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A study of professional advantages to manufacturing organizations by the way of utilization hot extrusion technique for production of brass Electrical contacts.

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Abstract
This paper presents the study and analysis of long term advantages gained by electromechanical product manufacturing Industries when the A class components like brass electrical contacts are manufactured by newly devised advance manufacturing technique of hot brass extrusion .After completion of the research and practical application this new advance manufacturing technique this has replaced previous traditional manufacturing technique of green sand molding and casting used for commercial production of brass contacts. The prime impact of research covers a newly devised innovative product life cycle which increases product life.

Key words-Electrical contact, Hot Extrusion, Traditional manufacturing techniques,class, Product life cycle.

I. Introduction

Manufacturing techniques play crucial role in consistent quality and productivity of product assembly and it all sub components. The key elements which define productivity are set up time, manufacturing cycle time are reduced due to use of suitableadvance manufacturing techniques. This paper mainly focuses on long term advantages derived by new product design and development industries.

If we deeply study various advantages we see that the product for which these manufacturing techniques are used undergo newly devised product life cycle and extends active product life in the market.In the context to advanced manufacturing techniques helps in higher productivity and consistent quantity of subparts but also simultaneously keeps betterprocess control of advance manufacturing technique. The process control eliminates wastes like post production inspection, reduction in machining operations and many other.

Process control gives inherent advantages such as, less wear and tear of the machine toolsimmediate correction of the process during part manufacturing as per need.This research is substitute'straditional techniques by advance manufacturing technique for the parts quantity are higher in volumes.In this study the brass material contacts required for socket assembly are 7, 50,000 no. per month.

The FIG 1 shows some typical examples of electrical contacts made by brass green sand molding and casting technology and further machining if required.

The FIG 2 fully finish brass electrical contacts electrical contacts manufactured by new hot extrusion process. (Photographs taken from three different directions).

FIG 1

FIG 2

It is general engineering practice to refer BOM chart for deciding further work plan.

BOM of Socket assembly is as tabulated in Table below.

TABLE 1

Number	Part Description	Qty. /Set
1	Housing -1	1
2	Housing-2	1
3	Clamping Bolt.	1
4	Clamping Nut.	1
5	Brass Contact.	3

The research had been undertaken due to the fact that the socket assembly price is too made more competitive in export market as per customers demand. The subject paper discusses the long-term advantages derived by the organizations after completion of the research. We have carried out subject R and D work by application of hot extrusion technique so as to produce long sections of contacts by extrusion and further slitting to suitable lengths we get almost finish near and neat shape of the contact.

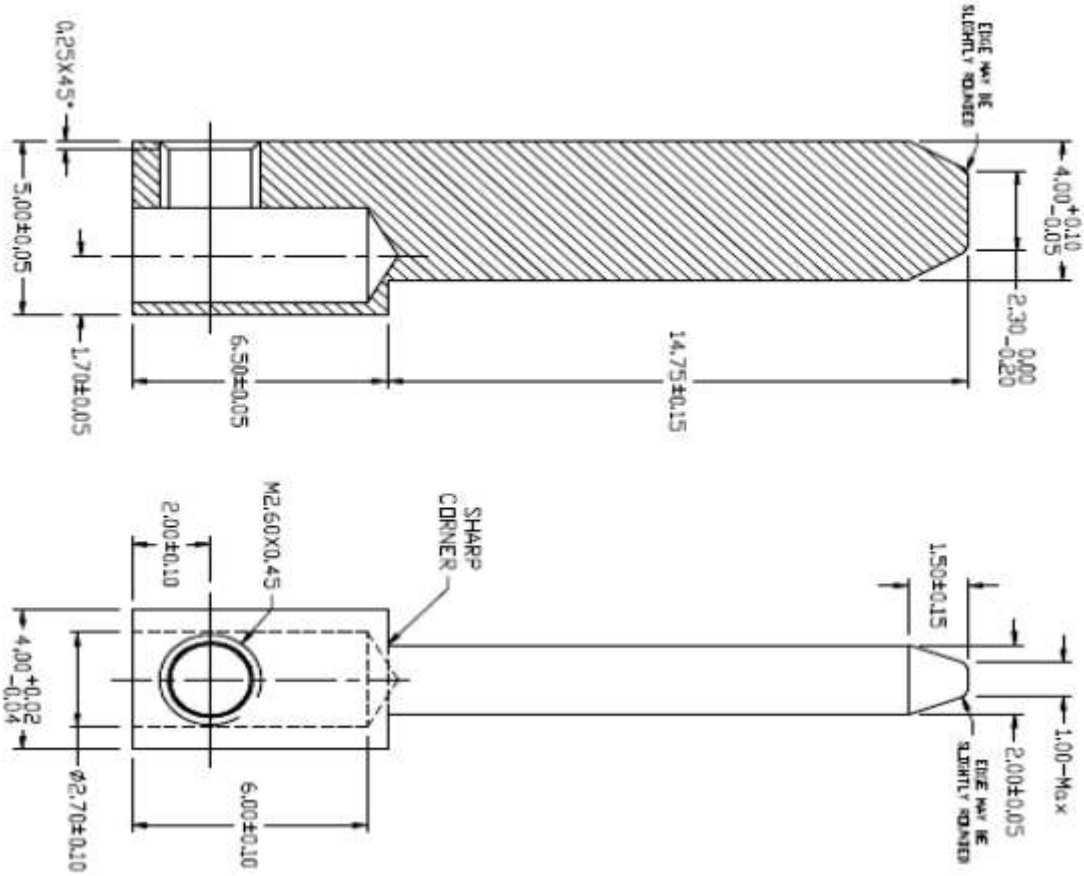
Quality Management Techniques used-

TQM fundamentals are significantly used in this research work. The homogeneous team forming and effective working of team till completion of the selected R and D project was helpful to concerned manufacturing industries. Not only this but also we have extended this concept and utilized by forming and using cross functional teams to get effective and time bound solutions to the productivity and quality problems of brass electrical contacts.

In this specific case study we have selected PP-043 EB/LB contacts used for power entry products which have very serious productivity and quality problems due to the reason that the contacts are manufacture by existing traditional green sand molding and casting techniques followed by further machining operations . Present cumulative rejection of contacts at various manufacturing stages works out in a tune of 50%. This study is carried out for a span of 18 Months after satisfactory completion and implementation of the said research work where data collection is performed on monthly basis.

In this paperproductivityand quality improvement through innovative process usage this has given us opportunity to use JIT revolutionary concept of inventory aspect.

Drg.No-1for finish duly machined contact.

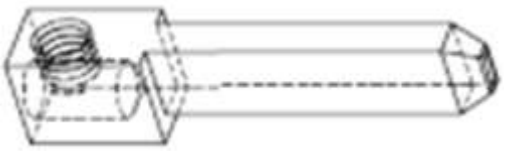


This contact component was selected from productivity, quality and cost improvement.

II. Research Methodology

The research methodology used here is very practical. This includes comparative evaluation of various probable le manufacturing techniques and selecting the best one which is most suitable. The research work is based on the limitations and advantages study and upon conclusion Hot extrusion technique is to be used for the purpose of manufacturing of long contact long cross sectional strips so as to reduce number ofmachining operations required for finishing of the contacts. This experimentation is the actual research methodology for the said research.The trials are conducted till satisfactory metal extrusion results are achieved.After long cross sectional strips are produced by hot extrusion these are further requiredto be drawn into finish sizes of cross sections since extrusionprocess does not give finish sizes in the required accuracies.

After these long sections are slit to the required thickness by slitting operation once the slitting operation is done we have to perform only side slot milling, drilling and tapping operations to get the desired finish part of the contact.



The following is the comparative table depicting the no of operations for traditional technique of manufacturing and

A new devised advance manufacturing technique. Both columns denotes the operational flow chart for getting finish component as ultimate objective.

TABLE 2

SR. NO.	**Traditional manufacturing technique.(Process)**	**Advance manufacturing technique of Hot extrusion.**	**Advantage due to new technique.**
1.	Charge melting.	Charge Melting.	Not required.
2.	Box molding with multi pattern.	Billet mold is readily available this is permanent water cooled mold.	No per piece molding required one billet gives very long strip of section of the contact.
3.	Pouring so as to fill all molds. This operations needed to be done depending upon number of boxes. Hence low productive.	Pouring in permanent molds to get required billet size.	No independent pouring in molding boxes. Only pouring of the metal in water cooled molds.
4.	Knock out. This operation is repeated for each tree of castings.	Not needed in this technique.	One billet gives long strip of sizable length of strip.
5.	Shot blasting. This operation is required to be performed for each casted part.	Not needed in this technique.	This operation is eliminated.
6.	Fettling is required to be performed for each casted part.	Not needed in this operation.	This operation is eliminated.
7.	Five Face Machining operations. This is group of five operations.	Not required.	Sectional finish sizes are achieved in extrusion and drawing. So this operation is eliminated now.
8.	Drilling operations –one number.	Remains as it is.	New technique limitation.
9	Drilling &Tapping operations two nos.	Remains as it is.	New technique is concerned with metal forming.
10.	De burring.	Not required.	This operation is now eliminated.
11.	Total no of operations-14	Total No of operations-6	

From above table it is seen that there is reduction of eight no of operations due to use of advance manufacturing technique.

The table below presents the comparison of the machining operations before and after completion of the R and D work. Such type of lower level reduction in rejection of the contacts is possible only due to reduced number of machining operations usage of SPMs for machining and simplification in machining operation.

III. Experimental Set up description -

The experimental set up used for the R and D work comprises of equipment specified below.

Induction furnace,water cooled molds ,billet cutting saws, billet heating furnace, hydraulic extrusion press, extrusion die with special innovative feature,steel channel track for flow of extruded sections ,straightening and drawing benches for extruded sections, slitting saw bench, pillar drilling and slot milling SPM.All equipment are listed in sequence as per operational sequence.

The advantages derived due this research work are effectively understood through study of various production related commercial parameters which are discussed one after the other in sequence on the basis of comparative data for before and after the completion and implementation of the research work. For this purpose we have selected a period of 18 months period after satisfactory completion and implementation of research work. Each technical innovation has to lead to the economic advantages for social growth.The benefits derived are so fruitful they are contributing to the social development in addition to organization benefits.

For clear understanding of these benefits we have selected following business parameters which are specified and compared one after the other as discussedbelow.

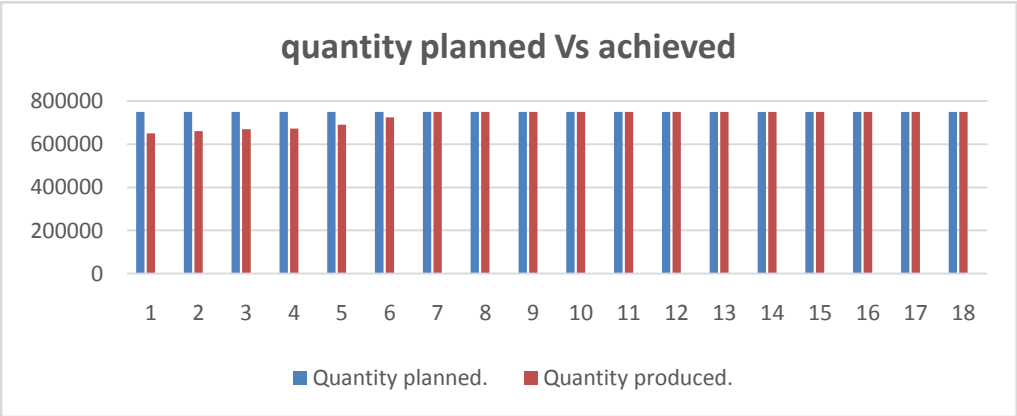
1 Quantified analysis of production quantity planned vs. achieved for contacts before and after completion of development and used for manufacturing.

Before the said research the when traditional technique was used the production of planned contact casting was no way achieved and as far as planned quantity of the contacts is concerned. The higher rejection in a tune of almost 50% was consistently occurring at casting manufacturing stage. The following table presents the quantity planned and achieved for eighteen months period after alternate

technique of hot brass extrusion followed by cold drawing was established and proven for the production.

The scenario of production after necessary R and D completion is as tabulated as under. Production ratings of the electrical contacts for the period of last 18 months after completion of the R and D.

GRAPH 1



After a period of about eighteen months new manufacturing technique when the process capability was calculated it was found to be capable enough to reach the required quality standard.

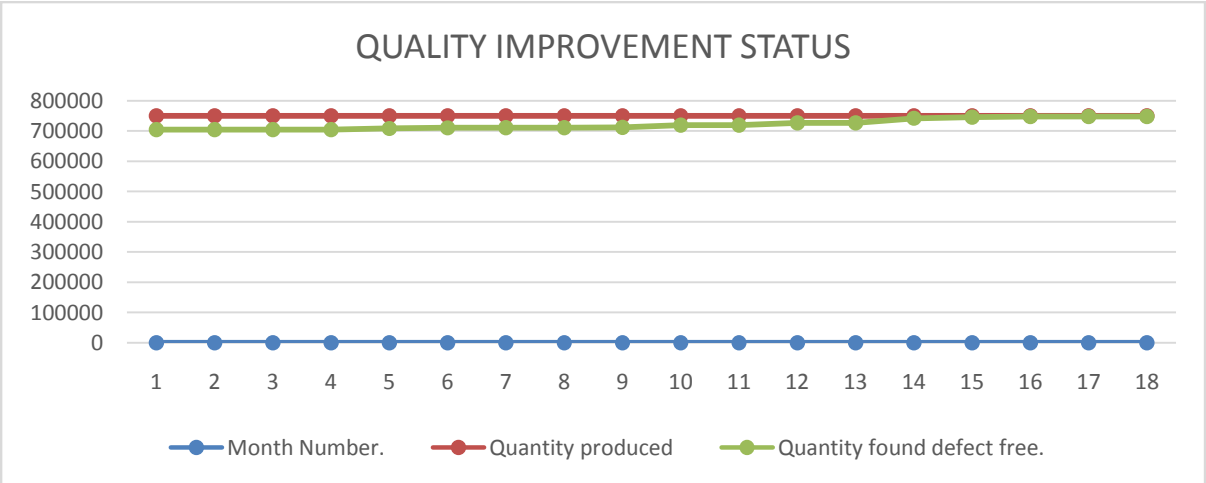
2Quality improvement status in terms of % of rejection.

Reduction in rejection during production always leads to the economic production this leads to the higher profitability and improves the profitability of the product .In long run it makes the product more competitive in the market. The table below depicts the rejection trends and hence contributes in reduction of losses and hence waste eliminations on long term basis.

Graph no-3 represents month wise rejection details. It is clearly understood that even at initial period of R and D the rejection is less and it is seen going down consistently and reaching to 0.05 at the end of 18 months span.

To add further the process control is monitored through the SPC software and for consistently 18 months CpK value lies between 1.70to 2.00. This proves the process is well within control and giving consistent quality output.

GRAPH 2



3 Machining operation rejection Control-

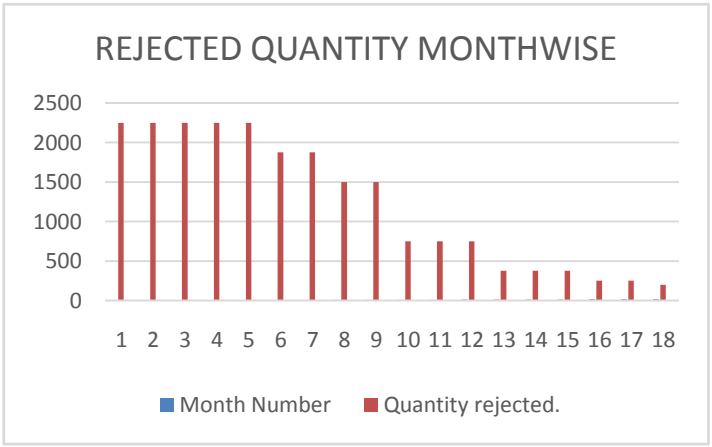
If more are the machining operations more process monitoring is required and more can be the rejection especially for non-automated machines tools. This process includes usage of hot extrusion and drawing operations to produce finish cross sectional length strips.Also this has reduced the investment in design, development and manufacturing of special purpose machines.

After the hot extrusion and drawing operations were developed we see that the overall process rejection comes well within control since initial phase

of development and comes to 0.02 % at the end of the development period.

The above tabulated data is giving us a clear-cut indication of reduction in rejection % as the process is getting improved by practical application of repeated running of brass extrusion. Set up.

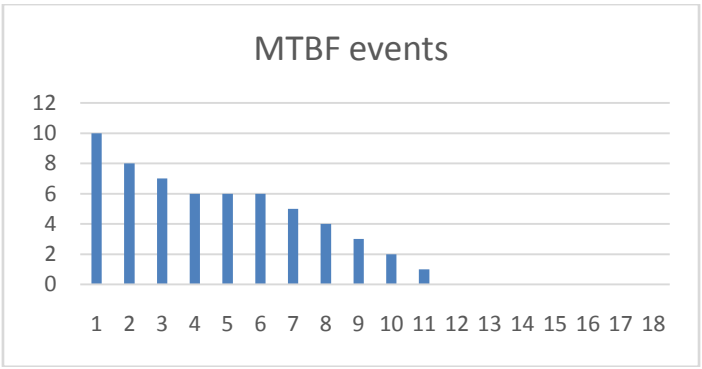
GRAPH-3



QUATITY PLANED PER MONTH IN ABOVE GRAPH IS 750000

4 Assembly MTBF –Here the word MTBF is used for explaining the situation when assembly function used to be failed when there was significant shortfall in the supply of the contacts. This was the scenario when the research work need was identified initially.
When we took this project for R and D work the situation was so beyond control that due to non-availability of the contact assembly function use to remain idle many times in a month. We monitored this failure for the said period of 18 months and could see that there is consistent reduction in the MTBF of the product assembly function. This is tabulated in the table below.

GRAPH-4



MTBF reduction means assembly remaining idle for the want of contacts.

5 Internal material handling distance before and after R and D-

Process layout of the new devised technique has become compact and things are remaining better under control and it is now easier to monitor the manufacturing status of contacts due to sizable reduction in the material handling distances.

The comparative evaluation of the material handling distances is as shown in the table -2

TABLE-3

Total Handling Distance for production of each piece of contact as per previous technique.	Total Handling Distance for production of single piece of contact as penew devised technique.
6.40 Kms.	1.1 Kms.

ROI -There is drastic change in the ROI due to following policy decisions-
1 It is decided to outsource the extrusion and drawing operations due this the subject R and D work is carried out without any additional set up investment with increased business for outsourcing vendor.

7. Product life before and after R and D-

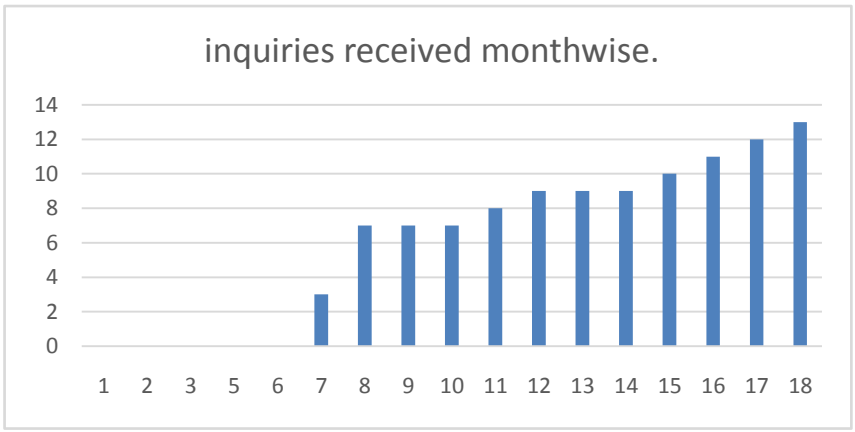
When the contacts were manufactured by traditional technique the product assembly use to remain idle and customers demand cannot be satisfied.

The product was ought to get closed due to customers refusal to accept on the basis non competency of price of the product. Now the projected life of product is minimum 5 years. Normally due to high competition in the global market and ever increasing customers'expectations there can be many minor changes in electromechanical product design .The average life of such consumable product is maximum in a tune of 5-6 calendar years.

8 Export Business Growth opportunities improvements-

Further to note that looking at the irregular supplies of the product assembly further new products from APC were stopped... When the consistent supplies were made it is seen that the customers confidence isregained they have now slowly started sending new inquiries without any reminder. The table below shows how there is is in the customer's new potential inquiries.

GRAPH- 5



9 Employee encouragement evidences after completion of R and D -

The total team of two engineers,one manager and 4 assistants had worked dedicatedly said R and D cross functional team withfirst author V. M. Dandge as team leader and technical co-ordinator.

They have successfully launched this advance manufacturing technique the organization is benefited and they are rewarded through the salary revision and hence their currier is enhanced.

TABLE 4

No.	Name /position of employee.	Previous designation.	Changed designation	Previous salary.	Revised salary.
1	Manager	Manager	Sr. Manager	INR 15000/Month.	INR 20000/Month.
2	Engineer	Engineer	Sr. Engineer.	INR 4500/Month	INR 5000/Month.
3	Assistants	Technical Assistant.	Technical Supervisor.	INR 3000/Month.	INR 3800/Month.

This was possible only because of the productivity and quality improvements in electrical contacts by using advance manufacturing technique.

10 Inventory level improvements are as per the table 3 below-

TABLE 5

Inventory status before R and D	Inventory status after completion of R and D work.	Inventory status after eighteen month review after completion of R and D work.
Inventories were not built at any stage of production.	Slow and steady increase in the inventory (WIP) levels of brass contacts.	Sufficient and consistent rise in inventory levels and JIT Control established for last ten months.

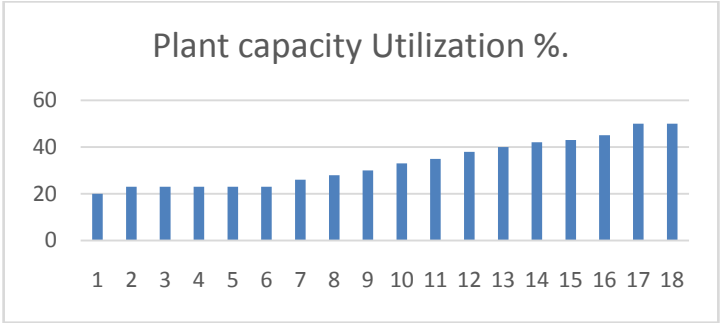
Initial lead time of contacts against confirmed customers purchase order has remain undefined strategy since building up three months inventory of contacts 750000 no's was just an impossible task as far as traditional method is concerned. Since new production technique has brought down the lead time to 17 days. Once inventory of 750000 contacts is built and scheduling this much of quantity per week in continuation we could achieve JIT system for inventory of the contacts .This has up course implemented JIT system for Manufacturing of finish products. After three months rigorous implementation of the system.

One extra set of Extrusion and drawing dies was kept ready to avoid contingent failures on account of maintenance. For rest of the equipment the designs selected are so safe that there is no chance of failure.

11Vendor plant capacity utilization of vendor indicates the picture of business growth of vendor

The graph below shows the steady growth in plant capacity utilization at the vendors end. This is to be noted that hot brass extrusion is high productive operation and 50% capacity utilization is sufficient to satisfy contact requirement equivalent to the active WIP.

GRAPH- 6



Effective manufacturing cost per piece of the contact –

As per previous manufacturing technique- INR 6.07/Pc.
As per new Rand D technique –INR 4.33/Pc.
Rs 2.04 /Pc of contact is net saving.
Monthly requirement of contacts is 750000 Nos.
The cost saved per month is INR 1500000.
Annual savings work of 1.8 Core INR.

Literature review is part of post research. This is done with reference to the product life cycle industrial engineering fundamentals, ROI principles, Moral and motivation, TQM and team working. The extract of such literature survey is as specified in brief as below in the references.

For extrusion we have referred various journal papers, books, die designing guidelines and many other tool designing books for the innovative study of the hot extrusion dies. Jamnagar in Gujarathas about80 extrusion units and about 50 Tool Room units which are well established in all respect. They have always extended their practical experience in brass extrusion technology so as to have high productive extrusion die equipment is designed and developed.

Due to reduction of contact manufacturing cost we see that there is proportionate rise in the profitability of the finish products looking at this aspect the decision has been made by the customer to pass on the cost saved to their export customer.This has made the product price more competitive in the export market.

IV. Conclusions

The consistent focus and review of the advances taking place in various manufacturing techniques is very much essential for the Manufacturing industries who are engaged in design, development and manufacturing of various product assemblies. The major portion of manufacturing cost is contributed by the manufacturing techniques. Such cost saving and productivity improvement techniques must be studied and used in practice by manufacturing industries at the design stage through cross functional teams for the business growth and

hence ultimately for social improvement. This also derives advantages such as waste elimination in waste elimination, more customer satisfaction and building an image of competitive manufacturer in global market.

Such research also helps in implementing concepts like JIT in both manufacturing as well as inventory management. In long run it also gives extended product life cycle.

Acknowledgments- We are thankful to Kulkarni Engineering works for giving us the opportunity to perform this research at their vendor located at Jamnagar Gujarat India. Also we must submit our thanks to other related industrial sectors in Jamnagar mainly tool room based and extrusion based industrial sectors where we performed ourexperimentation.

We are also thankful to Shimpukade Engineering (P) Ltd works for providing us Cp, CpK software training to our team members due to this we could monitor the process capability index and hence process consistency and repeatability.

Abbreviations- MTBF- Mean time between failures.
R.O.I- Return on investment.
B.O.M - Bill of Materials.

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