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Modification of Process Workflow Using Cellular Manufacturing in Gear Manufacturing Industry: A Case Study

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Abstract**—***Cellular manufacturing is a way in which similar parts are grouped together to process the parts with ease, this is an application of the group technology. This paper focuses on the application of group technology in the gear manufacturing industry. By the usage of DES (Discrete event simulation) the entire manufacturing process is modeled in terms of queuing model. It is found that with the few changes in the process work flow higher productivity rates can be achieved and with the assumption that 75 % of the inspection parts meet with the required standards*

Keywords**—** *Cellular manufacturing, DES, group technology*

I. Introduction

Cellular manufacturing is the paradigm that have helped the industrial automation to really take control on the processing of cell to work in optimized manner. The concept of cellular manufacturing introduces the factory layout, cell clustering, intra cellular and inter cellular moments, well this fundamental principles of cellular manufacturing leverage the overall productivity of the plant. The total concept of the cellular manufacturing has an idea of efficient usage of the machine shop floor based in the subsystems called as cells. A cell is a group of machines with the internal conveyor that communicate each other according to the features of part. This subsystem with two or multiple subsystems called as the systems or cellular manufacturing facility. This cells are clustered according to the various algorithms and process calculations and designed to work best in those pairs augments. The way in which the facility is planned is by using of DES (Discrete event simulation) in this process all the process and operations are modelled according to the queuing theory and the decisions are made by probability theory. Each process is connected to each other in progressive manner and from the decisions comes the feedback link to reroute the parts. The simulation is coded on SIMAN from Rockwell Automation through ARENA GUI tool.

II. Literature Review

Real time scheduling methodology for the flexible manufacturing systems by dynamic dispatching rule by using discreate event simulation mechnisms has made by the Mim Hee Kim and Yeong-Dee Kim (Kim 1994), Modelling of complex production lines in the manufacturing systems has made by implementation of virtual cell through discreet event simulation applied to assembly station for Malasiyan automobile maket has made by Muslimen, Rasli ,Yusof, Sha'ri Mohd Abidin, Ana Sakura Zainal (Muslimen, Yusof, and Abidin 2013), Optimisation of the manufacturing systems for complex problems has made by using optiquest for Arena tool was made by P. Rogers (Rogers 2002), Modelling of the cellular manufacturing systems by using Agent based modelling and performance measures have been compared with various methods was made by Baykasoglu, A.Gorkemli, L.(Baykasoglu and Gorkemli 2014), Flexible manufacturing implementations in virtual environment has made by Kushwaha, Anoop Bhuneriya, Arun Kumar (Kushwaha and Bhuneriya 2016) Designing of the manufacturing sytems by addressing the various application scenarios and credible models was made by Law, Averill M Mccomas, Michael G Law, Averill (Law et al. 1999) An cumulative approach of scheduling the manufacturing by using ant colony optimization approach has made by the Kumar.R,Tiwari.M, K,Shankar. R (Kumar, Tiwari, and Shankar 2003).

III. Methodology

The basic work flow in the gear manufacturing industry in respective to the type of gear has 5 major steps mostly a material removal process and the inspection process. The main pout at which the parts are finalized are in the inspection and this also have a direct effect on the optimal output of the gear parts. The point for which that the 75% of the inspected parts are meet with the required standards are required, to achieve this constraint the back end of the process where machines are updated and the process work flow has modified.

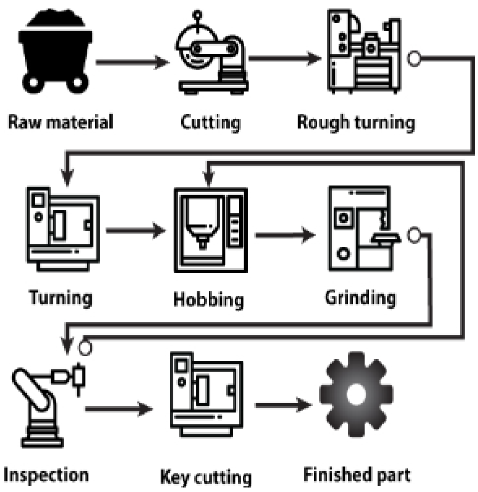

Fig. 1 Traditional workflow of the gear manufacturing industry.

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Use either SI (MKS) or CGS as primary units. (SI units are
With reference to the figure the traditional work flow of the gear manufacturing unit starts with the stainless steel billet is feed as raw materials to the cutting machines where the billets are chopped into discs where the thickness directly equals to the gear tooth thickness. The outer layers are removed with the help of rough turning in order to remove any oxidizing layer or the rusting or nicks and cuts and scratches. Later this billet is again feed into the final turning where the inner holes are drilled out later sent to hobbing process machine. In this machine the tooth of the gear is shaped and sent to grinding process. In this process the tooth and surface are grinded out and sharp edges are grinded and filleted. Next the parts are routed to the inspection in which parts are checked for the dimension inaccuracy and if any parts are not meet with the required standard then those parts are routed back to the hobbing machine which follows the queuing process.

TABLE I. The time required for each step in the traditional gear manufacturing industry are calculated for the single unit and applied in simulation.

Process Operation Timings		
Operation Number	**Process Operations**	**Time Taken In (minutes)**
1	Raw material arrival rate	1 billet per 30
2	Cutting	5
3	Rough turning	3
4	Turning	8
5	Hobbing	30
6	Grinding	15
7	Inspection	10
8	Key cutting	10

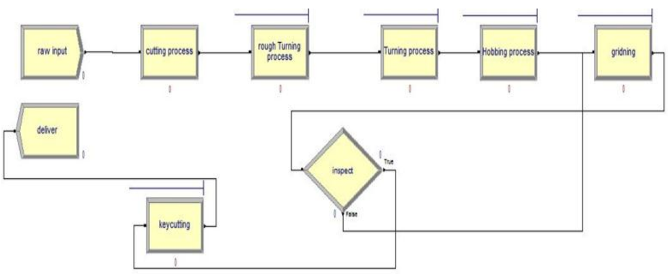

Fig. 2. Arena block model of the traditional gear manufacturing industry.

The simulation was carried out for an 30 hour and following parameters are yielded out.

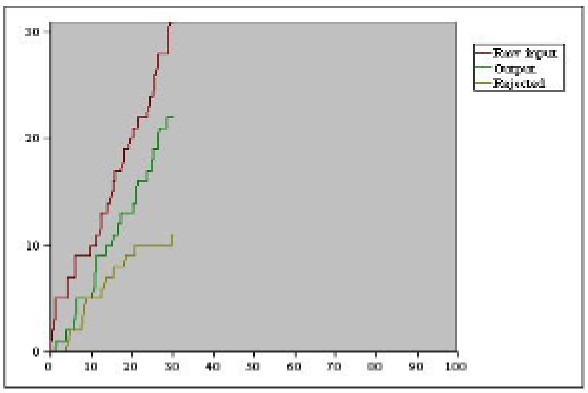

Fig. 3. Plot showing the number of hours' vs the parts processed where x axis shows the time and y axis shows the number of items processed.

TABLE II. The simulation results of the traditional gear manufacturing cell.

Yielded Parameters		
Parameter no	Operation name	Items processed
1	Raw input	31
2	Rejected items	11
3	Accepted items	23
4	Delivery output	22

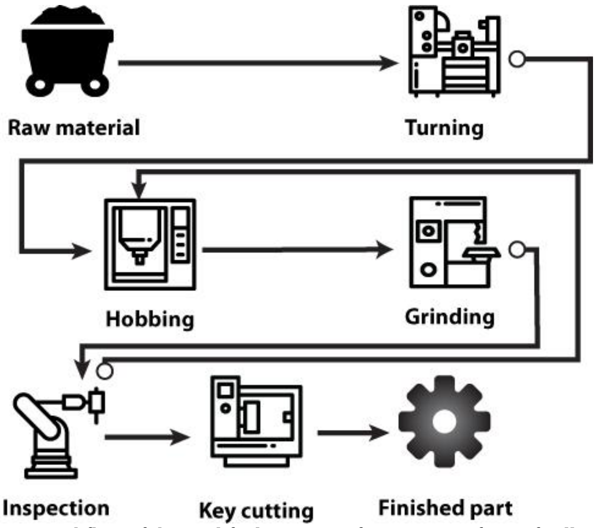

Fig. 4 Workflow of the modified gear manufacturing as a form of cell.

With advent of the automated machining tools and their multi-tasking features designing the cell or the workflow has been greatly optimized. The cutting tool and the rough turning has been replaced with the single turning machine where in which the time of processing has been greatly reduced though there is a bit time allocated in this process but it can be neglected. Because while in previous model the part need to first rough turned but in the modified procedure this is greatly compensated directly but turning it in exact dimensions.

TABLE III. The time required for each step in the modified gear manufacturing industry are calculated for the single unit and applied in simulation.

PROCESS OPERATION TIMINGS		
Operation Number	**Process Operations**	**Time Taken In (minutes)**
1	Raw material arrival rate	1 billet per 30
4	Turning	12
5	Hobbing	30
6	Grinding	15
7	Inspection	10
8	Key cutting	10

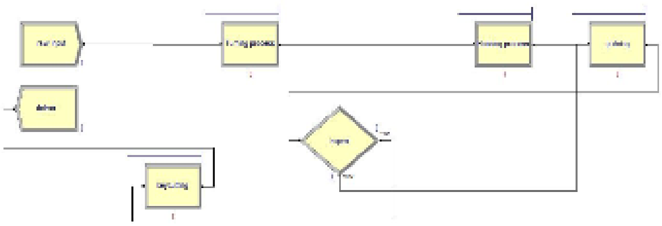

Fig. 5. Arena block model of the modified gear manufacturing industry.

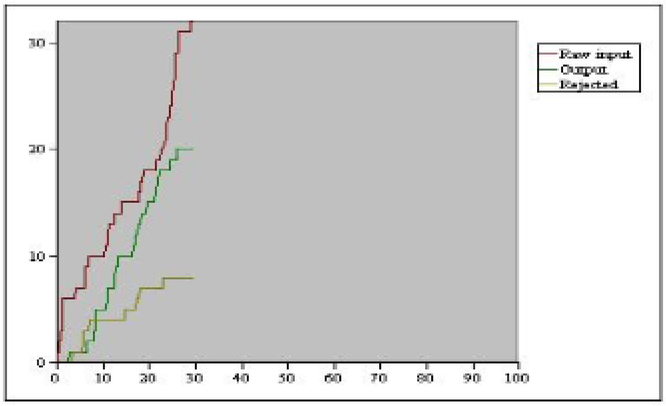

Fig. 6. Plot showing the number of hours' vs the parts processed where x axis shows the time and y axis shows the number of items processed.

TABLE IV. The simulation results of the modified gear manufacturing cell.

Yielded Parameters		
Parameter no	Operation name	Items processed
1	Raw input	31
2	Rejected items	8
3	Accepted items	23
4	Delivery output	25

IV. Conclusion

The observation made by the resultant of the simulations it has been observed that the with the modifies gear manufacturing cells by removing the two machines replaced by the single machine has given out the maximum change in the productivity of the cells. Even the time has been conserved and this time is utilized by the next successor part. This helpd in the increase the processing more gear parts have been increased.

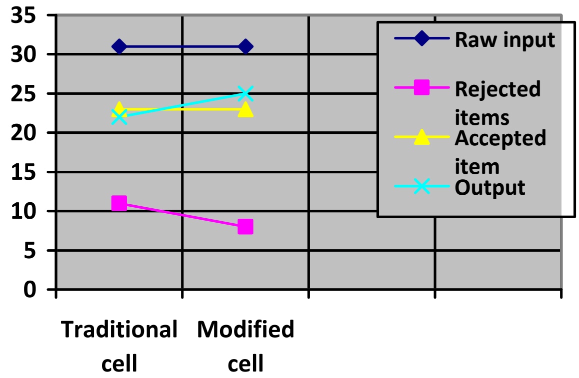

Fig. 7. The comparative plot showing the various simulated results of traditional and modified cell.

So with the little modification of the traditional manufacturing cell the outputs have been increased

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