Saving crore in sand casting: A known but little explored path

India, the third highest casting producer in the world is presently going through a critical phase.

As the domestic market volume has experienced a significant downward deviation from the forecast, a huge installed capacity which has been commissioned during 2012–2015 remains highly unused since 2013.

Consequently, to improve the competiveness, the casting manufacturers are facing massive cost pressure as never before.

Since the casting price for any specific type, size or alloy is fairly same across all customers, in order to sustain the reasonable Ebitda level, manufacturing cost reduction has become a must rather than an occasional event.

Traditional approach

For cost reduction in iron casting across the green sand foundries always focused on three major cost inputs. For a typical modern automotive foundry the cost contributions of these three factors are:

*Direct and indirect material (appx. 55–60%)

*Power & fuel (appx. 10–12%)

*Labour cost (appx. 5–8%)

These basic factors for cost reduction which consumes more than 75 per cent of the total cost is very much relevant and significant as always but the limitations of such action after first few quarters of operation are more or less experienced by every foundry manager in last few decades. While exercising such cost reduction drive this is found that:

*Raw materials (like steel scrap, pig iron, ferroalloys) and bulk materials (viz. moulding sand, bentonite, core sand, etc) which are the key cost contributors are pretty market driven.

*Except few specific cases (e.g. large and consolidated buying, nearness to the source etc), there is hardly any significant variation in price of such materials from one foundry to other.

*With the use of modern induction furnace (medium frequency), clean charge (CRCA bundles, heavy metal scrap, pig iron etc) and use of automated pouring device,energy consumption (kwh/MT) rate is also fairly a similar level across all the competitive foundries.

*With a reasonably higher level of automation especially in the automotive casting manufacturing units during last 10 to 15 years the dependency on skilled labour has reduced to a great extent. As a result the cost of skilled labour which has always been a key cost input is still important but no more a key differential among foundries of same level.

*Rather, cheap labour cost which has always been a USP of Indian casting manufacturers is no more enjoyable. With the use of similar HPML, core shooters, induction furnace, automated pouring equipment and Robo/CNC grinding equipment as being used in USA, Europe, China and japan, the contribution of labour cost in total casting cost has reduced drastically.

Therefore, such basic, must and common path of cost reduction is highly important but needless to mention that such means are exercised by all the competitive foundries.

After a certain period of operation good foundries reaches to almost a benchmark level and found very less further scope of reduction or in other words very less scope to make a difference from peer manufacturers.

At the same time there is always a customer demand of year on year (yoy) reduction. Thus sustaining the profitability and maintaining the growth become a challenge to every casting producer.

In this situation, where gross cost reduction from one single factor is not feasible, it is utmost important to work on various small cost inputs to accumulate accountable cost reduction.

Such minute factors are generally exercised at product level. Though, the CFT, individual casting engineers, operators and continuous kaizen can find numerous opportunities, this articles limited to certain common product related cost reduction factors in sand moulded iron casting which have not explored too much and have applicability over a wide range of castings.

Product-based approach

Cost saving starts at design stage: Design yield is a major cost driver in any casting process. Generally, the net to gross weight ratio of iron poured is considered as the yield. However it is rather more important to focus on enhancing the net weight (actual casting weight) of iron in mould. Increase in net weight ultimately reduces all the relevant cost of moulding, LT power and labour cost.

5 per cent increase in yield can lead even up to 2 per cent cost saving.

Optimisation of pouring cup, runner and feeder size, removal of unnecessary bends, air channels in running system are the key to increase the yield.

An effective filling and solidification simulation can help the method engineer to a great extent in this regard.

The thermal and solidification simulation is mostly used to optimise the fluid flow and establish the sound feeding but this all important tool can easily be used for yield improvement too. A following image (Fig–1) shows the scope of removal of undesired mass of iron in the mould:


Fig – 1: Scope of further reduction from feeder

Study report shows that 2-3 per cent saving on overall variable cost by means of optimizing the pouring cup and removing undesired section of feeder is fairly possible.

Table 1 shows a representative test result:

Table - 1	Modification		Saving	
	Before	After	Mass (kg)	%
Cast wt (kg)	30	30		
Mould wt (kg)	44.12	43.54	0.580	1.3
Pouring cup (with sprue)	5.35	5.05	0.300	5.6
Running system	3.20	3.20		
Feeder (2 nos)	5.57	5.29	0.280	5.2
Yield (%)	68	68.9		

Cost saving by redesigning the core: Further to this design optimisation of core can lead to accountable cost saving for any casting especially when the casting to core weight is over 2:1. Various techniques to reduce the core weight are:

*Design the core thickness to the optimized level avoiding higher core thickness.

*Use of pull out mechanism to make defined hollow section in core.

*Shorten the size of core blow channels to the 'just required' size.

*Use self-core wherever feasible.

A recent case study reveals that just by customizing the core thickness at various positions of an 18 kg core, the core weight is reduced to 16.5 kg. This means direct tangible saving of 1.5 kg core sand for each casting. This turns up to reduction of appx Rs 0.56 /kg of casting.

Fig-2 shows the typical reengineering done in that core.

Cost saving by controlled process: This is a common experience to all foundrymen that mostly the design yield remains in design if the production process is not controlled. Uncontrolled processes which affect the yield mostly are

*Over pouring (Fig–3)

*Filling of iron in core vents due to metal leakage to the channels.

*Filling of crater on the top of air vents (Fig–4).

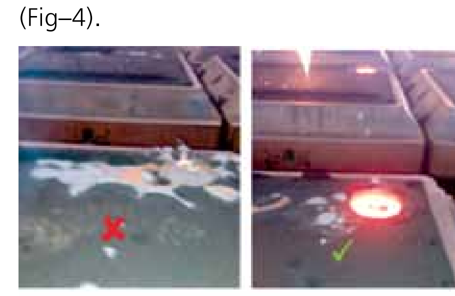
Fig-3

In a fruitful study shows that total quantum of iron used for these three reasons is highly significant and reduce the design yield from 2 to as high as 5 per cent in those specific moulds.

Fig-4


This is important to keep the pouring cup full during the entire pouring cycle but it is equally

important to leave the pouring cup level below the mould top to ensure not only the design yield but also saving cost by even keeping this level at least 1 inch down from the top mould face.

Use of an automated drilling for the opening of air channel is very much important to avoid creation of crater on the top by poking holes manually in the mould.

Cost saving by reducing the fettling and finishing operation: Fettling and finishing operation in foundry is entirely a non-value added, cost intensive and labour dominant process.

Very often this is experienced that the castings are left with huge quantum of fins and flash just to compensate the imperfection of the operations like moulding, core setting and tool manufacturing.

Cost of fettling and finishing bears significant contribution in the total variable cost of casting. It is generally varies from 3–4 per cent of total variable cost for casting with excessive fins and flash. Average cost may be as high as Rs 1.25 – 1.50 per kg of casting depending on the location and extent of such abnormal fins and flash.

Figs–5 & 6 show various shop floor examples of excessive fins in castings.

Fig - 5

Fig - 6

This is observed that there are mainly five distinguished factors which result to formation of additional fins in castings:

*High parting line radius

*Thick anti-crush on parting plane

*Wide clearance between mould and core print

*Unmatched mould and core draft

*Mould and core cracks

Such cost can easily be saved with detail study and analysis of physical phenomena at part level.

Followings are the some important path to follow:

*The use of correct cutting tool with required nose dia to achieve 0.5 mm parting radius found very much suitable to avoid any grinding at parting line.

*However, the good condition of moulding machine and sand quality have to be assured to ensure mouldability with such low parting radius; else this will be resulting into more finishing cost due to mould breakage at parting plane.

*Matching of mould and core print with workable fit is very much imperative and largely depend on the historic behavior of the moulding system.

*A very tight fit may lead to improper positioning of core and a loose one will result into excessive fins at core mould junction.

*The use of suitable core sand and core wash are important to avoid core crack.

*It is advisable to spend few bucks more on good quality (e.g. high HTS) core sand and core wash rather than incurring higher cost in grinding excessive veins in fettling shop.

A case by case study and implementation of all such actions is capable to save cost to the tune of 2–3 per cent of total manufacturing cost of casting without incurring any investment.

Typical Casting Input

	Before	After
Cast wt (kg)	30.00	30
No of Cav	1	1
Net wt (kg)	30	30
Mould wt (kg)	44.12	42.25
Yield	68%	71%
Core wt (kg)	10	9

Selling Price	60.00			Rs/ kg
Particulars	Present Structure		After Cost Saving	
Direct material	25.66	42.8%	25.45	42.4%
Indirect material	6.92	11.5%	6.42	10.7%
Power	7.09	11.8%	6.79	11.3%
Consumables	5.00	8.3%	5.00	8.3%
Labour cost (direct)	3.00	5.0%	2.72	4.5%
Fettling/ Finishing	1.75	2.9%	1.20	2.0%
Rejection	0.32	0.5%	0.32	0.5%
Variable cost	50.02	83.4%	48.77	81.3%
Total saving			1.25	2.1%

A typical estimation of tangible savings is tabulated below. Needless to mention that such in-depth product based improvement can yield a much higher tangible and intangible benefits than this tabulated one in long term for any green sand casting plant.

This estimation is very much conservative and even at this minimum rate for a 2500 MTPM foundry this small cost savings amounts close to Four crore per annum.

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