ALUMINIUM GDC TECH GREAT DIE CASTING

GREAT DIE CASTING TECHNOLOGY FORUM

JOURNAL FOR ALUMINIUM CASTING TECHNOLOGY

Volume 45 - April 2021

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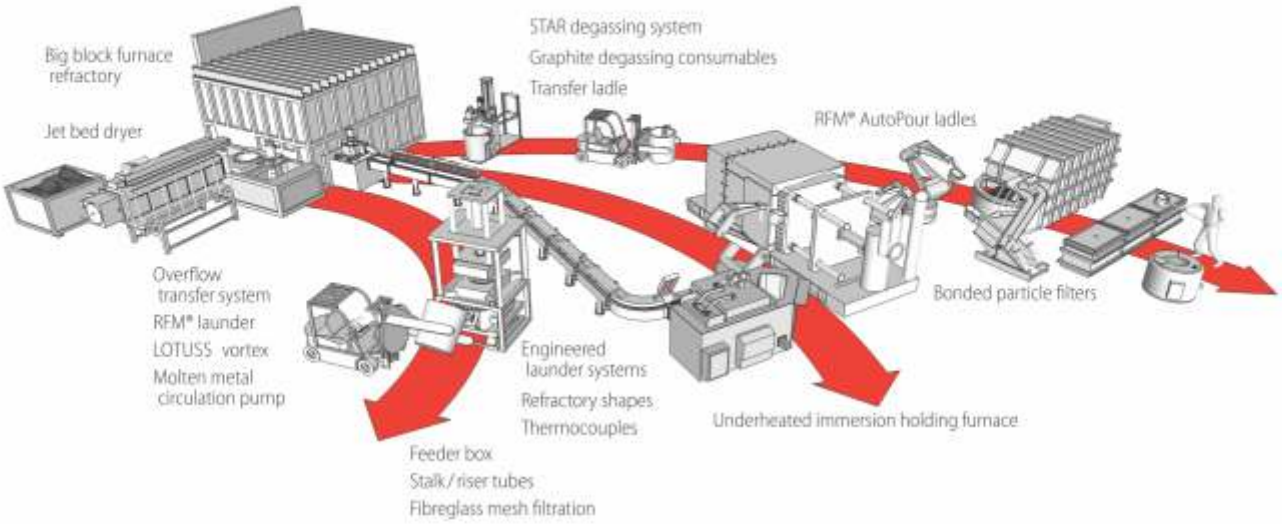

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Contents

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Great Diecasting Technology Forum

Training Programme Calendar 2021-2022

April

Die Design
21 - 22 PDC
(Thu-Fri)
6 hrs two consecutive days

Core Technology
28 - 29 GDC
(Wed - Thu)
1/2 Day each

April 2021

May

Die Coatings
13 GDC
(Thu) - Half Day

Quality & Process Control
27 - 28 Common
(Thu-Fri)
4 hrs. Two Consecutive Day

May 2021

June

Methoding of Aluminium Gravity Die Casting
17 - 18 GDC
(Thu-Fri)

Release Agent
25 PDC
(Fri) - Half Day

June 2021

July

Defect Analysis & Remedial Measures
15 - 16 PDC
(Thu-Fri)

Three days programmes for begineers/buyers (at two centres)
Common

July 2021

August

Three days programmes for begineers/buyers

(at 3 different centres)

Common

August 2021

September

Melting & Metal Treatment & Defect Analysis & Remedial Measures

16 - 17 GDC
(Thu-Fri)

September 2021

October

GDCTECH 2021

Virtual
Conf & Exhibition
21 - 22
(Thu-Fri)

October 2021

November

November 2021

December

GDCTECH Special

Thermal Management

16 - 17
(Thu-Fri)

December 2021

January

Two Weeks Proficiency Development Programme
17 - 29
(Mon-Sat)
Common

January 2022

February

Machine Maintenance
17 - 18
(Thu-Fri)
PDC

February 2022

March

Reserve Your Dates

Programmes are Virtual or Physical.
Will be conmmunicated well in advance as the situation may be
*** Programmes subject to change**

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INSURAL ATL ladle lining at NEMAK CZ

INTRODUCTION

Energy costs and environmental considerations continue to put financial pressures on the foundry industry. Concerns with global warming is result in governments taking both companies and individuals into becoming more fuel efficient. To remain competitive foundries will have to look closely at all working practices to see where cost savings can be made and more efficient forms of metal melting and holding will have to be considered along with good recycling practices

The foundry industry, where energy consumption is a major factor, must consider improving insulation along with sophisticated temperature control and monitoring in order to reduce costs.

One particular area of the foundry which is often over looked is that of transfer ladles, where costs are often not considered to the extent that they ought to be. Although these ladles are of fairly simple design they can play a key part in controlling quality as well as cost of production.

When looking for the ideal transfer ladle lining material a number of factors have to be considered. Many foundries use traditional refractory concrete linings which are poor insulators and difficult to dry completely. These linings can be a source of hydrogen pick up as they can take many days or coasts to fully stabilise.

Other foundries are crucibles to line ladles but these are inherently conductive and therefore lose heat rapidly

When looking for the ideal lining material a number of factors needs to be considered mainly good insulation properties, metal cleanliness's and speed of replacement.

INSURAL ATL a highly insulating simple lining system, has been designed for optimum performance in all these key areas. INSURAL ATL liners are pre-cast to shape, highly insulating, fully fired and delivered ready for rapid installation. The INSURAL ATL liner is fitted into a conventional steel shell and surrounded by a highly insulating backing material for secure fitting called INDURAL 10. The compete system is quickly installed and instantly ready for use with no further firing necessary.

INSULATION

To obtain optimum energy utilisation for melting more foundries are now using central melting, where large melting furnaces provide molten metal at the correct temperature on a fact and economic basis. For foundries that use this system it is becoming more popular to carry out metal treatment in the transfer ladle so that casting can begin quickly after transfer. Cleaning, degassing, grain refinement and modification can be completed quickly, particularly in a system such s the automated FOSECO MTS 1500 process, but even here a total time of 10 minutes may be required. For such a holding period insulation and temperature loss in an issue and so a highly insulating lining is essential.

For example, if a conventional lining with an expected temperature loss of 8^{0}C per minute is used than a super heat of 80^{0}C may be necessary leading to increased oxide formation and higher dissolved hydrogen levels. Whereas an INSURAL ATL lining system will only have a temperature loss of around 3^{0}C of superheat. This reduces the holding temperature of the melting furnace, leading to cost savings.

Figure 1 and 2 show the relative insulation of traditional linings against INSURAL ATL liners, an infra red camera is used to compare the energy emitted from both systems and the reduction in heat loss is clearly evident.

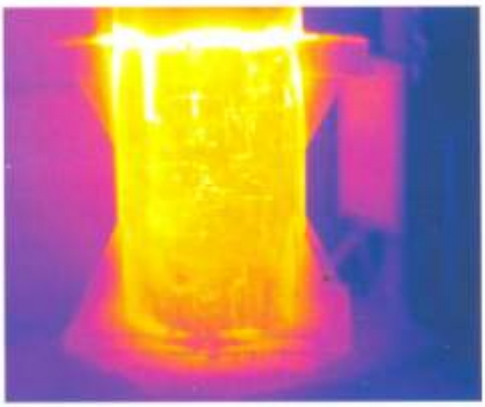

Fig 1 Refractory concrete ladle seen through an infra red camera showing the level of energy emitted.

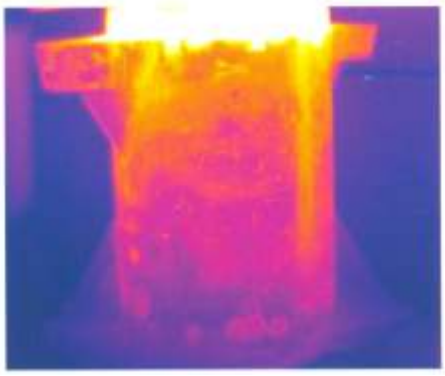

Fig 2. The same ladle after being lined with an INSURAL ATL lining.

METAL CLEANLINESS

To maintain casting quality the avoidance of oxide skins and non metallic inclusions is very important. Oxide films and inclusions will reduce mechanical properties, act as nucleating sites for porosity and unwanted intermetallic compounds, as well as increasing the changes of lack of pressure tightness. A ladle lining which avoids the formation of an oxide skin or, which makes any skin very easy to remove, will ensure there is no cross contamination between metal transfers and there will not be a build up of oxide which can grow before breaking away to give hard inclusions in the melt. Using a lining material which is non wetting will therefore be advantageous. INSURAL ATL is such a system where the skull of remaining metal can be easily removed once cooled, leaving a clean dry lining for subsequent transfers, compared to a conventional lining as seen in Figure 3 where a thick skull can be seen.

Fig 3 Conventional concrete ladle after 400 fillings showing a heavy build up of oxide.

The regular use of a refractory coating such as CERAMOL 258 G (Supplied as liquid, ready to use) or TERRACOTE 7667 (supplied as a powder) can further improve the ladle lining cleanliness of the INSURAL ATL liner, as shown in figure 4.

Fig 4 an INSURAL ATL ladle, which has been coated regularly, after 4000 fillings. The metal skull in the base in still easily removed by a gloved hand.

THERMAL SHOCK

Many ceramic and refractory materials suffer from thermal shock and thus have to be carefully preheated before use for a considerable period of time, this being a costly process. INSURAL does not have this problem and metal can be safely poured into the ladle even when it is below 150°Cwith no adverse effects.

Preheating

Many refractory concretes have high thermal capacities and will chill the molten metal on filling if not preheated close to the metal temperature. It is more unusual to see these factory concrete ladles being continuously preheated with strong gas burners when not in use.

INSURAL does not suffer from this problem and minimal preheating is required. To prevent hydrogen pick up.
INSURAL should only be preheated after standing for many hours, such as weekends, but in normal working conditions little or no preheating is required. The avoidance of preheating offers the foundry a significant reduction in energy usage.

WEAR resistance

INSURAL ATLA transfer ladles are available in sizes up to 2 tonnes, however, with larger ladles significant impact is experienced on filling. This impact will often be focused on the same position every time and so the ladle bottom can erode. Larger INSURAL ATL ladles are supplied with INSURAL 180 wear plates to avoid this erosion. These are of a material strong enough to avoid erosion and are fitted into the appropriate position in the base of the liner.

FLEXIBILITY OF SHAPE AND SIZE

INSURAL ATL liners are installed in a steel shell surrounded by INSURAL 10 backing powder. This means that an INSURAL liner can be applied in almost any ladle size or shape (figure 5).

Although there is a comprehensive range of INSURAL ATL liner shapes, sometimes are capacity of the transfer ladle has to be slightly reduced. However, the low density of INSURAL compared to more refractory materials means more aluminium can be transported without compromising the capacity of the crane or forklift.

Figure 5 Various ladle shapes and sizes

CASE STUDY

Nemak CZ produce 5,000 tonnes of gravity die cast cylinder heads per year by the gravity die process.

Melting is carried out in gas fired tower furnaces and is transferred by forklift using a 1000 kg capacity ladle, see Fig. 6. The ladle is moved to a treatment station for 10 minutes rotary degassing before being transferred to the casting line.

Fig.6 INSURAL ATL 1000 IB- Ladle with a capacity of 900 kg.

When the foundry was first commissioned a conventional refractory concrete lining was used and a gas fired preheater maintained a temperature of 800 0 C on the refractory surface. This was necessary to avoid excessive temperature loss.

This ladle has now been replaced by an INSURAL ATL 1000 ladle lining giving a safe transfer weight of 900 kg molten metal. The ladle lining was installed in 4 hours, pained with CERAMOL 259 G and put into service following careful heating. In order to use a tapping temperature of 750^{0}C and a delivered temperature of 710^{0}C the ladle liner is mildly heated and a temperature of 380^{0}c is maintained on the INSURAL surface. The gas consumption over the full period of the project was measured and a reduction in gas consumption over the full period of the project was measured and a reduction in gas usage of 90% was found. The gas usage was reduced from 3.117 cu m per hour to 0.29 m per hour.

Further advantages of using the INSURAL ATL 1000 ladle liners are minimum cleaning and maintenance compared to the old refractory concrete lining system, less aluminium skull remaining after each pouring operation and a reduction in hydrogen pick up due to lower melt tapping temperature. The first INSURAL ATL 1000 liner installed at NEMAK CZ gave a life of 12 months with 20 transfers per day.

CONCLUSIONS

The advantages of the INSURAL ATL lining system for aluminium transport ladles are:

- High Insulation
- Good refractory cleanliness, avoiding the carry over of oxides and other inclusions.
- Minimum or no preheating required, offering energy savings
- Enables lower tapping temperatures to be used, again saving energy
- Excellent resistance to thermal shock
- Wide range of sizes and capacities available
- Can be fitted to most existing steel ladles
- Supplied ready for use
- No drying required
- Fast relining.

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Vedanta launches Aluminium Cylinder Head Alloy

Press Release

Vedanta launches Aluminium Cylinder Head Alloy at ACMA 2021

- *First Indian company to manufacture Aluminium Cylinder Head Alloy for automotive industry; an alloy hitherto completely imported into India*
- *Deployed world class technology of Befesa (Spain) and Properzi (Italy) for manufacturing Cylinder Head Alloy*
- *Showcases market readiness with high-quality products, value-addition capabilities, and partnerships with global experts*
- *Evinces interest on collaborations for new product development with dedicated R&D Centre*

New Delhi, 10 February 2021:

Vedanta Limited, India's foremost producer of metals and oil & gas, announced the formal launch of its newest product, the aluminium Cylinder Head Alloy, a critical raw material for manufacturing cylinder heads and other automotive components. This is the company's latest value-added offering in its aluminium product line, which caters to various raw material requirements of the automotive industry. The Cylinder Head Alloy leverages material design to help automakers increase efficiency of internal combustion engines for improved performance on emission control, in line with BS-VI and CAFE (Corporate Average Fuel Efficiency/Economy) norms. Currently, this alloy is entirely being imported into India from other countries.

Vedanta has investmented in creating this cylinder head alloy capacity of 10,000 tonnes using world class technologies of Befesa (Spain) and Properzi (Italy). This initiative is in alignment with the government's thrust on self-reliance to cater to the domestic requirement of automotive companies and original equipment manufacturers to rely on indigenously procured material. Localisation of the domestic raw material supply chain will surely help the Indian automotive industry.

Speaking about the need for import substitution making India's automotive industry self-reliant, Mr. Ajay Kapur, CEO – Aluminium & Power, and Managing Director – Commercial, Vedanta Limited, said, "For India to become a USD 5 trillion economy by 2025 and an economic powerhouse, the entire manufacturing sector has a crucial role to play. India's auto component sector is among the fastest growing but lags in contribution to manufacturing turnover. The Indian auto component industry's aspirations of having a significant share of the global trade calls for a renewed focus on localization on every business front, particularly with respect to sourcing raw materials. As India's leading producer of a vast array of globally acclaimed metals and value-added products, Vedanta aims to partner with various industry sectors, especially automotive and auto ancillary industry, across their entire value chain, from large players to MSMEs, for the nation's growth."

The company was also the first to supply Aluminium Primary Foundry Alloy (PFA) for manufacturing wheels to the Indian automotive industry, prior to which the alloy was only being imported to the country.

The biggest strength of Vedanta's products is that they use best-in-class technology to meet global quality specifications and standards, and ensure that customers access products of the highest quality. Vedanta's capability to customize these alloys also equips the company to address the varying requirements of the auto industry.

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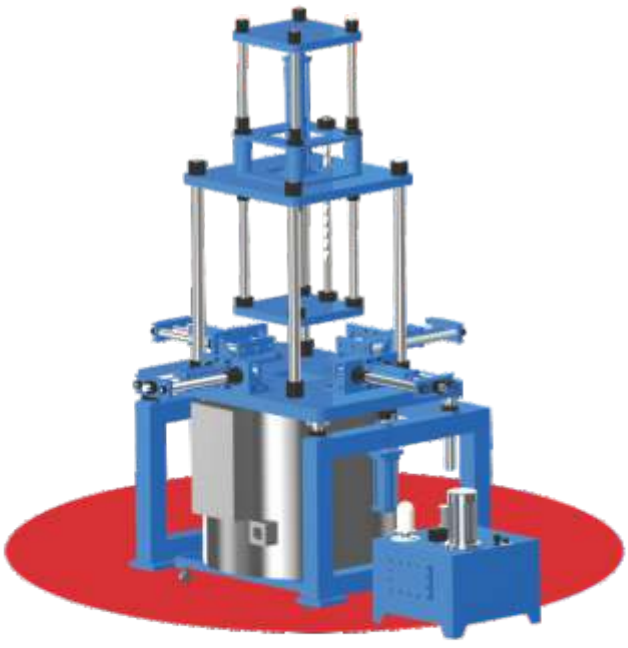

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Aluminum Gravity Die Casting / Permanent Mold Casting

C. Surianarayanan, Consultant, Tooling Soultion

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WHY WE SELECT GRAVITY CASTING PROCESS…

- Suitable for Low silicon alloys
- Higher section thickness parts
- Heat treated parts(T6 etc.)
- Intricate inner profiled parts

NOTE:
The design of Runner, gating and risers has been a important task in the design.

This presentation is described with common rules of thumb used by the foundry experts as well sharing our practical experience.

BASIC LAYOUT TECHNICS…

PART ORIENTATION RULE…

1. Heavy thick (Mass) of the part to be orientated in the top position
2. Ensure layout minimum height / Die height should be less than die length .
3. Place the part open spaces down.
4. Top risers can be placed on High points on the heavy sections.

SOME BASIC TECHNICS IN GRAVITY CASTING CONCEPT DESIGN …

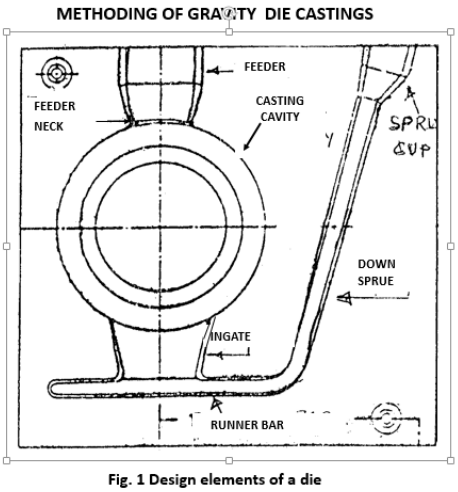


Fig. 1 Design elements of a die

SOME BASIC TECHNICS IN GRAVITY CASTING CONCEPT DESIGN …

- **Sprue :**
  It is a circular cross-section minimizing turbulence and heat loss and its area is quantified from choke area and gating ratio. Ideally it should be large at top and small at bottom. Down sprue should be tapered slightly for aspiration on of Air.

- **Sprue well :**
  It is designed to restrict the free fall of molten metal by directing .
  It in a right angle towards the runner.
  It aids in reducing turbulence and air aspiration
  Ideally it should be shaped cylindrically having diameter twice as that of sprue exit and depth twice of runner.

- **Runner :**
  Mainly slows down the molten metal that speeds during the free fall from sprue to the in gates.
  The cross section are of a runner should be greater than the sprue exit.
  It should also be able to fill completely before allowing the metal to enter the in gates.
  In systems where more than one in gate is present, it is recommended that the runner cross section area must be lowered after each in gate connection to ensure smooth flow.
  Runner crass section should be 1:2 to 1:4 times larger than the minimum size of the sprue outlet area.

- **Ingate :**
  It directs the molten metal from the gating system to the mold cavity.
  It is recommended that in gate should be designed to reduce the metal velocity; they must be easy to fettle, must not lead to a hot spot and the flow of molten metal from the in gate should be proportional to the volume of casting region / runner output area . (Ratio 1;2 to 1: 4 Based on casting intricacy)

In gate fillet radius will support to metal smooth flow .

- **Risers:**
It Feed the molten metal to the Casting .
Riser overall volume should be 5 to 6 % shrinkage volume of the section or part .

Metal feeding raiser neck area should be 18 to 20% by the weight of the raiser .

Riser volume should be required volume x 3 to 4 times based on the casting behavior / intricacy.

Riser height should be equal to riser cross section area may be 1: 1 to 1:3 max.
For diametrical riser height should be 1:1 minimum .

Top risers Should be placed on High points ...and should be top side near the heavy sections.

Example:
Riser Dia 40 mm riser height should be 40 mm (1:1)

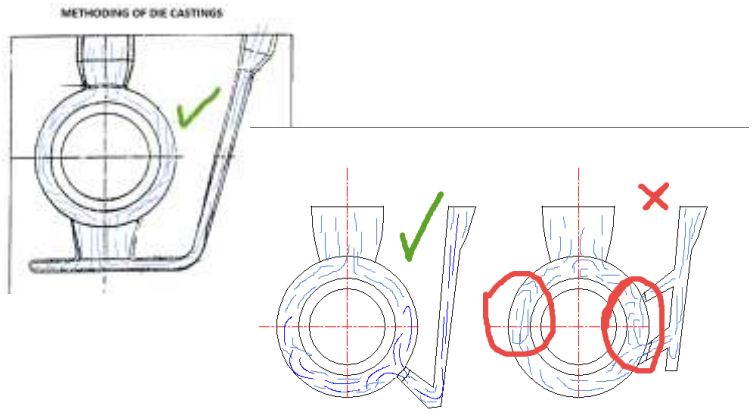
- **Air vents :**
Air vents will play the major role in the gravity casting process . It should be provided Which we are identifying air pressure generated areas or air entrapment areas in the die.

We can identify by using analytical software. Even flow tracer lines and hot spot areas also we can identify so we may provide vents / chills or feeders in the particular areas . same time casting solidification pattern also visualized so we can ensure even solidification pattern and prevent from Surprised internal shrinkage defects.

Ready made Air vent plugs are available and we can make from Hexagonal rods .But periodic air vent cleaning practice is` mandatory otherwise result will go down.

BASIC LAYOUT TECHNICS

ENSURE FLOW DIRECTIONS..



INTRODUCTION Metallostatic Head hst :

Vertical feeder stem is called downsprue.
Downsprue height and riser height is important in gravity casting design . It is called metallostatic head (hst)

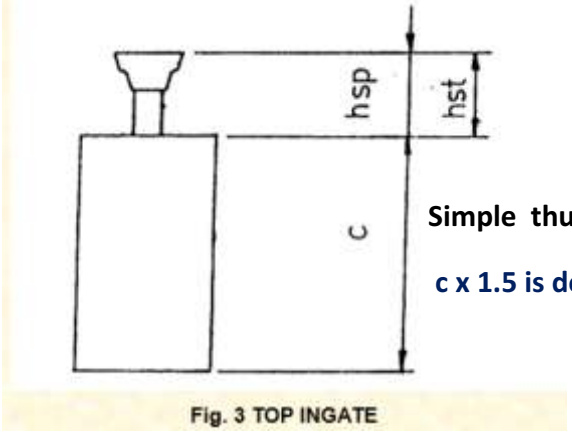


Fig. 3 TOP INGATE

Simple thumb rule is ...

c x 1.5 is determine the hst

CALCULATE THE FEED METAL REQUIREMENT :

- Calculate the feed metal requirement for the casting = 5% x Weight of the casting
(consider 4 to 5% Metal required for feed the casting volume)

CALCULATE THE TOTAL LIQUID METAL REQUIREMENT PER POURING (G) :

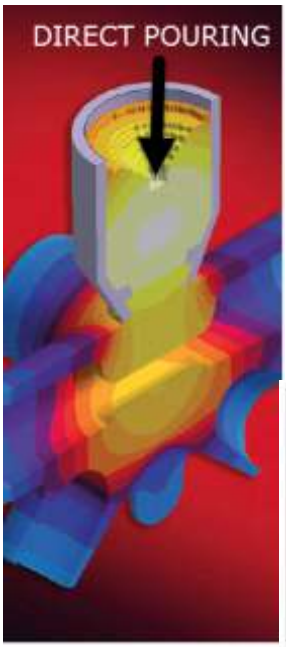
- (Weight of the casting + feed metal req.) x 1.5 to 1.6
- Aim for Average YIELD % Should be Minimum 50% for GDC process

CALCULATE THE POURING TIME (t) in Sec :

Multiplication Factor (f) 3.5 x $\sqrt{2G}$

EXAMPLE
Shot Weight (G) = 5KG
Pouring Time : **Pouring Time = 3.5 x$\sqrt{10}$ = 11.06 Sec**

Direct pour Technology for maximum Casting yield



KALPUR
The KALPUR direct pouring process is the combined use of a feeder sleeve and ceramic foam filter.

The KALPUR unit replaces one of the conventional feeders and the conventional gating system. Liquid metal is poured directly into the unit which connects directly with the casting cavity.

The KALPUR process can be used for steel and iron, by choosing the appropriate feeder and filter types. It is suitable for hand-moulded castings, and horizontal and vertical automatic moulding lines.

The KALPUR process entirely eliminates the need for a conventional running system. In addition, by allowing the foundryman to pour directly into the casting, directional solidification is improved.

Hand Moulding:
For hand moulding and basic moulding machines, open pouring cup shaped KALPUR units are available. They can be moulded in position on the pattern plate or inserted into a cope mould cavity formed by using an appropriate dummy pattern or dolly.

Insert Applications:
KALPUR insert sleeve technology facilitates the application of KALPUR units in high volume repetition iron and steel foundries. Units are available with the filter in position and can be supplied with or without breaker cores.

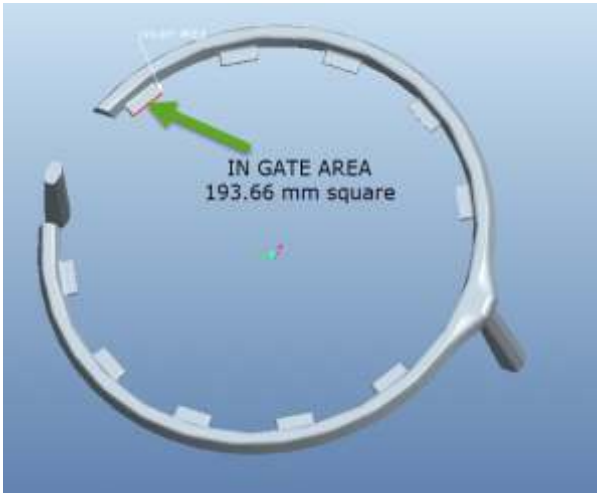
KALPUR units can also be successfully implemented in moulding plants using top runners with multiple down sprues.

Vertically parted moulding lines
In this case, KAPUR units are located in the core print either by hand or using an automatic core setter.

Suggestion :
Whatever shred are based on empirical values only. Following slides have some of the shop floor experiences faced and the corrective actions carried out then on. With this we suggest that die designer attend the trials for understanding the reality happening .

Values mentioned as empirical are the experience of personalities shared for reference .It has to be amicably adjusted for the environmental conditions.
Heat is the phenomena which has variation at every circumstances.

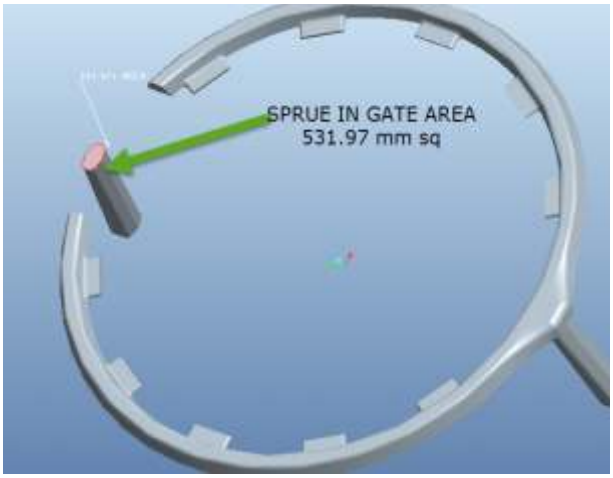
SUCCESS STORY....ALTERNATOR FAN...
EXISTING TRIED ..FAILURE DIE PHOTOS WE VISITED TO CUSTOMER END .....



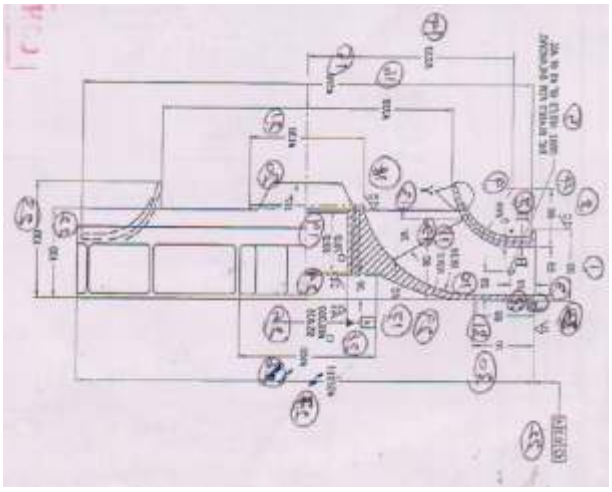
This project was assigned to a foundry and they were not able to achieve the desired results. After spending almost two (2) years and missing the great business volume they were on the look out for an avenue to come out of this issue.
Our team was requested and assigned to get the best of the results.
Basic mistake was the wrong engineering of the layout and the feeder system

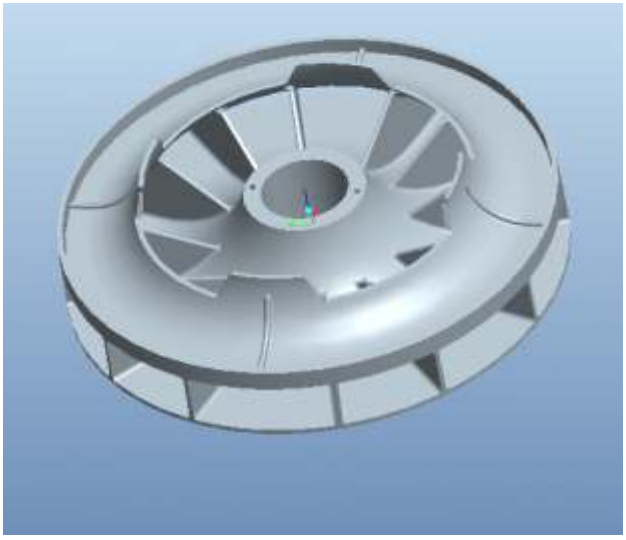
RUNNER WEIGHT ; 3.0 KG
DOWN SPRUE AREA =531.97X 2 POS
=1063.94 mm sq
RUNNER BAR AREA= 460.82X4 POS
= 1843.28mm sq
INGATE AREA = 193.66x 10 POS
=1936.6mm sq

CASE STUDY ALTERNATOR FAN PROJECT

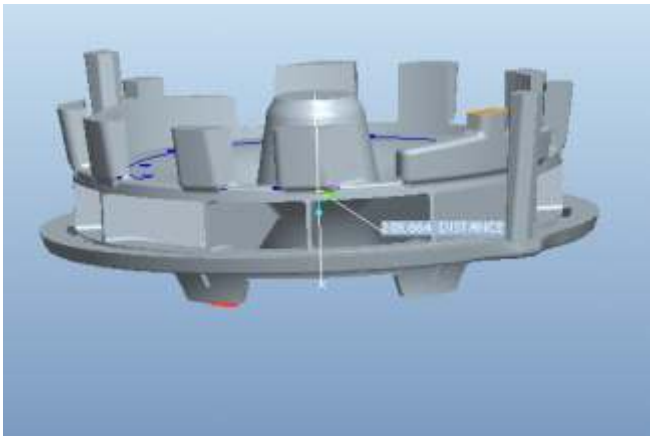


CASE STUDY ALTERNATOR FAN PROJECT





Product details
OUTER DIA :520 mm
TOTAL HEIGHT :130 mm
WEIGHT :12 KG
WALL THICKNESS: 5.50 mm



POURING TIME;

MULTIFICATION FACTOR X $\sqrt{\text{SHOT WT X 2}}$

=3.5X $\sqrt{46}$ =23.73 / 2 =**11.86 SEC**
(Double (runner) pouring)

RISER HEIGHT(hst) =75MM FROM (130 X 1.5) CASTING TOP LEVEL
TOTAL HEIGHT (PART + RISER)=130+75= 205MM

Guideline points to achieve better results

The sprue should be located centrally on the runner, with an equal number of gates on each side.
Rectangular cross-section sprues are better than circular ones.

Generally, rectangular sprues are used to avoid vortex problems.

Risers are located near thick sections of the casting

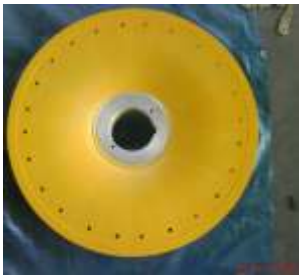
ACTUAL SAMPLE
T '0' TRIAL AND SUBSEQUENT CORRECTION

PART WEIGHT ; 12. 0 KG
RUNNER WEIGHT; 3.50 KG
RISER WEIGHT ; 7.5 KG
SHOT WEIGHT ; 23.0KG
YIELD ; 52%

POURING TO FETTLING AND THE PART AT CUSTOMER END IN ASSEMBLY…

Die Assembly

Production



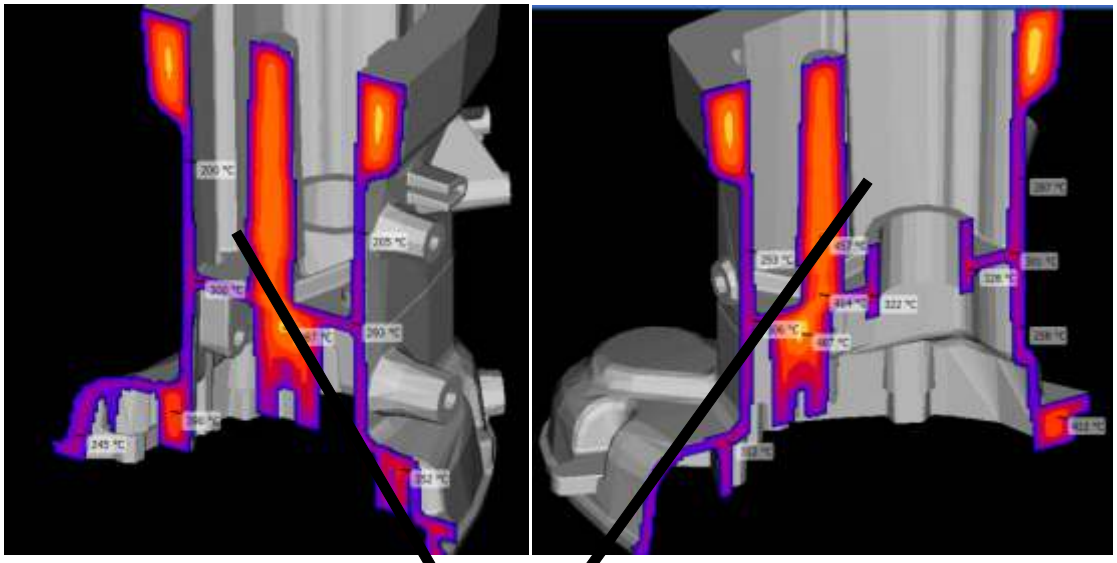
Pilot Lot Production

Pilot Lot Production

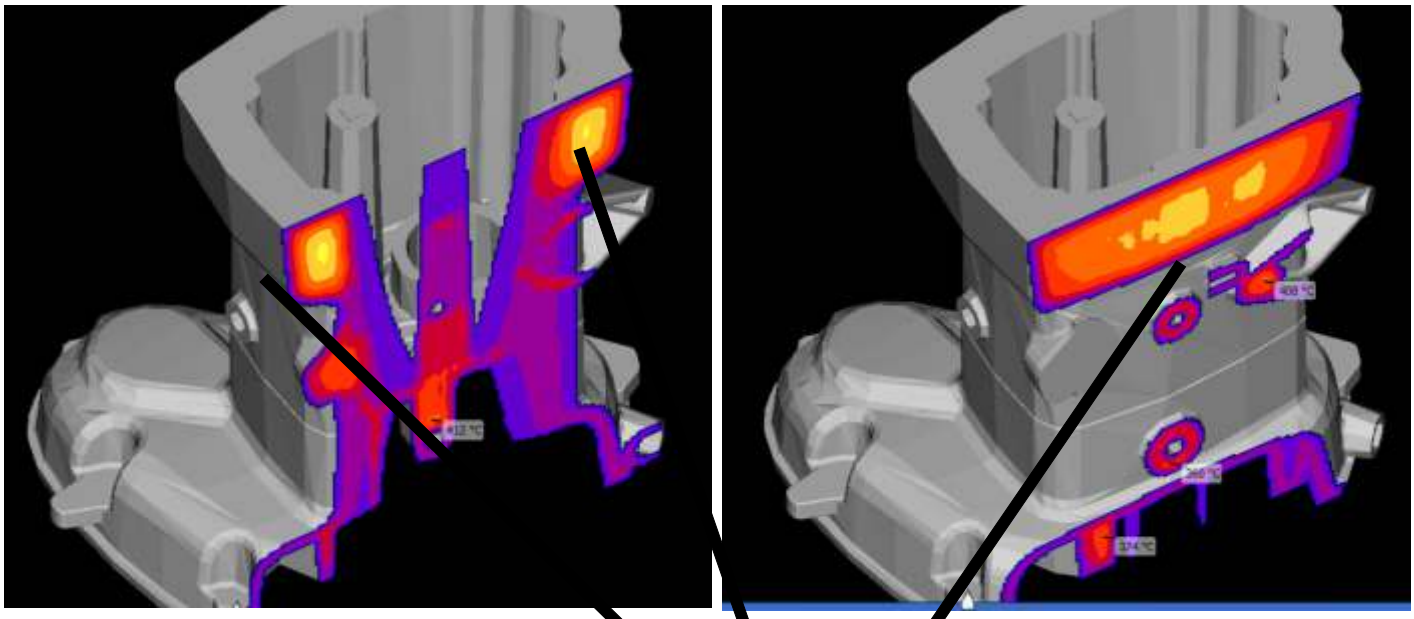
Cold Box - Sand Cores

Casting Pick up Troly

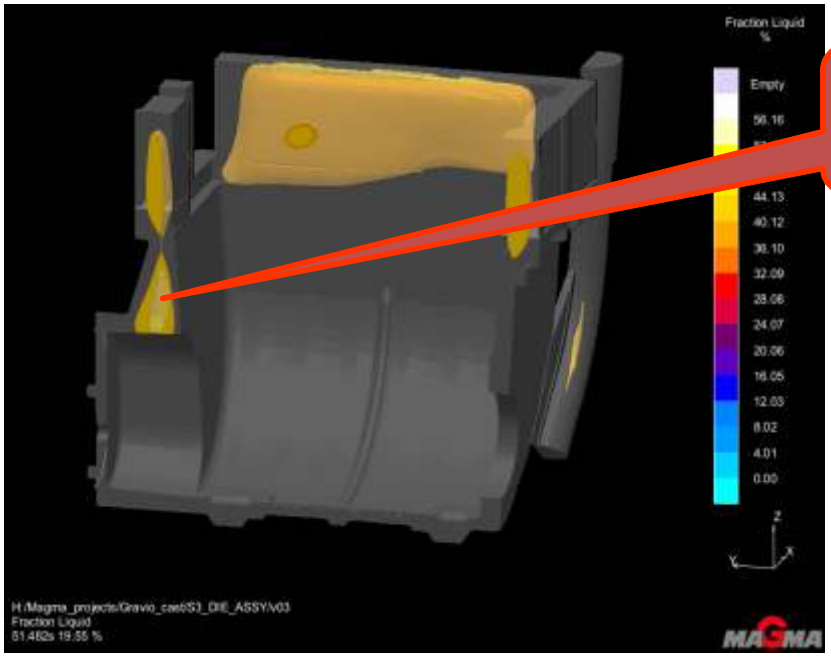
Final Assy. Customer End

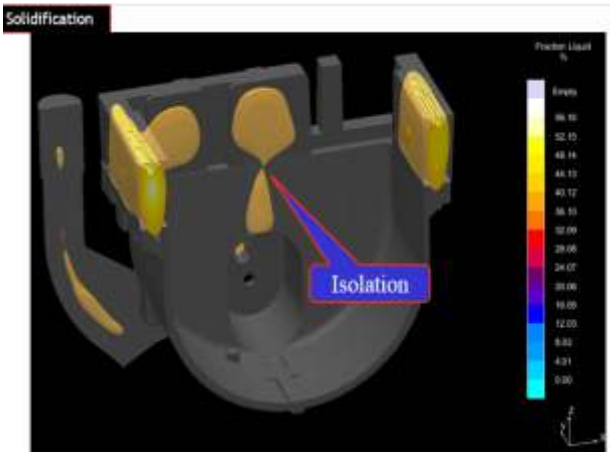


This location being thick in section hot metal in the riser and the casting will support to eliminate shrinkage. This solidification will take place very late And the metal needed for the profile will be drawn from the riser as they are hot and liquid enough.



These are the riser locations. Hot metal here is beneficial to feed the part profile as it solidifies.





NOTE:
WE MUST TAKE CARE IN RISER FEEDING AND ENSURE WHILE IN DESIGN STAGE ITSELF……BY USING ANALATICAL SOFTWARES

Hearty Congratulations!

It's a proven fact, for success no ways than dedication. Really proud of you.

AL FOR ENTERPRISE

Vaishali Jumde
BEEHIVE COMPUTER SYSTEMS
E-mail : vaishalijumde@gmail.com

PART I

AI for Enterprise	

The Incumbent's Path to New Growth

Business Growth:
A paradox surrounds the topic of Business growth. The world Economic Forum says that there will be many opportunities for value creation but many established enterprises say that their top business challenge is growth. Why is this discrepancy?

The Way We Were:
Most of the incumbent enterprises achieved their success in mature markets by scaling their systems and processes. These investments not only enabled steady growth; they also provided stability. But they also tended to create hierarchical organizations, functional specialization, siloes operations and infrastructure, and Isolated data.

The New Network dynamics:
The Internet and mobile computing shifted power to consumers by providing almost limitless choice, Extensive price transparency, Easy, realtime access to information and alternatives, ability to publish and amplify opinions via social media. As a result, customer preferences now develop and disappear rapidly. That churns continuously fragments and reforms markets. In turn, revenue and profit opportunities become increasingly perishable and unpredictable. But most established market incumbents haven't figured out how to sense these new dynamics - and respond appropriately.

Predictions of Incumbents' Defeat are premature:
Scale and stability, everchanging market dynamics, and competition from tech giants and insurgents are the new business realities for incumbents. Clearly, threats abound - but so do tremendous opportunities. Incumbents that leverage their scale and stability, and combine those strengths with hyper-agility, will position themselves to leapfrog the competition.

Why choose between having scale and stability, or being agile? Why not say you want both? You can. But getting there and succeeding against the new market dynamics will require a new approach to running a business.

Fundamentally Different Way to Run a Business:
Although they're common business responses to the lack of hyper-agility, these approaches aren't realistic for many reasons. Real results don't happen quickly. Expenses are too high. Implementation takes too long. Return on investment is questionable. And all of that unnecessarily increases risk to the business - something every business leader wants to avoid. Current business realities require something else.

The business continually senses what people want, and responds by always delivering value. Revenue-impacting business decisions are fully informed and optimized across the entire portfolio to deliver the maximum yield and return. And the business is measured in entirely new ways.

These sense-and-respond capabilities also form a feedback loop that symbiotically improves both demand understanding and supply optimization. When properly orchestrated, this system enables the business to respond.

How Cross-domain Enterprise AI works:
Cross-domain Enterprise AI does that by bringing together data from across the enterprise, regardless of location or format, in a secure private cloud. Then it adds external data – on customer segments, locations, distribution

models, and many other variables—to create a completely new and unified model of a business and its markets.

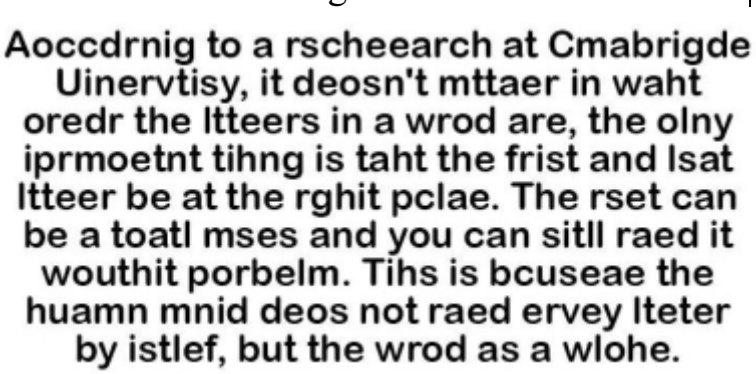
Cross-Domain Enterprise AI deeply analyses this information, uncovers new revenue opportunities that could never be seen before, and delivers predictions and recommendations that support the goal of new growth. Furthermore, these recommendations can be
implemented automatically using existing systems and processes.

And because cross-domain enterprise AI learns continuously, it quickly senses changes in market conditions and adapts its predictions and recommendations accordingly.

Data

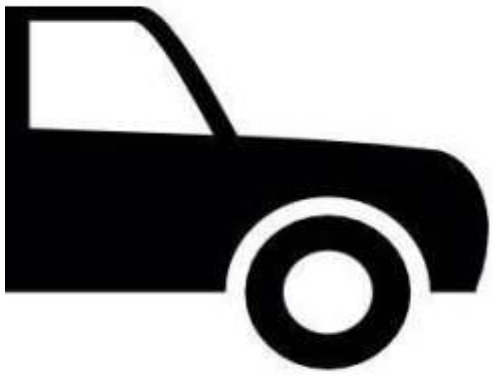
One of the most commonly-used definitions of AI is ―human-like intelligence‖ and humans are very good at understanding garbled and noisy data. You've probably seen some variation of this internet meme (Figure 1), which shows how the human mind can perceive patterns in ―messy‖ data: One can read this very easily.

Figure 1



The human brain is also able to recognize patterns in *incomplete* data. Look at this partial image (Figure 2): You can clearly see it is a car. If I ask you what type of car it is, you might say that it's probably a sedan but could be other one. And your guess would be affected by the picture's context: If the background is the streets of City, it's more likely to be a Sedan than if the background is a rural area.

Figure 2



Thus, our brain can answer different questions about the same partial data with varying levels of certainty. This enables us to make decisions quickly in the real world of incomplete information given a contextual background.
So, does **AI works in same pattern.**

Data Model, Data Warehouse and Normalisation: All business applications, including AI, used to be built based on the data model that governed a specific problem. Such a data model typically resides in a data warehouse.

A data warehouse is a place where all of the company's data can be stored. Each item of data is tagged and organized, like the shelves in a physical warehouse of products. This tagging and organization is known as the data model (i.e. the physical and logical schemas).

This approach results in a powerful storehouse of data, in which every piece of data is understood as to its meaning–and its relationship to every other piece of data. This is called normalization of data.

As a result, this process is very rigid and typically prevents IT/database professionals from promptly addressing business people's needs in a fast-moving market environment.

Data Lake:
An alternative method for enterprise data storage has emerged in recent years with the introduction of cloud infrastructure: a data lake. Unlike a data warehouse, there is little setup required for a data lake. You can pour in new data as easily as adding water to an actual lake. The data is just tossed into the lake as-is. In other words, the burden of understanding the data is still there. In addition, because you can't understand the data easily in a data lake, it is very hard to use AI algorithms on that data.

People, Places and Things:
We built the model based on the real-life elements (entities) in the business ecosystem that are represented by the data: people, places, and things.

Any market in the world can be described in terms of the interactions among the above entities. People are clients, customers, employees, etc. Places are physical or virtual locations where business is conducted, e.g. stores, warehouse, website, etc. Things are products and services sold by any business.

Our meta-model recognizes patterns of people, places, and things – the semantic building blocks of all enterprise data – even when the data is messy or/and incomplete.

The true business value is not in storing data, no matter how cleverly. The value is unlocked when you do something with the data. That's where the AI comes in.

Becoming a Digital Business
As consumers, we take digital technologies for granted… We don't wonder why these things are possible; we simply expect them, but the adoption of digital technologies in business doesn't come as naturally, especially if you're working in a big, old company. Inserting digital technologies to enhance operations and create new value propositions has proven extremely challenging. The design of a synchronized business requires much broader management engagement. Given its enterprise-wide scope, digital business design is the responsibility of a company's senior executive team.

How can a company that wasn't born digital incrementally transform into an agile digital business? There are five key building blocks or organizational capabilities that will help established companies rapidly develop innovative digital offerings:

- **Shared Customer Insights:** Organizational learning about what customers will pay for and how digital technologies can deliver to their demands;
- **Operational Backbone:** A coherent set of standardized, integrated systems, processes, and data supporting a company's core operations;
- **Digital Platform:** A repository of business, data, and infrastructure components used to rapidly configure digital offerings;
- **Accountability Framework:** Distribution of responsibilities for digital offerings and components that balances autonomy and alignment; and
- **External Developer Platform:** A repository of digital components opens to external parties.

The advantage of approaching digital business design as a set of building blocks is that it allows leaders to focus on specific, manageable organizational changes while implementing a holistic design. This is possible because the building blocks are interdependent: making one of the building blocks stronger contributes to making the others stronger. Each building block triggers changes in people, processes, and technology in ways that make the company more agile.

AI Adoption Strategies:
Most CEOs regard AI as one of the most strategically important technologies for achieving new growth, business transformation, and competitive advantage. But many struggle to create a foundational AI strategy attuned to an enterprise's capabilities and culture. Many just don't know where to begin or how to proceed.

A review of enterprise AI adoption approaches shows that no single strategy is effective for every enterprise. The factors, contours, and rationale of a small set of AI adoption strategies are summarized so you readily can apply them toward focusing and accelerating your AI adoption plans. We can refer figure 3 for generalised strategy.

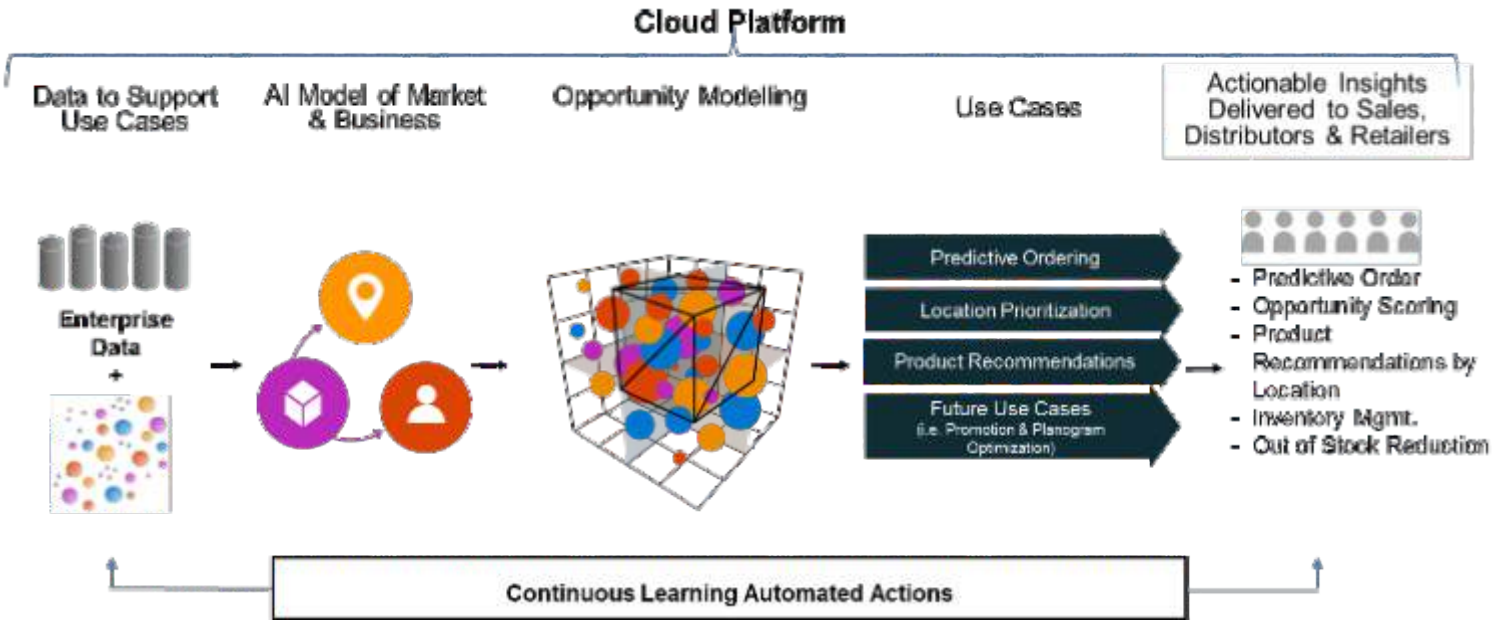
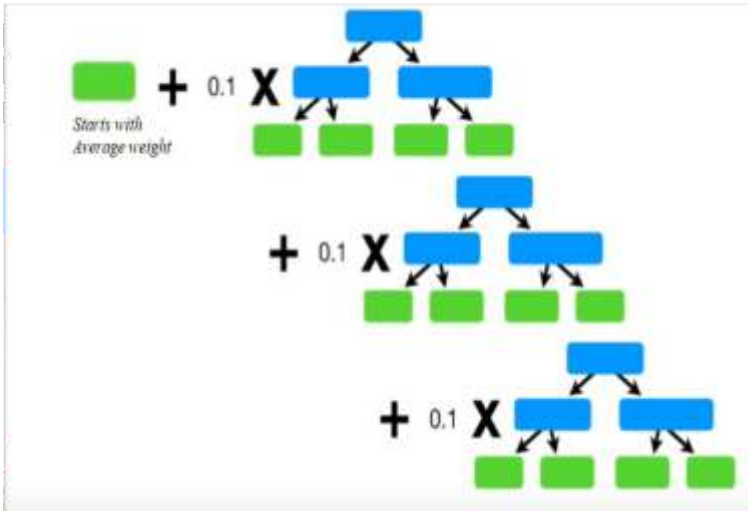


Figure 3

Modelling Approach

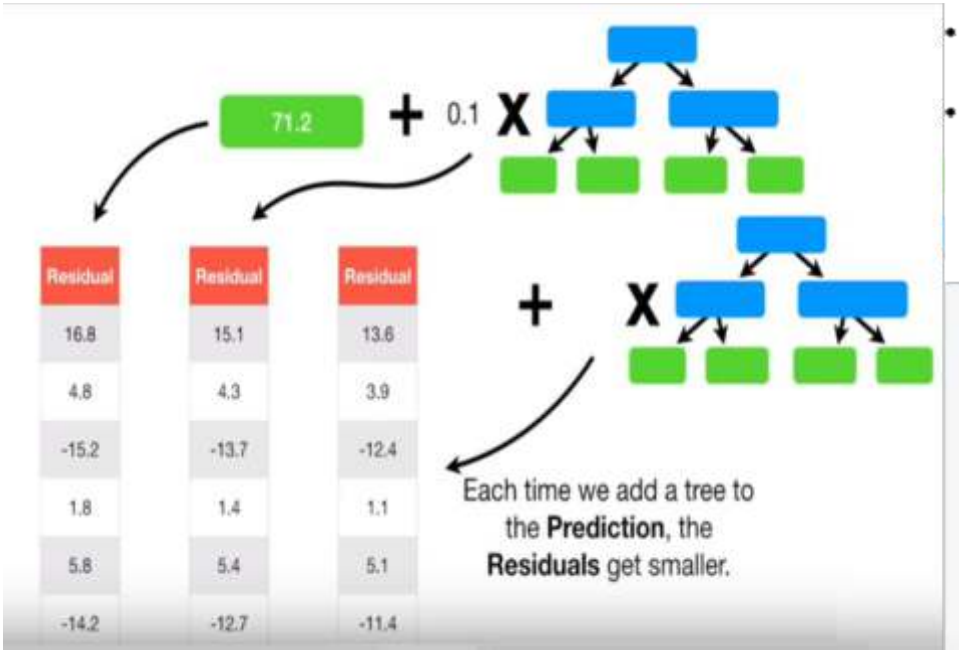
- Ifwe want to predict weight of a person based on the 3 features, this is how the algorithm will work

Height (m)	Favorite Color	Gender	Weight (kg)
1.6	Blue	Male	88
1.6	Green	Female	76
etc...	etc...	etc...	etc...

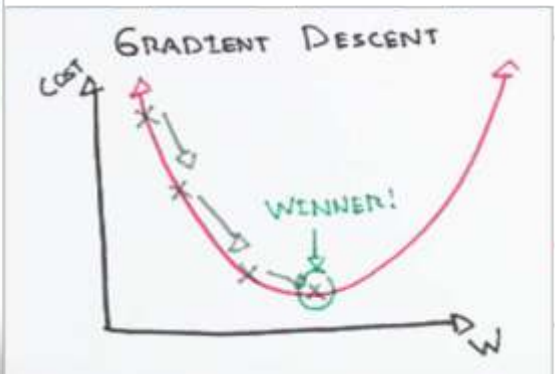


Here Model used is a decision Tree. What is it? It models a series of steps that we implement to make a decision. If I have enough historical samples, we can make the machine learn the same modeling mechanism. Its' all about approximations and improving our previous wrongly approximated results

While building an AI Model, The Algorithm uses a mathematical Error Optimization technique. An AI model will start with random decision parameter. Based on the random decision parameters it will predict the weight of a person, which will have a very high error rate and the model will be highly inaccurate. It will then employ all the error optimization techniques to make the error as less as possible to make the model more and more accurate It will stop training itself when the error rate is acceptable. Then your model is production/ deployment ready



- This will become a little more mathematical
- The idea is to reduce the error as much as possible, keeping the model generalized enough.



AI Application/ Use Cases

For every Heat, foundries are generating large volumes of information. This information is stored, and then processed through different statistical and Machine Learning methods, obtaining useful information for foundries to make decisions in the purchase of raw materials, materials' chemistries, or real recoveries in the furnace, among others.

In the above data analysis, AI algorithms are applied to optimize processes and predict behaviour based on the data recorded by the system. This technology is also being applied in the optimal scheduling of heats, and even of all the work carried out on the production processes (heat treatments, abrasive blasting, casting assembly…), by means of the Genetic Algorithms application.

System allows a total control in real time of our foundries, any external device can be connected (scales, furnaces, spectrometers, pyrometers, ERP…), allowing a complete control of the production process, making immediately adjustments, avoiding human error.

We can implement AI in with different goal in our mind. Those can be as follows

1. Metallurgical Analysis
2. Heat Analysis
3. Production Planning and Optimization
    a. Operations Optimization, Delivery Date of Any Product, Quantity vs. Profit Ratio Analysis, Reduce Lead Time
4. Pricing and Quotation Optimization
    a. Aggregate sourcing data into a unified federated image to perform pricing analytics and visualization. Build optimal price estimates for raw materials based on advanced machine learning analysis of previous pricing and expected consumption.
5. Profitable BoM
    a. Maintain accurate bill of materials (BOM) pricing and componentry for highly complex products at each stage of engineering, delivery, and after-market. Calculate profitability for design, as-built, and added components for aftermarket stages.
6. Demand Forecasting and Stocking
7. Inventory Optimization
8. Predictive Maintenance to reduce Maintenance Cost
    a. Machine Master info, Operational Data, If any Historical data is available .....Refer
9. Processing Conditions/ Operational Excellence/ Yield Optimization
10. Quality Management.

STRUCTURAL ALUMINUM CASTINGS FOR AUTOMOTIVE USING HIGH PRESSURE DIE CASTING

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Abstract
In this fast growing world, where the demand for being more efficient is increasing every day, for cars we expect to drink less fuel and run more miles. From government side there is a great push to increase vehicle mileage [3, 4, 5]. This demands the vehicles to be lighter in weight.

Aluminum part can be 70% less in weight than similar part made out of steel; and if aluminum part satisfies the strength requirements, then BINGO!

Nevertheless, making a thin walled robust aluminum part using HPDC, to replace steel parts in cars,turned out to be a nightmare for the casting companies rather than a sweet dream. It involves a thoughtful die cast die design, advanced cooling techniques, special heat treatment, straightening process and much more. The paper will shed some light on this new emerging technology.

Introduction
Aluminum die casting industry is mostly involved in making non-structural parts for auto industry. Usual parts are transmission cases, transmission housings, oil pans, steering housings, etc. Wall thicknesses is higher in these parts, averages about 8-10mm. Porosity is a concern, only if it opens up on machined surfaces causing leak/sealing concerns. Traditionally since 25-30 years, this business has become backbone of aluminum die cast industry.

With advent of electric vehicles and with increasing need for vehicles to give better mileage, aluminum die casting industry is trying to jump into a new product line in automotive industry. “Structural castings”.

Electric vehicles might make transmission, engine block redundant. They brought new products for casting industry like battery tray. For vehicle to be light weight, aluminum industry has developed structural components like hinge pillar, front and rear shock tower, rails, torque boxes, etc. They found new alloys that can give similar mechanical properties like steel. A single high pressure die casted Aluminum part can replace multiple steel parts, saving welding / riveting operation, reducing assembly time and thus reducing production cost.

On the down side though, the structural automotive aluminum parts are costlier to manufacture, than similar steel stampings. To satisfy mechanical properties required, manufacturing process needs to have tight control on metal chemistry. Also, most aluminum alloys require heat treatment which drives up the manufacturing cost. Stringent quality checks for internal porosity, mechanical property conformance, dimensions and traditional die casting defects like open porosity, cracks, poor flow, die breaks, etc. increase the piece price of structural casting. Die cast industry understands this shortfall, and is investing in to research for reducing these costs.

Developing alloys that do not require heat treatment will significantly drive down the manufacturing cost. Presently, smaller steps are taken for immediate cost reduction like picking correct component in cars that does not have high strength requirement, using alloys that need low cost heat treatments (Like T5, rather than T7) and educated part design. According to spotlightmetal.com [1], cost reduction is already achieved up to 20%. OEMs are demanding 20-30% more cost reduction, for the structural automotive parts to be viable for mass production.

Manufacturing process-flow for structural castings
On manufacturing floor, making structural casting involves quite a few different steps than conventional die casting.

Precise control on metal chemistry is very important. Special alloys are bought in form of ingots. Ideal process would be to only melt these ingots and reduce the chemistry variation to minimum. But scrapped parts and

gates-andrunners have to be remelted to save the cost. Thus metal chemistry has to be checked multiple times at set frequency. This has to be done in main furnace as well as holding furnace.

At beginning of casting run, die cast die cannot be heated using slow shots. Hence when die is cold, it has to be preheated using thermal control units.

Moreover, X-ray inspection, heat treatment are the additional steps in making structural castings.

Due to heat treatment, castings warp and lose their form. Hence it has to be followed by a restrike or a straightening process.

Mechanical properties are checked after heat treatment. They need to conform to customer specifications.

As castings are thin walled, they are easy to bend during manual handling like loading-unloading in racks, x-ray fixtures, CNC fixtures; along with dimensional nonconformance that might be introduced in manufacturing processes. Hence structural castings are 100% checked for key assembly features, before shipment.

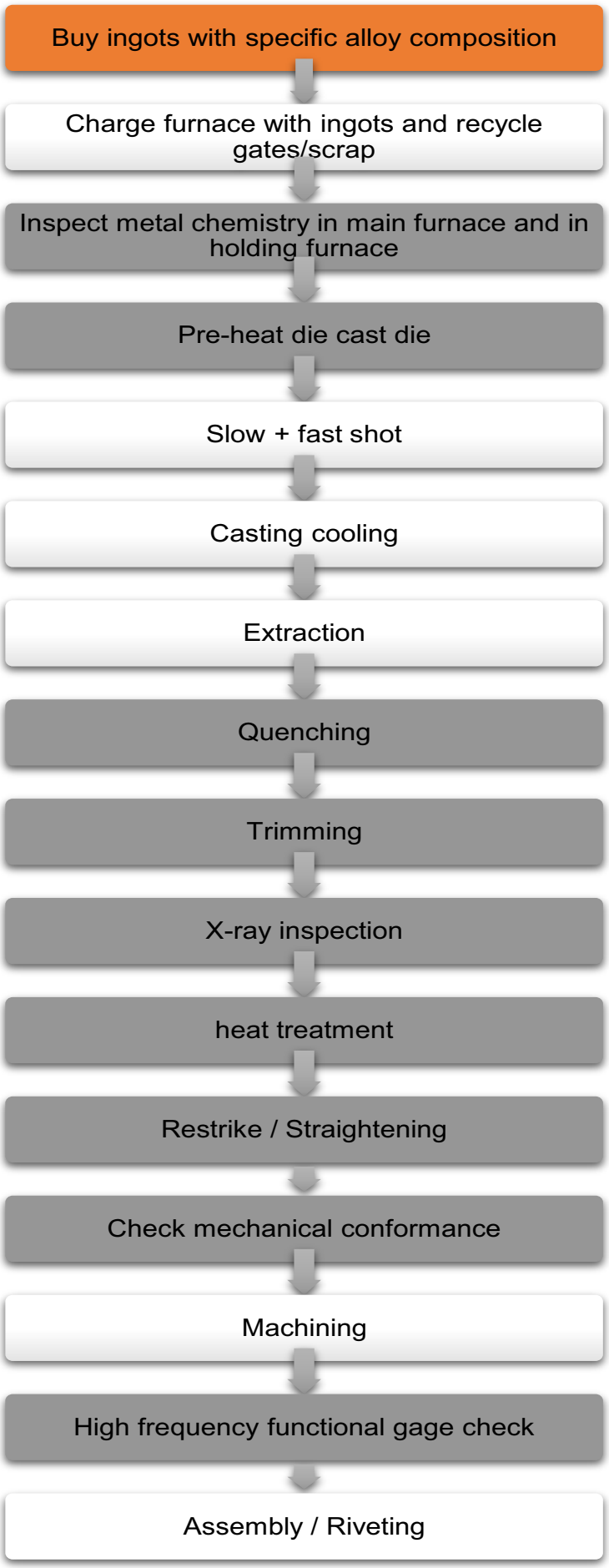
Major scrap reasons in structural castings

Biggest scrap is porosity. Porosity gets detected in X-ray inspections or opens up on machined surfaces or inside threaded holes.

OEMs specify porosity requirements using a standard, like ASME E-505. These standards specify porosity levels based on pores size and density. Standards have reference radiographs. X-ray inspectors need to be trained and certified for using these reference radiographs and for
using x-ray machines in general.

Though imaging is automated inside the x-ray machines, making the decision if casting is good or bad is still manual. X-ray machine manufacturers are working on softwares that can decide if porosity is acceptable or not. Few softwares are already in market.

Below flow chart shows these new steps highlighted in Orange.



Differences between traditional die casting and structural die casting

Non-Structural die casting	Structural die casting
Metal chemistry need not be monitored at high frequency	Metal chemistry is very important parameter to maintain. It decides the mechanical properties attained by casting after heat treatment. Metal chemistry is checked at fixed hourly frequency in main furnace as well as holding furnace.
No need to monitor remelt ratio	Remelt ratio needs to be decided as remelted castings have higher iron percentage; as well as the remelt has chemical composition of previously melted batch which may be high or low on certain elements. It might throws out metal chemistry of the current batch.
Not so high tonnage machines are needed	High tonnage machines with high shop speed are required. Thin walls castings need this for better filling.
Die preheating not required. Slow shots are used to heat the die, before starting fast shots	Die preheating is required. If shot is made in a cold die, aluminum gets severely stuck in thin sections of the die.
Quenching is not needed. Parts are air cooled	Quenching is needed to lock the dimensions. Air cooling warps the casting.
Trim die is easy to design. Gates usually are located on thicker sections	Trim dies need to give robust support in the bottom die halve. Gates are located on walls with same thickness. If walls are not supported while trimming, they bend.
X-ray inspection is required only on audit basis.	100% X-ray inspection is needed to confirm internal integrity.
Heat treatment not required	Heat treatment is required.
Restrike / straightening not required	Restrike / straightening is needed to fix bending during heat treatment

Mechanical property nonconformance is another high reason for scrap. Tight control on metal composition, porosity, metal temperatures, casting process and heat treatment process are key things in preventing this scrap. Tensile stress, yield strength and elongation are measured to assess mechanical conformance.

Dimensional nonconformance is also high. Structural parts being thin walled bend easily. This can happen during extraction, quenching or trimming inside DCM itself. Once the part is out on DCM conveyor, one can design a functional gage that can check important dimensions right at DCM. This will prevent a scrap part moving up in value chain.

Dimensions also go out during heat treatment. They can be brought back within specifications using straightening press. Straightening press needs to be high tonnage to make a significant impact on part dimensions. Apart from these three top reasons, cracks, die reaks, wrong inserts, trim damages, wrong machined features, etc. are some other important reasons for scrap.

Advantages of structural castings

Being light weight, and with similar strength as steel part, structural castings can make body-inwhite light weight by up to 70%. The cited study [8], achieved 23.5% reduction in their prototype vehicle weight.

Casted part can be of a larger size than a stamping. It was observed that 2 to 4 stampings can be combined in to one aluminum casting. This saves assembly time, and costs related to it.

Aluminum parts are 100% recyclable, unlike any other composite, fiber or plastic component in this aspect.

As an inherent feature of die casting process, once the process is set, castings can be made at a high production rate. A manufacturing floor can ship up to 800 -1000 pieces per DCM per day, depending on size of casting.

Opportunities for support companies

Process control is a key in making good quality structural castings. The industry is still struggling to make the process stable and efficient. It is a driving factor in making these casting cheaper and thus using them widely in automotive.

Raw material and Melting

As structural castings are made using special aluminum alloys, ingot suppliers will have higher demand for these special alloys. In future, ingot manufacturers can offer to buy scrap, gates and runner at cheaper price from die casters, and use them for making ingots. Requirement for metal additives like Si, Fe, Mg, Mn, etc. will also increase as they are needed in melters to adjust the chemistry.

Melting furnaces need to control the metal chemistry more precisely than before. Top of the line melt furnaces equipped with modern technology will be required by die casters.

Argon and Nitrogen are preferred for degassing. Their suppliers will also experience increase in demand.

Die cast machines (DCM)

High tonnage DCMs are needed for casting thin walled structural parts.

Precise control on die temperature is needed to make the required quality structural castings. This can be satisfied by using 'Thermal control units', flow control valves, etc. in DCMs.

Water based die lube gives high chances of porosity in structural castings. Porosity requirements are stricter in structural castings than non-structural castings. Industry is trying to shift to no-water/dry die lube. Also, specialized spray heads for each product can be made which will apply die lube efficiently and effectively.

Quenching operation is needed to be part of DCM to lock in the dimensions.

Trim die needs to cut the gates carefully without bending the thin walls of the casting. Hence the bottom trim die needs to be designed specifically to give support to the casting in required areas to prevent them from bending.

New process control softwares are in demand which can take feedback from different sensors and also from DCM operator, and tweak the process parameters at shot end.

All above opportunities are and will generate business for die cast support companies.

Heat treatment

Presently, most of the structural alloys need heat treatment. After casting, the parts need to be heat treated to relieve stresses and gain the required mechanical properties.

Simple heat treatment like 'T5' can be used which requires the castings to be held at 400-500 0F for 1-2 hours. This heat treatment is also called 'Aging'. If not done, castings will automatically gain these mechanical properties as they age. Heat treatment facilitate this aging process and parts are ready to use immediately.

There are more complicated processes like T7 heat treatment. It is a two stage process. First the castings are heated up to 850-950 0F, very close to melting point. Then they are quenched at a very high rate of cooling. This reduces warping heated up to 850-950 0F, very close to melting point. Then they are quenched at a very high rate of cooling. This reduces warping and also prevents developing stresses due to slow cooling.

Industry is currently looking at faster heat treatment ovens with higher production capacity.

Major disadvantages of heat treatment process are added cost and possibility of ruining a whole batch of parts if any mistake happens in heat treating the batch.
Die cast industry is trying to find alloys that need minimum or no heat treatment.

Conclusion

Light weight structural parts is a new requirement in auto industry. Die cast industry being highly dependent on automotive industry, needs to tweak in its product line to support this new demand.

There are many challenges on the way. They need to be addressed. Willingness to jump in this new product line, support for research and conducting trials are main things than die cast industry can offer, which will be mutually beneficial to auto industry as well as to the die cast industry.

Acknowledgement

Thanks to Ryobi Die Casting and Cosma Castings Michigan (part of Magna International) for giving me opportunity to work in die casting environment for 8 years.

Special thanks to Mr. Vivek Joshi for getting me started to work in die casting industry.

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