Process Management in Industrial Automation Sector

Submitted in partial fulfilment of the requirements

of the degree of

Bachelor of Engineering in Production Engineering

by

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8528

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University of Mumbai

2021-2022

Certificate

This is to certify that the project entitled **"Process Management in Industrial Automation Sector"** is a bonafide work of "**Dev Ketan Shah" (8528)** submitted to the University of Mumbai in partial fulfilment of the requirement for the award of the degree of **"Bachelor of Engineering" in "Production Engineering"**.

(Dr. V.S. Bilovalikar) (Mr. Hemanth Manchella)

Supervisor Company CEO, Founder

(Dr.Bhushan Patil) (Dr. Srija Unnikrishnan)

Head of Department Principal

Project Report Approval for B. E.

This project report entitled ***(Process Management in Industrial Automation Sector)*** by ***(Dev Ketan Shah)*** is approved for the degree of ***(Bachelor of Engineering in Production Engineering)***.

Examiners:

1)_____

2)_____

Date:_____

Place:_____

Declaration

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

Dev Ketan Shah

8528

Date:

No objection certificate

(To whomsoever it may concern)

This is to certify that Dev Shah student of Fr. Conceicao Rodrigues College of Engineering Bandra, has undergone a degree course in production engineering semester 7, and completed this inplant training at Janyu Tech pvt. ltd from December 20 2021 to April 16th 2022. This report does not contain anything that can endanger the secrecy and working of the company. This is to state that we have no objection to the printed matter and images contained in the report.

_____

Mr. Hemanth Manchella

CEO,Founder,

Janyu Technologies Private Limited.

Abstract

The emerging field of Robotic application and industrial automation has been seen as a fast-applying field in the Indian manufacturing industries in recent days. This somewhat indicates that there arises a need for Production Managers to have a basic knowledge of this field to actually bring change of automation in any traditional manufacturing lines.

The processes in executions of a project at a dynamic robotic and industrial automation company requires wide set of technical knowledge (mechanical +electrical +electronics +computers +image processing, etc), for managing one. So, I choose to learn and work in as many of the fields at such a company.

This written submission includes the details of the processes of project execution, some major projects and some minor projects and tasks done during the internship. In a broader sense, each of them showcases the work and experience at different levels of the company which can help in understanding of the complex situations faced at different departments of the company.

In total, they all contribute to the Process management of projects and production in the current practical scenarios as well as for the future.

The projects are based on my best application of theoretical knowledge of Production engineering academics along with the extra knowledge of personal. The aim of the report is to familiarize with the processes and challenges with potential solutions/ recommendations and explain the work and experiences at different departments of the company.

Contents

Chapter 1

Introduction:

1.1. Introduction to the company:

Janyu Technologies Pvt. Ltd. is engaged in design, development, manufacture, supply, installation and commissioning of Robotic solutions & Industrial Automation systems in various industrial sectors of economy i.e. Pharma, Healthcare, F&B, FMCG, Engineering, Automotive, Defence, Aerospace, Frozen Foods, etc.

JANYU TECH

JANYU TECHNOLOGIES PVT LTD

Vasai, Maharashtra, India

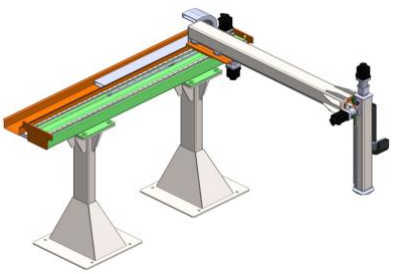
1.2. Classification of company's work-

The automation solutions provided by the company can be classified in 3 types based on project, product or service-

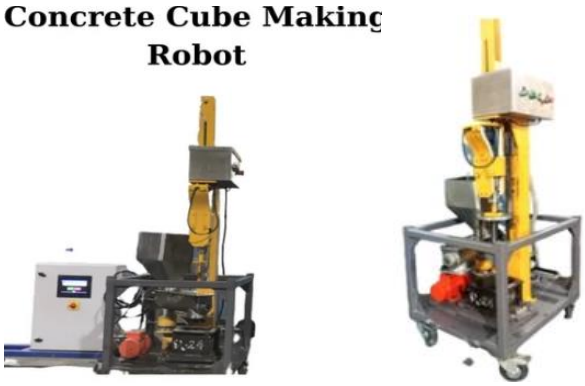
A. Projects: Projects are the ones developed and installed as an integrated system at client site or services provided with robots as per special requirements received from clients. Examples:

i. Complete Line Automation- Includes multiple systems integrated together.

ii. Material Handling and Smart Conveyors Gantry Systems



iii. Special Purpose Machines (SPM)- Concrete test cube making machine is for making Concrete Test Cubes of desired size and volume, per batch, for mandatory testing purposes, following proper standards of Tamping.



B. <u>Product:</u> Products are deliverables which are an in-house made product or commissioned market products. Examples:

i. Solar panel cleaning robot- This Robot allow to clean larger surface area of solar panel with the help of robotic arm using vehicle.
Benefits: To suite undulating uneven terrain, no need for additional railings/infrastructure, can be used for multiple arrays.

ii. UV disinfection Robots (also as service)- From the situation of pandemic, these Robots were developed to disinfect the rooms, flights from virus and deliver essentials by remote controlled trolleys between isolation wards.

iii. Sludge and chemical cleaning robots (also as service)-
For inspection, maintenance and sludge removal. This remotely operated robot moves freely in tank to break up and suck out sludge at bottom of tank. It is developed with use of anti-corrosion materials and this is highly effective method to perform sludge cleaning. It provides safety to the workers and is known for its high operational efficiency.


iv. Robotic arms and Material handling Robots


v. Defence robots- UGV Surveillance Robot has been embedded with video analytics. It has high strength and is demanded in the mining sector for mapping and plotting the mines. This is also known for military use.

C. Service- Use of UV Machines /sludge cleaning machines at client's site.

1.3. Process management:

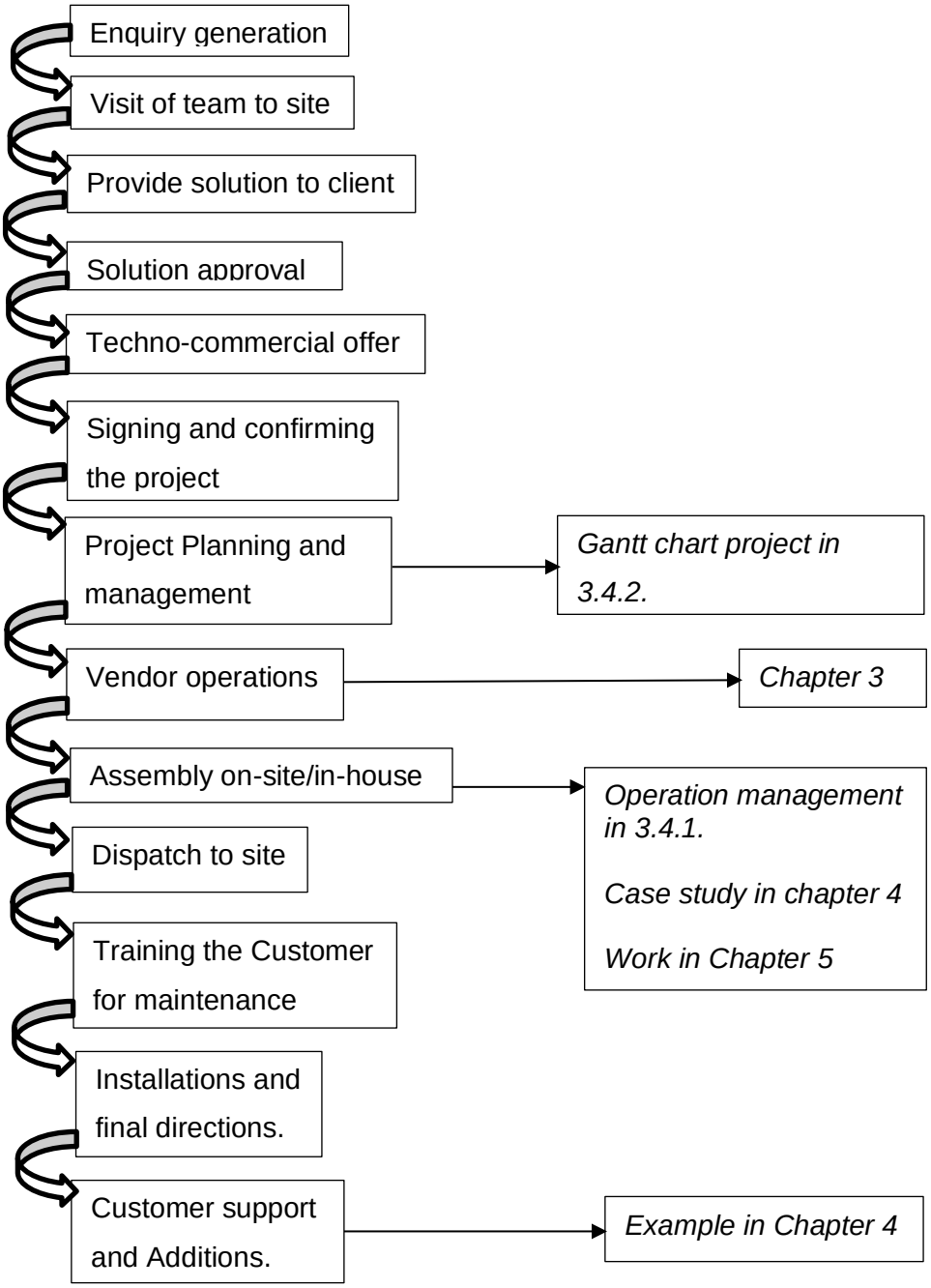
1. Process Management refers to analysing current systems, spot bottlenecks, identify areas of improvement., designing and implementing process architectures, establishing process measurement systems that align with

organizational goals, and educating and organizing managers so that they will manage processes effectively.

2. Another branch, "Business process management", is the discipline in which people use various methods to discover, model, analyze, measure, improve, optimize, and automate business processes. Any combination of methods used to manage a company's business processes is BPM (Business process management).

1.4. Processes of workflow of a Project-

Flow-diagram: (13 Steps in executing a Project at the company)-



I. **Enquiry generation-** It includes enquiry of customer for a solution. Or it is the work of sales and marketing department to do market research, identifying new opportunities and enquiring the Potential clients.

II. **Visit of team to site-** Generally, a relevant team of engineers visits the Client Company for noting/taking the site layout, drawings and inputs from clients.

III. **Provide solution to client-** Making of professional and conceptual CAD layouts, design, assemblies, etc and project cost estimations are done by engineers and PPMC (project planning and management team) respectively.

IV. **Solution approval-** Discussions with presentations between respective heads and engineers of the company and client.

V. **Techno-commercial offer**- Details of scopes, responsibilities, payment structure and negotiations of the project are exchanged between the 2 companies.

VI. **Signing and confirming the project**- Signing is done as per the terms of payment.

VII. **Project Planning and management-** First is finance and budget allocation. Second is providing schedule to individual department.

VIII. **Vendor operations**- It includes Procurement, Store management, Quality control inspection and proper Documentation.

IX. **Assembly on-site/in-house -** The work includes assembly, testing and quality assurance. This can be directly on site or at factory for trial.

X. **Training the Customer for maintenance-** The internal mechanism of the system is explained to the maintenance team of the client.

XI. **Dispatch to site**

XII. **Installations and final directions**- Installations of the machines and guidelines of operating to clients.

XIII. **Customer support and Additions**- Customer support is done in case of any faults or updates and also for further additions required to the system.

Chapter 2

Challenges faced in robotics and automation company:

1. **Sales and marketing-**

   A. Sometimes, justifying of Return of Investment (ROI) is complex for some clients. **("Appendix I")**

   B. Client from different cultures require different specifications. (Example- A less technical person will demand for life of machine, money calculations like ROI, etc, while technical groups would require precise technical specifications of components.) Hence, marketing strategies are difficult to be standardized.

2. **Finance challenges**- 'Payment challenges' often occur as the whole project cost includes roughly 66% or more material cost + more overheads of the company and projects lasting for around 4–5-month long causes 'cash flow crunch' in between processes.

3. **Procurement challenge**-

   A. As the parts are non-repetitive and not in mass quantity the vendors may get dis-interested and charge more with late deliveries.

   B. Vendor Management Current Challenge: Several organizations face issues in vendor management today due to the disjointed nature of software and manual processes. Since vendor management has too many stakeholders, the lack of visibility and siloed data can cause process gaps and make essential information fall through cracks in the documentation process.

   When a buyer fails to properly vet his/her potential vendors, monitor their performance, and ensure security with proper documentation, it can result in compliance issues and jeopardize the business relationship with the supplier.

   Also, since vendor management is not a single-step process, recognizing the importance of each stage (Qualifying, Engagement, Delivery Management, Payment Management, and Closure) and managing vendors throughout the entire lifecycle is vital to streamline the procurement process. But all this cannot be done with just a normal spreadsheet.

Ideal Solution: If your new procurement solution performs the same task as a spreadsheet, it would be of no use to your purchasing team. A mere spreadsheet program could neither validate vendors nor rationalize existing supplier bases. Without a standard supplier database, multiple departments will be purchasing similar items from a large variety of vendors at different costs, producing chaos.

An automated vendor management system will provide a central repository of approved vendors, track vendor history, payment and delivery terms at a glance. With supplier management automation, procurement teams don't have to scour through emails for confidential payment information or manually update supplier contact information.

An automated procurement system takes the responsibility of collecting and maintaining accurate vendor information from your procurement team's shoulder. Vendor self-service and digital portals make the vendor management process a breeze.

***(An attempt to make one similar solution to the current challenges is in 3.4.)**

4. **In- house production challenge-** Setting up a workshop for in house production of parts fixtures and tooling are difficult. **("Observations in Report 5.4.")**

5. **Quit of employees-** Causes project delays with addition of training for newly joined people. ("Decision Making [by intuitive method] Analysis" of reasons and solutions for employee leaving)- **("Appendix II")**

6. **Technical challenges-**

    i. In case of robotic applications, challenges are faced with different types of products and payloads in each project. Example, 1 mg of liquid dispense, handling of brittle solar wafer. For applications other than welding and plasma cutting robotic applications are easy, while for complex material handling and movement applications, a criteria of speed quality except of the robot does not match as that of a human in these days.

    ii. **Buckling up for Industry 4.0- (Chapter 5)**

Chapter 3

Process control and Production schedule

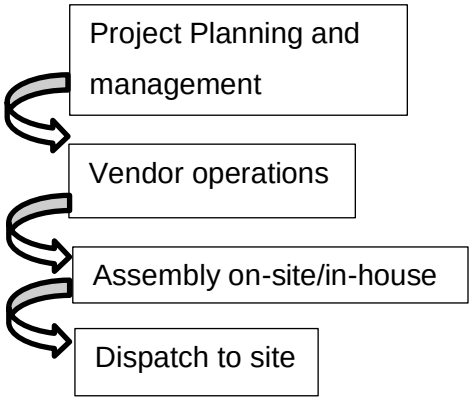
3.1. Introduction- As an assembly based robotic and machine making factory, the parts required are procured almost fully finished from different vendors. So, dealing with time scheduling of parts becomes very complicated and troublesome with the vendors. So, the aim of this project was to generate an all-inclusive time scheduling of a project which would ease out the process. Therefore, a dedicated excel was prepared with 2 main sheets.

3.2. Observations of issues-

1. Poor documentation of production and recording of activities in the factory due to non-coherent work between people with different roles (i.e., Purchase, Procurement, factory production manager, project manager and admin).
2. Over-communication with vendors, inappropriate involvement of other roles in procurement and record maintenance of vendor irregularity, over-costing in many.
3. Rework of parts due to different reasons which causes delays and often go un-documented.
4. Unable to keep time track of parts, assembly and testing with details.

3.3. String diagram analysis of workflow and communication

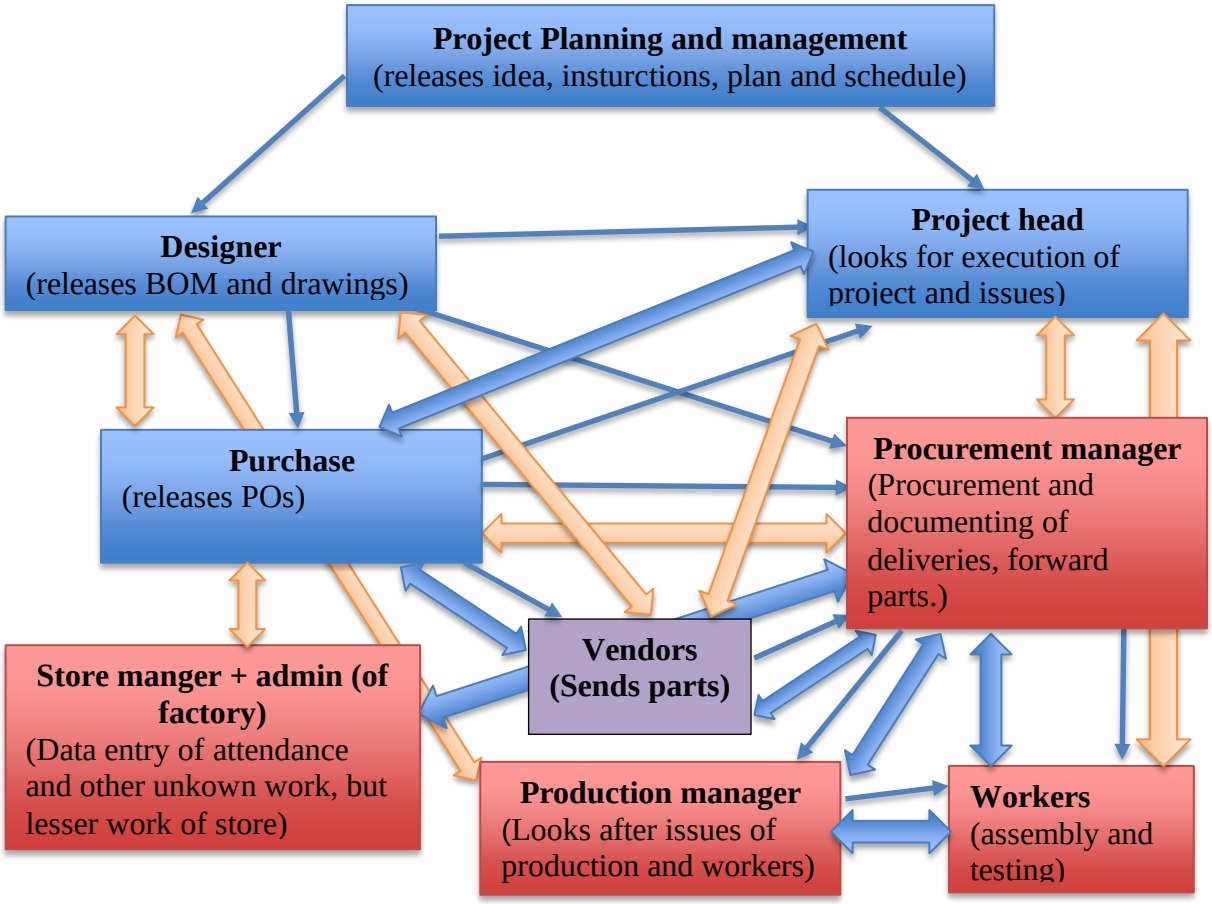
- *From 13 main steps,*



➢ Flow of work and communication in current situation:

Index:

Office Person/department.	abc
Factory Person/department	abc
Flow of work/object	
More frequent communication(duplex)	
Less frequent communication(duplex)	

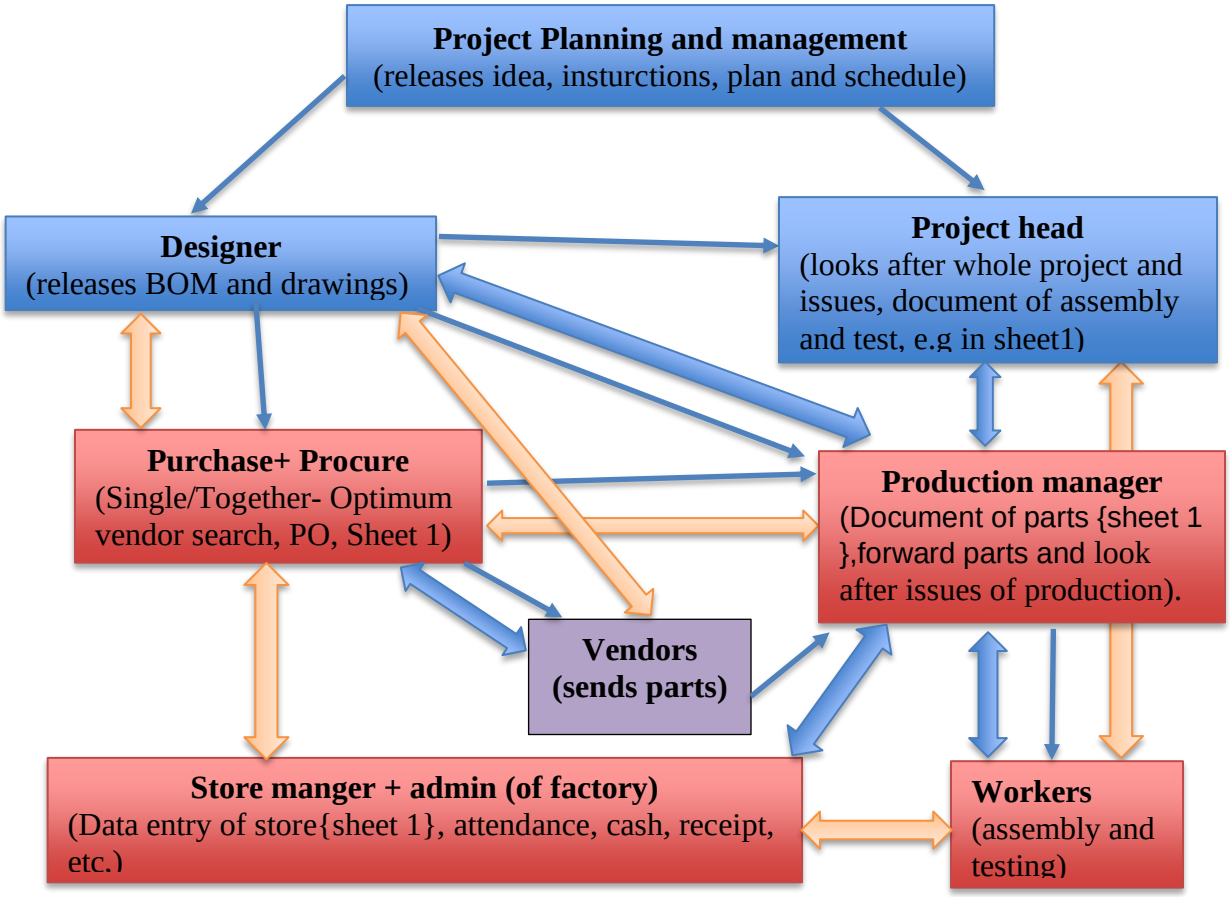


Observations and suggestions:

1. Unnecessary talks increase work complexity, mis-calculations/estimations, over-communication and confusion plus “poor documentation”.
2. Task of procurement person is to look after all the procuring work from po to delivery. (Here, sometimes we have even designer, project head going out for procuring).
3. Procurement is job of one department. Only they need to contact the vendor.

4. Someone with knowledge of manufacturing processes and machines, along with local vendors market knowledge can be advantageous in finding optimum vendor with optimum ways for part manufacturing. Thus, manging for effective costing.
5. Project head can be allotted with opportunity for R&D of relatable topics to bring up innovative or optimum solutions in the Processes, Design, Assembly & Testing of the projects.

➢ Recommended string of workflow in procurement and production:

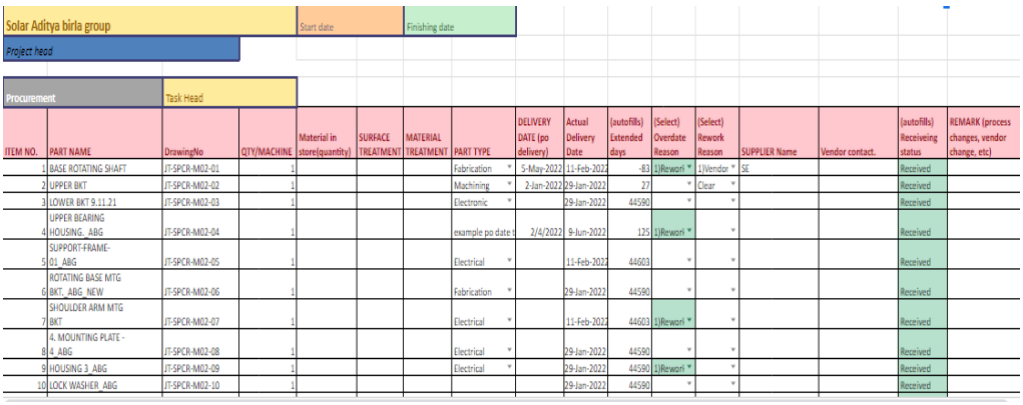


3.4. Solutions:

3.4.1. "Sheet1"-

1. Made with a view to keep track of procurement of all the parts in actual timings. This sheet can help the multiple departments (purchase and procurement, store, project and production managers) to work cooperatively and efficiently for a project.
2. Auto-calculating extended days from columns of input dates can help to identify vendor behaviours and remarks can me marked for it.

3. Many of the columns are auto calculating and some have data validation. (Sheet 3) format which in simple terms is selection from drop down list. Provisions for rework reasons selection from drop down list can keep track of it.
4. Also tracking for assembly and testing of machines is made available.



Solar Aditya birla group				Start date		Finishing date										
Project head																
Procurement		Task Head														
ITEM NO.	PART NAME	DrawingNo	QTY/MACHINE	Material in store(quantity)	SURFACE TREATMENT	MATERIAL TREATMENT	PART TYPE	DELIVERY DATE (po delivery)	Actual Delivery Date	(autofills) Extended days	(Select) Overdate Reason	(Select) Rework Reason	SUPPLIER Name	Vendor contact.	(autofills) Receiveing status	REMARK (process changes, vendor change, etc)
1	BASE ROTATING SHAFT	JT-SPCR-M02-01	1				Fabrication	5-May-2022	11-Feb-2022	-83	1)Reworl	1)Vendor	SE		Received	
2	UPPER BKT	JT-SPCR-M02-02	1				Machining	2-Jan-2022	29-Jan-2022	27		Clear			Received	
3	LOWER BKT 9.11.21	JT-SPCR-M02-03	1				Electronic		29-Jan-2022	44590					Received	
4	UPPER BEARING HOUSING._ABG	JT-SPCR-M02-04	1				example po date t	2/4/2022	9-Jun-2022	125	1)Reworl				Received	
5	SUPPORT-FRAME-01_ABG	JT-SPCR-M02-05	1				Electrical		11-Feb-2022	44603					Received	
6	ROTATING BASE MTG BKT._ABG_NEW	JT-SPCR-M02-06	1				Fabrication		29-Jan-2022	44590					Received	
7	SHOULDER ARM MTG BKT	JT-SPCR-M02-07	1				Electrical		11-Feb-2022	44603	1)Reworl				Received	
8	4. MOUNTING PLATE - 4_ABG	JT-SPCR-M02-08	1				Electrical		29-Jan-2022	44590					Received	
9	HOUSING 3_ABG	JT-SPCR-M02-09	1				Electrical		29-Jan-2022	44590	1)Reworl				Received	
10	LOCK WASHER_ABG	JT-SPCR-M02-10	1						29-Jan-2022	44590					Received	

Columns 1-9: These columns can be filled by the ‘purchase and procurement head’. They can simply copy paste data from the BOM and POs of the parts.

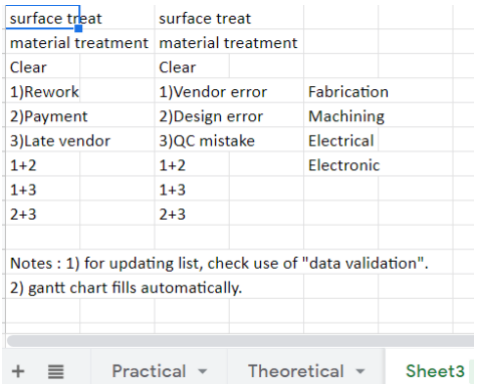
	(BOM)	(BOM)	(BOM)	(from store)	(BOM)	(BOM)	(BOM)	(PO)
ITEM NO.	**PART NAME**	**Drawing No.**	**QTY/ MACHINE**	**Material in store (quantity)**	**SURFACE TREATMENT**	**MATERIAL TREATMENT**	**PART TYPE**	**DELIVERY DATE (po delivery)**
1	BASE ROTATING SHAFT	JT-SPCR-M02-01	1		Black-oxiding	hardening	Fabrication	5-Jan-2022
2	UPPER BKT	JT-SPCR-M02-02	1	1			Machining	2-Jan-2022
3	LOWER BKT 9.11.21	JT-SPCR-M02-03	1				Electronic	
4	UPPER BEARING HOUSING._ABG	JT-SPCR-M02-04	1				example po date taken	2/4/2022
5	SUPPORT-FRAME-01_ABG	JT-SPCR-M02-05	1				Electrical	
6	ROTATING BASE MTG BKT.AB	JT-SPCR-M02-06	1				Fabrication	
7	SHOULDER ARM MTG BKT	JT-SPCR-M02-07	1				Electrical	

***The fill-ups in columns of ‘BOM’ can ‘PO’ can be automated with help of software automation RPA (robotic process automation). (“Appendix III”)**

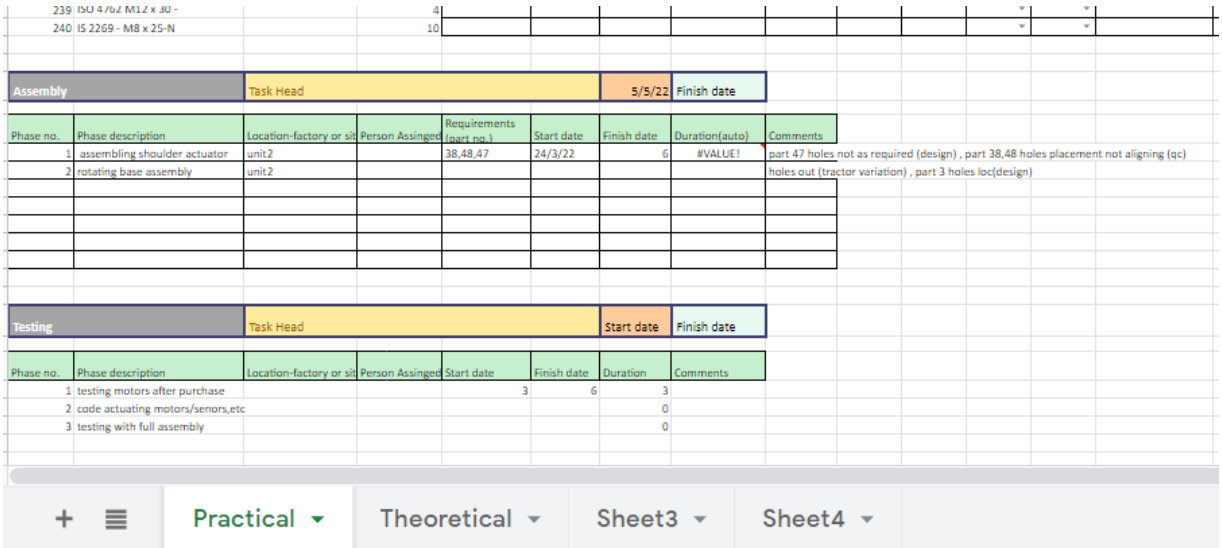
Columns 10-17: These columns can be handled by the ‘Production manager’. (Except POs)

(manualy changed with every update)	(auto -fills)	(drop down list)	(drop down list)	(PO)	(PO)	(autofills by changes of Col. 10)	
Actual Delivery Date	**Exte nded days**	**Overdate Reason**	**Rework Reason**	**SUPPLI ER Name**	**Vendor contact**	**Receiveing status**	**REMARK (process changes, vendor change, etc)**
11-Feb-2022	37	1)Rework	1)Vendor error	SE		Received	
29-Jan-2022	27		Clear			Received	
						P	
9-Jun-2022	125	1)Rework	2)Design error			Received	
11-Feb-2022						Received	
		1)Rework	2)Design error			P	

The drop-down lists are made with data validation technique. (Data validation in Sheet3)



Assembly and Test tracking- This can be done by the Task head/project manager. Both the assembly and testing tables can help better in project management.



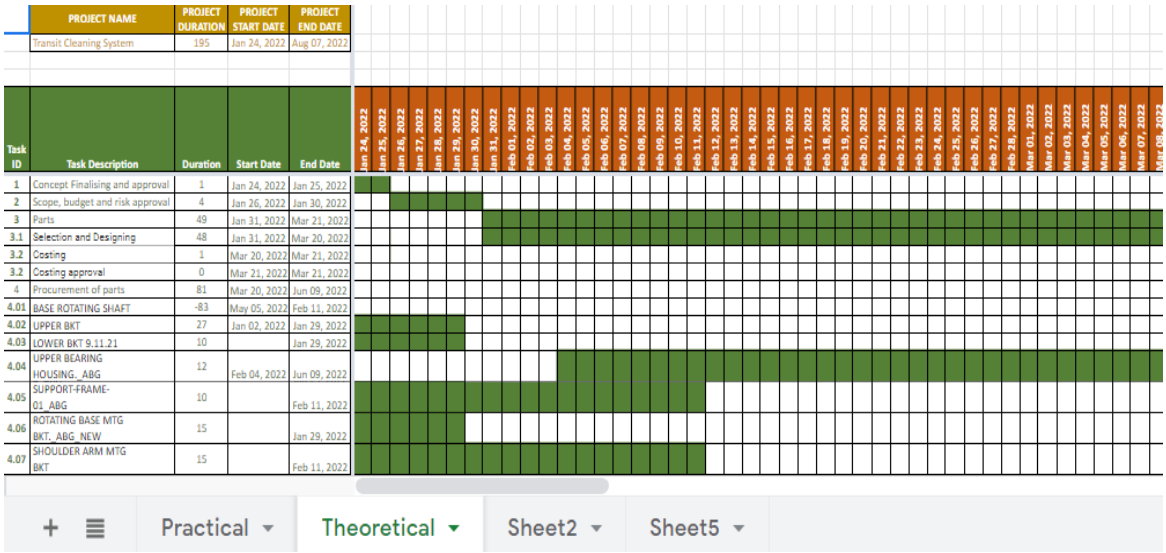
The requirement part no. can be allotted so that appropriate questioning can be done with workers or production manager for testing and assembly purposes.

Phase no.	Phase description	Location-factory or site(name)	Person Assinged	Requirements (part no.)	Start date	Finish date	Duration(auto)	Comments
1	assembling shoulder actuator	unit2		38,48,47	3/22/2022	4/4/2022	13	part 47 holes not as required (design), part 38,48 holes placement not aligning (qc)
2	rotating base assembly	unit2						holes out (tractor variation) , part 3 holes loc(design)

Phase no.	Phase description	Location-factory or site(name)	Person Assinged	Start date	Finish date	Duration	Comments
1	testing motors after purchase			22 March	5April	14	
2	code actuating motors/senors,etc					0	
3	testing with full assembly					0	

3.4.2. “Sheet 2” –

1. It includes a special Gantt chart which can automatically fill the blanks with just entering or updating the dates. This can be used for ‘Theoretical Project planning’.
2. Or we can also copy the dates directly from sheet 1 to have an eagle view of the practical situations. Therefore, this sheet can be fully automated.



3.5. Conclusion-

1. The processes of documenting and managing the inventory, vendor operations, task assigning and production tracing of the machine/assembly at the factory can be easily maintained in Sheet 1. (This sheet was partially demo-ed, but it will be used in future, said by senior).

2. The process of making a theoretical chart can be easily and automatically carried out with sheet 2 (This sheet was used in some projects and maybe also for client verification).

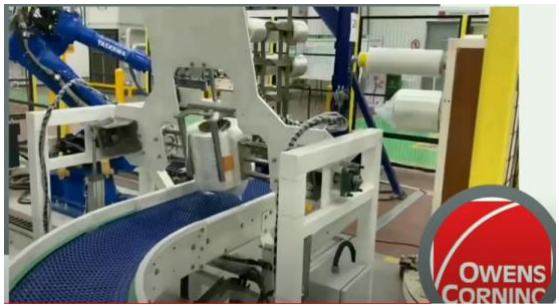
3. Just like there is scope for development with RPA techniques to automate BOM and PO entries, there is also scope for setting up a method to record vendor errors frequency and automatically sort them w.r.t no. of extended days with reasons of vendor.

Chapter 4

Case study of client site's 'Owens Corning'

4.1. Introductions- The site is in at the factory of Owens Corning. It is an Automated Warehouse for MATERIAL HANDLING, Robotic PALLETIZING and Customized Software System Integration. The production line has the operations of handling the trolley of fibreglass rolls, manual wrapping of plastic and palletizing.

This line was had been automated by our company Janyu tech. 1st system includes an automated trolley (with unwrapped rolls) changing mechanic system, 2 pick and place robots for wrapped and unwrapped rolls, 90-degree tilt unit all integrated with one PLC system. The wrapped rolls are sent to 2nd system via conveyors. 2nd system had 1 more robot for palletizing with 4 pallet handling conveyors integrated in a PLC system.



Assembly at this site was done in a duration of 3 months which included machinal fitting, wiring, plc coding, robot simulation and coding.

Updates/additions required by the client- To increase production time of System 1.

4.2. Report of 2 days of work:

Introduction- This visit was organised by respected Mr. Yogesh sir, with a motive to have a "time motion study", observe issues and delays in motions of the 3 robots and also prepare an idea for implementations of future projects of 2 gantry systems on the lines.
We were a 4-member team, all from different backgrounds of engineering.

Details of Journey- The Journey of both the day started with boarding on a train of 6:55am from Vasai stn. to Navade stn. (near Taloja), reaching the factory by 9am, work finished by 5:30pm and then returning to Vasai stn. at 9pm.

Project details-

1) **Time study with team-** The time study was done with a digital stopwatch.

Client : Owens Corning : Doff Handling & Palletizing Automation
Date : : OC-2020-01

S.N	Motion	Time of Nearest Bobbin (In trolley or pallet) secs			
		Individual Time	Sub total	Sub Total	Total
A	Unloading Area (Trolley >> Wrapping >> Conveyor)				
1	Trolley Handling & movements				
	Trolley travel time from Home to unloading station	32.12			
	Trolley locking in positon time	1	33.12	33.12	
	Trolley waiting time for unloading 12 bobbins by robot	248	248		
	Trolley unlocking , indexing & locking in positon time	11.36	11.36		
	Trolley waiting time for unloading 12 bobbins by robot	251	251	510.36	
	Trolley moving time starts and reaches unloading station	36.48			
	Trolley travel time from Home to unloading station		36.48	36.48	579.96
	Trolley unloading and loading time by operator	120	120	120	120
	Trolley rotating time before going to home position	7.7	7.7	7.7	7.7
		LINE 1		LINE 2	
2	Robot Handling	1A	1B	2A	2B
	Robot moves from home to vision check position	1.55	2.26	2.01	1.7
	Vison checking time				
	Robot moves vision check position to pick up position	0.9	0.9	0.95	0.9
	Robot moves in , lifts up bobbin from trolley & comes out	3.43	3.5	3.12	3.12
	Robot moves to Wrapping machine pick up stand by positon	3	3.24	2.27	2.08
	Waiting time for (if any) for Wrapping machine (to rotate & halt)				
	Robot moves in , lifts up wrapped bobbin from spindle & comes out	2.9	2.9	3.68	2.7
	Robot indexes the gripper to loading position	1.01	1.01	0.9	0.76
	Robot moves in , leaves the new bobbin into spindle & comes out	2.62	2.62	2.57	2.69
	Robot waiting time (If any for Wrapping machine rotation)				
	Robot moves to 90 deg turn unit	1.4	1.4	1.47	1.32

3	Wrapping						
	Index table rotation & stop in position time(180deg)	6.91					
	Manual wrapping time	11					
	Index table rotation & stop in position time(180deg)	6.69					
4	90 deg Tilting	LINE 1					
	Robot clearance time after placing bobbin	2.18				2.1	
	90 deg unit gripping, tilting, retracting	7.68				8.24	
	90 deg unit tilting time back to receiving position	6.54				8.64	
	Bobbin travel & clearance (below 90 deg unit) time on conveyor	6.51				6.15	
B	Palletizing	1A	1B			2A	2B
	From Home position , robot moves to conveyor pick up position	1.43	1.02			1.04	1.06
	picks the doff with Gripper(forward+grip+moves up)	2.28	2.2			2.05	2.03
	Robot moves to Pallet	1.1	1.98			1.48	1.11
	loads the doff with Gripper(forward+ungrip+moves up)	2.47	2.34			1.96	2.18
	robot moves to home positon	1.44	1.02			0.92	1.38

2) **Issues observed about the 2 wrap assisting Robots:**

(The issues were carefully noted down in the discussions with the line supervisor. Suggestions and some comments are based on personal opinion)-

Issues	Comments	Suggestions
Frequent Gearbox Shaft failures at both disc of wrap machine	Torsional breakage of shafts. They changed 3 shafts in total. On observing damaged shaft, marks of wearing and stress deformations were found at pin slot (Shaft material-SS before, MS now.)	The pin slots deformations indicate to me a gradual effect, not a sudden. Design review may be needed. Insufficient greasing may be a factor.
Improper Gripping	Robot gripper fingers hit the Trolley and wrapping machine.	
Trolley movements	1)Trolley doesn't rotate properly sometimes. 2)Trolley shuttle locking failures. 3)Locking shaft broken twice.	2)the hole dia. can be Increased a little. 3) The shaft of the linear actuator should be extended more inside to have less torque.
Blue conveyor	The blue Upper links breaks on the side edge and sometimes dismantles fully.	
Conveyor specs.	Request for Specs of all conveyors shaft and gearboxes for replacing.	
Component Drawings	The client requested for component drawings; they only have assembly drawings.	
Data logging program	Incomplete	
Client request	Request for a re-cabling/tagging of robot cables.	
Robot goes into an empty hanger in a trolley.		

3) **Maintenance enquiry report-**

- Client does not do any maintenance of the robot and its gripper. (Black grease was seen coming out at a robot's joint).
- Lubrication and greasing of other parts is done weekly.
- Opening of the disc of the wrapping machine to do maintenance of bearing and sprockets, etc is done in 1-2 months.
- "Frequency of all Maintenance is not based on proper study".
- "The chains and visible gear parts looked dry on personal note, the reason said by them is the glass particles, which doesn't seem relevant".

4) **Other delays observed- (with Yogesh sir)**

Delay cause	Delay time	Remark
Mandrel issue	1min	18-20/shift
New trolley (1a to 1b)	5 sec wait from home	
Partial bobbin	4-5sec line 1, 9sec line 2	(More than usual)
Improper grip pause time	1min30sec	
Fallen residue clean time	Approx. 1 min	

5) **Update and future additions:** Discussions on addition and placement of a gantry system and removal of 90-degree unit to reduce cycle time of the 2 robots in system 1.

4.3. Conclusion-

The skills of doing time study of motions of robots, soft communication, report writing, etc, required for executing tasks at client site have been presented and applied.

Chapter 5

Buckling up for Industry 4.0

5.1. Process management in era of industry 4.0:

Industry 4.0 is nowadays a topic of research and interest for many universities, research institutes, and businesses. Research focuses on how this concept is implemented in practice. It requires, in particular, the transition to the digitization of business processes and their ICT support. In particular, the use of cyber-physical systems, which allow to simulate reality and implement digital twins for virtual machine control, including robots and processes.

Rising hot line of BPM plus IOT- New technologies of Industry 4.0 brings an important role in process design and process modeling. In the context of process management, digital transformation refers to transforming the business operations, services, and models. Digital transformation covers all processes in the companies, and the aim is to build a digital model of enterprise with the digitized process attributes (input, output, sources, and indicators).

'Data collection' is a vital part of industry 4.0 because there is a need to evaluate if a process is functioning correctly, and without feedback, there is no possibility to decide that. Data can be transmitted from PLCs, sensors; basically, from every part of a system, we can gather relevant data. Those data needs to be stored in a safe location and with industry 4.0, and for better accessibility, data are stored in the cloud and then send to certain IoT software. The data can be used for process monitoring.

Compiling- Industry 4.0 has many different system integrated to one, taking data from electronics and different devices, managing it, real time updates and synchronization, different understandings from various backgrounds of engineering.

Inference-

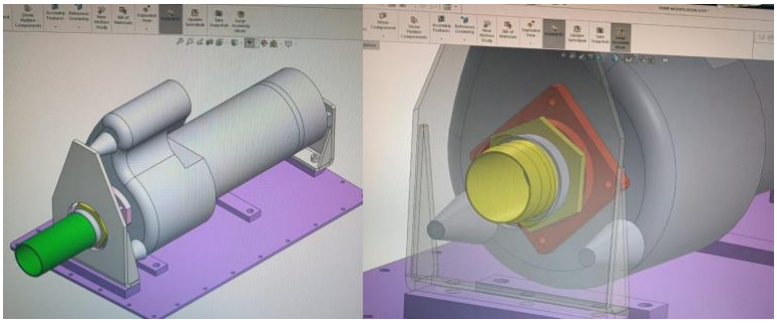
1. These all changes the management duties and process management in great ways. The basic understanding of all aspects of work of a company are required for setting up a proper Process management/ BPM in a company.

2. So, to start getting enough tech savvy knowledge of multiple fields, I worked at basics of them and following are the showcases of some minor projects and activities.

5.2. Work at the Office unit:

5.2.1. Work of Design department-

Work done: The designing of parts is done on solid works, but sometimes the designer needs to get dimensions of the actual part (for e.g., of a solar tractor or a purchased pump, for mounting purposes). So, I was asked to make part drawings of 2 different pumps. The drawing was made a bit roughly but the dimensions measured were close to the required accuracy and understandable for the designing person.



Issues and failures noted in design department:

1. Many a time the designer has to go to the factory or site to take the dimensions needed for making solid works models, all by himself.
2. FEA simulations have not been done here for parts or assembly most of the time.

3. Case study- Failure in a ‘Throw Bot Rover’ - wheels deformation and track misalignment and inability to rotate were mainly due to improper thickness, material properties and maybe design error. It incurred heavy wastage of energy and money.


4. Part dimensions like thickness of plate, gussets, holes for weight reduction, etc are decided by standards or just experience where chances of fatigue failure are high. (For e.g., Rod deformation + bearing failure in solar arm assembly.)

Suggestions put forward:

1. A person with experience in making drawings (for e.g., diploma in relevant fields), can help to make the part drawings.
2. Assembly Simulations could have helped in finding the fault and so deciding the accurate material the optimum dimensions as in the case study of failures of ‘Throw Bot Rover’.

   *(Further recommendations based on the case study: Use of value analysis for the current failure and value engineering for future.
   - “Value Analysis” is the application of a set of techniques to an existing product with a view to improve its value. Thus, it is remedial process.
   - “Value Engineering” is the application of exactly the same set of techniques to a new product at the design stage project concept or preliminary design when no hardware exists to ensure that bad features not added. Thus, it is a ‘preventive’ measure.
   - Methods - DFMEA or FAST method.)

3. Again, simulations can help in optimum dimensions and weight reduction and also help to increase part’s life.

Feedback by senior designer:

1. Phone communication with someone can be an alternative to make full part drawings.
2. It is very much true that simulations could have saved the Throw bot failures.
3. Simulations needed can be ANSYS simulation for fatigue failure and stress analysis, drop test, temperature test, truss analysis.

5.1.2. Automated Stetter cleaning system plc coding.

Project overview- The Stetter transports the RMC between RMC plant and construction site, many trips, during the day and it gets dirty due to various reasons like mud, dust etc.

ULTRATECH is looking for a solution to keep the Stetter clean. Currently the stetters are cleaned once in a while at the RMC plant or construction site, as per driver's decision.

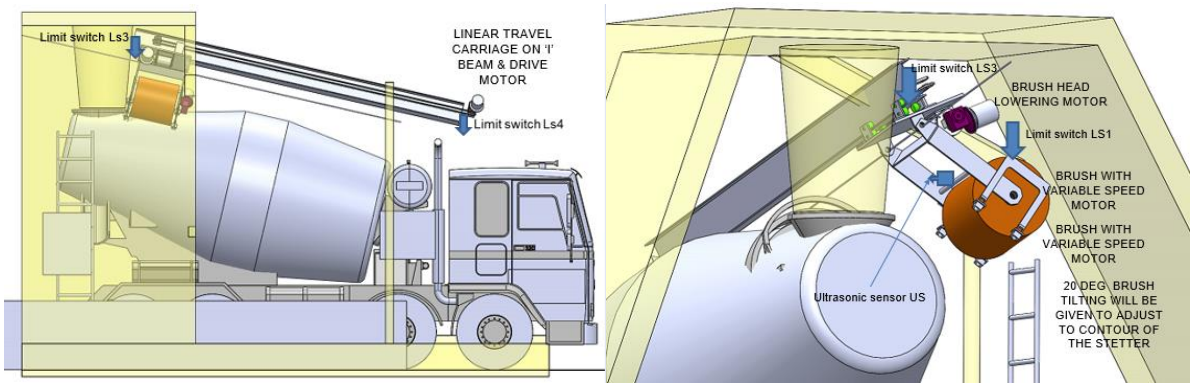
Proposed solution by JANYU-

1. Janyu proposes a single cleaning brush system automated with limit switches and ultrasonic sensor which travels along the profile of the Stetter.

2. Water is sparsely used using efficient nozzles, pressurised with an additional pump.

3. Micro PLC is used to operate the cleaning process by a touch of a button by operator.

Conceptual Design-



Task-

The task undertaken by me was to make a PLC code for the working of 4 sensors (ignoring the pump action and vfd signals for that moment) in sequence of the system and simulate it till accuracy.

Defining input and outputs: 4 inputs and 6 outputs-

Inputs (4)	**Symbol (4)**	**Outputs (6)**	**Symbol (6)**
3 limit switches	ls1, ls3, ls4	*brush head lowering motor, with vfd.*	m1 f (forward) m1 r (reverse)
ultrasonic sensor	Us	*brush rotation motor, with vfd*	m2 f, m2 r
		long travel motor,with vfd	m3 f, m3 r

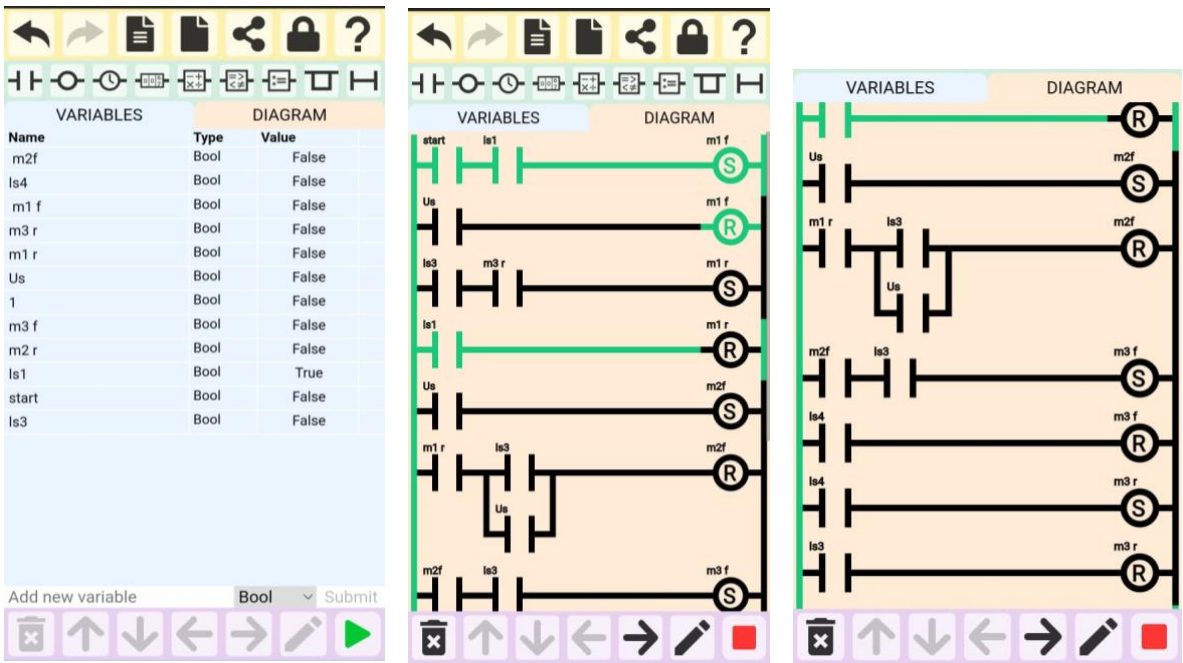
Defining Action/motion of the system-

1. Starting from LS1 (home position), on press of a start button, brush head lowering motor m3 f should start till LS3.

2. After triggering Ultrasonic sensor, Us, m1 f should stop and mf 2 should start.

3. Then m3 f starts and on completing the entire length of the Stetter with all m3 r reversed, the brush rotation stops at LS3, brush head moves up and it is moved back to the home position LS1.

Execution - Using a free plc simulator online the code was executed with desired action.



5.1.3. Greenhouse research-

Introduction: The new trends of agriculture nowadays include closed space agriculture. The space is called a greenhouse which traps sun heat and is ventilated according to need.

The design of a greenhouse plays a major role in the working of the life inside it and the cost to run one. So, the following paper is dedicated to proper ventilation and estimates for power consumption of a unit.

Analyses: After reading many research papers, it came out to me that not enough research had been done to analyse optimum solutions of fans and vents for a proper mixing of air. So I also tried to include these in the project.

1. Fan sizing: The fan system should be sized to provide one volume air exchange per minute to a height of 8 feet for summer ventilation. This will result in an 8-10°F rise from the intake louvre to the fan. For example, for a 25-foot by 96-foot greenhouse the fans should have a capacity of 25-foot by 96- foot by 8-foot = 19,200 cubic feet per minute. In southern climates, a height of 10 is sometimes used to get a greater ventilation rate.

   If the greenhouse is not used during the summer, for instance, greenhouses used for bedding plant production, the capacity can be reduced to ¾ – volume air change per minute. For winter ventilation a capacity of ¼ volume air change per minute is adequate.

In Our eg-
1) 8*8*8 ft Cube -cfm =512, ach= 60
2 exhaust fans of 300 cfm each, 2 vents/louver operated with actuator or 2 inlet fans of 300cfm.
2) 8*16*16 ft Cube cfm =2048, ach= 60
3) 16*16*16 ft Cube cfm =4096, ach= 60

(A reduction in output of 10 percent or more occurs when a fan is exhausting into the wind)When purchasing new fans, select those that have been tested in accordance with Air Movement and Control Association (AMCA) standards.

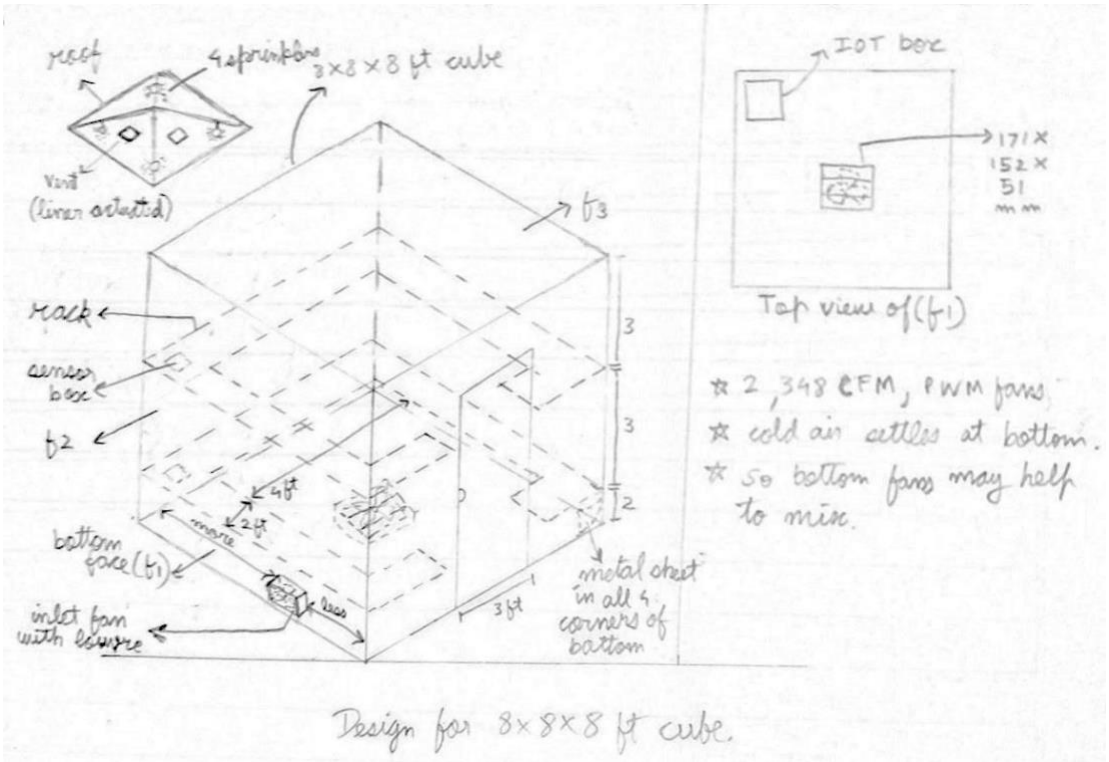
(Ventilating Efficiency Ratio (VER)- This is the ratio of the volumetric rate of air movement to the rate of energy consumption. This varies from about 10 – 20 cubic feet per minute/watt. Fans having a VER of 15 or higher are desirable.)

Energy can also be saved by using larger fans with smaller motors. For example, a 36" diameter fan with a 1/3 horsepower motor will give the same output as a 30" fan with a ½ horsepower motor with a saving in electricity of 180 watts/hr.

2. Power consumption- To prove power proportional to cube volume:

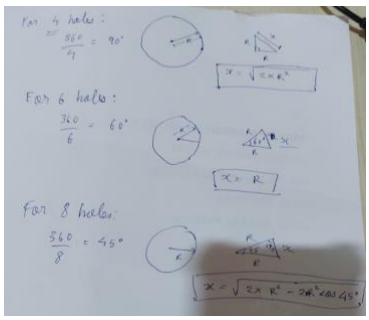
1) 8×8×8(512 cfm) – 0.12kwh (for 300 cfm fan 0.03kw)
2) 8×16×16(2048cfm) – 0.36 kwh
3) 16×16×16(4096)- 4 (3300mcube/hr) fans of 0.15 +4(300 CFM) =4(0.15 +0.03) =0.72 kwh
Hence proved, Power is directly proportional to cube size.
Total power required- (for 8*8*8 ft cube) = 250w approx...
(Fans=120 w, lcd=1w, water pump=70w, cctv= 8w Arduino=0.5w bulb=25 w gsm=15w Leds, etc).

3. Design of cube: After making a rough sketch, it was forwarded for the design department for CFD (computational fluid dynamic) simulation. (Internship ends.)



5.3. Work at the Factory unit:

5.3.1. Mechanical Assembly-

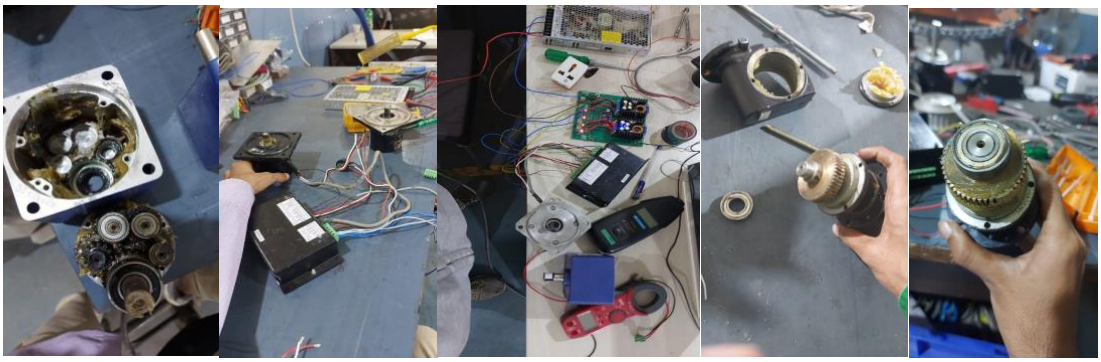
Some Project/task	Observation/learnings
Anode butt prototype 	We were asked to prepare a sodium residue anode butts prototype for a camera detection test. A prototype was with sponges, board and heat gunned plastic bag with white sprayed spots on it.
Manual work with workers.	Helping with co-workers' work, drilling and tapping the holes, fitting assemblies, procurement and QC inspection of some parts.
Assisting workers to make equidistant holes on a p.c.d. of any circular part.	Made a sheet and taped it to the wall. 
Timed (chemical+ water) spray automatic system	Helping in assembling system components like plc, pump, compressor, pressure valve metre and understanding the plc code.

5.3.2. Maintenance and testing of Motors and Gearboxes-

Introduction- Some motors and gearboxes were affected by rain flood in the store room. The task assigned was to dismantle the gearboxes of the motors and test both of them and generate the results in the form of technical data.

Work-

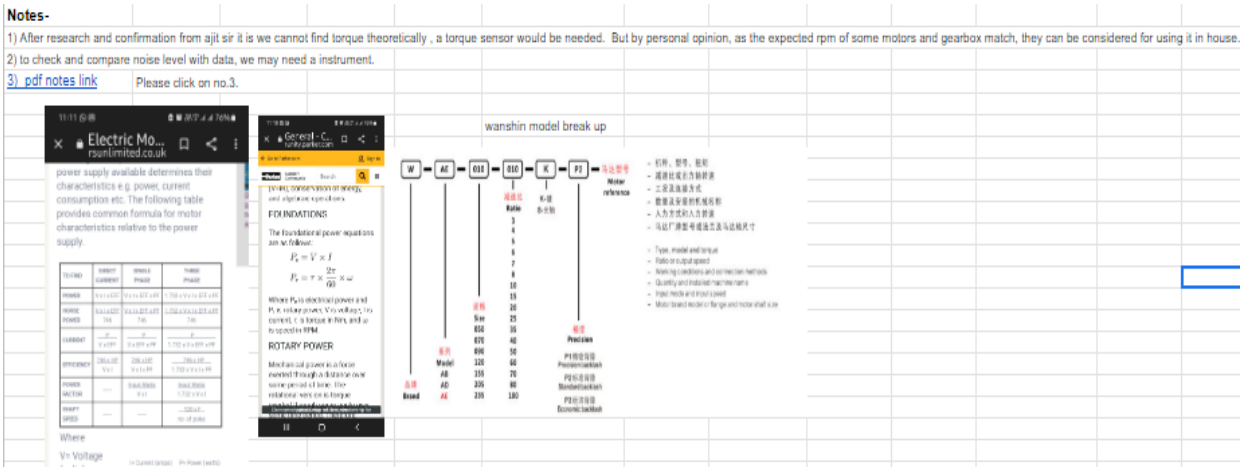
1. Company specific models of the gearboxes and motor were searched for familiarising with the specifications (e.g., no load/full load current and rpm, teeth ratio, types of gears, etc).
2. Following was the task to dismantle all which had to be done and after that cleaned them with diesel to remove the dirty grease.
3. Oil had to be applied before testing. Oil selection was done based on the research. Oil 320 was purchased for its higher viscosity.
4. After that, testing was done with different available equipment. They included Digital clamp metre, voltmeter, motor driver, tachometer, SMPS and a dc-dc buck converter.
5. After testing, 2 final excel sheets consisting of the final results was made.



Excel sheet1 for motor test results:

* tachometeric all motors tested with 36 frame.

Name	name assigned.	model	Nominal voltage	No load current	full load current (with gearbox M1, ratio 5)	no load rpm	full load rpm (m1,5)	Expected full load rpm	torque	comments	comment by sir
tachometeric	m1	23F . 2	24	4.12	not taken	2314	462.8	462.8		litlle bit noisy,no auto st	varnish required for auto start.
tachometeric	m2	23F . 2	24	4.85	4.9	2250	446	450		-	
tachometeric	m3	23F . 2	24	-						not turning on, overly rusted	
tachometeric	m4	23F . 2	24	4.85	4.85	2230	446	446		-	
tachometeric	m5	23F . 2	24	4.9	4.6	2600	511	520		-	
				loads here are m1 m2 m3 gearboxes respectively.							
Chandra electric motor	m1	bldc brake motor	24	.23-3.1	.21-.29	2975	123.1			working okay.	
Chandra electric motor	m2	bldc brake motor	24	.54-.74 (not chec	.9-1.2 (after with replacing n	2975	123 forward and reverse.(with new bearing)			gearbox damage (solved with new bearing)	
Chandra electric motor	m3	bldc brake motor	24	0.21-.27	.15 -.35	3030	125.3 f,, 330 ,635			full load rpm varying, gearbox issue.	
CEM	m4	bldc								very rusted, not tested.	
										no wiring found on motor.	
maxon 3177(rest of labelling rusted)											
pm dc(company not known) , wiring not there											
1 unkown											
seasme motor (driver not found)		PEC90 80 Arcmine P2									



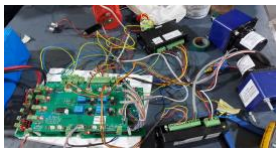
Excel sheet2 for Gearboxes' test result:

name assign	name	type	model (with ratio)	ratio	motor used to check	max rpm output	expected rpm	comment
m1	tachometric	helical,2shaft	igh 90-r 5	5	m4	446	446	both rotation , less greased.
m3	tachometric	unknown	igh 90x90 R 50			-		no rotation, water damaged , screws jamed, rust.
m2	tachometric	spur, 5 shaft	igh 90 - R75	75	m4	30.1	29.73333333	both rotation, noisy due to less grease.
m4	tachometric	helical driven,spur output,5	igh 90x90 R 50	50	m4	44.6	44.6	both rotation ,noisy due to less grease.
m5	tachometric	helical driven, spur output,	igh 90 - R75			-		no rot
m1	chandra	worm	CE brand, model not found.	48/2	m1	123	123.9	original grease is okay,working okay
m2	chandra	worm	CE brand, model not found.	48/2	m2	123	123.9	gearbox heavily damaged, no rotation with hand *(solved with new bearing)
m3	chandra	worm	CE brand, model not found.	48/2	m3	125	123.9	gearbox damage
m4	chandra	planetry						looks rusted
	wanshsin		WABR060-70-K-P1					
	wanshsin		WAE070-050-K-P1					
	wanshsin		WABR090-80-K-P1					
	wanshsin		(not readable)					
	2 unkown, multiple input box							
Notes:								
1) For highly rusted and jammed screws, i tried very hard on openeing,but they dont seem to openable and be repairable.								
2) For damaged gearbox, most probably the bearings are damaged, so replacing them may get the gearboxes back in use.								
3) gearboxes which are yet to be greased properly, shiv bhai said it will be better to do it after grease is used for the sce machine.								

Conclusion:

1. Experienced mechanical fitting, changing bearing, fasteners, different types of motors and gearboxes and also use of different electrical equipments.
2. The documented data can help with the further use of the gearbox motors.

5.3.3. Electronic and It Testing.

Some Project/task	Observation/learnings
Testing of UV machine 	Helping in testing the electronic and electrical components (e.g., ultrasonic sensors, motors, alarm, Arduino, ethernet shield, working circuit boards) of UV aircraft disinfectant machine.

Panel wiring 	There had to be changes in the wiring of the panel to make change from 1 phase connection to 3 phase connection in particular automatic machine So, on 1 full day, one electrical person and I did all the cable cutting, labelling, crimping lugs, covering, soldering.
RC car pic code	Understanding basic working of a C code of pic16f876 in a RC car, from a senior.
Computer networks Course (by self)	Self-learning. To know better in the testing of machines. Computer networks is important for Cyber Security.
Camera delay in tab of a communication module in 'Throw Bot Rover'.	On Analysis, camera quality was fine on the PC browser. When the tab is connected via ethernet it works fully fine, but not on wireless. So using my computer network knowledge and searching about better protocols my idea was to make changes in or change the RSTP protocol. Senior feedback was that it can be tried; he'll try to directly use the browser in the UI if it can be done.

Inferences:

1. Time study is not necessary done only for the shop floor people it can also be done for the office work. Example- For giving purchase orders, taking xerox, etc. Variation of "Maynard operation sequence technique (MOST)", MaxiMOST can be used for longer (more than several minutes), non-repetitive operations.
2. So, to understand the processes involved in work of other engineering backgrounds, gaining some experience and knowledge is necessity. So, some activities are shown above, also including reading of some available catalogues of electrical and magazine of electronics, to familiarize with different field's work of different projects and also with the upcoming industry 4.0.
3. Computer networks and Cyber security- Computer networks help to understand the basic setups of links, IP addresses, etc between communication modules. Also, it forms a base and helpful for a practitioner (manager, engineer or cyber-security expert) involved in the evolving manufacturing Industry 4.0 as it is worth noting that

the large surface area of networks and computer systems makes it complex and difficult to secure a business from cyber-attacks. Thus, having some knowledge in it may be beneficial at some time.

5.3.4. Report of work of Factory unit-

Factory observations-

1) It is roughly 4km away from office unit. Electronics store is in the office and the mechanic store is not organised.
2) All parts are procured from Vendors (also ready-made plc panels). Manual work includes qc, electronic wiring and soldering, drilling and assembly.
3) Machines – surface grinder, hand wheel grinder, bench drill press, hand drill, compressor, 2 uv disinfectant machines, heat gun, forklift, etc.
4) Area is roughly 3300 sq. feet with ample unused area. Solar panel testing area remains unused most of the time.
5) Some employees have very little work and spend very much of the time on phones.

Suggestion inputs-

1) Organise both office and factory stores. Combine both stores if beneficial keeping in accordance with factory area lease time.
2) As fitters can do welding, I also confirmed that the workers know how to use a lathe, so buying a lathe machine and welding kit may increase efficiency.
3) Plc programming and Panel wiring and can be made possible in-house.

Result and feedback from senior-

1) Stores at the factory were re-arranged well.
2) More accurate details needed on lathe purchase based on future forecasting.
3) Inhouse plc programming started with the joining of 2 plc engineers in the company. For the panel making proposals, an experienced senior addressed that “field wiring man can’t do panel wiring unless by force and also since the requirement of panel is less as per the projects”, so inhouse panel making is not economical.

Inferences from work:

1. Project managing- The assembly and testing of every project is different at such a company, so assigning a specific work to a specific person cannot be feasible. Managing people's emotions, specifically laziness and executing project tasks can be a challenge sometimes. Thus, having wide knowledge of different aspects of the task and abilities of differently qualified persons is necessary for a project manager. This can become a very handy skills set to execute projects on the client's site.

2. Production manager of factory- Self- experience collected from doing some work along with the workers can be beneficial in maintaining our stand at such a dynamic project company and have better relations along with the co-workers. Or else very less involvement in other’s work may lead to isolation and error which eventually results unfit for the job of factory manager in such a dynamic company.

Results and Discussions:

Results of major projects: The Understanding of the Project flow and the challenges of the company in Sec 1.3 led to the knowing of the processes of project management.

The Process control and the production scheduling excel project resulted in forming an organized production workflow and overall project scheduling to solve the actual challenges faced in the company in a practical manner. On other hand the project result is a potential product of project scheduling.

Project of "Owens corning" resulted in experience of a site automation, Time motion study of robots, increase in skills of soft communication and report writing.

Results of chapter 5:

5.1.] Understanding the changing processes in Industry 4.0 and the roles of Process management in upcoming future.

5.2.] Office work: Application of part drawing and assisting in designer's work. Application of PLC coding skills. Research experience.

5.3] Work at factory: Experiences of work of different fields and increase of knowledge.

Discussion:

In work life, one can find the continuously updating automation bringing changes to the roles of management as well as all other jobs. To find the balance and smooth flow in the work environment, one has to stay updated with the new technologies, methods and experiences with people from different backgrounds.

Thus, the wide range of skills and knowledge can help in managing and executing a dynamic project a robotic and automation company or to apply an automation change in some production line of another industry.

Conclusion:

The crux of the projects is-

1. Complex Process analysis and control method can be done using ‘Flow diagrams’ and ‘string diagram study method’. Excel skills can bring some automation like RPA to the sheets and helpful in practical applications and helpful for data presentation for production scheduling and project management. BPM and RPA are the rising trends for Process managers.

2. As production manager, one should know what to use and what not will be beneficial in the production line and to the current environment. Thus, getting ready for industry 4.0 is a requirement. Therefore, buckling up for Ind 4.0 can help to implement the cyber- physical systems, IOTs, smart factories and execute such projects in any company of any size.

3. Working at the factory from lower levels of work and projects, benefits in understanding the minute details and flaws in the management of the company.

4. Involvement in different fields with some interest and some self-learning, increases knowledge. Also, the ability to understand the work of other persons becomes better and so does the managerial perspective of the one. One benefit for a project managing person is that he can know the work, its complexity and bring estimates of costs, time study, etc even for such various tasks of other fields.

Scope:

Knowledge of automation shall be the new trend and a cutting edge in the near future for roles of management in a company. Specifically for Process management- BPM and RPA.

Switching to automatic solutions changes the whole environment of workplace including the inflexible and meaningless jobs. Energy and resources can be utilized efficiently.

Machines do things which a human couldn’t do. But for nowadays, a human standing in front it for hours to operate, actually seems lame to me. Isn’t there a need to change that? Don’t we need more smart people doing things the smarter way? Then automation is the way...

Appendix:

Appendix I: (For sales and marketing challenges)-

Challenge- Though manufacturers recognize that automation expansion will improve operations, many find that implementing a new or expanded automation strategy comes with its own set of challenges. One such challenge is justifying the return on investment (ROI) to management.

{ROI is a performance measure that evaluates the efficiency of an investment and is shown as a ratio between net profit (over time), and the cost of the investment.}

Not all manufacturers have a standard ROI strategy in place, however, making an accurate calculation difficult to assemble. Numerous variables must be factored with regard to the cost of the project and the total impact on operations. Because each project is unique, establishing a universal methodology for ROI is difficult.

Recommendations of a report- One key component that manufacturers are increasingly looking at to help them determine these complicated ROI figures, is overall equipment effectiveness (OEE). OEE measures total potential manufacturing output of a given machine or enterprise against the actual, realized total output of said machine or enterprise. Or, as the report states, "a measurement of the percentage of overall manufacturing capability that is actually realized during production." (An OEE of 100% would mean that a given machine or enterprise is producing the most it is capable of without defect, at the fastest speed possible, with no downtime between production runs.)

So, the suppliers of machines have an emerging opportunity to step in and offer assistance to help manufacturers craft ROI and OEE calculation strategies.

Methods- OEE and TEEP

OEE is also the crucial input needed to calculate total effective equipment performance, or TEEP, which is a metric comparing OEE against total time of production. This calculation can be used to measure the percentage of active manufacturing time against the realized OEE output of an enterprise to give an accurate picture of how often a manufacturer is producing at their full capability, or how far they are from that ideal.

OEE= (Good Count x Cycle Time)/ Planned Production Time

TEEP=OEE x (Planned Production Time/ All Time)

The two measurements, OEE and TEEP, play a crucial role in calculating the ROI of any given investment. They equip project leaders with data that clearly indicates to management what the potential output of a project is, laying out the length of time and level of efficiency required before an enterprise will break-even on their ROI for automation projects.

Appendix II: ["*Decision Making (by intuitive method) Analysis*" of reasons and solutions for employee leaving, *causing project delays.*]-

Information analysis of the employees:

LET'S HAVE A LOOK AT THE CONDITIONS OF WORK AND WORKERS-

	(Century) 1800-1900	**1900-2000**	**2000..**
Scenario (generally of the globe).	Industrialization (workers needed to change their field and get industrial jobs)	Specialization (workers needed to be dedicated and specialized in a field) (Degree qualification)	Digitalization (workers are needed to be specialized in a particular job) (Skill qualifications)
Need	Looking for fulfillment of daily needs	Looking for standard of living	Looking for growth and quality of life
Security	None	Daily needs taken care by previous gen.	Standard of living already provided.
Behavior	Loyal, Stoic, will never leave the job (mostly).	Loyal, hard-working, may leave only in adverse conditions	Distractive, smart work, may quite in un-satisfaction.

- From a researched report, development and work/life balance are more important than financial reward-
  - This generation are committed to their personal learning and development and this remains their first-choice benefit from employers.
  - In second place they want flexible working hours.
  - Cash bonuses come in at a surprising third place.

Issues observed-

1. Slow or less growth: Since learning has been become all available for mostly free on the web, anyone can learn new skills in short time span. There is not much secret-ism left in the industries. Many don't like to stick to one job for long time, they like quick growth.
2. Obsolete workplace and traditions: Youngs want flexibility in-place of the old trends of compulsory routines and work timings.
3. No joy/happiness: Happiness from the work depends on how happy is the worker in time right now. It is very dynamic to capture.

Brainstorming for choices of an employer:

Aspect	Challenges	Choices
Growth	1. Historically, career advancement was built upon seniority and time of service. Millennials don't think that way. They value results over tenure and are sometimes frustrated with the amount of time it takes to work up the career ladder. 2. Students learn much theory but get less chance to apply it in real. Same job for long time. 3. Diverse minds with different interests.	1. Allow faster advancement. If not possible, then wage difference between ranks should be kept less. 2. More training/development programmes with R&D opportunities. 3. Managers need to really understand the personal and professional goals of millennials. Put them on special rotational assignments more frequently to give them a sense that they are moving toward something of their interest.
Flexibility	1. Fixed working hours. 2. Old style workplace.	1. More automation in Company allows flexibility in time and work. 2. Modified workplace with industry4.0.
Happiness	1. No source of enjoyment in the workplace. 2. Lack of motivation in work.	1. Simply bring the fun elements of worker's choice. 2. Flexibility can be the key. Use of "Management Theory Y".

Appendix III: (RECOMMENDATION FOR USING RPA)

Recommendation- To automate the data entry of details of parts of BOM (released from the designer) and the POs (from the Purchase department) using RPA for the achieving its benefits. An employee can be dedicated for the learning and implementation or outsourcing can be done.

RPA-Robotic process automation is a software technology that makes it easy to build, deploy, and manage software robots that emulate human's actions interacting with digital systems and software. Just like people, software robots can do things like understand what's on a screen, complete the right keystrokes, navigate systems, identify and extract data, and perform a wide range of defined actions. But software robots can do it faster and more consistently than people, without the need to get up and stretch or take a coffee break.

Benefits of Rpa- Robotic process automation streamlines workflows, which makes organizations more profitable, flexible, and responsive. It also increases employee satisfaction, engagement, and productivity by removing mundane tasks from their workdays.

Few examples of Rpa solutions for manufacturing sector-

1) Supply chains-
   (1) Let robots prepare purchasing proposals, collect auction bids, and create contracts
   (2) Enable real-time data gathering, collation, and reporting across your supply chain

2) Operations-
   (3) Automate bills of material (BOM) management to make it simpler to share technical drawings and to make changes to materials and manufacturing processes in plants.
   (4) Streamline production management and gain transparency into real-time stock movement by automating the creation of PO's and PR's.
   (5) Automate open exchange order reporting and uploads of service records and certifications into ERPs like SAP.

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