A REVIEW ON DESIGN FOR MANUFACTURING FOR SAND CASTING

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Abstract : Paper presents Design For Manufacturing (DFM) to improve the manufacturing process and to eliminate the defects in sand casting. So paper also contains defect analysis to know the defect and its causes. Production of casting involves various processes like pattern making, molding, core making and melting etc. Defects in casting may occur due to different parameters like design, process and labor individually or combined. It is very difficult to produce defect free castings

Design revisions are expensive and time consuming. Yet, these are inevitable because product designers have limited knowledge about casting processes and have no means to evaluate the influence of design features on castability. This paper presents use of numerical simulation software AUTOCAST to assist product engineers in assessing a part design for castability.

Keywords- Casting Defect, AUTOCAST X1, Sand Casting, Design For Manufacturing

I. INTRODUCTION

Sand casting is defined as pouring of molten metal into a sand mold where molds are generally provided with a cavity of the shape to be made and allowing it to solidify inside the mold. Complex castings can be produced by the use of sand molds. Sand casting is a unique process and is capable of being used in mass production. The size of components is varied from very small to very large, with intricate shapes and designs

Design for manufacturing is the process for ease of manufacturing, which saves time and cost.DFM includes two things 1)Improved component design 2)Improved processing of casting. Component design is improved by design principles for casting. whereas process is improved by casting rules. Design for Manufacturing also aims at improvement in overall efficiency. Mold cavity utilization is discussed here regarding efficiency improvement

II. LITERATURE REVIEW

Dr.B. Ravi *et al.* [1] presented work about the importance of design for casting. Design revisions are expensive and time consuming because product designers have limited knowledge about casting processes and castability (costs, quality and productivity). Problems appear much later, at the tooling or manufacturing stage, when it is much more expensive to incorporate changes than at the design stage.

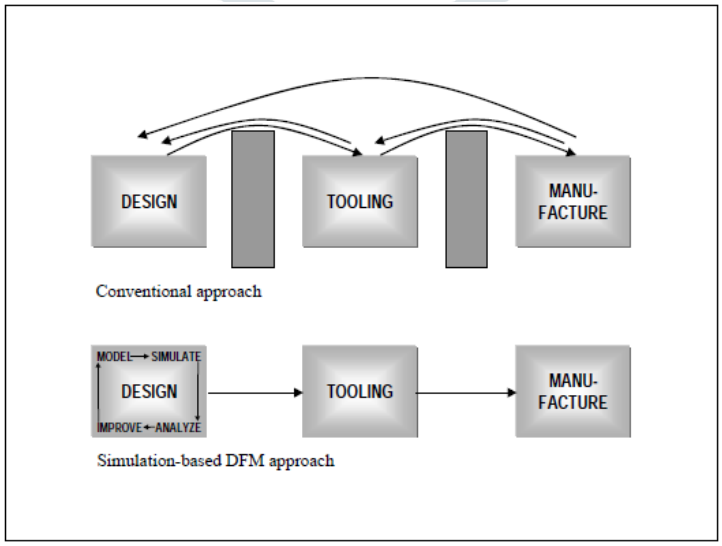

Fig.1 Design for manufacture vs conventional approach[1]

Durgesh Joshi *et al.* [2] Presented work which co-relates shape complexity with tooling cost. shape complexity factor is determined via input parameters part volume ratio, surface area ratio, number of cores, core vol. ratio, thickness ratio, depth ratio and a equation was generated for overall shape complexity factor(CF) and it was co-related with tooling cost from this it was found that number of cores have higher significance in CF. Whereas thickness ratio and depth ratio is less significant

Dr. B. Ravi *et al.* [3] Key inputs, steps and results in Computer Aided Design(CAD) and simulation for optimizing the feeder and gating design for casting is discussed in this paper. First casting part model has to be made in CAD then for simulation AUTOCAST software has been used. Accurate gating and feeding system can be designed which saves non value time.

C. M. Choudhari *et al.* [4] The defects like shrinkage cavity, porosity, and sink can be minimized by designing an appropriate feeding system to ensure directional solidification in casting. Numerical simulation software AUTOCAST X has been used. After setting the boundary conditions the hot-spots were seen (Figure 2) which were shifted to feeder (Figure 3) by this software without any practical trial. That is how time and money can be saved

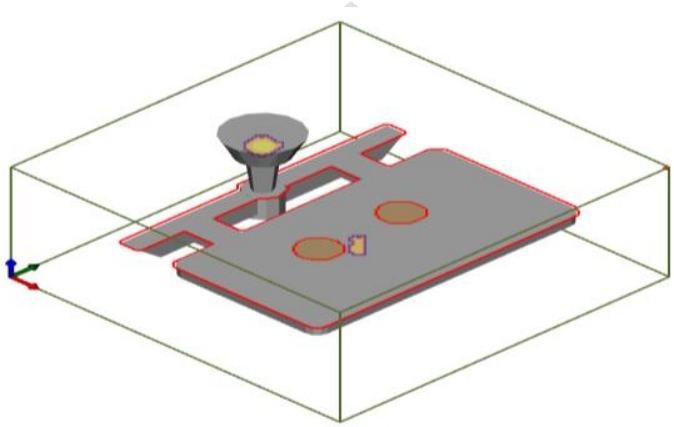

Fig.2 Hot spots location is inspected [4]

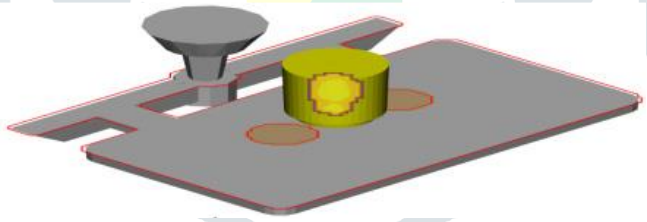

Fig.3 Feeder designed and located [4]

Vasudev D. Shinde *et al.* [5] This article presents methodology to optimize mold yield by selecting the correct combination of the mold box size and the number of cavities based on solidification time and mold temperature. The criterion of change in mold temperature and casting solidification time has been proposed to determine the values of the minimum values of cavity-cavity and cavity wall gaps.

Mold yield formula, $Y = W_{(metal)}/W_{(mold)}$

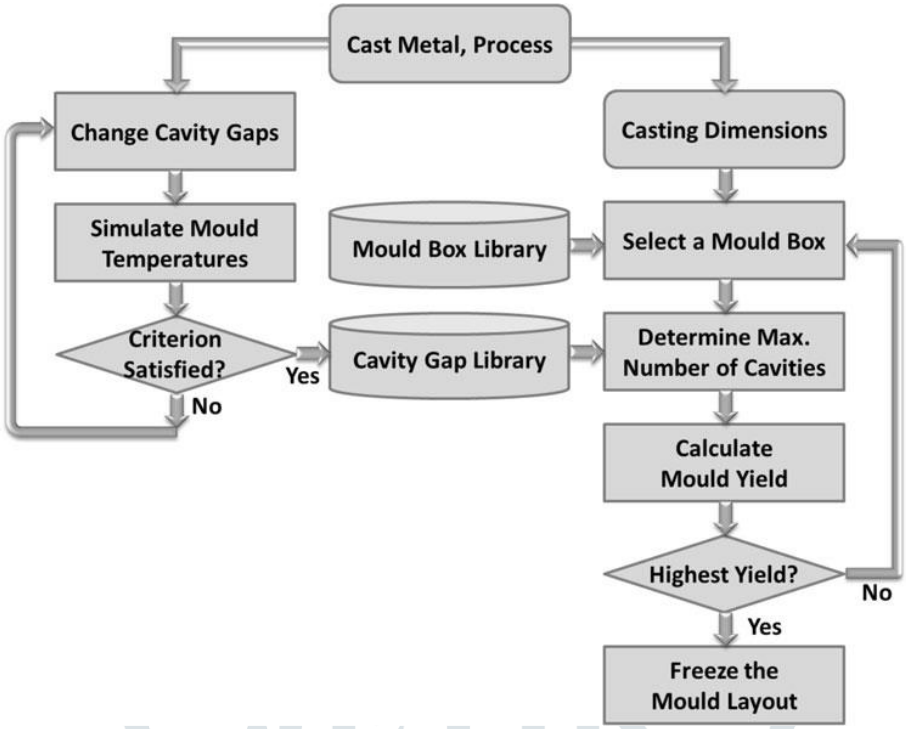

Fig.4 Flow chart for mold cavity layout optimization [5]

Sachin L. Nimbulkar *et al.* [6] Casting quality is increasingly dependent on the success of gating/riser system design. The entire study has been carried out in four stages, viz. design of feeder and gating system, numerical simulation by using Auto-CAST X1 software It was observed that solidification simulation enables and visualizes the progressive freezing from inside a casting to external environment and also identifies the last solidified regions, hot spots, metal flow rate, etc

$$\text{Feeding yield} = \frac{volume\ of\ casting}{(volume\ of\ casting + volume\ of\ feeder)}$$

$$\text{Gating yield} = \frac{weight\ of\ casting}{(weight\ of\ casting + weight\ of\ gating)}$$

$$\text{Casting yield} = \frac{weight\ of\ casting}{(weight\ of\ casting + weight\ of\ feeding + weight\ of\ gating)}$$

And in AUTOCAST software above mentioned yield will be calculated by giving boundary conditions.

Mark Jolly [7] Prof. John Campbell's Ten Rules for Making Reliable Castings-Mark jolly has pointed 10 casting rules of Prof. J.Campbell. By implementing these 10 rules, reliable castings can be made.1)Shrinkage damage,2)Liquid metal quality,3)Bubble damage,4)Core blows,5)Segregation damage,6)Heat treatment damage,7)Machine damage,8)Convection damage,9)Liquid metal front stoppage,10)Surface turbulence

B. Chokkalingam *et al.* [8] This paper presents a systematic procedure to identify as well as to analyze a major casting defect (mould crush) occur in an automobile transfer case casting poured in cast iron grade FG 220. It is described in Figure 5. It was found that the core was the root cause for this major defect. The necessary remedial action was made in the core box to take the core as a single piece.

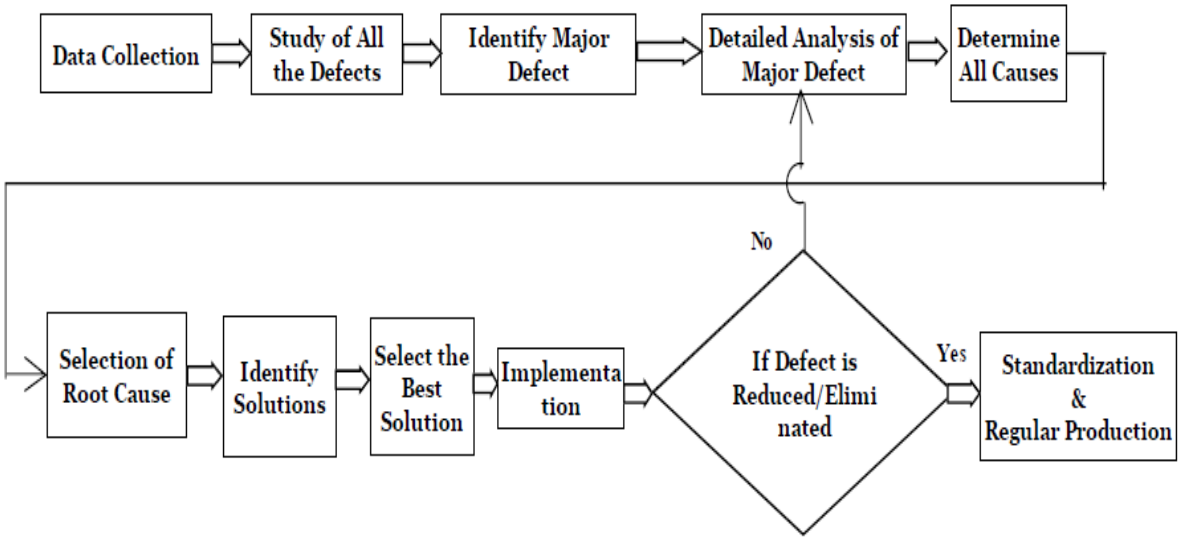

Fig.5 Defect diagnostic approach [8]

Santosh Reddy Sama *et al.* [9] This article provides Design rules for optimal sand casting performance. 1)Avoid sharp angle. 2)Use simple parting line. Flat plane, known as a straight parting line separating the two mold halves, results in more economical casting than a contoured separating surface. It is shown in Figure 6 3)Minimum number of sections at intersection. A well-designed casting brings the minimum number of sections together at intersections and avoids acute angles

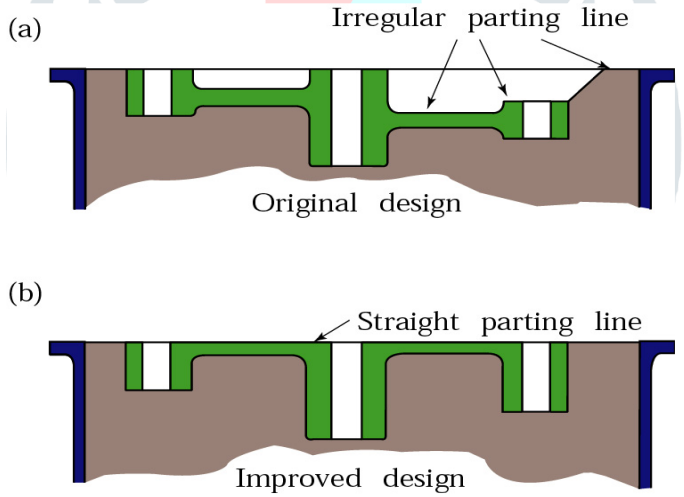

Fig.6 Irregular vs Straight parting line [9]

L. Elmquist *et al.* [10] The aim of the present work is to investigate how the earlier moments of solidification affect the formation of shrinkage porosity. The general reason for this type of defect is the different volumetric contractions taking place during solidification. Depending on the formation mechanism, shrinkage porosity can be found at three different positions, between eutectic cells, between dendrite arms and also between primary crystals.

Amit Sata *et al.* [11] At present, casting defect analysis is carried out using techniques like historical data analysis, cause-effect diagrams, design of experiments, if-then rules (expert systems), and artificial neural networks (ANN).In this paper new hybrid approach has been proposed for defect analysis. It is shown in Figure.7. The parameters for defects are grouped into 1)Design, 2)Material, 3)Process. The one of the limitation of the conventional approach for defect analysis is that it considers only the effect of material and process parameters on occurrence of defects. It is also required to consider effect of design parameters on occurrence of defects as they play a very important role in DFM.

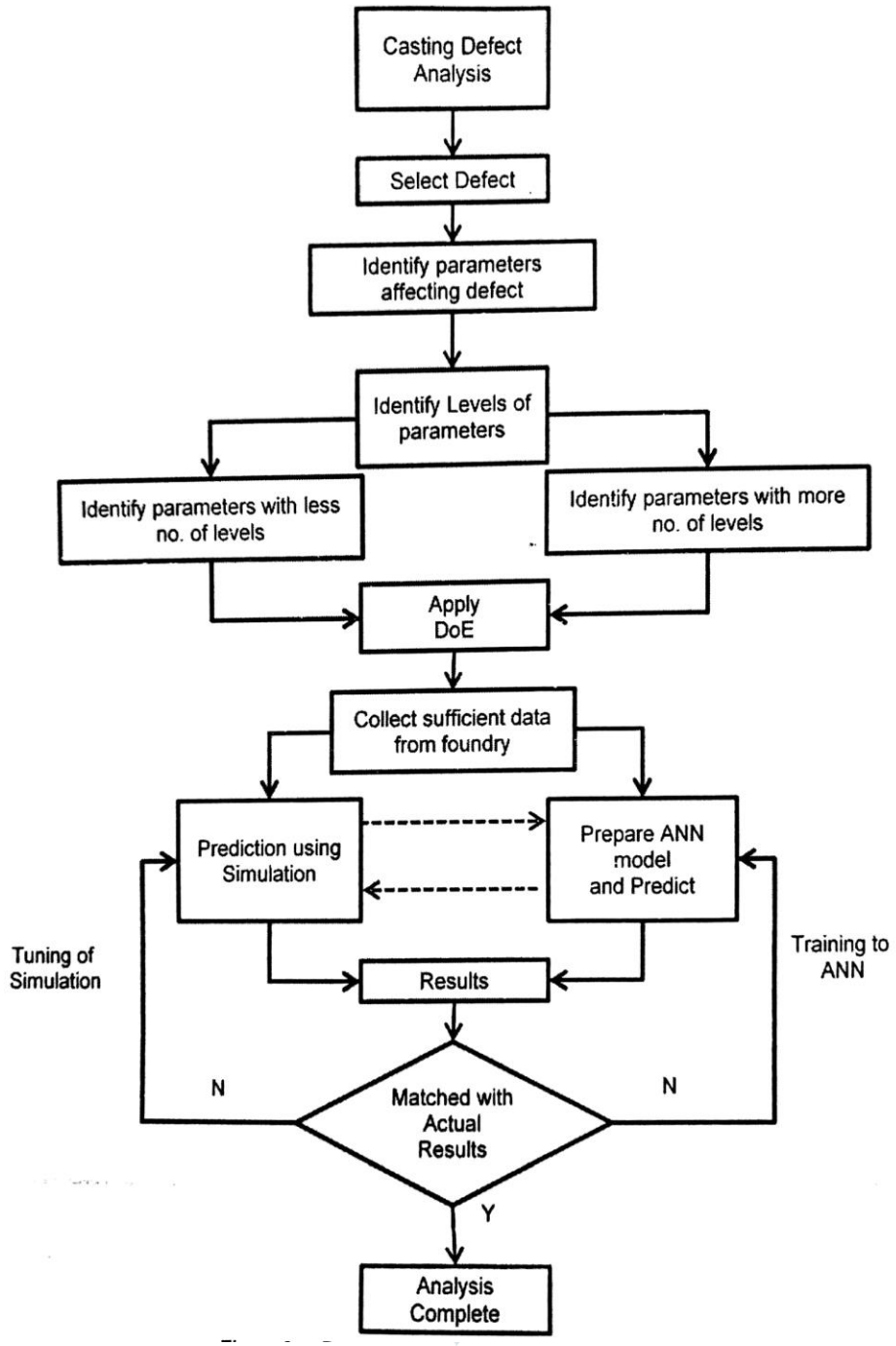

Fig.7 Proposed approach of Defect Analysis [11]

III. CONCLUSION

The limitation of the conventional approach for defect analysis is that it considers only the effect of material and process parameters on occurrence of defects . It is also required to consider effect of design parameters on occurrence of defects as they play a very important role in DFM. To improve casting process and improve design of a cast product, Design For Manufacturing principles should be implemented. Use of numerical simulation software helps in determining casting defects from earlier stage, which makes casting process more efficient. And casting can also made reliable by implementing casting rules.

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