UTILIZATION OF EXTRUSION AS AN ADVANCED MANUFACTURING TECHNIQUE IN THE MANUFACTURE OF ELECTRIC CONTACTS

Virajit A. Gundale[1] ,Vidyadhar M. Dandge[2]
[1]Prof. & Academic-Incharge, Sharad Institute of Technology, College of Engineering, Yadrav, Kolhapur India.
[2]Asstt. Prof., Dr. J. J. Magdum College of Engineering Jaysingpur, Kolhapur, India

ABSTRACT

It is common that each engineering assembly product has A,B and C class components which together comprises assembly. A class component has high contribution in product function, cost and profitability of the engineering enterprise. A special technical research is must for this class of components. Product assembly is another crucial function where all failures are coming on the surface. Where all components are to be available simultaneously to complete assembly. This is important stage because if component supply is interrupted assembly function stops. Many times the components cannot be supplied due to selection and use of traditional manufacturing techniques used at the time of sample lot submission. These short cuts taken during development phase are becoming hurdles at the time of commercial or bulk production of assembly. Selection of most suitable and advance techniques for manufacturing of all components gives quality and quantity of all components and streamlines assembly functions. Keen approach towards manufacturing techniques eliminates quality and productivity problems which occur at the supply stage of the product. This also derives long term benefits such as customer satisfaction gain, product life cycle growth.

KEYWORDS: *Manufacturing techniques, productivity, product life cycle*

I. INTRODUCTION

This paper presents and discuses the results of the research work of application of advance manufacturing techniques used for long term elimination of quality and productivity problems of electrical contacts required for electro-mechanical power entry products. Due to highly competitive global market the time available for design, development and sample submission of product assembly is very short. Every manufacturing industry has to take each customer enquiry as an opportunity for business growth. After submission and approval of sample lot of new developing products the next immediate demand of the customer is bulk supplies of products. At this juncture the problem faced by manufacturing organization and they are unable to expedite the supplies as per customers schedules. This problem was taken for investigation after performing why-why analysis with related design and development team for this problem. We understood that the root cause for occurrence of this critical situation lies in the fact that is supplier has used traditional manufacturing techniques for supplying sample lots of brass electrical contacts. This product is socket assembly. The assembly has three varieties of components viz-Two types of plastic covers, three Brass contact of same specifications, and pair of mild steel fasteners. The BOM of the product indicates that Brass contact is a A class component and the supplies of these components are not made from Jamnagar based vendor is unable to supply contacts in time results in continuous stoppage of assembly results in business loss. This product is socket assembly of export market and brass electrical contact play key role in the product assembly function. The samples are approved and at latter stage customer demands commercial supplies of the product but the product supplies cannot be rushed with required rates e due to low productivity and quality of contacts at vendor end. Frequent occurrence of this situation ultimately resulted in the loss of customer satisfaction. This subject is very sensitive for the organization starving for business growth. This is so alarming that this product has further no future if this situation continues to remain the same. This has become major obstacle in export business growth of the organization. Plastic covers and fastener pair have no problems for quality and productivity. Hence to overcome this tricky business situation we focused on brass electrical contact manufacturing technology used by vendor and used hot extrusion technique followed drawing as advance metal forming techniques to give near and neat shape to T section of contact.

II. CONTACT SPECIFICATIONS

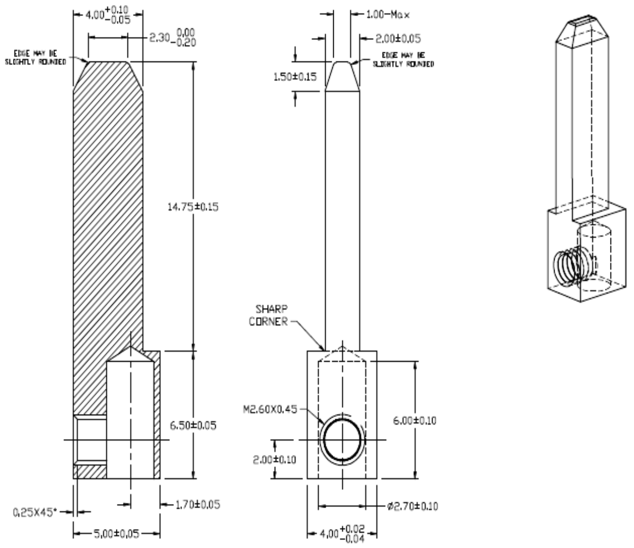

Figure. 1 Contact

This figure above shows sectional, front & isometric view of said contact. The basic material is 70-30 Brass.

2.1 Research Methodology The three phase research methodology is used to achieve desired results. Phases are as below.

Phase 1-Analyze existing Brass contact manufacturing technique and to find causes for low productivity and high rejections at various stages.

Phase 2 -To evaluate and compare probable alternative manufacturing technologies and select the most suitable one.

Phase 3-To select and establish most suitable advance manufacturing technique to come out with productivity and quality solutions for bottleneck contacts due to which the assembly work of the product is badly affected. This should solve organizational problem and rewarded new life to the product.

Existing technique is manufacturing raw casted contacts using green sand molding technology and machining all over. Technical evaluation of existing manufacturing technology this is done in two steps.

Step1-Evaluation of green sand molding and casting technology.Step2-Evaluation machining processes of the contacts to the finish dimensions.

The critical points observed as apart of casting process limitations are a)We must provide machining allowance of 2.50 mm all over the contact surfaces since we cannot get finish contacts by casting technique. Due to low sectional thickness (refer drawing) faster cooling of castings takes place results in hard scale formation b) For lower cross sections streamlining metal flow a big question mark. As a combined effect of these two heavy casting rejection occurs. This is as tabulated in table No 1

Table 1. Type of defect and rejection percentage

No	Type of defect	%
1	Pin holes and unfilled	12
2	Chilled surfaces	13
3	Scaling and blow holes	22

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The total rejection is 47%. Existing sequence of operations of manufacturing of raw casted contacts is in total 14 operations required to get finish contact.

Table 2 indicates process and estimation of the cost incurred.

No	Operation	Time	Estimate Base.	Per contact. (INR)
1	Melting	On Wt. basis	Rs 30 /Kg. contact Wt. 10gm.	INR 0.30
2	Material cost.	Wt. basis	Rate INR 315/Kg	INR 3.15 (Raw Contact Wt. 10 gm.)
3	Design ,Dev. of pattern.	72 Hrs @250 INR/Hr=Rs 18000	One time cost.	INR 0.18 (Pattern life 100000 castings)
4	Mounting.	24 Hrs @INR 250.	6000 One time.	To amortize on 1000 molds ie25000castings =INR O.24
5	Mold ing	100 /shift	INR 500/Shift	25 castings per mold. INR.0.13.
6	Pouring.	10 Min.	2 persons INR 500/shift	2=00 Divide by 25 No of patterns works INR 0.10
7	Knock out..	2 Min.	1 person	1=00/25 works to INR 0.04
8	Fettling and cleaning		On Kg basis	1=50 works to INR 0.15
9	Hardness testing.		On per piece basis	0=20 works to INR 0.02
10	Facing.	0.5 Min	INR 80/Hr.	INR 0.66
11	Straddle milling.	0.25 Min	INR 80/Hr	INR 0.33
12	Slot milling.	0.5 Min	INR80/Hr	INR 0.66
13	Drilling.	0.2Min	INR25/Hr	INR 0.10
14	Tapping.	0.30Min	INR 25/Hr	INR 0.15

The production cost per piece of the contact is Rs.6.07.Add hidden cost5% & the net cost =Rs.6.37/Pc.

It is well understood that the process is non productive and gives poor quality. Cannot be used further to satisfy customer's higher quantity demands. Hence search of better manufacturing technique is must.

Research content Phase -2: This mainly covered study of probable alternative techniques through industrial surveys and literature review this is as per Table 3.

Table 3 Industrial Survey findings

No	Name	Advantages	Limitations
1	Die forge.	Better Material Utilization	Further finishing by machining required.
2	Powder Metallurgy	Finish parts. No machining	Higher set up and tool cost.
3	Press Tool .	Productive for low thickness parts.	Poor tool life. Higher tool maintenance cost.
4	Extrusion	Higher productivity. More Yield..	Higher set up cost. Usable only for long sections.

The above table concludes that for the said contacts it is preferable to select forward hot extrusion as metal forming technique to extrude T-sectional long strips with additional allowance of 0.25 mm per face and further to use drawing technique to remove this allowance to get finish section dimensions. Drawing being cold working operation gives better surface finish and closer tolerances as per drawing in figure 1.

Research content Phase3: Practical implication of Hydraulic forward extrusion and drawing operations. These are very high productive techniques hence decided not to make any investment in these set ups but to outsource from reliable sources with available spare capacity. The principle of outsourcing is no investment needed in set up. We buy only technology and overhead cost saved.

2.2 Extrusion Die Development

One important step of extrusion die design & development activity is explained in following Bill of Material Table 4.

Table 4 Extrusion die design & development activity

No	Part	R/ M	Heat treatment done if any
1	Sub bolster	H13	Std part of press
2	Bolster	H11	Std part.
3	Backer	H11	Not required.
4	Die	H13	Quench and temper.
5	Die ring.	H11	Not required.
6	Die slide	H11	Not required.
7	Dummy block	H11	Not required.

The manufacturing of various die components is done by using Machines such as ram turret milling, spark erosion and wire cutting ,as per need lapping is also done manually. The half sectional view of two cavity Extrusion die is as shown in the Figure 2.

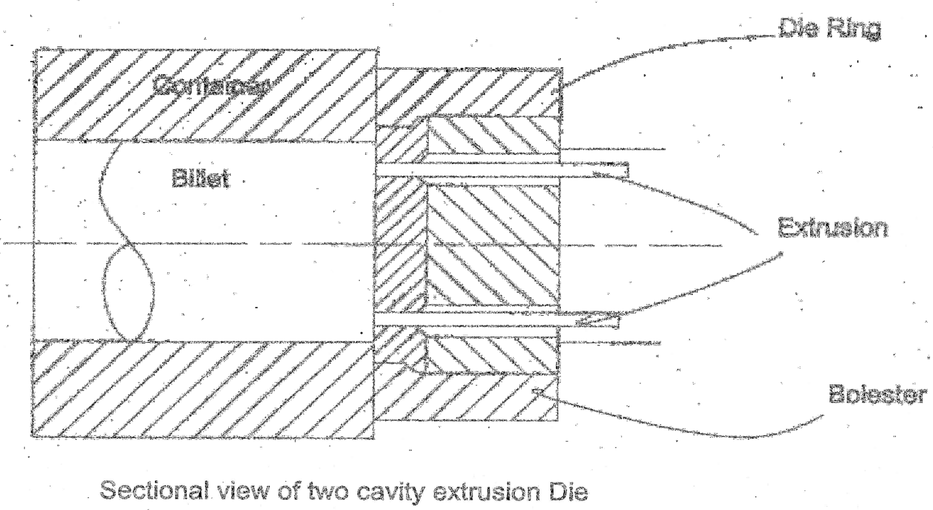

Figure 2 Sectional view of two cavity extrusion Die

2.3 Extrusion Press Capacity estimation

Other key area is finding extrusion press capacity. This works out to 250 MT from standard practice based on brass max shear stress and extrusion Ration. This is cross verified by comparing capacity required for extrusion of similar section components. For initial production runs single cavity die design is used so that further two cavity die can be used after freezing die dimensions. The shrinkage allowance provided is 2% on all linear cross sectional dimensions for brass. The weight of input and output of brass remains constant in the process. Input weight = Output weight .On these basis output extrusion sectional length is calculated. Extrusion ram speed is output speed of the cross section extruded. This is 1200 mm / Min. & slitting saw width is decided 1 mm. By slitting we cut extruded sections to suitable lengths. In this case this is 1000 mm. After extrusion these long sections are further drawn so as to get cross sectional finish dimensions. After slitting we have to do three machining operations viz.1 Side slot milling by using SPM & HSS side and face cutter as cutting tool.2 Drilling by using SPM .3Tapping by tapping machine. For design and development of These

SPMS we have made a two engineers team dedicated to work with SPM developing vendor. The prime objective of developing special purpose machines is to reduce manual handling of work piece to reduce labor fatigue and fool proofing of machining operations. The production sequence and cost estimation by using this technique as shown in the table Table 5.

Table 5 Production sequence and cost estimation

No	Name of the operation	Machine or set up used	Estimate Base .	Per contact Cost.
1	Raw material cost	Market Rate	INR 315/Kg	INR.3.15
2	Billet casting Pouring.	Melting +Pouring into molds	INR 20/kg	12 Kg Billet wt=INR 240/Billet =INR 0.25
3	Heating of the billet	Oil/gas fired furnace	INR 10/kg	INR 120/billet= INR 0.12
4	Die Design, development	Tool room machines	48 Tool room Hrs. INR 250/Hr	INR 12,000/- is effective of INR 0.12
5	Loading the die on extrusion press		Manual(30 Two persons)	INR. 31.25 /Loading INR=0.05
6	Extrusion and drawing	Hydraulic extrusion press.	INR/Hr 280	Ram Speed 1200 mm. /Min=INR 0.05
7	Slitting the extrusion to suitable length	Slitting saw	INR 8/Hr Time 0.5 min	INR 0=06
8	Inspection	Manual	INR 30/Hr	INR0.02/Pc
9	Milling	SPM	INR80/Hr	INR0.22/Pc
10	Drilling	SPM	INR12/Hr.	INR0.05/Pc
11	Tapping	SPM	INR12/Hr	INR0.04/Pc

The total number of operations is 11 Nos.

2.4. Commercial impact of the Research Cost per piece of the contacts as per advance manufacturing technology is INR 4.13 /Pc add 5% in this for hidden cost.=INR 4.33 /Pc. Cost saved per contact INR 2.04.Cost saved /Month=INR 612000 Qty. Basis 300000 is average

Annual savings= INR 6120000 assuming ten month assuming ten months business per year.

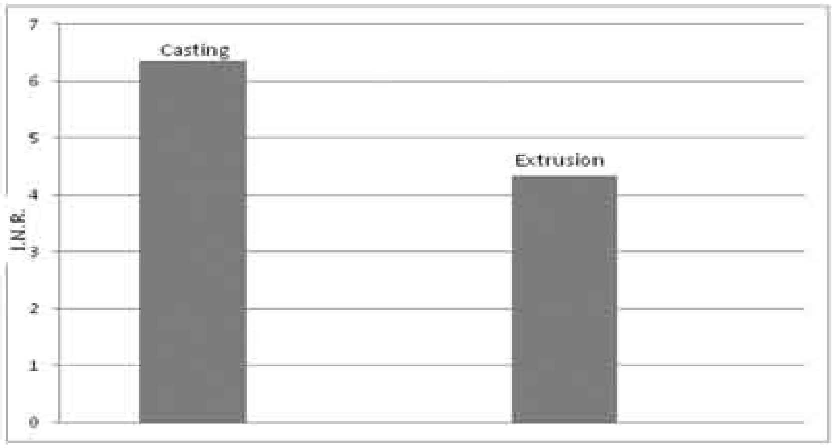

Figure 3 Cost per contact comparison

2.5 Quality improvement

Initial cumulative rejection stages =47%. Rejection after using advance manufacturing technique average -7 %.Refer graph plotted from for three months field rejection data for both casting and extrusion process .Figure 4 as below. The Graph shows reduction in percentage rejection from 47 to average 7 percentage for 3 months.

Figure 4 indicates process rejection.

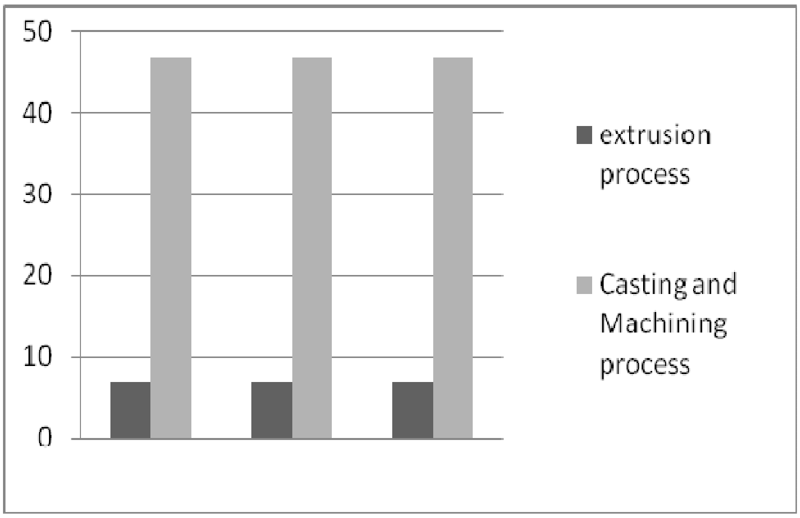

Figure 4 Reduction in percentage rejection

2.6 Lead Time Reduction

Lead time reduced from 15 days to 7 days a batch of 100 000 Nos.

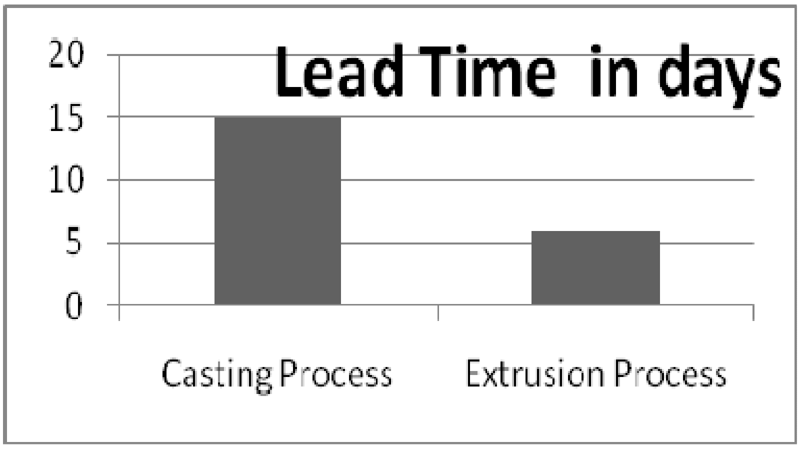

Figure 5 Lead Time Reduction

Figure 5 clearly indicates reduction in lead time.

2.7 Overall advantages

The overall advantages are lead time reduction and productivity and quality enhancement. Assembly function runs in time .Customer expectations satisfied in time.

2.8 Results and Discussions

The estimated cost as per casting and machining process used initially was INR 6.21 per piece of electrical contact and after implementation of extrusion technique, the cost reduced to INR 4.10 i.e. there is net cost reduction of INR 2.11 per piece or say around 33%. Any saving done due to use of advanced manufacturing technique directly contributes to the net profit of the product. Due to high cost competition in the market, this cost reduction benefit is passed on to the customer to make product more competent in the global market. If we look at cycle time required for completing a batch of contacts we see that previously lead time required was 15 days. This is now reduced to 7 days. In the long run manufacturer can think of reducing wip inventory. This is again long term benefit to the organization. This research has extended product life cycle of the said product which was landed into trouble at mass production stage itself.

III. CONCLUSIONS

Engineering manufacturing houses engaged in the design and development of products and selling their products in high competitive market must go for study and practicing use of advance manufacturing techniques suitable to all class of components with priority for A class components not at latter stage but at the design, development and prototyping stage of the components. This derives long term benefits to the organization which mainly includes higher productivity, consistent quality and more competitive prices for sales of the product. By this organization is in position to sell the product at lower prices and capture more and more market at global levels. The cost reduction is also achieved because of material waste reduction due to utilization of advanced manufacturing techniques. Due to higher productivity the return on investment also starts at initial phase of mass production. This is long term economic advantage to manufacturing organizations and they should consistently starve for establishing a system of appropriate manufacturing technique selection through team working with special focus on continuous assessment and updated knowledge of advanced manufacturing techniques.

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Authors

Virajit A. Gundale is presently working as the Professor & Academic In-charge at Sharad Institute of Technology College of Engineering, Yadrav Dist. Kolhapur, India. He obtained his B.E. in Mechanical Engineering from Shivaji University and M.S. in Manufacturing Management from BITS, Pilani. He obtained his Ph.D. in Manufacturing Technology from UNEM, Costa Rica in 2010. His total experience including Teaching and Industry spans more than 11 years. He is also a fellow of the International Institute of Mechanical Engineers, South Africa.

Vidyadhar M. Dandge is presently working as the Assistant Professor at Dr.J.J.Magdum College Of Engineering Jaysingpur, Dist-Kolhapur, India. He obtained his B.E. in Mechanical Engineering from Karnataka University and M.E (Production) from Shivaji University. His total experience including Teaching and Industry spans more than 25 years.