

Comparative Study of Production Enhancement Using CIM and Conventional Method in a Fabrication Unit

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Abstract- In the past decades, CAPP has been one of the dominant research areas in CIM environment. Computer Integrated Manufacturing, known as CIM, is the phrase used to describe the seamless automation of a manufacturing plant, with all processes functioning under computer control and digital information tying them together. Realizing the importance of CIM, an attempt has been made in this work on the implementation of CIM with an objective to gain more insights into the integration and adaptability issues. This paper focuses on improving integration and adaptability as design and implementation objectives of computer-integrated manufacturing systems. A conceptual model has been developed to illustrate the key issues of integration and adaptability of CIM. The model has been explained by surveyed observations. In addition, a new framework has been proposed in this paper for the design and implementation of CIM and some future research directions are suggested. The work study noted the need to adjust the processes at the case study organization as well as replacing some pieces of equipment in the plant for anticipated improvement on production efficiency. Overall productivity could be increased by 40%. While equipment utilization increased by 25% from the current system to the proposed system. The cost of producing a Class 1 S8000/1100 boiler was reduced by 39.2 %. Operational efficiency was improved by 14%. Production throughput time could also be reduced from 5 months to 3 months.

I. INTRODUCTION

Initially, machine tool automation started with the development of numerical control in 1950s. In less than 50 years, it is amazing that today's manufacturing plants are completely automated. However, establishment of these plants gave relatively a few varieties of product. At first we define what do we mean by a manufacturing plant? Here, we are considering a several categories of manufacturing (or production) for the various

manufacturing plants. Computer-integrated manufacturing (CIM) refers to the use of computer-controlled machineries and automation systems in manufacturing products. CIM combines various technologies like computer-aided design (CAD) and computer-aided manufacturing (CAM) to provide an error-free manufacturing process that reduces manual labor and automates repetitive tasks.

The CIM approach increases the speed of the manufacturing process and uses real-time sensors and closed-loop control processes to automate the manufacturing process. It is widely used in the automotive, aviation, space and ship-building industries. CIM is a manufacturing approach that provides a complete automation of a manufacturing facility. All the operations are controlled by computers and have a common storage and distribution.

The fabricated metal industry – including metal service centers, suppliers, and consumer products manufacturers – is dominated by small to midsize enterprises. Many of these in Zimbabwe are wrestling with how to accomplish long term opportunities for growth while contending with outdated, non-integrated computer systems that manage their critical manufacturing, human resources, supply chain, and financial information. There is a realization that past practices of under investing in technology puts them at a disadvantage and that their limited technology infrastructure can actually prevent them from operating efficiently across the geographies and from reaching profitable goals. The way forward would be to rely on leading best practices to gain control over all aspects of their business – from streamlining manufacturing to taking aggressive measures to continue to improve operational efficiencies that reduce material waste,

inventory, and working capital as well as provide value-added services that command wider margins

II. LITERATURE REVIEW

A. Manufacturing overview

Manufacturing is a complex activity in which raw materials or components and energy are brought together to make saleable products. This is done through involving people who have a broad range of disciplines and skills, and a wide variety of machinery, equipment, and tooling with various level of automation, including computers, robots, and material-handling equipment. The efficiency with which raw materials or components can be brought together affects the amount of profit the manufacturer can make when the product is sold. And as such all these activities must be responsive to product user demands and trends [3].

Modern methods of manufacturing involve use of computers to control machines that make and assemble components. Use of computer controlled machines to cut and form a product is referred as computer numerical control (CNC) machining in metal fabrication industry. The same facility can control the movement of materials, components, and finished products around the factory floor and distribution to the points of sale. Computers can also be used to design a product through a technique known as CAD (computer-aided design). Use of CAD, CNC and computer controlled logistics together is called computer-integrated manufacturing (CIM) [4]. This method of manufacturing allows designers, engineers and marketers to decide on how a new product looks, works and how it may be made more quickly than before.

B. Traditional manufacturing methods

These are mainly based on the use of historical cost accounting and justification methods, which are mainly focused on direct labour because it is easy to measure and understand. The equipment is replaced with similar one with no thought given to any changes in the manufacturing method.

Delay in moving to advanced manufacturing technologies can result in a competitor gaining a market advantage that may be difficult or impossible to reverse [5]. Hence such a migration from traditional methods is justified based on resultant

productivity savings, reduced warranty costs, reductions in scrap and rework costs.

C. Advanced manufacturing systems (AMS)

When AMS was originally conceived, its goal was to improve productivity by creating a fully automated factory, often referred to as the factory of the future, where the operator's role on the manufacturing shop floor would be minimized or eliminated [6].

Advanced Manufacturing Systems (AMS) encompasses manufacturing technologies such as CAM (computer aided manufacturing), FMS (flexible manufacturing systems) as well as CIM (computer integrated manufacturing). Initially the systems were involved to address lack of compatibility and limitation of various automated manufacturing tools and machines [7]. AMS is set to revolutionize the nature of manufacturing industry, and its capability in the development and utilization of automated and automatic systems of production. This is in line with the fast shortening life cycle of products on the market. Advanced manufacturing technologies are a source of strategic competitive benefits, such as improved quality, greater flexibility and cost reduction [8].

The benefit of AMS entails the short time from development, manufacturing, distribution to marketing of new products. As it coordinates all key processes there is increased manufacturing productivity and improved quality deployment as a result of its implementation. A number of areas of contemporary manufacturing are undergoing rapid evolution. Intelligent manufacturing and solid modeling are basic technologies that underlie other emerging manufacturing technologies. Rapid prototyping, molecular manufacturing and bio manufacturing are such technologies.

III. CASE STUDY

This research was done at Metallica Engineering Co based in Jamnagar, Gujarat. The organization undertakes all forms of heavy engineering fabrication. It has heavy plate rolling machines, sub-arc welding, hot pressing and heat treatment furnace. The machine shop is equipped with two CNC machine centers for batch machining of similar parts. It is involved with Class I shell boiler design and pressure vessel manufacturing.

The company also manufactures pressure vessels like heat exchangers, gasifiers and many other specialized items used in the plant to specific BS, ASME and DIN codes. Met Engineering Co imports about 80% of its raw material requirements. Its main processes are drilling, machining, welding, drilling, cutting, rolling, bending, assembling, pressing, tube expanding and pressure testing. The organization sees no need to change the manufacturing systems This research aims to explore ways of modernizing the current traditional manufacturing system that is characterized by jobbing, batch manufacturing, project manufacturing and quality control; with the view to adopt advanced forms of manufacturing like computer integrated manufacturing (CIM), flexible manufacturing (FMS), total quality management (TQM) and operations management to improve productivity and efficiency of operations. Of late the company has been failing to meet delivery dates of major contracts and actual manufacturing activities have slowed down, with regular customers developing negative perception due to low quality standards and poor service delivery. Manufacturing system change can only be achieved when the components of the system are changed as well. This includes changing the technology in use and in some instances, changing the manufacturing processes, the methods and management system.

IV. METHODOLOGY

Effort was made at the case study organization to assess the current traditional manufacturing systems in place and establish potential opportunities available for the implementation of AMS. Interviews, observations, historical experiences and questionnaires were employed to assist in the evaluation of the organization’s capabilities. In reviewing manufacturing systems, the objective was to understand the operations and processes step by step, the systems and technology in use with a view to finding the best out of the total systems in terms of quality, throughput, flexibility and cost reduction; with a view to reconfigure the existing the existing facilities or recommending purchase of more efficient equipment. In this project Extend 4.0 was used to do simulation on discrete model basis.

V.RESULTS AND DISCUSSIONS

This section gives the information gathered from Metallica Engineering based in Jamnagar, Gujarat customers and employees.

5.1 Overall level of performance

Going by the key performance indicators level given by Table5.1 and Fig 5.1 below, it was found that there were a lot of manufacturing inefficiencies within the plant. These would be the important points for improvement in this particular factory.

Table 1 Position in addressing objectives

S.No	Objective	Current Level (%)	Desired Level (%)
1	Productivity	37.5	95
2	Product quality	75	100
3	Service quality	62	100
4	Equipment utilization	55	95
5	Cost reduction	67	95
6	Efficiency	50	95
7	Throughput time	56	95
8	Customer lead times	60	100
9	Flexibility	25	100
10	Employee motivation	66	100
11	Sustain & expand current market	78	95
12	Open new markets	5	100

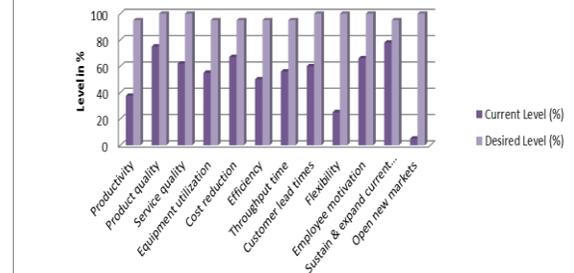


Fig. 1 Organization’s position in addressing key objectives

5.2 Man-hours for major operations

The main products manufactured at Metallica Engineering based in Jamnagar were Class 1 Shell and tube boilers (S00 model). It was these key products’ manufacturing processes which were analyzed from plate marking up to painting of the finished product. The Table 2 and Fig 2 below give time comparison of various processes of each operation under both existing and when using modern systems (which include operations, machinery and equipment). A number of processes could benefit

from time reduction if modern systems and equipment could be introduced in the plant.

Table 2 Comparison of various processes of each operation under both existing and when using modern systems.

S.No.	Major Operation	Time using existing machinery and technology (man-hours)	Time using modern machinery and technology (man-hours)
1	Marking	650	350
2	Oxy-Acetylene (cutting)	1500	200
3	Plasma cutting	0	100
4	Guillotine(cutting)	0	50
5	Drilling	1700	700
6	Rolling	600	600
7	Sub arc welding	2300	2344
8	Machining	132	70
9	Assembling	2942	2000
10	Handling	528	352
11	CO2 welding	352	110
12	TIG welding	88	88
13	Stick welding	1144	890
14	Pressing	1100	350
15	Bending	18	36
16	Tube expanding	1100	220
17	Pressure testing	90	27
18	Lagging & cladding	352	88
19	Painting	54	54

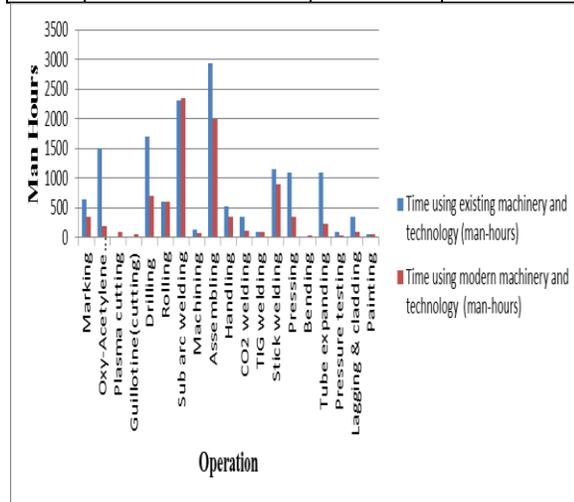


Fig.2 Major Operation's analysis

5.3 Cost of major operations

The cost of major processes was compared to reveal and analyses the processes in terms of cost, which was reflected in the product price. These are given by Table 3 and Fig 3 below. The overall costs of the two

scenarios indicated the need to migrate to AMS for the shop floor processes.

Table 3 Overall costs of the two scenarios

S.No	Major Operation	Cost using existing machinery /technology (Rs)	Cost using modern machinery /technology (Rs.)
1	Marking	4767	2567
2	Oxy-Acetylene (cutting)	9500	1267
3	Plasma cutting	0	653
4	Guillotine(cutting)	0	317
5	Drilling	10767	4433
6	Rolling	3800	3800
7	Sub arc welding	19167	19533
8	Machining	968	513
9	Assembling	21575	14667
10	Handling	3344	2229
11	CO2 welding	2933	917
12	TIG welding	733	733
13	Stick welding	8389	6527
14	Pressing	8067	2567
15	Bending	114	228
16	Tube expanding	6967	1393
17	Pressure testing	570	171
18	Lagging & cladding	2229	557
19	Painting	342	342

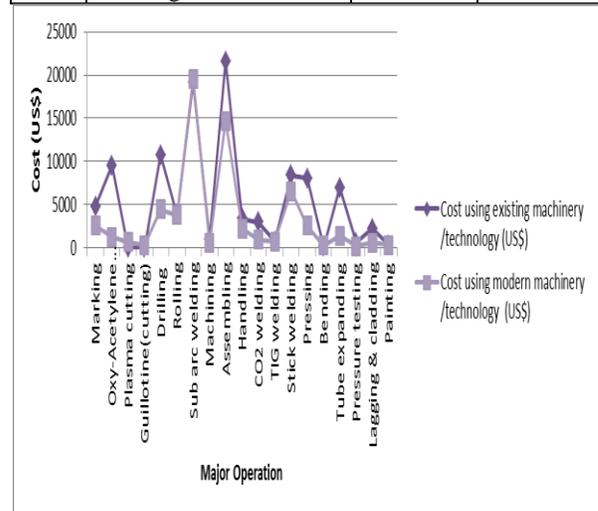


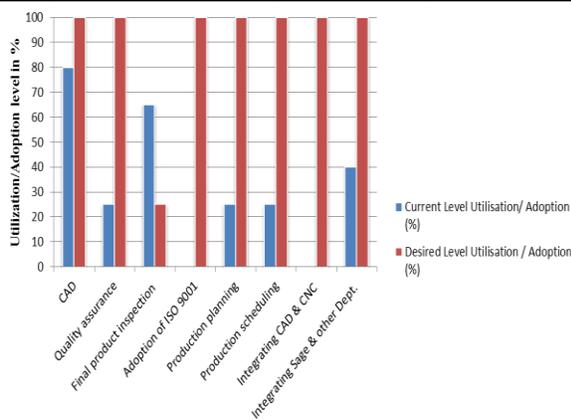
Fig.3 Major Operations cost analysis

5.4 Missing key functions and lack of coordination

Some critical functions were found to be not existent at all in practice. Also there is lack of Production Planning, Quality Management Policy and integration of CNC machines with AutoCAD for drawing generation. This resulted in some inherent inefficiencies of the manufacturing plant as depicted by the Table 4 and Fig 4 below.

Table 4 Inherent inefficiencies of the manufacturing plant

S.N o.	Function	Current Level Utilization/Ad option (%)	Desired Level Utilization/Ad option (%)
1	CAD	80	100
2	Quality assurance	25	100
3	Final product inspection	65	25
4	Adoption of ISO 9001	0	100
5	Production planning	25	100
6	Production scheduling	25	100
7	Integrating CAD & CNC	0	100
8	Integrating Sage & other Dept.	40	100



Function
Fig.4 Selected function analysis

Also based on simulations a number of possible improvement increases in percentage terms were picked as indicated by the graph in Fig 5.

Table 5 Improvement increases in percentage terms

S.No.	Functions	Percentage of benefits in (%)
1	Productivity	80
2	Utilization	25
3	Total Cost	65
4	Efficiency	0
5	Through-out time	25
6	Customer lead time	25

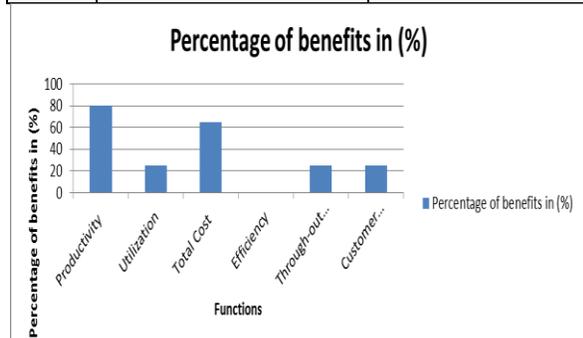


Fig .5 Percentages of benefits in different functions.

VI. CONCLUSION

Overall productivity could be increased by 40%. While equipment utilization increased by 25% from the current system to the proposed system. The cost of producing a Class 1 S8000/1100 boiler was reduced by 39.2 %. Operational efficiency was improved by 14%. Production throughput time could also be reduced from 5 months to 3 months. During which time, new products could be designed and penetrate new foreign markets. Customer lead time could as well be reduced from 6 months to 4 months, and this time would allow other ancillary items for the boiler to be made. The automation on welding machine and upgrading of the press machine were recommended for quality as well as time saving on the major plant operations and processes. The successful implementation of AMS requires far more than just the automation of production and manufacturing activities

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