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ADVANCED SYNCHRONIZED MANUFACTURING SYSTEM

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ABSTRACT

F.W. Taylor, the father of 'Scientific Management' who isolated work –study from general range of management work, led the real foundation. World war –II brought new revolutions in the field of the Time Study and work measurement, is now a base line to productivity enhancement, incentive schemes, labour control, material handling, planning and plan and product designing. What so ever is the present from of work, definitively a improved one from past, and to have a possibility of change to get a improved one, this process is going on and remain till the existence of man and hence work."Synchronized Manufacturing System" is one of the most versatile systems in the present scenario. 3M, Kanban, 5' S', TQM, TPM, Single Piece Flow. SMS is the combination of above stated systems. For understanding SMS, we must go through what is called "Conventional Manufacturing System". The traditional system of production used to follow process based production ethics.

KEYWORDS: Synchronized Manufacturing System, Scientific Management

INTRODUCTION

Synchronized Manufacturing System" is one of the most versatile systems in the present scenario. It can give

- Higher productivity
- Minimum storage
- Better flow of material
- Process standardization
- Continues improvement
- Better utilization of recourses
- Keeping pace with the market
- Self-motivated quality improvement
- Better customer supplier relationship
- Strive for customer delight, may be internal or external

All these can be achieved by combination of all the new concepts of manufacturing -practice of the world such as:

- 3M

- Kanban
- 5' S'
- Total Quality Management (TQM)
- Total Productivity Management (TPM)
- Flow Management (Single Piece Flow)

Process Layout

This type of layout is designed for non-repetitive intermittent production, wherein low volume of production, of variety of components/design can be obtained and is suitable for job-shop production. It's a process-oriented layout, which may be appropriate when flows are not maintained in standardized manner owing to variety of products

Table 1

Lathe M/C'S	Milling M/C'S		Assembly Line
Drilling M/C'S	Planner M/C'S	Grinding M/C'S	Storage

Product Flow Layout

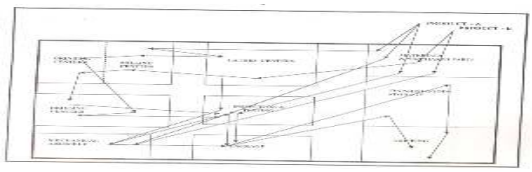

Figure 1

Product Layout

This type of layout carries the process machines, assembly station, and inspection-station arranged according to the sequence of operations are to be performed. It is product oriented layout with product based organization and continuous supplies of inventories. Thus, each component flows smoothly from one machine to another with the shortest move at a time, until all the necessary operations including assembly and inspection operations are completed this type of layout may prove to be most suitable for continuous or repetitive operations i.e. mass production.

New Mantras of World Class Manufacturing

The 5'S'

- **Proper Arrangement (Seiri)**
  - Sort through and then sort out,
  - Sort through what you have, identify what you need, and discard what is unnecessary,
  - Saving of time and saving of place
- **Orderliness (Seiton)**
  - Set things in order,

- Assign a separate location for all essential items Make the space self explanatory so everyone knows what goes where,
- Simplify means to neatly arrange and identify parts and tools for ease of use.
- Less difficulty in getting the things
- Lesser useless purchases

- **Cleanliness (Seiso)**
  - Clean equipment, tools, and workplace
  - Keep the workplace spotless at all times.
  - A clean environment at work place.
  - Clean machine and lesser maintenance
- **Standardize (Seiketsu)**
  - Maintain equipment and tools,
  - Keep the workplace clean.
- **Discipline (Shitsuke)**
  - Stick to the first four rules scrupulously,
  - Make them a habit.

Total Productive Maintenance (TPM)

Total Productive Maintenance (TPM) is an initiative for optimizing the effectiveness of manufacturing equipment. TPM is team-based productive maintenance and involves every level and function in the organization, from top executives to the shop floor. The goal of TPM is "profitable PM."

Kaizen

It refers to efficient utilization of worker, equipment and materials through, gradual, orderly and continuous improvement in the process or procedures etc. the bases of these activities are to enhance and demonstrate the technological and analytical power of worker. TPM analysis is being used as a tool in order to obtain effective solution to chronic problems. The 15 major losses are classified as follows:

Figure 2: Total Productive Maintenance for Kaizen

- Failure or breakdown losses,
- Measurement loss,
- Minor stoppage losses,

- Cutting toll loss,
- Reduced speed loss,
- Management loss,
- Quality defects and reworks loss,
- Startup loss,
- Adjustment step loss,
- Line organization loss,
- Operating motion loss,
- Energy loss,
- Logistic loss,
- Die and jog loss,
- Yield loss.

Total Quality Management

In TQM, we are considering "one present improvement in thousand things rather than thousand percent improvements in one thing". In short, we are considering the improvement of quality in each functional aspects of company i.e. we expect quality of finance, quality of humane behavior, quality of administration, etc. TQM is a complete "bottom up" management philosophy.

Total: Everyone in each function of the company is responsible for the quality of the output

Quality: Conformance to agreed customer requirements Quality is not relative high or low it conforms to the requirements if it is a quality product

Management: Like any other business strategy it is management led and seeking a strong bottom up involvement

Kanban

Kanban carries the information for production control. They are frequently tags or pieces of paper.

- The subsequent process goes to the former process to get parts,
- The former process produces the quantity removed by the subsequent process.
- Quality is built into the product Defects are never sent to the subsequent process.
- Kanban always accompany products on the line thus ensuring through visual control.
- Production quantities are level to avoid fluctuations and eliminate wastes.
- Reducing the number of Kanban increases their sensitivity and reveals places where process improvements are needed. This is inventory control.

Cellular Manufacturing

Cellular Manufacturing is an application of Group Technology in which dissimilar machines or processes has been aggregated into cells, each of which is dedicated to the production of the part or product family or a limited group of families. The typical objectives in cellular manufacturing are

- To shorten manufacturing lead times, by reducing setup, work part handling, rating times and batch sizes.
- To reduce work in process inventory smaller batch sizes and shorter lead times reduce work in process.
- To improve quality. This is accomplished by allowing each cell to specialize in producing a smaller no. of different parts. This reduces process variations.
- To simplify production scheduling. The similarity among parts in the family reduces the complexities of production scheduling. Instead of scheduling parts through a sequence of machines in a process type shop layout, the parts are simply scheduled through the cell.
- To reduce setup times. This is accomplished by using group tooling (cutting tools, jigs and fixtures) that has been designed to process that part family, rather than part tooling, which is designed for an individual part. This reduces the no. of individual tools required as well as the time to change the tooling between the parts.

Cycle Time or Pulse Rate

"Cycle Time" is the time is takes to carry one part all the way through the cell. As we know that the raw material has to go through different operation un-till, we get the final product. Therefore, the time consumed during this operation is the **"Cycle Time or Pulse Rate".**

How to Calculate "Cycle Time".

$$\text{Daily Quantity} = \frac{\text{Monthly Quantity Needed}}{\text{Working Days per m Month}}$$

STATEMENT OF PROBLEM

Management is all about learning Things are not mellifluous all the times, especially when we talk about productivity in this highly competitive environment we need to be constantly updated about the new methods and new techniques of production. Since need is the mother of all the inventions and need of humans is never satisfied.

Now during production each and every machine contributes to the process of production Each and every worker also plays an important role in productivity but still the efficiency of any plant i.e. number of effective product coming out restrained by some factor may be man or machine.

This may also results from improper location or positioning of machining this restrains the number of product coming out of any machine or plant and this situation is known as bottleneck and the operation is known as bottleneck operation In this project too the bottleneck operation was the prime concern and it was to be found out in machine shop of KBL. The target with proper standards after implementation of SMS was 200 units but only 154 units could be brought to compromise upon which 123 units are produced daily.

Analysis of the Problem

The problem of bottlenecking needs prime attention. This situation can be traced by one of the many prevalent methods of industrial engineering. The method we adopted here to trace the product cycle over each machine tool using "Time Study Technique (stop watch technique)". Measuring the time with a stopwatch, taken by the operator to perform each element of the operation. Either continuous method or snap back method of timing could be used.

Time study has been defined by British Standard Institution as **"The application of technique designed to establish the time for a qualified worker to carry out a specified job at a defined level of performance"**. This is absolutely essential for both the planning and control of operations. Without the measurement data, we cannot determine the capacity of facilities or it is not possible to quote delivery dates or costs. We are not in position to determine labor utilization and efficiency. Here a question arrives that "why and in which situation time study may be conducted?" the reasons are:

- The job in question is new one or not previously carried out.
- Change in the method of existing time standard.
- Complaint received from workers or unions regarding the time standards.
- To find out bottleneck operation in the process.
- To design financial incentive schemes.

Steps in Making Time Study

- Select the work to be studied
- Obtain and record all the information available about the job, operator, working conditions is likely to affect the work condition.
- Break down the operation in the element an element is a distinct part of a specified activity composed of one or more fundamental motion, selected for convenience of observation and timing.
- Measure the time by means of stop watch taken by the operator to perform each elements of the operation at the same time assess the operator effective speed of work relative to the operators concept of normal speed this is called performance rating.
- Adjust the observed time by rating factor to obtain normal time for each element.

  Normal time = (observed time * rating)\100
- Add the suitable allowances to compensate for fatigue, personal need, contingencies to give standard time for each element.
- Compute allowed time for entire job by adding element standard time considering frequency of occurrence of each element.
- Make a detailed job description describing the method for which the standard time is established.

- Test and review standard are necessary. Equations

WORK PROGRESS SCHEDULE

Behind every successful organization exorbitant management ethics is involved. To implement such ethics and techniques class managers and co-operative co-workers and subordinates too are integral.

Management is not always all about learning only but at time is also about implementing thus, effective management has always enticed us as budding engineering and one such philosophy is SMS, which needs special attention. Now SMS as our project was no easy job and required some adroit follower of it. So, our acumen paved its path in the following manner

Week 1: Exhaustive search was carried out on SMS and its elements such as Kanban, JIT, Kaizen, TQM etc. and we were frenzied to know all of them.

Week 2: Study was carried out by taking each subject and their principles into account and pillars of such management techniques were jotted down.

Week 3: Each and every process has it's own way to handle situations in any organization. So every module can only be understood but not covered in details thus we were drawing limits and boundaries against the search and study.

Week 4: We understood how SMS can really change the productivity The change in layout could bring such a substantial hike was really an enigma getting solved.

Week 5: We also understood that for better analysis an expert follower of SMS was to be found out soon from the market. Now one such beneficiary was Kirloskar Limited, Dewas. But semester exams delayed the good work.

After our exams we needed to move immediately to KBL, Dewas and collecting statistics as well as studying layout and bottleneck was of prime concern.

Final Week

It was the climax nearing and we need to study the industry as per the philosophy of SMS. After much toil and labor we were able to find the bottleneck operation and recommended few words against the present layout. Time Study really helped us a lot in concluding our project and thus it was a moment to be exulted.

TIME

Table 2

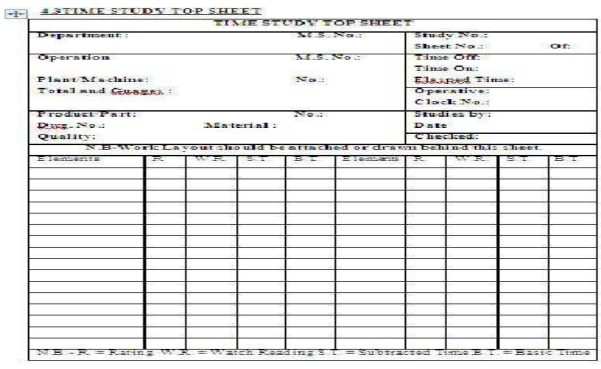

Table 3

TIME STUDY TOP SHEET						
Location: Kirloskar Brothers Limited, Dewas					Study No.: 01 Sheet No.: 01 Of: 01	
Plant/Machine: Machine Shop Tool and Gauges: Stop Watch Only					Studies by: MAYUR THOMBRE Date: 14/03/2009	
Product/Part: Single Phase Centrifugal Pump					Checked:	
N.B-Work Layout should be attached or drawn behind this sheet.						
S.No.	Element Description	Machine Centers	Observed Times (sec)			Average
			I	II	III	
01	Mounting Casting	CNC-500 – I	130	138	130	132.66
		CNC-500 – II	124	121	126	123.66
		Drilling	78	75	79	77.33
		Name Plate Drill	79	19	19	19.00
02	Delivery Casing	Lathe	89	83	85	85.66
		Milling	62	65	66	64.33
		Drillings	103	119	84	102.00
03	Motor Body	Cold Press Turning,	180	198	200	192.6

Table 4

04	Shaft & Rotor	CNC – I	122	128	125	125
		CNC – II	157	142	150	149.6
		Grinding	188	190	188	188.6
		Thread Rolling	11	11	10	10.6
		Keyway	62	82	68	70.6
		Drilling	15	16	16	15.7
		Cold Press – I	56	40	50	48.6
		Turning	149	72	100	107
		Cold Press – II	21	23	23	22.3
05	Assembly Line	Assembling, Painting, Packaging.	2600	2400	2565	2521.6

Graphical Representation of Time-Study Measures

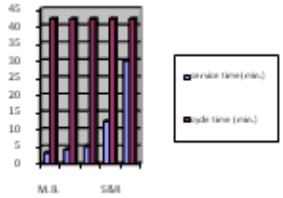

Figure 3: Components of Cycle Time on Single Phase Cell- I

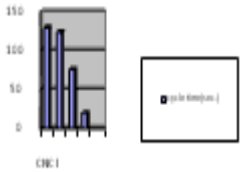

Figure 4: Components of Cycle Time at Several Station on a Mounting Casing

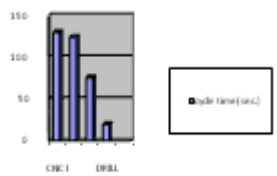

Figure 5: Components of Cycle Time at Several Station on a Delivery Casing

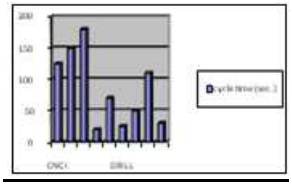

Figure 6

ANALYSIS OF SINGLE PHASE CENTRIFUGE PUMP CELL AT KBLE

A number of quantitative techniques have been developed to deal with problem areas in cellular manufacturing. The analysis is carried out under two steps.

- Grouping parts and machines into families
- Arranging machines in a cell.

Now as far our problem is concerned we are going to suggest an innovative method of grouping produce and their machines in **the single phase centrifuge pump cell of KBL, Dewas**, in order to obtain even much better product flow. Foremost we need to understand the basics of problem forming and thereby the following theory would assist us to solve the enigma.

PRODUCT FLOW ANALYSIS

This is an approach to part family identification and machine cell.

Formation that was pioneered by J. Burbidge. Production Flow Analysis (PFA) is a method for identifying part families and associated machines grouping that uses the information contained on production route sheets rather than on part drawing. Work parts with identical or similar routings classified into part families. These families can than be used to form logical machine cells in a Group Technology Layout. The procedure in PFA must begin by defining the scope of study, which means deciding on the population of the parts to be analyzed. Should all of the parts in the shop be included in the study or should a representative sample be selected for an analysis? Once this decision is made then the procedure in PFA consists of the following steps

- **Data Collection**

The minimum data needed in the analysis are the part no and operation sequence which is contained in the shop documents called “Route Sheets” or “operation Sheets”. Each Operation is usually associated with a particular machine so determining the operation sequence also determines the machine sequence.

- **Sortation of Process Routing**

In this step the parts arranged into groups according to the similarity of their process routing. To facilitate this step all operations or machines included in the shop are reduced to code numbers. A sortation procedure is then used to arrange parts into PACKS, which are group of parts with identical routing. Some packs may contain only one part number indicating uniqueness of the processing of that part.

- **PFA Chart**

The processes used for each pack are then displayed in a PFA Chart. This Chart is a tabulation of the process or

machine code numbers for all the part packs by Moody (Refer 2). In recent GT literature the PFA Chart have been referred to as Part Machine Incidence Matrix, the entries have a value X_{ij} = 1 or 0. A value of X_{ij} = 1 indicates that the corresponding part I requires processing on machine j and X_{ij} = 0 indicates that no processing component I is accomplished on machine.

- **Cluster Analysis**

From the pattern of the data in PFA Chart related grouping are identified and rearranged into a new pattern that brings together packs with similar machine sequence.

- **Quantitative Analysis in Cellular Manufacturing**

The problem addressed here is to determine how machine in an existing plant should be grouped into machine cells. The problem is the same whether the cells virtual or formal. It is basically a problem of identifying part families. By identifying part families the machines required in the cells to produce the part families can be properly selected.

- **The Rank Order Clustering Technique**

First proposed by King (Refer 3) is specifically applicable in production flow analysis. It is an efficient and easy to use algorithm for grouping machines into cells. Rank ordering clustering works by reducing the part machine incidence matrix to set of diagonalized blocks that represent part families and associated machine groups. Starting with the initial part machine incidence matrix, the algorithm consist of following steps

- In each row of the matrix read the series of 1's and 0's from left to right as a binary number. Rank the rows into order of decreasing values. In case of tie rank the row in the same order a they appear in the current matrix.
- Numbering from top to bottom is the current order of rows the same as the rank order determined in the previous step? If **YES GO TO STEP** 7 if no go to the following step
- Re order the rows in the part machine incidence matrix by listing them in a decreasing rank order starting from the top.
- In each column the matrix read the series of 1's and 0's from top to bottom as a binary number. Rank the columns into order of decreasing values. In case of the rank the row in the same order as they appear in the current matrix.
- Numbering from left to right in the current order of columns the same as the rank order determined in the previous step. If **YES GO TO STEP** 7 if no go to the following step
- Re order the column in the part machine incidence matrix by listing them in a decreasing rank order starting with the left column **GO TO** step 1.
- STOP

SOLUTION TO THE PROBLEM

Let us thereby start the solution by getting into the very first step of analysis-Grouping parts and machines into families. The machines involved and product components are abbreviated as

Table 5: Machines Involved

LATHE M/C	L
COLD PRESS M/C	CP
CNC	C
DRILL M/C	D
GRINDING M/C	G
THREAD ROLLING	TH
SLOTTING	SL

Table 6: Product Components

MOTOR BODY	MB
MOUNTING CASING	MC
DELIVERY CASING	DC
ROTOR + SHAFT	R+S

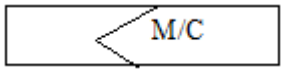

Figure 7: Other Notation

Now the entire problem is formulated in the part machine incidence matrix as shown below as per the theory discussed above.

Step-1

Table 7: Step 1 Grouping of Machines and Product into Families

Binary Eq.	8	4	2	1	Decimal Eq.	Rank
Machines	MB	MC	DC	R+S		
L-1	1				8	1
L-3			1		2	5
L-4				1	1	8
C-2		1			4	3
C-4				1	1	9
-2		1			4	4
D-3			1		2	6
D-4				1	1	10
M-3			1		2	7
G-4				1	1	11
CP-1	1				8	2
CP-4				1	1	12
TR-4				1	1	13
SL-4				1	1	14

Step-2 & Step-3

Table 8: Step 2 & 3 Grouping of Machines and Product into Families

Binary Eq.	8	4	2	1	Decimal Eq.	Rank
Machines	MB	MC	DC	R+S		
L-1	1				8	1
CP-1	1				8	2
C-2		1			4	38
D-2		1			4	4
L-3			1		2	5
D-3			1		2	6
M-3			1		2	7

Table 8: Contd.,

L-4				1	1	8
C-4				1	1	9
D-4				1	1	10
G-4				1	1	11
CP-4				1	1	12
TR-4				1	1	13
SL-4				1	1	14

Step-4 & Step-5

Table 9: Step 4 Grouping of Machines and Product into Families

Machines	MB	MC	DC	R+S	Binary Eq.
L-1	1				8192
CP-1	1				4096
C-2		1			2048
D-2		1			1024
L-3			1		512
D-3			1		256
M-3			1		128
L-4				1	64
C-4				1	32
D-4				1	16
G-4				1	8
CP-4				1	4
TR-4				1	2
SL-4				1	1
Decimal Eq.	12288	3072	896	127	
Rank	1	2	3	4	

Table 10: Step 5 Grouping of Machines and Product into Families

Machines	MB	MC	DC	R+S
L-1	1			
CP-1	1			
C-2		1		
D-2		1		
L-3			1	
D-3			1	
M-3			1	
L-4				1
C-4				1
D-4				1
G-4				1
CP-4				1
TR-4				1
SL-4				1

We have successfully obtained the grouping of machines and product into families. Thus the final obtained above depicts the desired grouping. The next step towards the solution is – Arranging machines in a cell. But this portion involves two heuristic approaches suggested by – **HOLLIER.** But this requires some statistical inputs regarding flow of products **'from' and 'to'** different machines. We were unable to retrieve this data due to some technical problems and thereby

RESULTS & CONCLUSIONS

In this era of globalization it is not easy for any company to sustain and make profit since competition among different companies as well as among their products is increasing consistently. So there is a need to adopt a modern philosophy. During our project we found that implementation of SMS brings about wonderful changes in productivity, waste management, work management and last but not the least in inventory management too. Labor and different resources are also efficiently managed and ultimately reduce the cost of production. Hence to make a company consistently competent and demanding in market. SMS can do miracle for any company.

Changes in production procedure are continuous and in our industrial observation and study at KBL, Dewas we found scope of changes, which could put some profit in companies pocket are jotted below

- Implementing SMS was worker friendly and reduced frequent breakdowns.
- Inventory built up between two machines or processes was reduced.
- The hazardous situation of smoke and spillage of oil as well as heat from conventional Shrink Fitting of bearings was replaced by the new Cold Press Fitting Operation.
- Ownership feeling of workers over their machines was admirable concept by SMS.
- Team work to obtain group incentives instead of individual ones was another excellent move.
- Work place was so designed that there was chair in place of bench which implies that only required amount of rest or allowances are acceptable otherwise the person would have even which would again make him lazy.
- Cleanliness was really improved and noticeable.

Implementation of the above discussed management ethics displays the following excellent improvements:

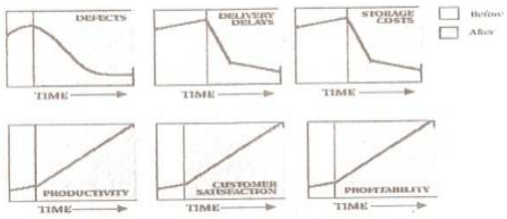

Figure 8: Time vs. Various Points

The reduced number of the breakdowns during the past 3-years with the help of TPM is represented as under:

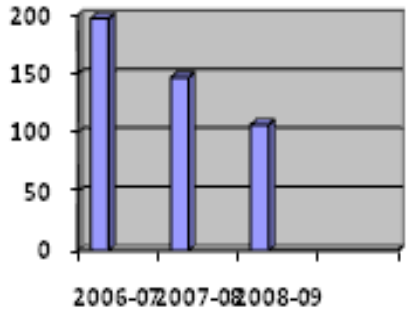

Figure 9: Breakdowns Nos

DISCUSSIONS & SCOPE FOR FUTURE WORK

The following graphical results depicts the summary of what we analyzed at Kirloskar Brother Limited, Dewas

In the entire machine shop the rotor and shaft sub-cell consumes the maximum cycle time excluding the assembly line. Since assembly line is an automated time bound operation therefore it has the minimum margin of alteration. Thus, it is concluded that rotor and shaft sub-cell need the prime attention.

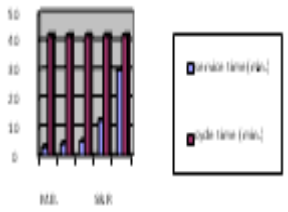

Figure 10: Component of Cycle Time on Single-Phase Cell-I

Taking feedback from the above conclusion, Shaft and Rotor sub cell clearly shows that the grinding m/c involved the maximum cycle time of the product. This also indicates the amount of inventory built at grinding which is not at all desirable. The remedy may be an implementation of some new technology m/c.

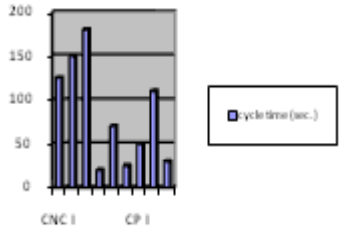

Figure 11: Component of Cycle Time at Several Stations on a Shaft & Rotor

Step-1

Table 11: Step 1 Grouping of Machines and Product into Families

Binary Eq.	8	4	2	1	Decimal Eq.	Rank
Machines	MB	MC	DC	R+S		
L-1	1				8	1
L-3			1		2	5
L-4				1	1	8
C-2		1			4	3
C-4				1	1	9
D-2		1			4	4
D-3			1		2	6
D-4				1	1	10
M-3			1		2	7
G-4				1	1	11
CP-1	1				8	2
CP-4				1	1	12
TR-4				1	1	13
SL-4				1	1	14

Step-2 & Step-3

Table 12: Step 2 & 3 Grouping of Machines and Product into Families

Binary Eq.	8	4	2	1	Decimal Eq.	Rank
Machines	MB	MC	DC	R+S		
L-1	1				8	1
CP-1	1				8	2
C-2		1			4	38
D-2		1			4	4
L-3			1		2	5
D-3			1		2	6
M-3			1		2	7
L-4				1	1	8
C-4				1	1	9
D-4				1	1	10
G-4				1	1	11
CP-4				1	1	12
TR-4				1	1	13
SL-4				1	1	14

Step-4 & Step-5

Table 13: Step 4 Grouping of Machines and Product into Families

Machines	MB	MC	DC	R+S	Binary Eq.
L-1	1				8192
CP-1	1				4096
C-2		1			2048
D-2		1			1024
L-3			1		512
D-3			1		256
M-3			1		128
L-4				1	64
C-4				1	32
D-4				1	16
G-4				1	8
CP-4				1	4
TR-4				1	2
SL-4				1	1
Decimal Eq.	12288	3072	896	127	
Rank	1	2	3	4	

Table 14: Step 5 Grouping of Machines and Product into Families

Machines	MB	MC	DC	R+S
L-1	1			
CP-1	1			
C-2		1		
D-2		1		
L-3			1	
D-3			1	
M-3			1	
L-4				1
C-4				1
D-4				1

Table 14: Contd.,

G-4				1
CP-4				1
TR-4				1
SL-4				1

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