# Cost reduction in Cast Components Manufacturing

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Today, the Market is Customer driven and it is very much essential to produce the cast components in foundries with high quality, reliable, consistent and at lowest cost. This puts pressure on casting producers which compel them to think of techniques which will result in to positive. The cost of casting component is generally high due to various reasons which involve unnecessary costs such as : Lack of information / knowledge, honest wrong beliefs, human bad habits and attitudes, short cuts / shortage of time, Insufficient Ideas, insufficient funds availability, limited toolings, unavailability of proper human resource, non adoption of latest efficient technologies, prevailing government policies and circumstances.

To reduce the costs, Cast components producers can think of techniques such as use of CAE – Computer Aided Engineering; CAD – Computer Aided Design and Value Analysis Value Engineering methodology at appropriate stages in foundries for product design, processes and services.

When Cast components performance, weight and cost become driving force the integration of Computer Aided Engineering - CAE sets the ground work for continuous improvements in casting in the form of: Gating and Risering design, fluid flow, Solidification, Methoding, mechanical and thermal stress analysis, fatigue analysis and Design for manufacturing and assembly. Metal shrinkage can be factored into tool design. CAE must be implemented as system, with software and hardware compatible with those of primary customers.

The CAE can also co-ordinate measurement machine and non destructive testing techniques. It can raise casting quality, reduce casting weight, cost and virtually eliminate Prototyping. Products can be manufactured accurate and at faster rate by minimizing implementation and validation time.

Development of machine tool cutter paths is computer based and required for numerical control (NC) machining patterns, Dies and fixtures. After the tool build and production of initial castings, reverse engineering techniques can be used to validate toolings and parts relative to the product design. Parts then can be tested and the results correlated to the original theoretical analysis using closed loop computer systems to continuously improve the accuracy of CAE models and predictions.

Fluid flow can be computed from both a process and products perspective. Metal flow in gating systems within mold can be analyzed by using CAE.

Thermal stress analysis represents one of the most complex applications of CAE available to the casting designer. It combines the technologies of fluid flow, heat transfer and mechanical analysis to predict the development of thermal stresses within a part.

Using sophisticated gating and risering analysis, the foundryman can optimize the feeding system and maximize the number of good parts per mold.

For ascertaining weights of Cast components and or manufacturing the foundry toolings / sample parts, help of Computer Aided Design – CAD is considered. The foundry begin with 2-D drawing and design and progress into 3-D wireframes and, finally, surface models. With this type of design data, NC machining cutting paths can be developed for use of Computer aided \manufacturing of foundry toolings. After accepting the part, CAD of the pattern toolings can begin. This confirms all partings and optimizes the mold layout. Once completed, a tool cutting path model is developed for direct computer numerical control machining (CNC) of the toolings. Use of CNC machining centers with precision cutter paths allow rapid, accurate and repeatable tooling construction and complete exploitation of the capabilities of CAE and design.

Among the advantages of using computer technologies, is the reduction in time and effort needed to attain high levels of quality even with the introduction of new products. By having working knowledge of the product and providing full service capabilities, the foundry is in better position to assist the customer and be in leadership position in manufacturability, productivity and profits.

CAE tools are very widely used in the automotive industry In fact, their use has enabled the automakers to reduce product development cost and time while improving the safety, comfort, and durability of the vehicles they produce. The predictive capability of CAE tools has progressed to the point where much of the design verification is now done using computer simulations rather than physical prototype testing.

Cost reduction can be accomplished with Value Analysis and Value Engineering – VAVE methodology which is systematic application of techniques by multi disciplinary teams which identify the function of a Product or Process or Services; establishes a worth for the Function; generates alternatives through Functions and implement ideas at the lowest cost. The multi disciplinary team may comprise of members from Product design Engineer; Manufacturing process Engineer; Manufacturing Engineer; ,Pricing/costing Engineer; Commodity purchase Engineer; Quality Engineer; Supplier Representative.

Value is a personal perspective of willingness to pay for the performance delivered by a product, process or service. Value Analysis is reviewing of existing components, processes and services to improve function and optimize the cost. Value Engineering is reviewing of components, processes and services while they are at early design stage but before being built to improve function and optimize the cost. VAVE focuses on delivering the product or service at the best price by incorporating those value characteristics deemed most important by the customer. It uses a combination of creative and analytical techniques to identify alternative ways to achieve objectives. Value methodology is used for identifying improvement potentials and develop into new alternative proposals to enhance the value while optimizing the cost. Value is determined by least cost to achieve desired function with essential quality. Value of product is improved by : improve function while reduce cost; reduce cost while maintain function; Improve function while maintain cost; improve function more by marginal increase in cost and reduce function marginal while reduce cost more.

Information is to be gathered for Product: design, material, manufacturing process, drawings, Design failure mode & effects analysis, Process failure mode & effects analysis, design validation plan, problems, voice of customer, cost and quality reports. Various key functions of the component are listed and worth of these to be found out. The functions of products are : Basic function; secondary function; support function; unnecessary function; Design function and all time function. This will tell us which functions can be eliminated or have poor value. Function modeling using FAST diagrams to be prepared. Cost/worth relationship is to be ascertained. Creativity phase comprising of brainstorming, group discussion and idea generation workshops are conducted and ideas are listed and prioritized. The ideas are then evaluated by asking questions of how idea will work, at what cost without affecting function and best implementable idea. The idea is then implemented, and audited.

With the methodology, the cost reduction can be achieved in various areas of

Raw materials: By using C I Borings in the form of Briquettes to the extent of 30% replacing casting returns / Pig iron / steel scrap in charge mix even in Cupola can reduce total melt cost by Rs 3 per kg.

Toolings: Maintaining toolings i.e. core box, bush, pins, closing pins, match plate in good condition and manufacturing Pattern, Dies, Gating system thru CAD and on CNC machines can reduce casting mismatch, various casting and core rejections. Casting weight can reduce. Casting quality and productivity will rise to great extent.

Cost reduction can be achieved in Core making, molding, fettling, shot blasting and painting; Human resource, Power / Energy, In machining process: machining cycle time reduction, elimination of unwanted machining operations, combining of machining operations. The cost reduction will occur due to reduce weight of cast component, reduced material cost, reduced time in machining, improved function, better yield, reduced power/energy consumption and better market share.

With the help of CAE CAD and Value Analysis & Value Engineering techniques, we have achieved castings weight reduction, machining cycle time reduction and deployed alternate process. Thus, it has resulted in cost reduction of Flywheels, Brake drums, Housings, Cylinder blocks, cylinder heads, Cylinder liners, Engine front covers, Brake discs etc,.

**Case study:**

Component: **Engine Fly wheel**.

**Information:**

Supplier: M/s ABC

Material: Grey Cast Iron

Casting mfg process: Conventional molding and pouring

Casting Weight: - 'X' Kg

Machining process (cycle time): conventional and CNC combination: 'Y' min

Fly wheel cost: 'Z' Rs.

**Methodology applied**: Use of CAE, CAD and VAVE at appropriate place.

With the use of CAE and CAD, 3D casting model was prepared with minimum draft angle and machining allowances. New Patterns were made and assembled on match plates. Castings were poured and weighed. The castings were machined

with existing machining process and found to have weight less by 1.1 kg. The audit was conducted after fairly large trial and found to be OK.

With the help of VAVE, The machining process was redefined. The trials were conducted and resulted into machining time less by 25 minutes. The audit was conducted after fairly large trial and found to be OK.

With the help of Value methodology, functional analysis was done. Various functions were questioned for product and processes. Some of the non functional areas were taken off by keeping some portion of machined flywheel to be kept as cast and some of the machining operations deleted. This resulted into machining cycle time reduction and casting weight reduction giving cost reduction by 6%.

CAE CAD and Value Analysis & Value Engineering techniques are being applied to existing components as well as future components.

The journey is on……

References:

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## Introduction:

Mr Purshottam K Godhia, Senior Manager in the department of Integrated Material Cost Reduction (IMCR) is working for M/s. Mahindra & Mahindra ltd. Auto sector Mumbai for 35 Years having worked in Machining & Assembly of Transmission, Axle, Engine and Foundry product unit in capacity of Manufacturing, Quality in charge.

For last four years involved in Material cost reduction team and completed over 100 projects in casting and forging components for Input weight reduction and machining cycle time reduction.

Various projects on hand also include conversion of forged parts into S G Iron and Austempered ductile iron castings.