process characteristics (type of processing required, available machinery that performs this type of process, and processing sequence).

Workers in cellular layouts are cross-trained so that they can operate all the equipment within the cell and take responsibility for its output. Sometimes the cells feed into an assembly line that produces the final product. In some cases a cell is formed by dedicating certain equipment to the production of a family of parts without actually moving the equipment into a physical cell (these are called virtual or nominal cells). In this way, the firm avoids the burden of rearranging its current layout. However, physical cells are more common.

An automated version of cellular manufacturing is the flexible manufacturing system (FMS). With an FMS, a computer controls the transfer of parts to the various processes, enabling manufacturers to achieve some of the benefits of product layouts while maintaining the flexibility of small batch production.

Some of the advantages of cellular manufacturing include:

Cost: Cellular manufacturing provides for faster processing time, less material hand less work-in-process inventory, and reduced setup time, all of which reduce costs.

Flexibility: Cellular manufacturing allows for the production of small batches, which provides some degree of increased flexibility. This aspect is greatly enhanced with FMSs.

Motivation: Since workers are cross-trained to run every machine in the cell, boredom is less of a factor. Also, since workers are responsible for their cells' output, more autonomy and job ownership is present.

CHAPTER THREE

DATA PRESENTATION AND ANALYSIS

3.1 INTRODCTION

In this chapter, the data collected through questionnaires and company documents will be presented and analyzed using statistical tables and narrations, as may be convenient, and interpreted. The findings from the respondents on different aspects of gear manufacturing system and possible reasons for any forthcoming problems and solutions are also presented. In our case we use three types of questioners or format one for customers the second questioners is for marketing department of HMMBI and the third questioner is for production planning and controlling and work shop managers. The whole format bears fourteen different questioners to be filled.In order to evaluate HMMBI gear manufacturing methods the questioners will be filled by selected samples. The questioners have three parts. The first part include four questioners for the customers of Hibret Manufacturing and Machine Building Industry. I take twenty customers as a sample.

The second part includes three questioners for the marketing department of Hibret Manufacturing & Machine Building Industry. I take ten samples from this department. And the third part includes eight questioners filled by to Hibret Manufacturing and Machine Building Industry production planning and controlling and work shop managers. For this part I take twenty samples for this purpose. Totally I take fifty samples for the whole research.

Table1. Type and Number of Respondent

	Questioner For Respondent	Number Of Respondent
1	customers	20
2	marketing department	10
3	PPC & work shop managers	20
Total		50

- Source: Questionnaire

In this study study fifty questioners are set as a tools for this analysis. The responses are collected and translated into scores according to the respondents response as shown below. In this section we will analyze the weakness and strength of Hibret Manufacturing and Machine Building Industry gear manufacturing methods by comparing with through put time gear manufacturing. The basis for the development of through put time for gear manufacturing is the establishment of clear and standards gear manufacturing line in the industry. If the industry is expected to perform gear manufacturing in a successful way putting clearly laid down manufacturing methodology. The following table is compiled from responses given by sample respondents included in the survey.

3.2 Presentation and analysis of data collected from customer

Table 2 Length of time as customer

Length of time as customer	Number of customer	% of respondent
Less than 5 years	9	45%
5 to 10 years	6	30%
More than 10 years	5	25%

Interpretation

Sa we can see from the table customer of Hibrt manufacturing and machine building industry grown up from time to time on ordering manufacturing of spare parts including gear. The demand of spare part and gear manufacturing is grown because the demand for industrial spare parts is high demanded . AS we can see from the table 25 % of the customer from the respondent is length time as customer more than 10 years , 30% of the customer from the respond is length time 5 to 10 years . and 45 % of the customers from the respondent is length time as customer below 5 years . so it shows more customers are length time less than 5 years.

Table 3 **degree of delivery with the due date**.

Length of time as customer	Average number of order per year	Average number delivery within due date	Percentage of met due date
Less than 5 years	135	112	82.96
5 to 10 years	95	69	72.63
More than 10 years	64	42	65.62
Total	294	223	73.73

- Source: Questionnaire

Interpretation

As we can see from table 3 the customer order of gear manufacturing is increasing from time to time and customer meet delivery due date is increasing . but when we see the meeting delivery due date for customer more than 10 years is 65.62 % meeting delivery due date for customer 5 to 10 is 72.63 % and meeting delivery due date for customer below 5 years is 82.96 %. The average meeting delivery time date is 73.73 % so HMMBI Indeed improvement on process of gear manufacturing .

As per date collector from market and ppc department the average delivery with in due date is 70 % there is a difference between customer and marketing and ppc date. The reason is the marketing take all customer .but the customer on this paper are limited.

3.3 Reason for not meeting the due date as responded by marketing department , PPC and work shop mangers.

An the work shop managers respond that the type of lay out in manufacturing of gear is functional type that is machine are organized on type of machines

1. The response for type of machine layout is lathe milling, slot, gear bobber grinder, furnace
2. The response for manufacturing process for gear manufacture is black preparation, turning milling, slotting, teeth cutting ,heat treatment, grinding
3. The selected population of workshop manager from HMMBI are selected from two factories of the industry, from conventional manufacturing factory and precision factory. And the response for the Question is all confirm that gear is manufacture on both factories.
4. For Question to workshop manager and PPC member the work shop manager put the location on their factory by select as shown below on fig 1 and the PPC member put the location of the two factories by put as shown below on fig 2
5. The reason for waiting time to produce gear all the workshop members and PPC members put their reason but we can summarized as below
    - There are many order of different spare parts which are manufactured on the same machine that used to manufactures gear this makes waiting time to make gear
    - There is some bottle neck machines and process for manufacturing of gear for example milling machine and heat treatment process
    - Some machine and process are located in one factories like grinding gear hobber, heat treatment in precision manufacturing factory and this take time to transport from one factory to other factory.

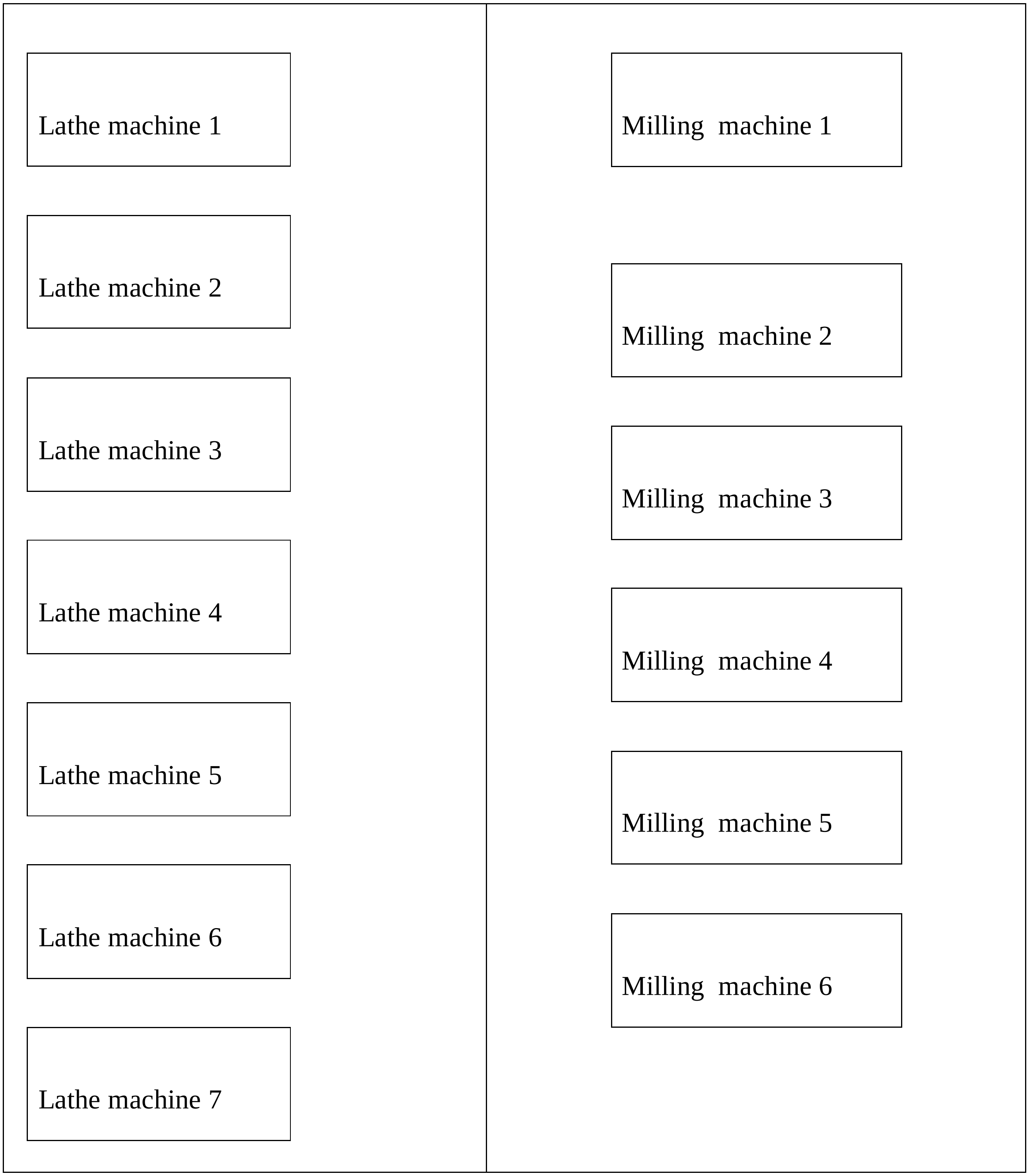

Fig 1 Machine layout of conventional manufacturing factory

Problem of the above lay out for gear manufacturing . the lay out consist tow type of machine that is lathe machine and milling machine. As discussed in the previous the process for gear is Turing Chamfering , Slotting, gear cutting ,heat treatment and grinding .so for the above operation the process needs lather machine, milling machine ,slotting machine gear hobber, grinding machine and heat treatment Furnace. On the existing HMMBI process semi finish gear are manufacture in the work shop and transfer to next factor that is precision manufacturing and this take time to transport from one factory to other factory and it leads to dely on delivery due date.

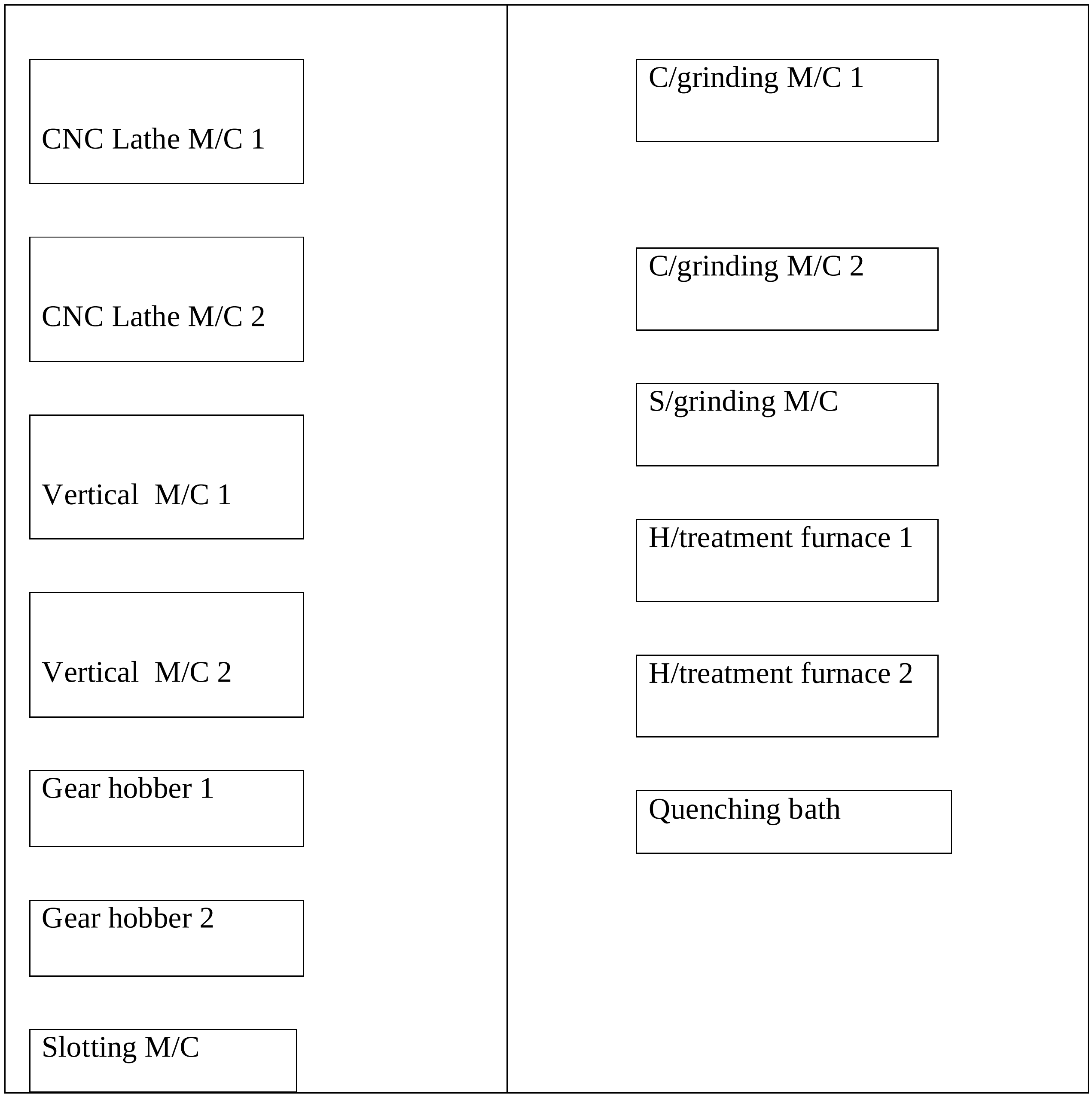

Fig 2 Machine layout of precision manufacturing factory

Problem of the above layout as we seen the process for gear manufacturing . this factory has machine need for gear manufacture but the machine are CNC(computer Numerical Control so it is not recommend to make turning and Chamfering in CNC lathe it is better to work on convection lathe and the factory as its name implies it has task to work precise spare parts like die & mould and this rates waiting time to manufacture gear.

CHAPTER Four :

CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusion

As we discuss the previous chapter through put time is the time of order given and completion (finishing) of the work. When we see the gear manufacturing the average meeting customer delivery order is 63.4 % on from the Qualitative analysis of the study we can conclude that the location lay out of the machine used to manufacture gear used also to manufacturing other spare parts and their location is in different factories of the industry.

4.2 Recommendation

We have seen from the past chapters and from the conclusion that the machine used to manufacture gear and the layout of the machine is functional type so to enhance the customer satisfaction and to reduce the through put time, The machine layout for gear manufacturing should be cellular type of layout . Cellular manufacturing is a type of layout where machines are grouped according to the process requirements for a set of similar items (part families) that require similar processing. These groups are called cells. Therefore, a cellular layout is an equipment layout configured to support cellular manufacturing.

Processes are grouped into cells using a technique known as group technology (GT). Group technology involves identifying parts with similar design characteristics (size, shape, and function) and similar process characteristics (type of processing required, available machinery that performs this type of process, and processing sequence).

Workers in cellular layouts are cross-trained so that they can operate all the equipment within the cell and take responsibility for its output. Sometimes the cells feed into an assembly line that produces the final product. In some cases a cell is formed by dedicating certain equipment to the production of a family of parts without actually moving the equipment into a physical cell (these are called virtual or nominal cells). In this way, the firm avoids the burden of rearranging its current layout. However, physical cells are more common.

An automated version of cellular manufacturing is the flexible manufacturing system (FMS). With an FMS, a computer controls the transfer of parts to the various processes, enabling manufacturers to achieve some of the benefits of product layouts while maintaining the flexibility of small batch production.

Some of the advantages of cellular manufacturing include:

Cost: Cellular manufacturing provides for faster processing time, less material hand less work-in-process inventory, and reduced setup time, all of which reduce costs.

Flexibility: Cellular manufacturing allows for the production of small batches, which provides some degree of increased flexibility. This aspect is greatly enhanced with FMSs.

Motivation: Since workers are cross-trained to run every machine in the cell, boredom is less of a factor. Also, since workers are responsible for their cells' output, more autonomy and job ownership is present.

The machines used to manufacture should be re organized in one workshop so that the work shop will produce only gear those machine will come from the two factories of the industry thinking that some delegated machine will organize from the existing machine on the two factories. And this enhance and leads to specialty of gear manufacturing and technology of gear will be developed through specialization and delaying and waiting time until other spare parts finished will be reduced so that through put time will be reduced. The new work shop machine layout for gear manufacturing should be equipped as the machine shown in fig 3 .

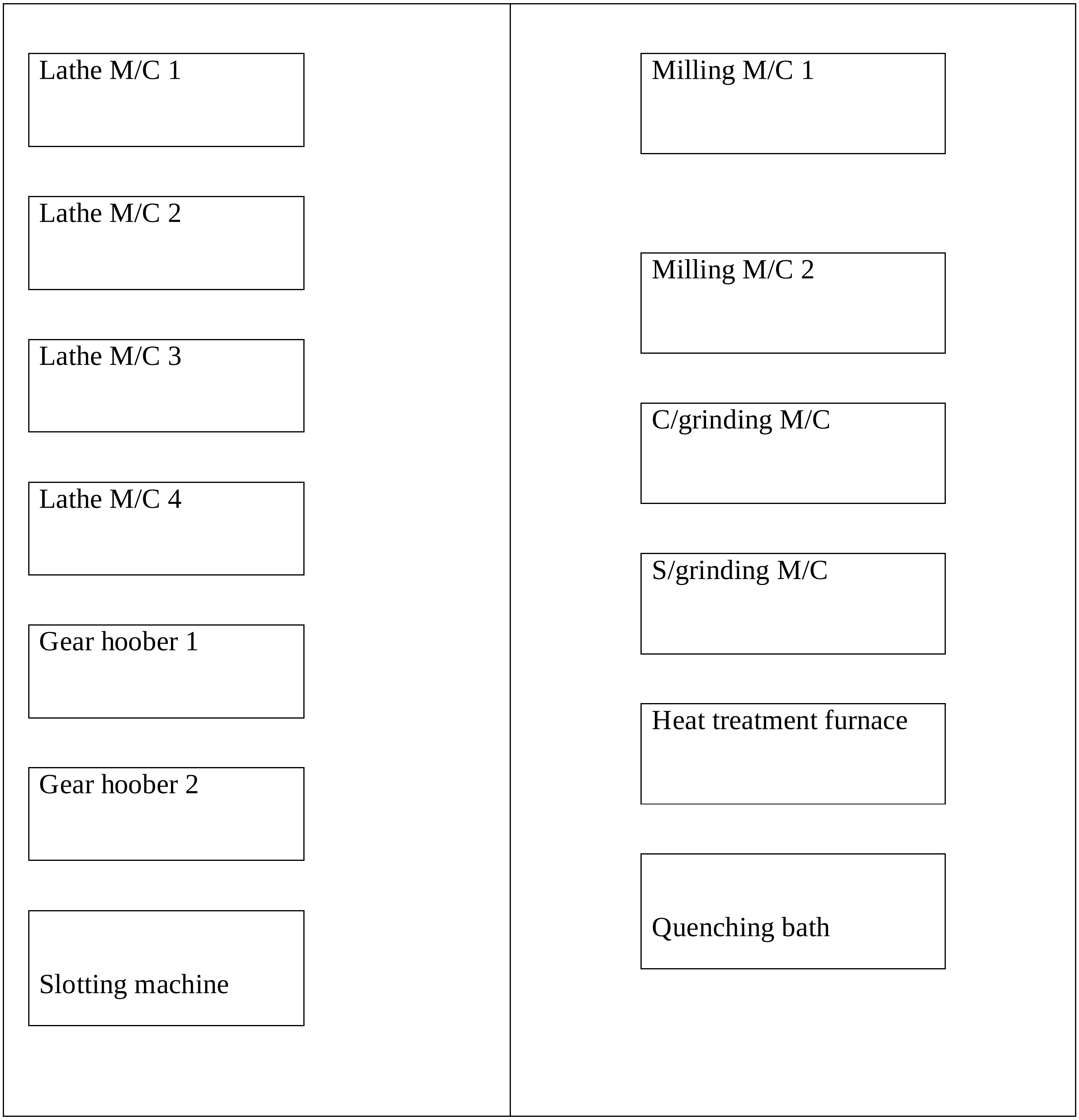

Fig 3 Recommended Machine layout of gear manufacturing work shop

As per the literature and comments from work shop managers the above layout is recommended. In this from recommendation some machines from the above two factories are selected and should be organized in new work shop those machines are your lathe machine and two milling machines from conventional manufacturing factory and two gear hobber , one slotting mach one surface grinding machine, one heat treatment furnace and one Quenching bath from precision manufacture factory, and this improves productivity, specialized in gear and reduce waiting time.

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ANNEX-1

INDIRA GANDHI NATIONAL OPEN UNIVERSITY

MS 100

Interview questions

The role of Machine Layout on reduction of through put time for gear manufacturing

Dear respondent

This instrument is dispatched to you in order to assess your experiences, views, and feelings on the role of Machine Layout on reduction of through put time for gear manufacturing in METEC-Hibret Manufacturing & Machine Building Industry. The information you provide in response to the items in the questionnaires will be used for partial fulfillment of MBA (Master of business administration).

The researcher pledges that the responses you provide here will be used for no other purposes than those specified here above; your anonymity shall be maintained; and that the outputs of the study will not be manipulated towards any end whatsoever. As a primary stakeholder, your cooperation shall be of great meaning to the process and outcomes of this study and is duly appreciated.

Part I: General information

I. Questionnaire to customers of Hibret Manufacturing and Machine Building Industry (HMMBI).

1. Customers company ______________________________________
2. Position of the interview ___________________________________

Part II: Main interview questions

2.1 For how many years are your company customers of Hibret Manufacturing & Machine Building Industry (HMMBI)? _______

2.2 How many type of gears your company order to Hibret Manufacturing & Machine Building Industry (HMMBI)? In line item and qty.

Line item _________

Qty _____________

2.3 How many of those order fulfill your delivery time? _________

S.N	1.1	1.2	2.1	2.2	2.3

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II. Questions to marketing department of Hibret Manufacturing & Machine Building Industry (HMMBI).

1. How many gear type order to Hibret Manufacturing & Machine Industry (HMMBI) in three years?

   In line item _____________

   In qty. __________________

2. How many customers are get their order on time?

   Out is the average through put time of gear

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III. Questions to Hibret Manufacturing & Machine Building Industry (HMMBI) production planning and controlling and work shop managers.

1. Explain the type of layout used in Hibret Manufacturing & Machine Building Industry (HMMBI) to manufacture gear?

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2. Explain the machines used to manufacture gear?

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3. Explain the process used to manufacture gear?

4. On how many factories from the industry gear is manufactured?

5. Explain the location of the machines used to manufacture gear?

6. Explain, if there is, the reason for waiting time to produce gear?

7. What is the transport means used to transfer gear blank & semi finish product and final product?

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8. What is the average through put time of gear?

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