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Virtual Commissioning of Small to Medium Scale Industry Using the Concepts of Digital Manufacturing

Akash.M.R[1], Dr. B. R. Narendra Babu[2], Dr. K.Chandrashekara[3]
[1]M.Tech, Department of Mechanical Engineering, Vidya Vikas Institute of Engineering and Technology, Mysore-570028
[2]Associate Professor, Department of Mechanical Engineering, Vidya Vikas Institute of Engineering and Technology, Mysore-570028
[3]Professor, Department of Mechanical Engineering, Sri Jaya Chamarajendra College of Engineering, Mysore-570006

Abstract
Small scale industries produce certain products depending on the type of industry they have established. If these small scale industries decide to become medium scale certain changes have to be incorporated in plant layout to meet certain requirements. Certain changes include change in layout design, introducing new machines and equipments in the industry in order to produce new component .To implement these changes in the company we have to get information regarding the new component the company would produce based on this information we have design new plant layout.

The purpose of this project is to plan a suitable plant layout which could meet company requirement. To design a new plant layout we are using Delmia as the simulation software. DELMIA Production System Simulation allows the process planner to validate the manufacturing system dynamically. Product flow and operation time, as well as scheduled maintenance and random equipment failure events, are simulated to help the planner understand how they will impact the system’s capacity. Process planners can determine if changes to the system are needed to achieve the desired production demands.

Keywords: Delmia, Virtual commission, Digital manufacturing.

I. INTRODUCTION

Digital Manufacturing represents an integrated suite of PLM tools that supports manufacturing process design, tool design, plant layout, and visualization through powerful virtual simulation tools that allow the manufacturing engineer to validate and optimize the manufacturing processes.

DELMIA Production System Simulation (PSS) enables dynamic evaluation and improvement of manufacturing system and material flow. Modeling and simulating the system over multiple cycles helps with decision making in uncertain conditions.

Using the established process plan, the planner defines the manufacturing system, which consists of areas for processing, storing, and transferring parts. The flow of parts can be defined from area to area. Once the system is defined, it can be simulated to evaluate its capacity, utilization, and other performance measures. The planner can then evaluate alternative scenarios for product routing and system design.

DELMIA Production System Simulation allows the process planner to validate the manufacturing system dynamically. Product flow and operation time, as well as scheduled maintenance and random equipment failure events, are simulated to help the planner understand how they will impact the system’s capacity. Process planners can determine if changes to the system are needed to achieve the desired production demands.

During simulation, 3D animation of products and an iconic display of the system make it easy to understand the state of the manufacturing system. The planner can view, in chart form, the number of products, waiting and operating times, time spent in various states, and utilization.

Discrete event simulation is an important decision support tool to evaluate changes in manufacturing, distribution or process facilities. The challenge arises when it comes to the integration of simulation as an effective tool to detect manufacturing constraints and to suggest improvement alternatives. DELMIA Production System Simulation makes it easy to understand the behaviour of the system and to identify bottlenecks.
Users of DELMIA Production System Simulation are able to define and validate the manufacturing system with simulation. Specific performance aspects of the system, such as throughput, utilization, and work in process are measured and reported. Users can experiment with system parameters and layouts to determine optimal design and operating conditions.

II. SYSTEM MODEL

Requirement from the Manufacturer is that to establish a Small to Medium scale Manufacturing Plant & also a repair workshop. As per the request from this organisation a complete End to End Manufacturing solution is required starting from planning the Incoming Inventory management through varied operation in the shop floor and to till the dispatch of the finished part.

Project requirement: Complete Manufacturing solution by using the concepts of Digital manufacturing using a OLP software or a also called as a simulation software.

Software Required: Delmia V5 by Dassault Systems.

Product used in Delmia V5: Digital Process for Manufacturing.
Parts for which production planning is required for are:

- Conversion of Forged to Finished part for Camshaft.

Table 1: Equipment Details

	Bending Machine		Range	Length	Plate width max. (mm)	Plate Thickness max. (mm)
		EMPBM320	3mm to 20 mm	1500 mm X 1066.8 mm to 3000 mm	2000	3
	Min. Rolling dia. (mm)	Upper roller dia.(mm)	Lower Roller dia. (mm)	Lower Roller central distance	Plate rolling speed (m/min)	Power of main motor (KW)
	300	150	130	200	5.7	2

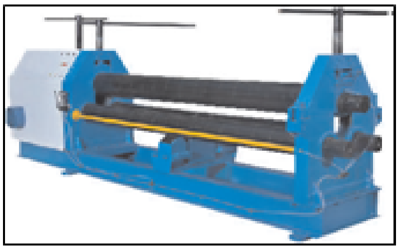
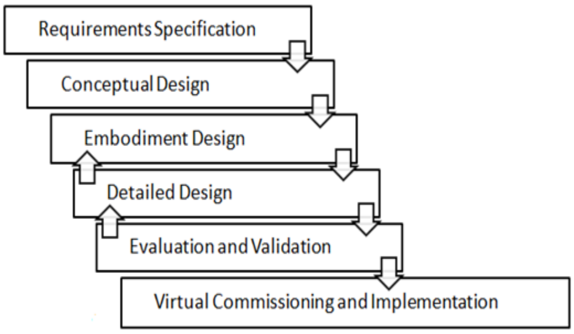


Fig 1:Bending Machine

III. PROPOSED METHODOLOGY



1. Project Management: During the course of the project, the activities will be managed according to its life-cycle. The project will be initiated and planned, it will be executed following the method described and monitored by status reporting and other scheduled activities. At the end, the project will be closed ensuring that the objectives were achieved.

2. Requirements Specification: At this stage, the product functional characteristics and the process constraints will be studied in the current station in order to understand the nature of the current operations sequence and therefore the restrictions for defining a new automated sequence. Documentation will be created along this and every other stage of the process.

3. Conceptual Design: At this stage, equipment (e.g., robots, tools, fixtures, turntables, etc.) will be selected and/or designed to comply with the requirements specification. Preliminary layout examples will be designed incorporating the chosen equipment. The best alternatives will be selected as conceptual models for several levels of investment.

4. Embodiment Design: At this stage, full-scale use of Delmia will begin. It will be assured that there are CAD models for the equipment selected and/or designed. If necessary the definitive layout will be designed using CAD models of the resources and products in a CAT Product. Delmia's Factory Layout and Robotics module will be used
to assemble the station and provide kinematics. From this point, the project process starts to be iterative

and it may be possible to come back from later stages to make changes.

5. Detailed Design: At this stage, the advantages of using Delmia's data-based system will be seized by designing the interaction of the process/product/resources with the PPR Hub. Device tasks and activities will be defined to plan the process and the system will be optimized according to cycle time using different tools. Control functions for the equipment will be developed and the structure of the data interaction will be analyzed.

6. Evaluation and Validation: At this stage, the resulting production system will be simulated and evaluated. Its quality will be assured by collision detection and the result will be validated. As an output, it is expected to provide all information necessary for the implementation of the proposed solution in the actual plant.

7. Virtual Commissioning: At this stage, further research will be made to generate solutions for the interaction with the data structures currently in use.

IV. SIMULATION/EXPERIMENTAL RESULTS

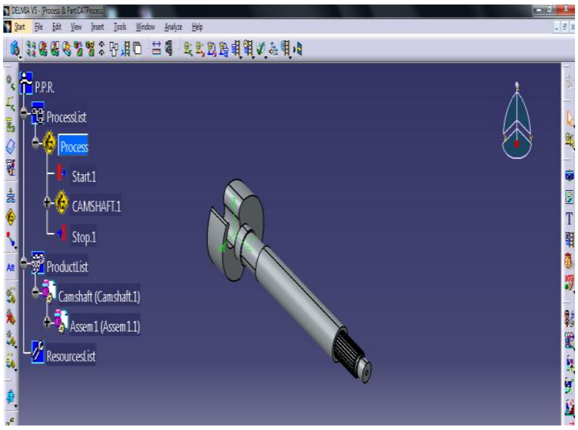


Fig 2: Camshaft done using Delmia

Cam Shaft Process Flow:

Sl. No	Step by Step Process Flow for Conversion of Camshaft part to Finished part	Machine		Manual work	
		Operation	Time (min)	Operation	Time (min)
1	Raw material incoming to part inspection			*	2
2	Part pick up and placing on the inspection table			*	
3	Inspection for cracks			*	
4	Inspection for rust and impurities on the part			*	
5	Select OK parts and placing on the Roller Conveyor 1 to next operation			*	
6	Select NOT Ok parts in the rejection Bin 1			*	0.16
7	Part pickup from Roller Conveyor 1 by next operator and placing in Facing m/c			*	0.5
8	Set camshaft part for facing on both ends and length updates			*	
9	Start the operation	*	1		
10	Face the first end of the part	*			

11	Stop the operation			*	
12	Face the second end of the part	*	1		
13	Do the length correction by required material removal operation	*			
14	Set the machine with Centering Tool			*	0.5
15	Start centering operation	*	0.66		
16	Stop the operation	*			
17	Set the required tool and part for Outer Dia Turning operation	*			
18	Start the Outer Dia Turning	*	1		
19	Wait for operation to complete	*			
20	Stop the operation	*			
21	Set the required tool and part for Body Turning operation			*	0.5
22	Start Body turning operation	*	1.5		
23	Wait for operation to complete	*			
24	Stop the operation	*			
25	Set the tool and part for CIR Clip groove cutting operation			*	0.5
26	Start grooving operation	*	0.83		
27	Wait for operation to complete	*			
28	Stop the operation	*			
29	Remove the part from the m/c			*	0.5
30	Place the part in Roller conveyor 2 for next station			*	
31	Pick the part from Roller Conveyor 2 onto Deburring station			*	0.33
32	Operator uses the grinding tool to perform the deburring operation	*	1.5		
33	Operator performs the Stage inspection for any imperfections obtained during previous operations			*	2
34	OK parts are sent to Roller Conveyor 3			*	
35	NOT OK			*	

	parts are sent for rework				
36	Next operator picks up the part from Conveyor 3			*	0.66
37	Set the part and tool in Hobbing M/c			*	
38	Wait for operation to complete	*	2		
39	Stop the operation	*			
40	Pick up the part from the m/c and place it on roller conveyor 4			*	0.33
41	Next operator picks up the part from Conveyor 4 and loads onto the fixture provided in the heat treatment unit			*	0.33
42	Start the operation			*	
43	Wait for heat treatment to be completed	*	4		
44	Stop the operation	*			
45	Place the parts on to next station for Tempering			*	0.16
46	Start the operation	*	4		
47	Wait for tempering operation to be completed	*			
48	Pick up the Tempered parts and place it on Roller conveyor 5 for subsequent operations			*	0.33
49	Operator picks up the part for Inspection			*	1
50	Performs Axis correction			*	
51	Sets the tool and part for Journal Grinding			*	
52	Start Bearing Journal Grinding	*	3		
53	Wait for operation to complete	*			
54	Stop the operation	*			
55	Perform Final Inspection				
56	Place the parts in the Wooden Box provided			*	0.5
57	Seal the box after filling			*	
58	Send to Dispatch			*	
		T_o	20.3	T_h+T_{th}	10.2

CALCULATIONS:

Camshaft Calculations:

Cycle Time: $T_c = T_o + T_h + T_{Th}$

Where, T_c = Cycle Time (mins/Pc)

T_o = Time of Actual Processing (mins/Pc),

T_h =Handling Time (mins/Pc),

T_{Th} = Tool Handling Time (mins/PC)

$T_c = 20.3+10.2$

T_c = 30.5 mins/Pc

Production Rate: $R_P = 60/ T_c$

R_P = Production rate (Cycles/Hr)

$R_P = 60/30.5$

R_P=1.96 Pc/Hr

Production Capacity: $PC = n\ S_W\ H_{Sh}\ R_P$

Where, PC =weekly production capacity of facility (O/p unit/week),

n =No of work centres working in Parallel Production in Facility,

S_W =no of Shifts/Period (Shifts/week),

H_{Sh} =Hours/shift (Hr)

R_P = Production rate (PC/Hr)

Where n = 7; S_W =12 shifts/week; H_{Sh} = 7.5 Hours/shift; R_P =1.96 units/Hr

PC= 7 X 12 X 7.5 X 1.96

PC=1235 units/week

Actual Production Rate (Q):

Considering a Utilization Factor of 80%, we have

U= Q/PC

Where Q = Actual Quantity produced by the facility (Pc/Week)

Hence Q= U*PC

= 0.8 X 1235

Q=988 Parts/Week

V. CONCLUSION

- Complete Process simulation can be achieved resembling the real life scenario.
- Design & Validation of manufacturing systems can be done with Simulation.
- Specific performance aspects of the system, such as throughput, utilization, and work in process can be measured and reported.
- Users can experiment with system parameters and layouts to determine optimal design and operating conditions.
- Finally, with all these useful capabilities Delmia provides, a well balanced Process Planning can be devised to help suit the Organisations requirements.

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