1st June ’21 – 21st June ‘21
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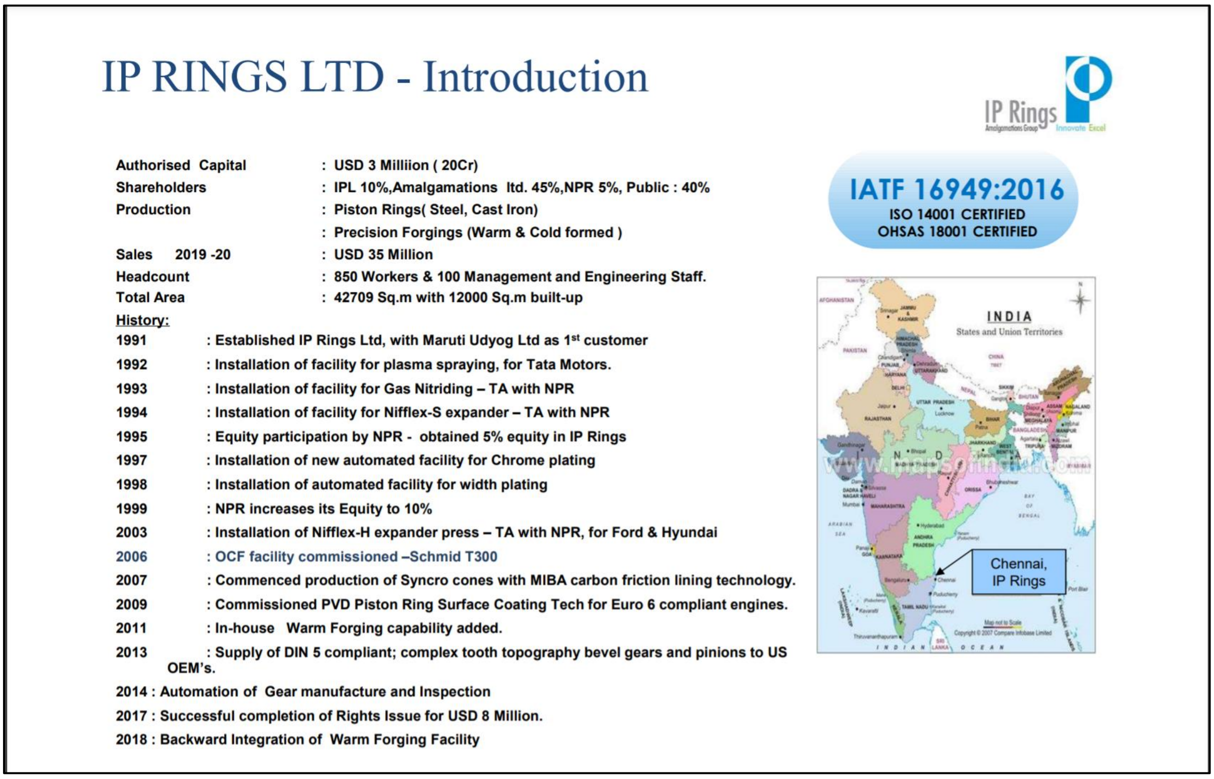
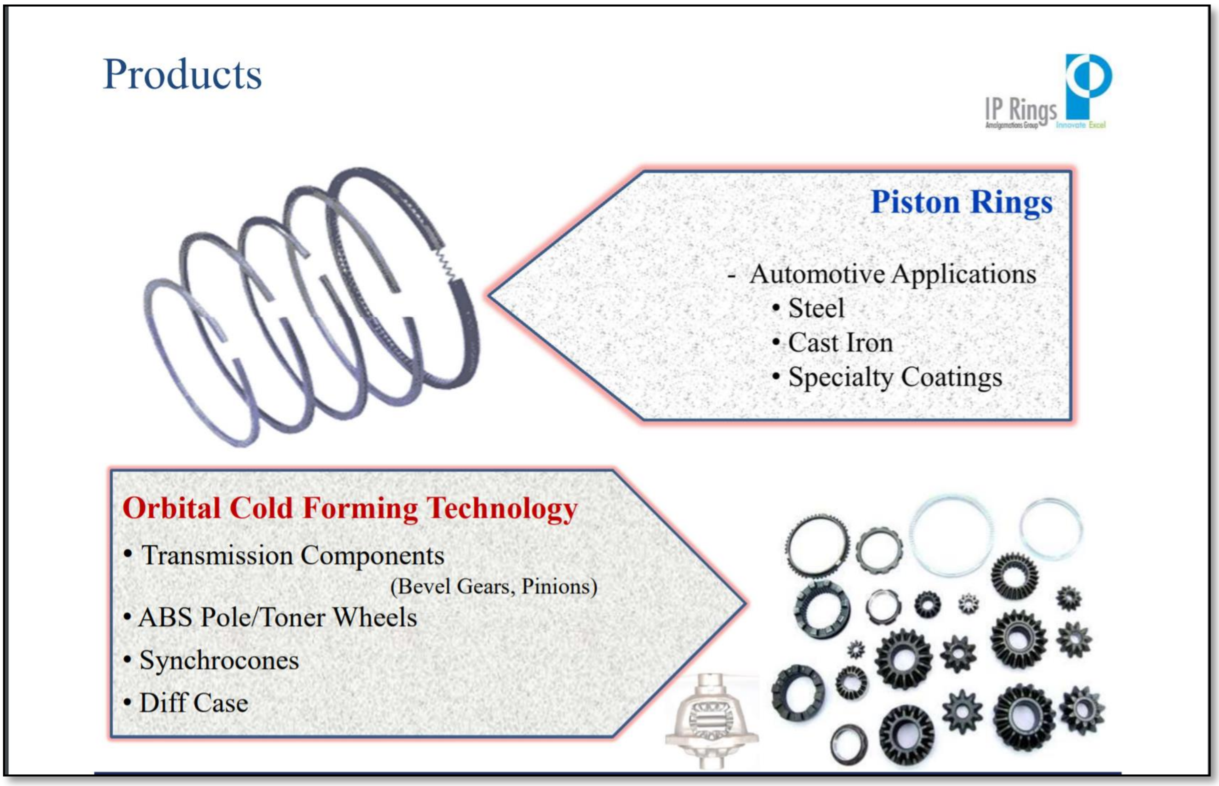
To reduce manufacturing costs for JL Gear using Value Analysis/Value Engineering techniques

Background:

IPRings is a company involved in the design and manufacture of high precision automotive components.
The company registered a Sales Turnover of USD 40 Million in the year 20-21.
The company has a division that manufactures near net shaped cold forged components like Bevel Gears and Pinions, Shafts, Flange, etc.
I did my internship in this division.





Value Engineering:

Value Engineering can be defined as systematic, organized approach to providing the necessary function in a product or project at the optimum cost.
In a manufacturing environment VA/VE (Value Analysis / Value Engineering) promotes substitution of materials, substitution of methods and eliminating waste without sacrificing the functionality of the product, process or project.

A brief history:
The concept of Value Engineering began in the 1940's at General Electric (GE), during World War 2. Due to the war, purchase engineer Lawrence Miles and his team actively began to search for alternate materials, components since there was a huge shortage caused due to the war. These alternate materials and components were often found to reduce costs and provided equal or sometimes even better performance.
Mr Miles defined '*product value'* as the ratio between two elements. *Function and Cost*.
The *Function* of an item is the specific work it was designed to perform.
The *Cost* refers to the cost of the item during its life cycle.

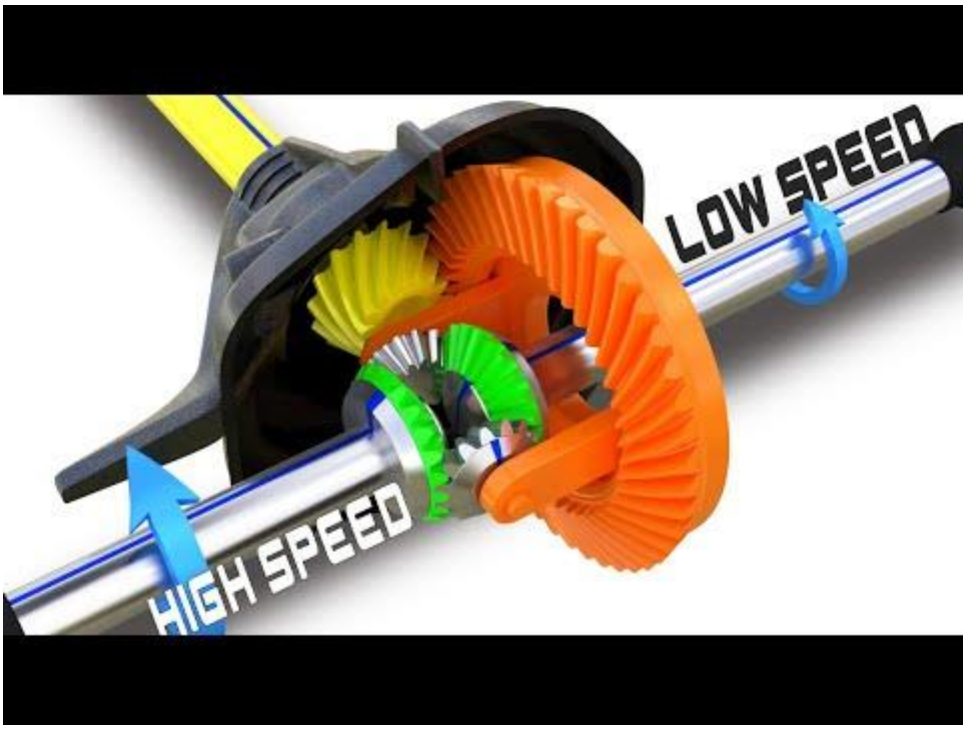
Value of the Product = Function / Cost

In Value Engineering, the costs related to design, production, maintenance and replacement are included in the analysis.
During this project, we focused on the costs associated with the *production of the product.*

Manufacturing or Production Costs:
In a manufacturing or production process, every process has a particular purpose or function.
How to reduce costs without sacrificing the functionality of the process is the challenge that manufacturing engineers face every day.

For this project, I was part of a team that was tasked with reducing / eliminating manufacturing costs associated with a *Bevel Gear for a customer* – ***JL***

What is a Bevel Gear and Pinion and how does it work in a vehicle?



OR

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VA/VE Procedure:
To Value Engineer a Process, one needs to map the process and understand the need for each step in the process (function). We can also identify some potential areas to re-engineer the process so that costs can be eliminated.

Definitions:

1. *Process Mapping*: a sequence of operations / processes required to ensure that the final product is 'fit for use'.
2. *Material:* In the manufacture of a product, the selection of raw material is very crucial since it often tends to be a significant portion of the cost of the product. In IPR, the bevel gear for customer JL, RM was 33% of total cost of manufacture.
3. *Yield:* Is defined as the ratio between input material used and final output material that is sold. Yield can be controlled in two significant ways:
   a) Reduce the amount of input material being used. This can be done by altering the design of the die used to forge the component.
   b) Reduce the rejections that are caused at each process.

Since this project used a Value Engineering methodology, the focus was on reducing the input weight.

4. *Process / Throughput*: Process redesign without sacrificing the purpose of the manufacturing process (to make a part that is fit for use by customer) is the basic job of the Process Engineering team in a manufacturing organization. Throughput is defined as the rate at which parts are being produced. A reduction in Lead Time to manufacture results in an increase in Throughput.

				VA/VE Opportunity		
Number	**Process Name**	**Picture**	**Function**	**Material**	**Process/ Throughput**	**Yield**
# 10	Raw Material		Strength/ durability	Alternate		
#20	Raw Material Inspection		chemical composition / dimensions / mechanical properties			
#30	Billet Sawing		to maintain weight and dimension			Band saw width
#40	Shot Blasting		surface cleanliness / preparation			
#50	Hot Forging		Preform with accurate dimensions for subsequent finishing operation			Die design to reduce flash
#60	Annealing		Softening for subsequent forging		Continous furnace to save reheat costs	
#70	Shotblasting		Surface cleanliness			

#80	Zinc Phosphating		Antifriction coating for Mos2 adhesion	Alternate coating		
#90	Mos2		Antifriction coating for Cold forming	Alternate coating		
#100	Orbital cold forming		Tooth formation to size		Alternate process	Die design to reduce weight
#110	PreMachining		Premachined to size		Machine to final drawing size	
#120	Tooth Deburring					
			Deburring the tooth sharp edges		Automate/ eliminate burrs	

#170	Hard Turning		Final Bore / Mounting face machining as per final drawing		Eliminate by maintaining dimensions before HT at PM	
#180	Final Inspection		Visual / Dimension inspection			
#190	Eddy current check		Material change / Part mix up inspection			
#200	Oil and Packing		Rust prevention oil and packing			
#210	Transportation					

Choice of Project:

The task force brainstormed Value Engineering ideas for each process and identified potential opportunities.

Priority was given to Eliminate Hard Turning since this Project would give IPR the maximum benefit in the shortest period. Moreover, the complexity involved to implement this Project was identified to be low. Finally, the benefit from implementing this Project is expected to cover the following areas:

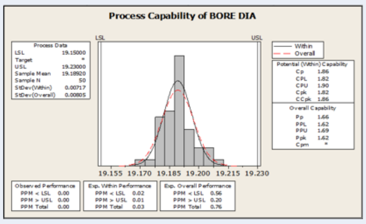
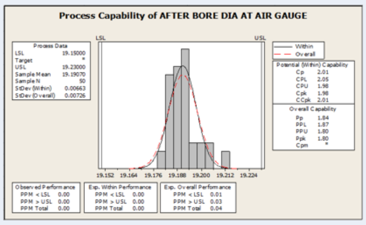
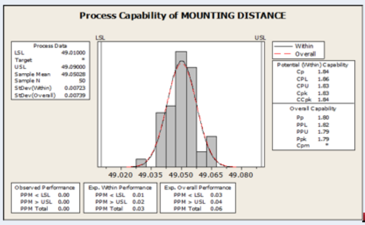
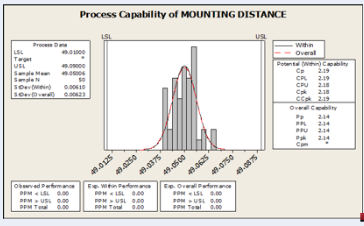
a) Saving in costs (conversion costs and manpower costs)
b) Saving in space
c) Increase in throughput (since lead time to produce the part is now lower)

Steps to implement "Hard Turn Elimination":

1. A complete study to understand the Process Capability at Pre-Machining Operation was conducted. Statistical Tools were used to understand the capability of the Process to maintain a closer specification.
2. The dimensions that were taken for study are, Mounting Distance and Bore Diameter.
3. A trial batch of 50 components were taken and finished to the final specifications required at PM stage.
4. These components were further processed and measured again at final inspection, to ensure that further processes did not impact the final specifications. These were again measured, and statistical tools used to understand the Process Capability.
5. The whole exercise was repeated using a larger Lot of 1000 pieces and after the process was proved to be statistically stable, the hard turning process was eliminated, and the part was finished to the final drawing using the Pre- machining process only.

Process capability – Current process
Hard turning

Process capability – Proposed process
Without Hard turning

PART NO	CURRENT PROCESS (WITH HARD TURN)	PROPOSED PROCESS (WITHOUT HARD TURN)	REMARKS
2006101 – E PINION	BORE DIA (19.23 0 / -0.08) – Cpk -1.82	BORE DIA (19.23 0 / -0.08) – Cpk – 1.98	
	 Click Here Adobe Acrobat Document	 Click Here Adobe Acrobat Document	Process capability met customer requirement
	MD (49.05 ± 0.04) – Cpk - 1.83	MD (49.05 ± 0.04) – Cpk – 2.18	
	 Click Here Adobe Acrobat Document	 Click Here Adobe Acrobat Document	Process capability met customer requirement

From the above graph, we can see that the Process Capability after removing hard turning has improved from a CpK of 1.82 to a CpK of 1.98 for the parameter Bore Dia and for MD (Mounting Distance) has improved from CpK 1.83 to CpK 2.18.

Cost Saving Calculations:

To calculate the cost saving resulting from 'Elimination of Hard Turning' I spent time with the costing and finance department to understand how to calculate the savings.

Definitions:

- *Raw Material: Material used for manufacturing*
- *Yield: Ratio of Finished part weight vs the input weight*
- *Variable cost: All cost that are directly attributable to production of the part*
- *Fixed cost: All cost that are attributable to production and sale of the part but do bot vary to the production numbers ex equipment is required if even one part has to be produced, Fixed cost per unit decreases with improved productivity and throughput*
- *Productivity: The rate of production per shift*
- *Throughput: The flow of material in the production line*
- *Contribution: The ratio of sales price vs Sale price – variable cost*
- *Fixed Cost Absorption: Higher contribution will lead to better absorption of Fixed cost and leading to a drop in break-even point*

- *Break Even Point : Fixed Cost / Contribution % equates to Break even Value and Fixed Cost / Contribution in value equates to Break even in Units*
- *Working Capital : Amount invested in inventory , debtors and creditors*

Methodology:

- Key Benefits
    - Higher yield as excess material required for Hard turning is negated
    - Reduced Variable cost on
        - Savings on tooling cost
        - Savings on Manpower required for the process
        - Higher Throughput as the part is not required to go through and process thus improving productivity
        - Overall Improved contribution leads to a drop in Break even point ensuring better profitability
    - Reduced Fixed Cost
        - Savings in depreciation and interest (as the eqpt is not required and can be repurposed for other use)
        - Savings in working capital
            - Increased throughput and productivity lead to lower inventory in raw material and work in progress the reduced inventory leads to reduced working capital improving cash flows and saving in Interest

Hard Turn Elimination Working

Cost Type	Values	Remarks	Cycle time and productivity working	Values	Remarks
Raw Material			Cycle time	30	sec per part
Input wt	0.685	in gms	Per shift	840	
After elimination of Hard Turn	0.670	in gms			
Net Saving	0.015	in gms			
Cost Per Kg	98	in Rs	Selling price per part	300	in Rs
Saving per part- A	1.47	in Rs	Contribution Saving per part	7%	in %
Variable Cost					
Manpower per part	17.9	in Rs			
Tooling cost per part	1.25	in Rs			
Saving per part - B	19.1	in Rs			
Total Varibale cost	20.6				
Saving in Fixed cost					
Hard turn equipment	45	Rs in Lacs			
Depn- A	0.25	15 years in life and per month			
Interest- B	0.13	per month			
Working Capital					
No of parts	12600	assuming 5 days in inventory saving			
Standard Cost per part	2331000	at Rs 185 per part			
Interst saving- C	1.75	per month			
Total Fixed cost Saving A+B+C	2.13				
Breakeven Nos	10,349	Possible reduction in Break even point in Nos			
Breakeven Value	31.32	Fixed Cost / Contribution Saving %			

CONCLUSION:

Based on the Process Capability of the new process it is recommended that the process of Hard Turning be eliminated.

From a Financial perspective, we understood that eliminating Hard Turning will lead to a saving of Rs 2.13 / part.

Besides this, there would also be a saving in Space and can lead to shorter lead time to produce the part.

Therefore, eliminating Hard Turning is a good decision.