Innovative Ideas for Improving Foundry Productivity and Casting Quality

R. Venkataraman
Foundry Consultant
Mahindra & Mahindra Ltd.
Swaraj Division (Tractor Operations)
Village & P.O. Sialba Majri, Ropar - 140 110 (Punjab).
Email : venkataraman.r@swarajenterprise.com

Abstract

In today's competive environment for Foundry Industry, reducing Manufacturing Cost by better/improved Productivity & Quality through innovative ideas is becoming mandatory on each Foundryman. We will discuss in this presentation two or three case studies in areas like Design of Product, Methoding Practice, Pattern Manufacturing, Moulding, Core-making, Melting and Pouring, Post Processing after casting evacuation, and lastly Q A & Project Engineering. Cases are all live and include Poke-Yokes also.

1. Introduction

1.1 Cost and Quality are essential. Customers are asking for Open Book Costing, Transparency in Product Costing, Plans for maintaining prices at the same level for two to three years, Sharing of Savings resulting from New Ideas, and Cost Reduction & Yield Improvement Plans.

1.2 Share of Business is dependent on major factors of cost and quality, followed by delivery and faster development etc.

1.3 We will discuss some successful case studies as examples to kindle your thinking in areas like Methoding, Product/Process/Design, Operation, Quality Engg., Project Engg. etc.

1.4 Major requirements are response time, pro-active approach, root cause analysis, cft approach, continuous improvements, customer delight, participation in customer design and dedicated customers.

2. Case Studies for Improvements

2.1 Product Design

2.1.1 Case study of Hub and Axle Housing for a simpler design for core elimination and cost reduction. Product cost calculation required to be done in each case. Intangible benefits explained *(Fig.1a & b)*.

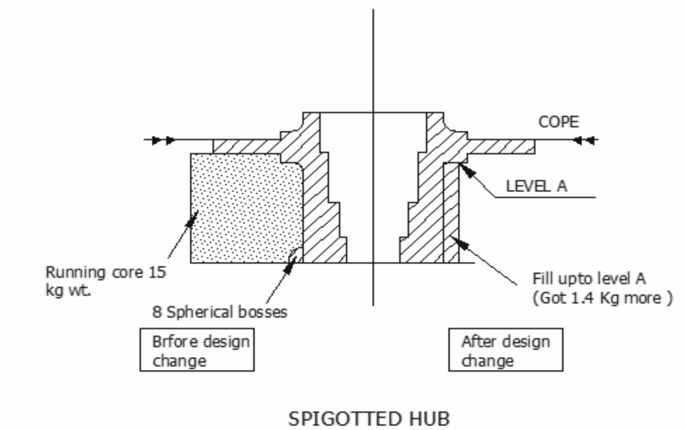

Fig. 1(a)

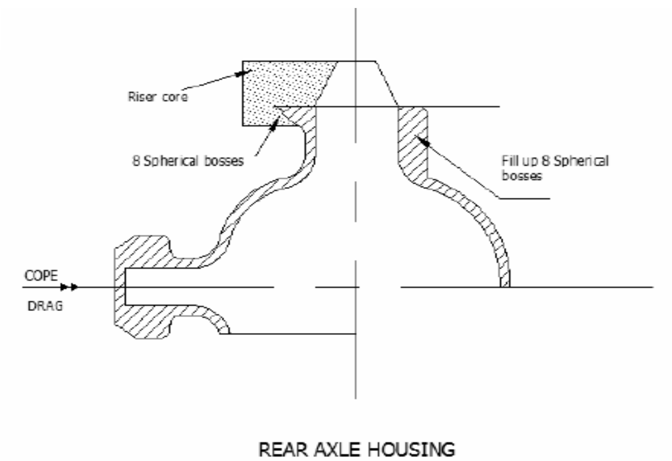

Fig. 1(b)

2.1.2 Case of a Tractor Housing and Cylinder Block for single core design to give multiple benefits *(Fig.2a & b)*.

2.1.3 European Foundry costing is based primarily on number of cores. During feasibility study stage or during design participation stage, team to do this.

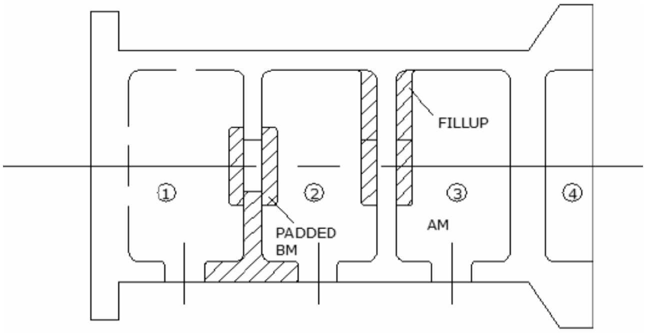

Fig. 2(a)

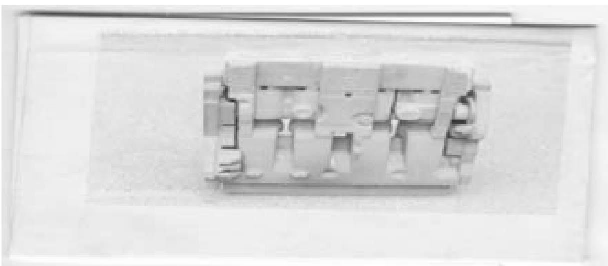

Fig. 2(b)

2.2 Methoding and Pattern Design

2.2.1 Shifted parting line for making manufacturing feasible and reducing sand fusion. Two Case studies of Rear Axle housing and Cooler Plate, respectively. Should have sufficient space in L & W direction of box for coping out *(Fig.3)*.

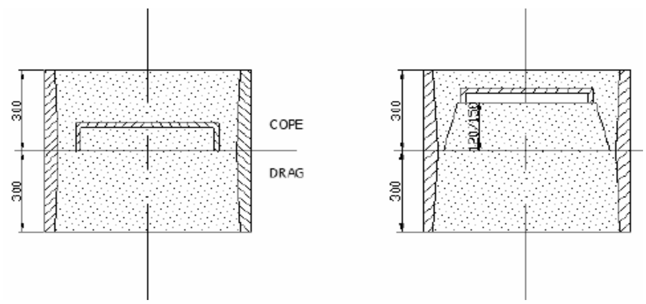

Fig. 3(a)

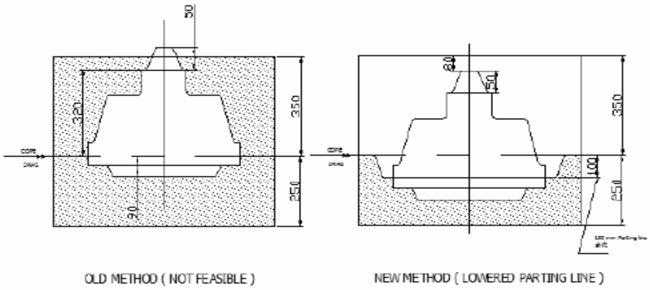

Fig. 3(b)

2.2.2 Ideas for increasing productivity of Cylinder Blocks/ box by 100% with new concepts of sandwich core or back-to-back system. To be careful about dimensional issue involved in such design *(Fig.4a, b & c)*.

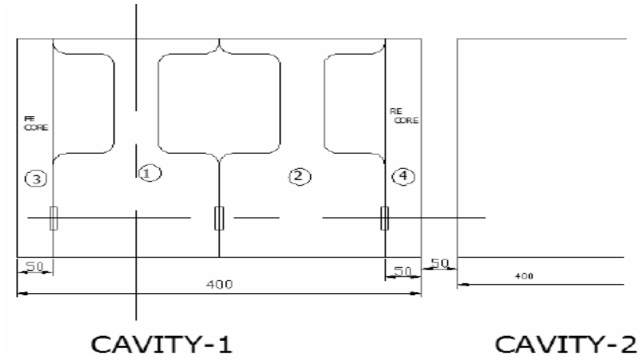

Fig. 4(a)

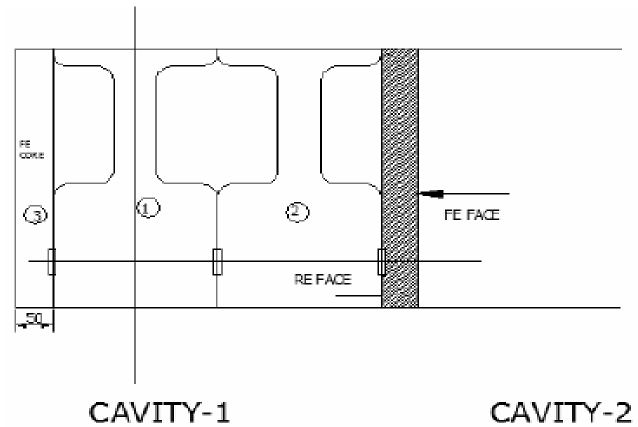

Fig. 4(b)

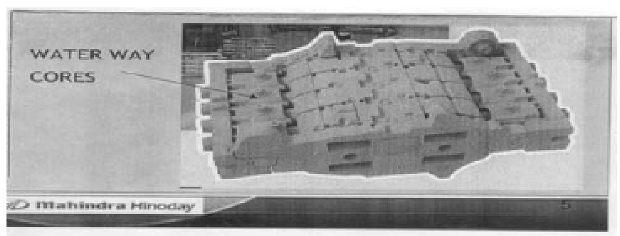

Fig. 4(c)

2.2.3 To improve net yield or match plate yield following concepts can be used.

- Chills, denseners, tellurium paint, risers to be hot. Avoid thin sand between riser and casting.
- Common riser principles *(Fig.5)*

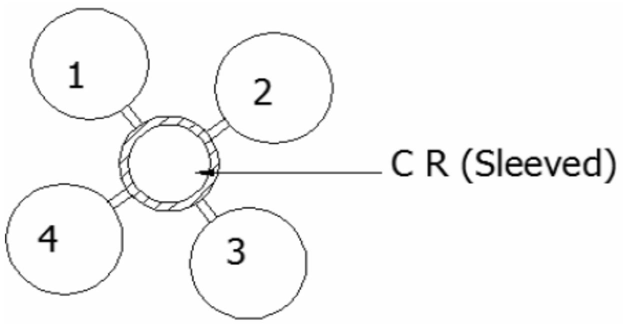

Fig. 5

- Exothermic Sleeves (mef – 1.6, riser effy. shr 4 % to 5 %, feed vol. :16 %). You have to satisfy modulus, feed volume and feeding distance requirements *(Fig. 6a & b).*

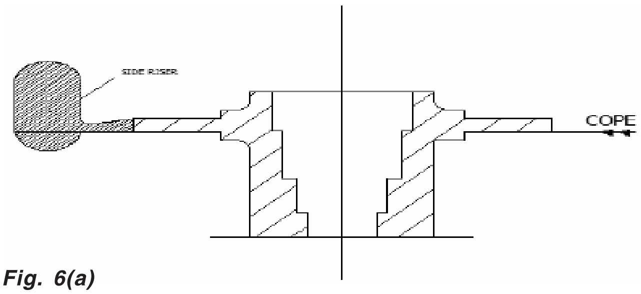

Fig. 6(a)

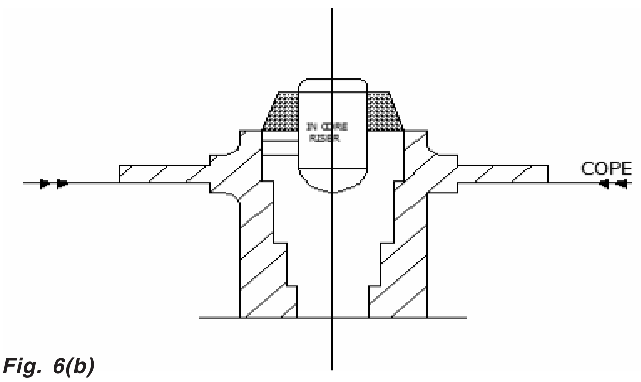

Fig. 6(b)

- Provision of Ceramic Filter gating ratio: 1 : 1.1 : 1.2 *(Fig.7)*

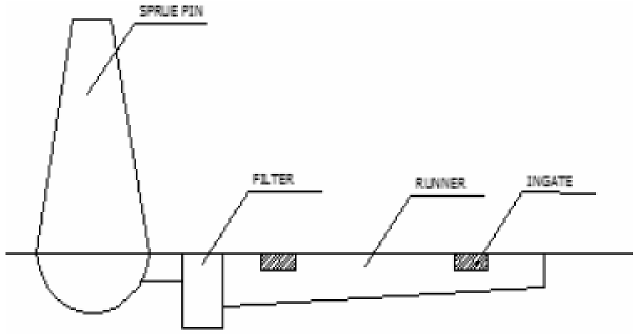

Fig. 7

- Stepped Runner *(Fig.8)*

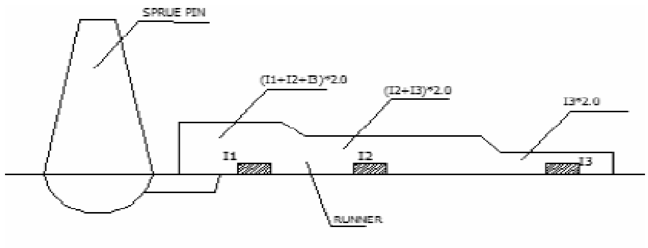

Fig. 8

- Top side vent design (wedge type) *(Fig.9)*

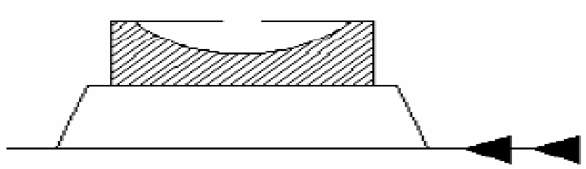

Fig. 9

- Avoid top vent breaking *(Fig.10)*
- Reduce fins. Concept of metallics losses (2 to 3% each in melt and rest) and monthly evaluation.

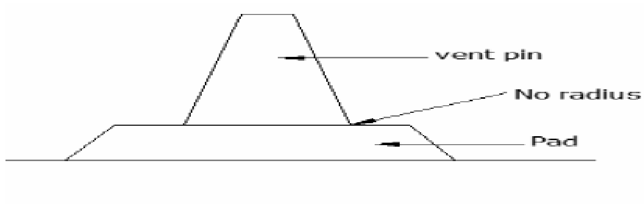

Fig. 10

2.3 Moulding Process

2.3.1 Time study each of processes like drag/cope moulding time, core setting time, box closing time, pouring time, and casting shakeout/evacuation time. Implement new ideas for increasing productivity by reducing cycle time and attacking controlling cycle(s). One case study for improving cope mould cycle time explained. In case of core setting, ideas like two jigs bases, assembly of cores, combination of cored and uncored items on the match plate can be decided. In case of shake out time being more we can think of permanent magnets, cluster integrity etc *(Fig.11)*.

Fig. 11

2.3.2 Good system for self opening of mould vents with conical cups on squeeze board *(Fig.12a & b)*.

Fig. 12(a)

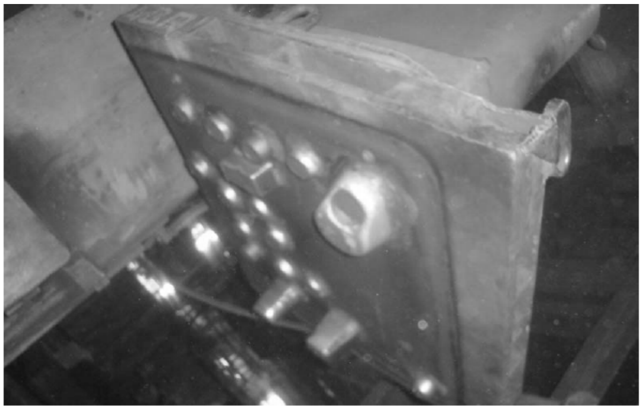

Fig. 12(b)

2.3.3 Provision of weight on core to prevent lift where chaplet becomes handicap due to low temperature *(Fig.13a & b)*.

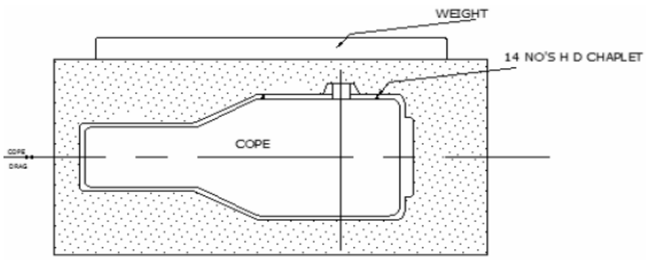

Fig. 13(a)

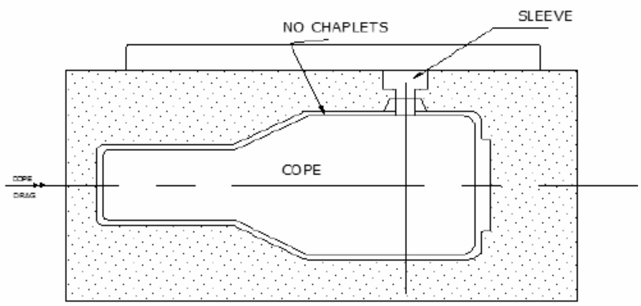

Fig. 13(b)

2.3.4 To integrate sand cutter with squeeze system *(Fig.14)*.

2.3.5 Provision of pressure switch to stop operation, if pressure drops below working requirements.

Fig. 14

Fig. 15(b)

2.4 Design of Pattern Equipments and Fixtures

2.4.1 Following need to be incorporated in CAD-CAM tooling from design stage.

- Centre line in L & W direction in cope and drag (helps component inspection) *(Fig. 15b)*
- Sunk in patterns (no mismatch)
- Integral nissan fin/all round radius at p/l
- Sand collectors integral
- Direct mounting of sprue/risers/vent pins from bottom *(Fig. 15a)*
- Hardened p/l wear plate (0.8 – 1.0 mm ht) ensures sand to sand contact and no leakage
- Steel plate/sheet in wear prone area
- Core rest points to take care of wearing out of core prints in handling.

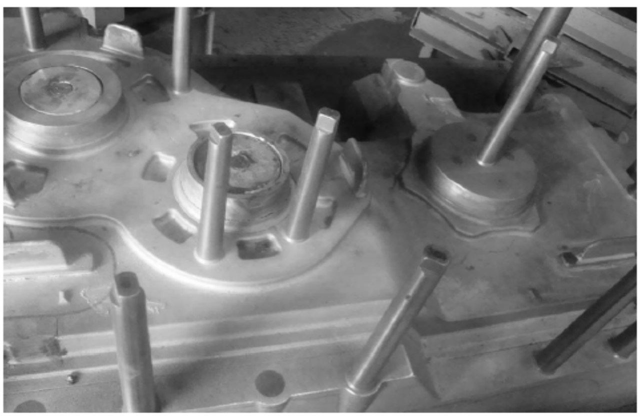

Fig. 15(a)

2.4.2 Pattern design/mounting innovation to adjust contraction where trials are required for ascertaining final percentage. Case study of 180 kg Axle Housing – integral with barrels (S.G. Iron) pattern split into 3 parts along length *(Fig.16)*.

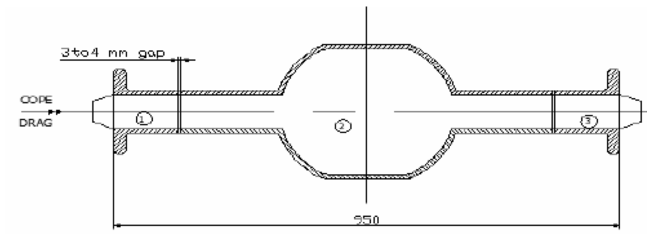

Fig. 16

2.4.3 Casting configuration irregular shape on opening side, here print matching difficult, resulting in sand crush/metal leak. Hence, design simple print, also matching draft, to avoid excessive matching stock *(Fig.17)*.

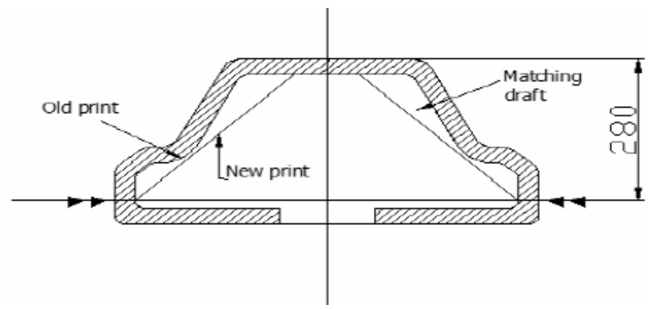

Fig. 17

2.4.4 Foundries producing blocks/housings with identical geometry/shape need design improvements to avoid interchangeability, primarily by print design/ csf design *(Fig.18a & b)*.

Fig. 18(a)

Fig. 18(b)

2.4.5 Innovation in core setting fixture design for tackle with core to be lowered perpendicular to p/l so that mould crush/core shift avoided. Fixture is in 3 parts, viz. bottom base, tackle guide frame with linear motion bearings and top tackle *(Fig.19a & b)*.

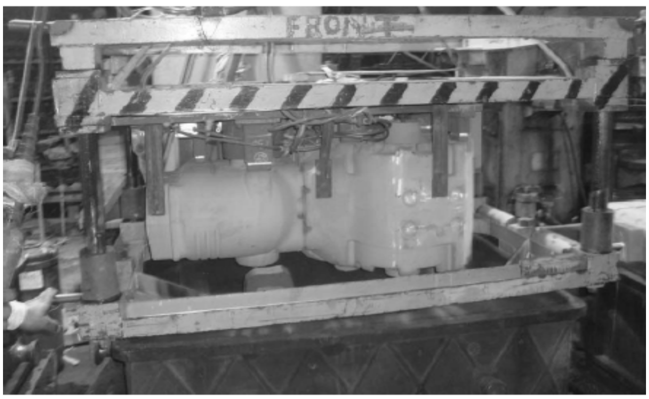

Fig. 19(a)

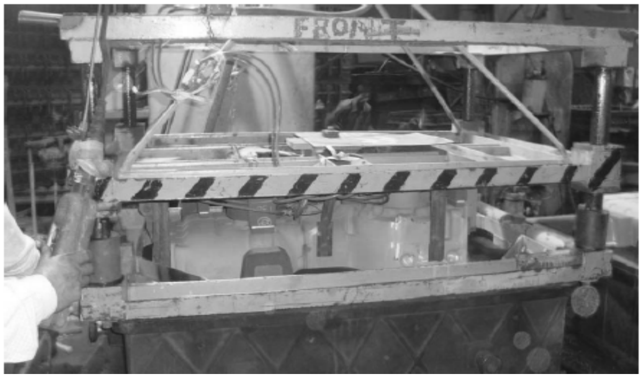

Fig. 19(b)

2.4.6 Core lift system design innovation by cylinder operated/cam operated element through top openings of housing castings for automobiles/ tractors *(Fig.20a & b)*.

Fig. 20(a)

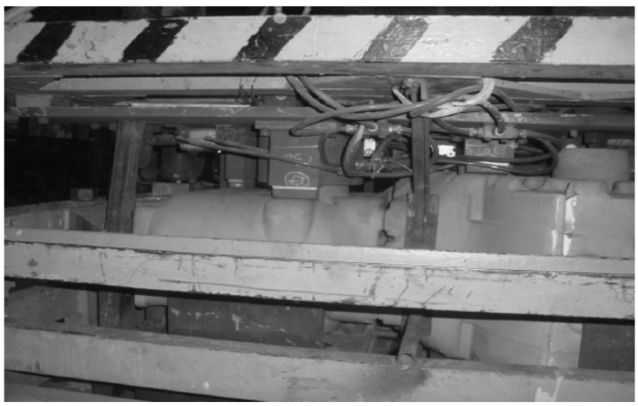

Fig. 20(b)

2.5 Core Tooling and Core Process Design

2.5.1 Core print design change to eliminate additional core. Case study of Cylinder Block, where sadle core is eliminated by mushroom print design of cr. case cores *(Fig.21a & b)*.

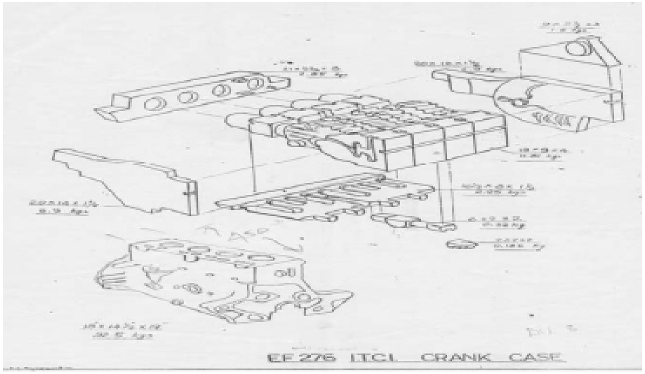

Fig. 21(a)

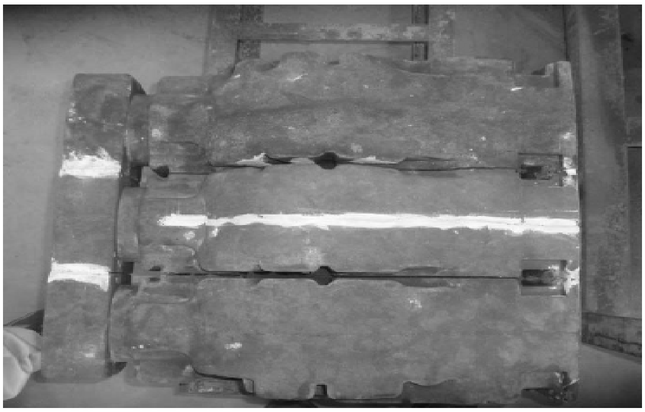

Fig. 21(b)

2.5.2 Idea to **double productivity** (100% increase) of flat cores for housing from shell core machining by introduction of a bride fixed on machine Tie-rods operating a parting plate (it is used for hollow out mandrels also). Machine manufacturer supplies such gadgets *(Fig.22a & b)*.

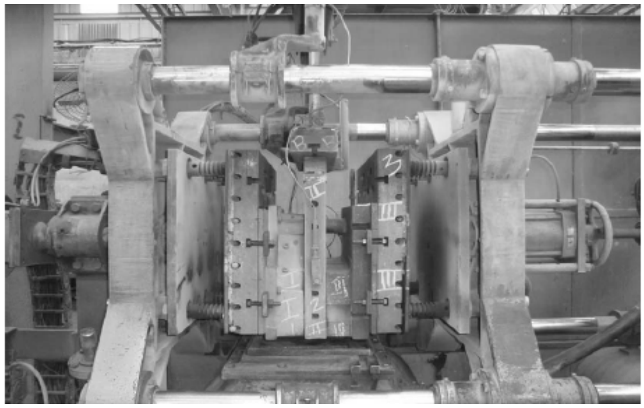

Fig. 22(a)

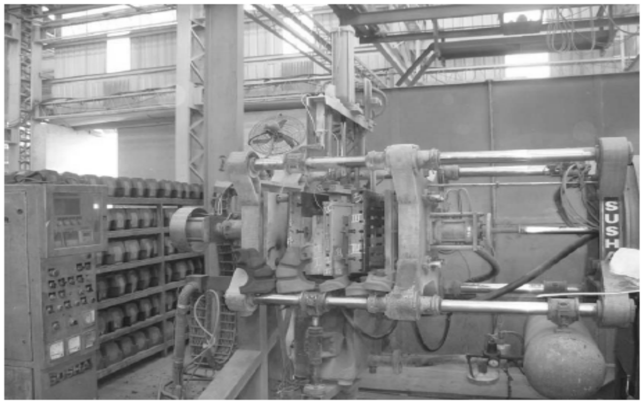

Fig. 22(b)

2.5.3 Innovation in core assembly process by using hot melt gum and normal gum. Normally cores get shifted from original position before they are dried in hot air oven. To prevent this, 2/3 dots of hot melt gum which hardens instantaneousely is done using a gun and special gum. Suggested system gives permanent solution of core shift. (You need not nail, etc.) *(Fig. 23)*

Fig. 23

2.5.4 Core handling innovation: Case study of big housing cores eliminating complicated tackle design special eye bolts with nut used immediately after core is ejected from core box and removed only after core is placed on csf. This helps integrity of cold box core print area used for lifting, resulting in better dimensional accuracy *(Fig. 24)*.

Fig. 24

2.5.5 Innovative venting procedure for Cylinder Head water jacket core made by shell process on shooters. Special spring steel wire upto 2 mm to 3 mm dia used all along length of core. This wire is pulled immediately after investment (before curing). This vent is connected to top opening knobs sealing both ends.

2.5.6 To incorporate chills and perforated reinforcements integral with cores, permanent magnets (pot magnets) can be used.

2.6 Melt/Pour Innovations

2.6.1 Pipe inoculation (manually operated) is a simple m.s.i. system (low cost and highly efficient). Practised in South Indian foundries. No great technology, and simple to operate. Results in excellent metallurgy of product *(Fig.25)*.

2.6.2 Innovation in case of automatic inoculation dispenser to ensure 100 % metallurgical quality. Majority of dispensers work on screw conveyor principle (some on compressed air) where there is some chance of powder (0.2 mm – 0.7 mm size) not being discharged for some reason. A sensor detects when material flow is not happening, and stops metal pouring, thereby suspending poor quality product manufacturing.

Fig. 25

2.6.3 Metal spurting prevention by a mobile cover moving alongwith ladle covering top area of mould. This ensures safety of people, plant and facilities.

2.6.4 System for pouring control by installing a timer which is started when metal is tapped from furnace. You can set 9 - 10 minutes. Time depending, on your process requirement of last box temperature. You get sound/light signal for warning to suspend pouring further.

2.7 Improvement in Post-Processing after Casting Evacuation

Use permanent magnets (copper coil and air cooled) for casting evacuation

To minimise Casting damage at shakeout :

- Remove loose metal pieces from shakeout
- Avoid excessive shakeout time.
- Maintain cluster integrity by gating design (16 pieces in 4 clusters)
- Frequently replace Alu.bars fixed on shakeout grid (since these get harder with work hardening.)
- Provide Damage pad

Shot-blasting efficiency and quality of shot-blast can be improved by special hangers and hooks *(Fig.26a & b)*.

Fig. 26(a)

Fig. 26(b)

2.8 Quality Engineering / Layouts

2.8.1 Inspection innovation by suitably designed gauges to filter defective castings. These are simpler systems to implement during pilot lot stage of production *(Fig.27)*.

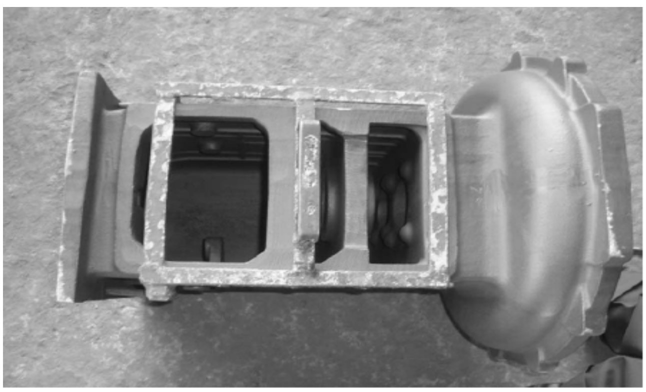

Fig. 27

2.8.2 Raw Part Inspection: Fixture guarantees dimensional accuracy. All machining stock, core shifts, fouling points can be identified and name of inspectors for feed back. Poka-Yokes to ensure water openings, Valve tappet openings, Oil Pump openings are OK in castings *(Fig.28)*.

Fig. 28

2.9 General Shop Layout Improvements

2.9.1 Do first shot-blast in-house for better defect control

2.9.2 Shakeout, Casting Cooling Conveyor, Decoring, Shot-blast, Inspection, Definning, Despatch to fettler in truck in the same shed. This is best the layout *(Fig.29)*.

(PTO for Figure 29)

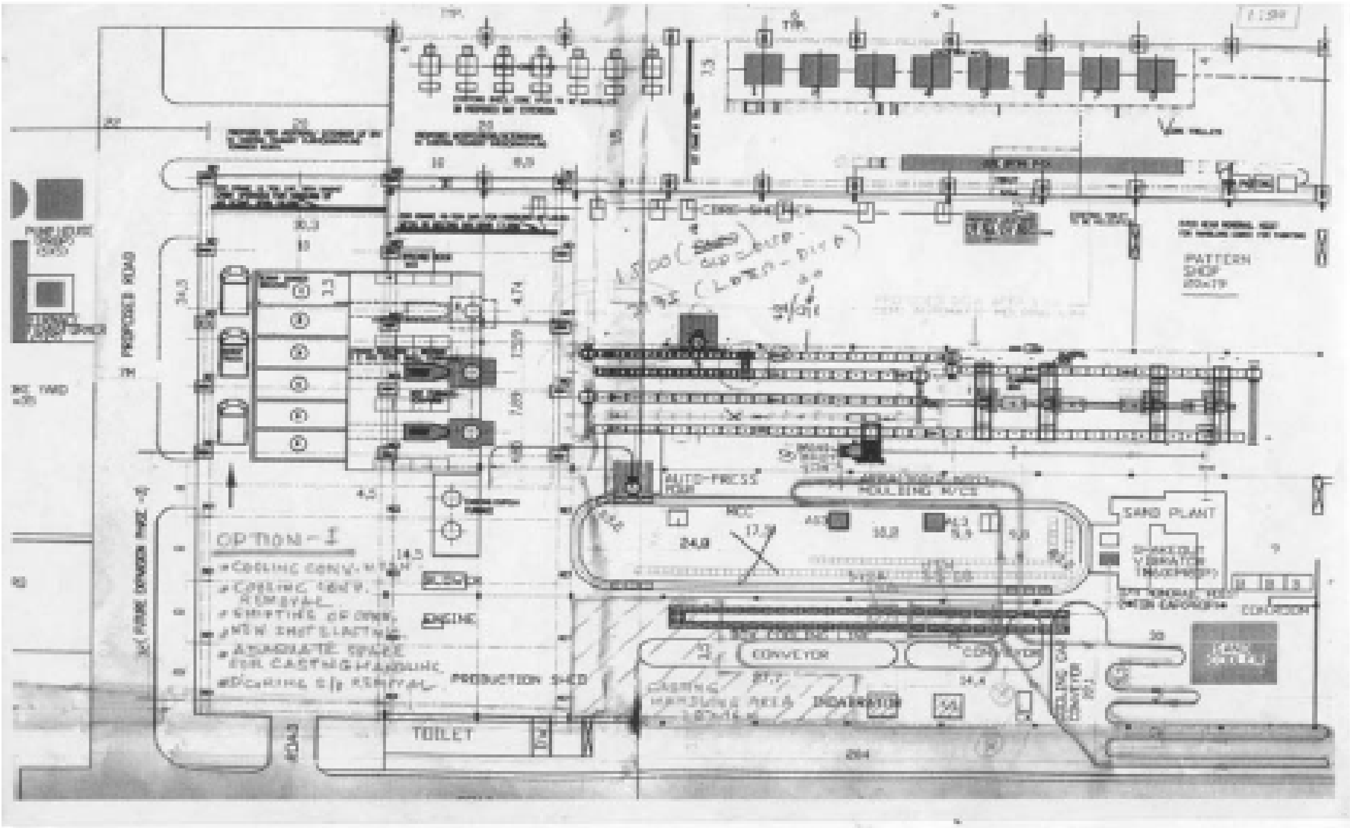

Fig. 29

2.9.3 In finishing area, the best layout is with : Second shot-blast, paint, final inspection and dispatch in a single shed *(Fig.30)*.

Fig. 30

2.9.4 Minimum Automation: punchout device,box/pallet cleaning device, weight transfer device, 90 min. cooling by additional cooling lines, indexed mould line with Autopour/ Dispenser, Sand Cutters, Spillage Conveyors, Box cleaning Device etc.

Concluding Remarks

Foundryman to initiate plenty of improvements through innovations using CFT & Cost Re-Engineering concepts. I have taken an initiative to direct your thinking in this direction. Believe me, savings can go to Lakhs of Rupees if the idea clicks. *As Tom Peters says, "Try more and more ideas, without getting disheartened by failures"*.

My Best Wishes to you in this journey.