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# JOURNAL FOR ALUMINIUM CASTING TECHNOLOGY

Volume 44 - February 2021



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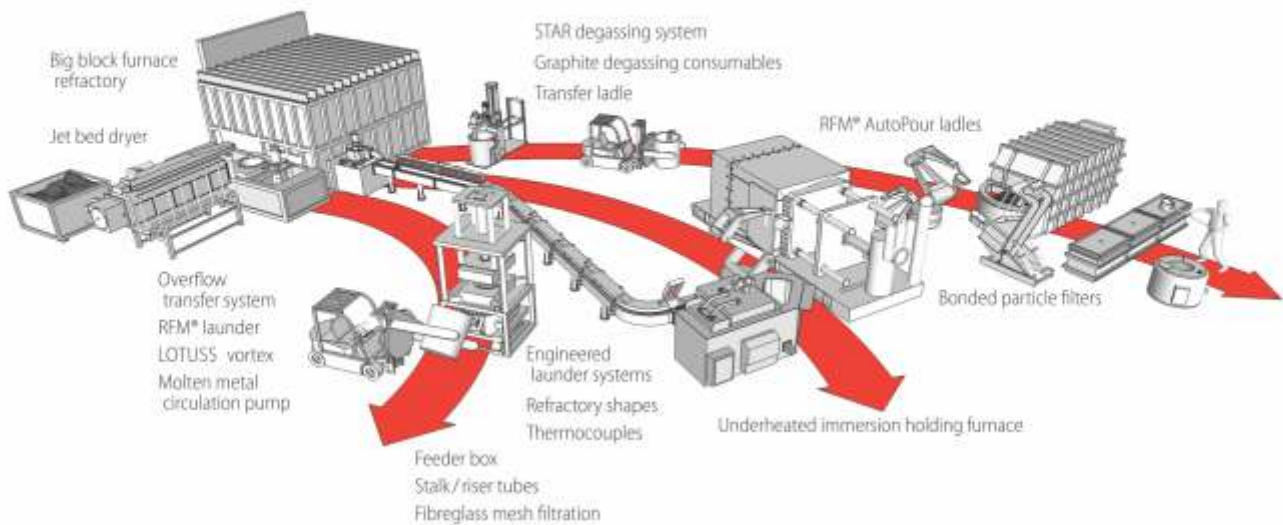
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*Note: Some images in some articles may not be clear. Interested readers may contact the author*

# PREDICTABLE DEGASSING THROUGH SIMULATION

## A REALITY CHECK

### Degassing of Aluminium: Why Degass?

The trouble with Hydrogen is not just because it is the only gas soluble in liquid Aluminium, but essentially more because it is insoluble in Solid Aluminium.

While the very obvious effects of Hydrogen are Porosity defects and post treatment defects like blisters, it also has a significant effect on the Tensile Strength and the Fatigue life (Figure 1)

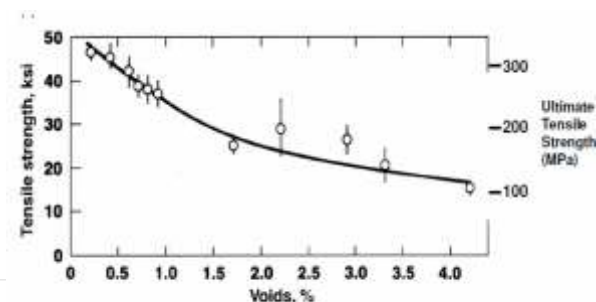


Figure 1

### What affects the Hydrogen pick up?

- I. **Ambient Conditions:** The degassing of melt in its simplest form is a process of driving the equilibrium of Hydrogen in the atmosphere and that in the melt. The Water vapor pressure in the atmosphere (Relative Humidity) therefore, has an important effect on the Hydrogen pick up. (Figure 2)

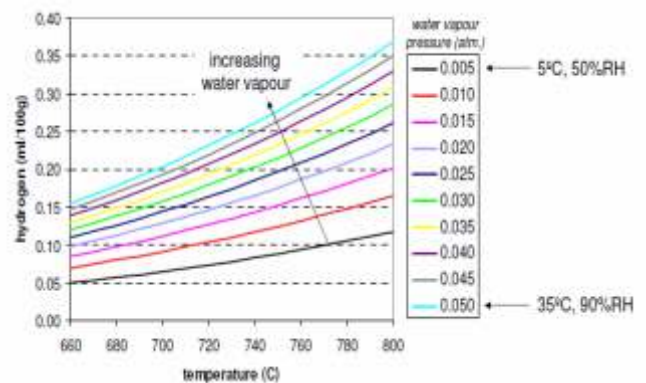


Figure 2

- II. **Exposure of Metal to Atmosphere:** For similar reasons as stated above, the surface area of the furnace or the ladle also has an effect on the Hydrogen pick up: The more the exposure, more will be the pick up.

- III. **Alloying Elements:** Individual alloying elements have their effects on the Solubility of Hydrogen in Aluminium. Some elements like Magnesium, Strontium and Titanium increase the solubility, while Silicon, Iron, Copper and Zinc reduce it. (Figure 3)

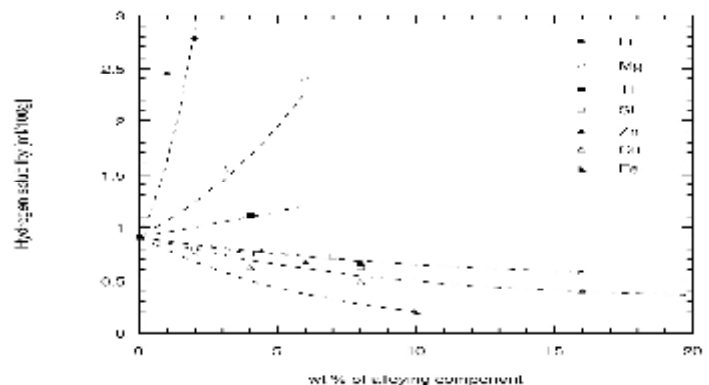


Figure 3



# PREDICTABLE DEGASSING THROUGH SIMULATION

## A REALITY CHECK

### How do we remove Hydrogen?

**Rotary Degassing:** In impeller degassing, (Rotary Degassing) thousands of small bubbles of inert gas are flushed through the liquid metal to facilitate removal of Hydrogen by floatation. (Figure 4)

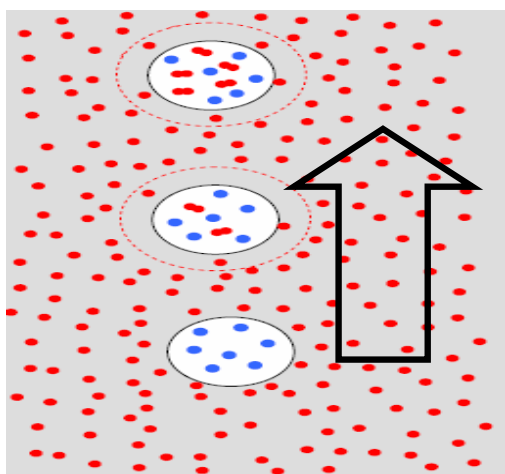


Figure 4

### So What affects Hydrogen Removal?:

Practically, the efficiency of a degassing process is decided by various factors: some of them can be controlled, and some can not, though they will still have their individual and collective impacts on the equilibrium.

- I. **Degassing Process Parameters:** Efficiency of degassing is directly proportional to the speed of the rotor and pressure of inert gas up to a limit, since they reduce the size of the bubble and increase their numbers, thereby reducing the Hydrogen gas rapidly (Figure 5)

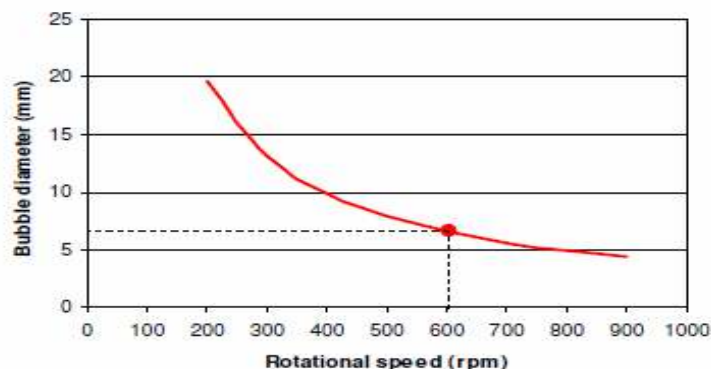
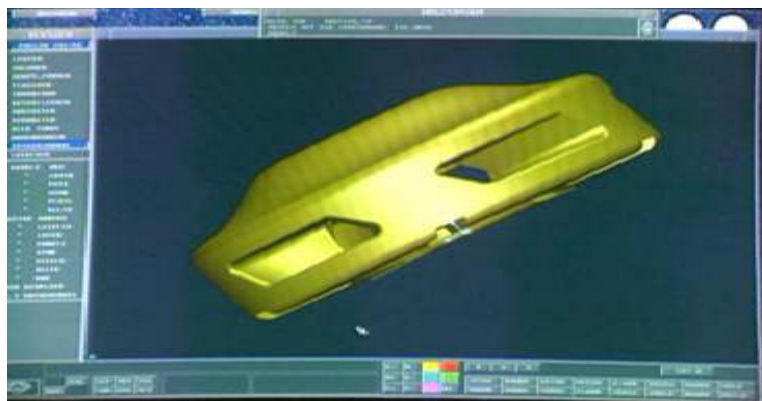


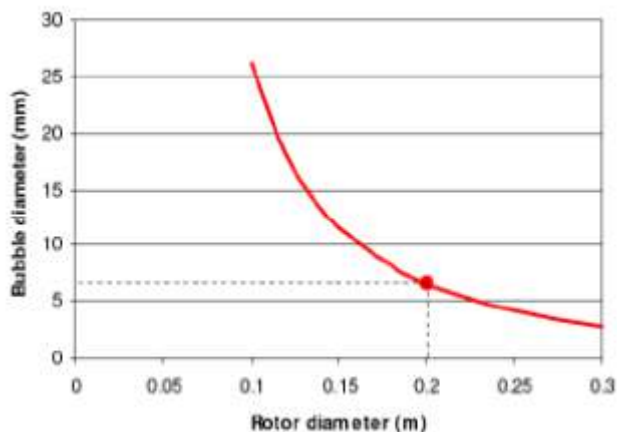
Figure 5

- II. **Degassing Time:** Degassing for a longer time would also reduce the Hydrogen further for similar reasons as above.
- III. **Presence of a Baffle:** A Baffle helps in breaking the inert gas bubble diameter and thus improves the efficiency of degassing.
- IV. **Rotor:** The Power of the Rotor is a direct function of the Rotor geometry and its rotational speed. The larger the rotor more is the power. Another factor that decides the power of the rotor is its design. All Foseco Rotors are designed to produce a patented Pumping Action, thus giving more power and better mixing. (Figure 6)



# PREDICTABLE DEGASSING THROUGH SIMULATION

## A REALITY CHECK



**Figure 6**

Every design has a different power and hence efficiency of creating a designated size of inert gas bubbles.

### So, what is the collective effect?

All of these parameters are acting simultaneously as the degassing process is progressing. Through seasons and various alloys, different furnace sizes and designs; and not to mention, through the life of the rotor, (as the geometry changes due to erosion) the degassing efficiency will vary.

To summarize: Atmospheric humidity, temperature (atmospheric and melting), presence of alloying elements and crucible designs will have an effect on how much

Hydrogen will be picked up, while the rotor design, rotor size, rotational speed, flow and pressure of inert gas and treatment time will have an effect on how much of Hydrogen is removed.

It is practically difficult to interpret the collective impact and the foundries then have to resort to trials and errors and rely on experience and experiments. Many may choose the option of playing it extra safe by adopting higher levels of parameters and possibly run a risk of over degassing and hence shrinkages, apart from the risk of compromising on productivity and optimum use of consumables.

When the equilibrium condition is understood precisely and the Power on the rotor is known, one can decide how much of degassing will happen as a function of time, speed and given geometry of Rotor.

**FOSECO Degasser Model** is a mathematical model that simulates this equilibrium process of Hydrogen pick up and removal by degassing process, while taking in to consideration all the above parameters. It is based on the first principles and provides the user with a plot of the degassing time against the Hydrogen level, allowing them to decide upon the best combination of productivity and desired gas levels. A typical screen shot of the output of the simulation is as given in Figure 7

# PREDICTABLE DEGASSING THROUGH SIMULATION

## A REALITY CHECK

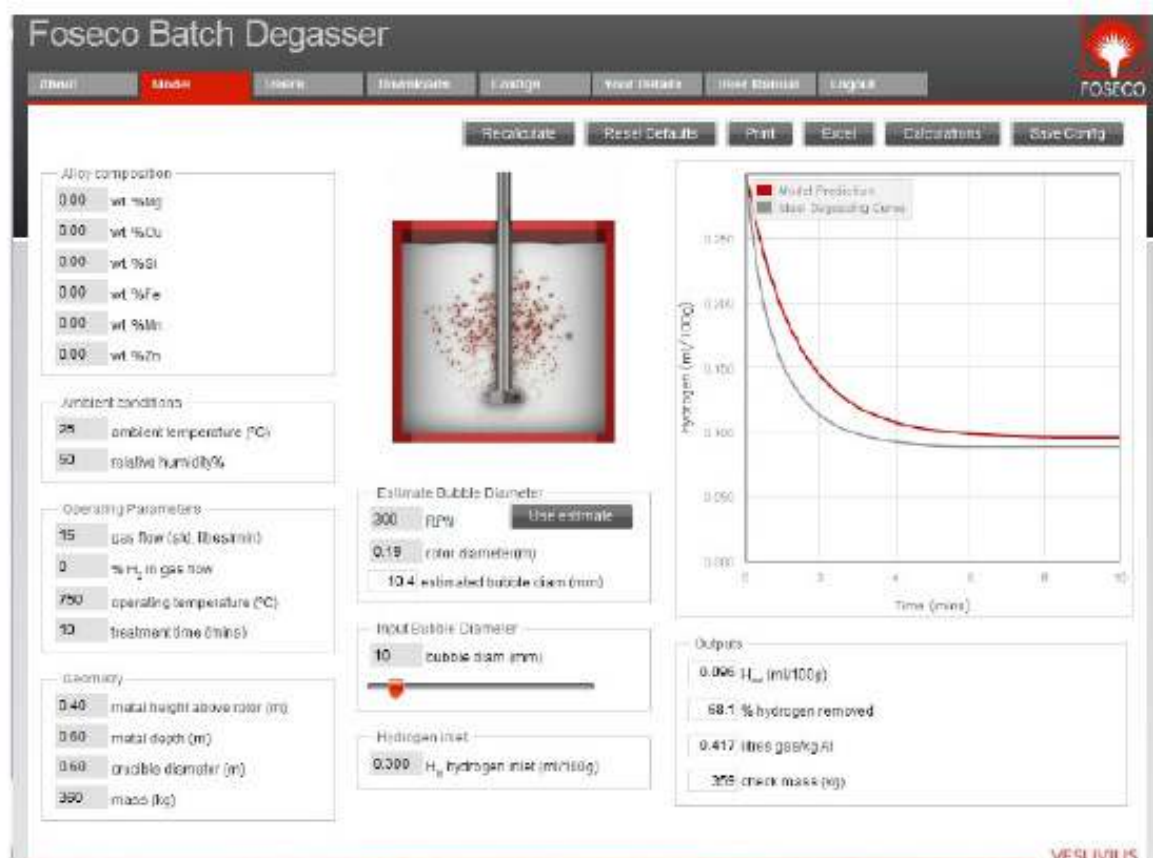


Figure 7

### Application of the Model:

The simulation exercise helps the foundry in various ways such as:

- 1 Laying down a new degassing Process for a given foundry and alloy
- 2 Bench marking to avoid under or over degassing in various seasons or with the life of the Rotors.
- 3 Development of a new casting
- 4 Optimization of the existing degassing process
- 5 Process control and audit

These exercises can be undertaken by using the **Alspek H** technology available with the local Foseco representatives for online measurement of Hydrogen, before and after the process. The necessary support for simulation is also provided from the back end once the base data is ready.

## Report on Training Programme

GDCTECH FORUM organised a Virtual 2 Weeks Online Certificate Course on Aluminium Casting Technology aimed at Proficiency Improvement especially for Fresh Working Engineers and New Enterprenuers.

The 30 hrs course was conducted from 08 to 23 December 2020

Following topics were covered as follows:

### GDC

- Defect Analysis & Remedial Measures
- Methoding
- Pouring Techniques
- Die Design
- Core Technology

### PDC / LPDC

- Defect Analysis & Remedial Measures
- PDC Die Design
- PDC/LPDC Machines and Maintenance
- Machine Automation
- Vacuum Die Casting

### COMMON

- Melting & Metal Treatment
- Metallurgy of Aluminium alloys
- Process Control & Cost Reduction
- Heat Treatment
- Safety on Shopfloor
- Communication, Planning and Delegation
- Quality
- Open House Discussion with Panelists.

**The Faculties were:** U. M. Nadgar, Anand Joshi, Avinash H. Patil, R. D. Dhumal, B. B. Lohiya, Rajesh R. Aggarwal, Pramod B. Gajare, Vilas G. Patil

*The programme was highly appreciated by about 41 delegates from 17 companies. The delegates included seven casting buyers also. Delegates were from following companies*

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EMERSON INNOVATION CENTER - PUNE  
FRECH INDIA MACHINERY PVT. LTD.  
GODREJ & BOYCE MFG. CO.LTD.  
HI-TECH ARAI PVT. LTD.  
MAP ALLOYS

NOBLE CAST COMP. PVT.LTD.  
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ROCKMAN INDUSTRIES LTD.  
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SUPERKINO EQUIPMENTS PVT. LTD.  
TAG CORPORATION  
UNITED METALLURGICALS PVT. LTD.  
VOITH TURBO PVT. LTD.

*A test was conducted almost one month after the programme. This helped in self assessment for the delegates and companies as also to GDCTECH Forum to understand the effectiveness of the programme.*



# PREDICTABLE DEGASSING THROUGH SIMULATION

## A REALITY CHECK

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# Aluminium Casting Alloys and Development

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Aluminium Foundry Alloys can be designed to cover a wide range of mechanical performance through chemistry and/or process control. There are four main categories based on Al-Si(-Cu), Al-Cu, Al-Mg(-Si), and Al-Zn(-Si)-Mg systems. The vast majority of cast Al components are based on the Al-Si system because of its good castability. Some Al-Cu, Al-Mg and Al-Zn alloys exhibit better properties than Al-Si alloys, but their casting properties are generally poor. In particular, they show a high tendency to hot tearing.

## **Al-Mg Alloys:**

Highly corrosion resistant, these alloys polish to a high shine and can be anodised. Good strength/ductility compromise without need for high temperature heat treatment. Used to produce high-pressure die cast automotive steering wheels and structural components.

## **Al-Zn-Mg Alloys:**

Used to avoid quench distortions, as these alloys are subject to age hardening at room temperature without previous solution treatment.

Al-Mg-Si and Al-Zn-Si-Mg Alloys: The addition of Si to these alloy systems in adequate quantities gives better casting properties. Various alloys have been developed or are under development.

Al-Cu Alloys: The strongest of the casting alloys, the Al-Cu family sees use mostly in the aerospace industry. They also see service as automotive suspension knuckles, high-end turbocharger impellers, etc. The alloys are very hot short and difficult to cast in complex shapes. Usage is limited to low volume production for sports cars and other exotic vehicles.

Al-Si Alloys: The most popular alloys of the casting industry world-wide. Exhibiting excellent castability these alloys feed well, resist hot tearing, and are in general the most manufacturable casting alloys. Addition of Mg results in good mechanical properties after heat treatment, addition of Cu gives a better

machinability and increases strength at temperature. Al-Si-Mg alloys are used for wheels, structural castings and suspension parts requiring moderate to high strength and good ductility. Al-Si-Cu(-Mg) alloys dominate the market for power train components such as engine blocks, cylinder heads, pistons, and die castings where strength at temperature and/or wear resistance is more important than ductility.

Foundry Alloys – Primary and Secondary Alloys: Primary alloys are produced from pure aluminium, melted with addition elements. Secondary alloys are produced at a lower cost from scrap (end-of-life recycled) aluminium materials, which are remelted after classifying, with adjustment for main elements. Secondary alloys have relatively high levels of impurities, esp. Fe, as most available scraps are contaminated with iron or steel components (e.g. bolts, rings, etc.). Fe is detrimental to many properties, mainly castability and ductility, and must be kept at levels as low as possible, with an exception for pressure die casting.

Alloys for sand and permanent mould applications: For applications requiring high ductility, Fe content is generally specified < 0.20 %, which requires primary alloys. When ductility is not a criterion, the Fe level may be raised, and the criterion can be castability or machinability, and secondary alloys can be selected with Fe content as high as 0.5 %, or higher if acceptable.

Alloys for pressure die casting applications: There are two basic alloy groups used in high pressure die casting. These are based on Al-9Si and Al-12Si. These make up the majority of high pressure die casting alloys. There are many other alloys but these make up a much smaller percentage of the overall market. A range of alloys can be observed in many of the metal data sheets.

Typical alloys in each of the groups are:

Al-9Si – LM24, A380, ADC8, CA313, AlSi8Cu3Fe

Al-12Si – LM6, A413, LM2, ADC12, AC3A, AlSi12

Hence, it is common for the alloys to contain a number of additional elements that range from advantageous to tramp.

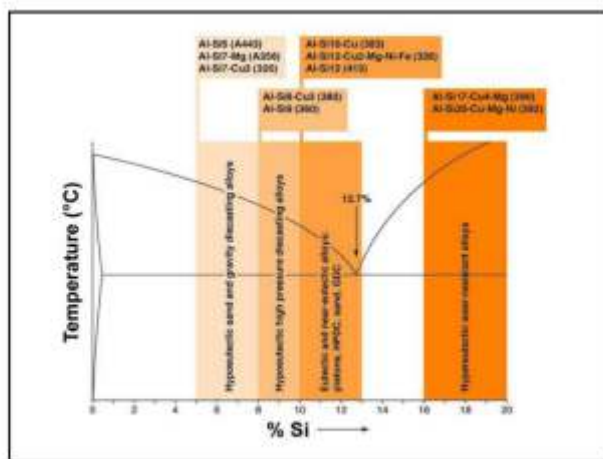
Silicon – aids fluidity and makes the alloy more castable.

Iron – reduces the rate of attack of the dies by the aluminium. For this reason Fe content is specified with a minimum value, generally 0.6 % or more, and secondary alloys are quite suitable. The maximum value depends on ductility requirements; it is generally around 1 %, up to 1.3 %.

Copper – increases the hardness of the casting. Excess can result in increased cracking.

Magnesium – increases hardness.

A combination of elements can result in the formation of large intermetallic called sludge. Process therefore needs to be carefully planned to avoid this issue of sludging.



Schematic Al-Si phase diagram showing the composition ranges for the most common foundry alloys

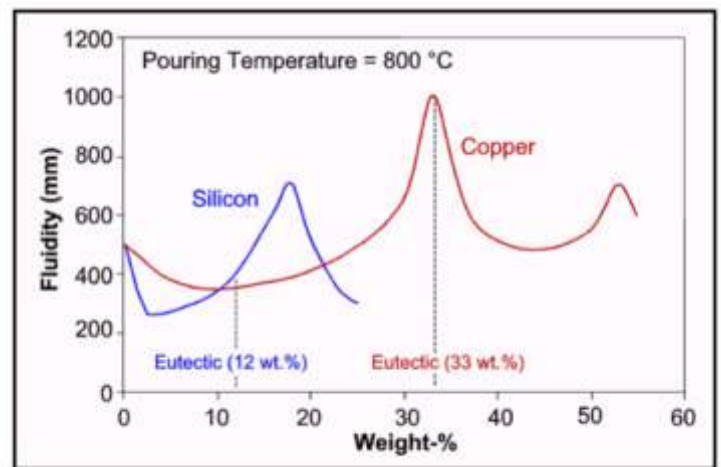
Aluminium-silicon alloys form a eutectic at 11.7 wt% silicon, the eutectic temperature being 577 oC. This represents a typical composition for a casting alloy because it has the lowest possible melting temperature. Al-12 Si wt% alloys are therefore common

## Composition Effects on Castability

The level of casting properties is determined by the alloy composition and the technological aspects of the process. Among the most important casting properties, it is necessary to mention liquid fluidity and shrinkage, and associated with them are hot cracking and tendency to the formation of shrinkage porosity and macro-segregation.

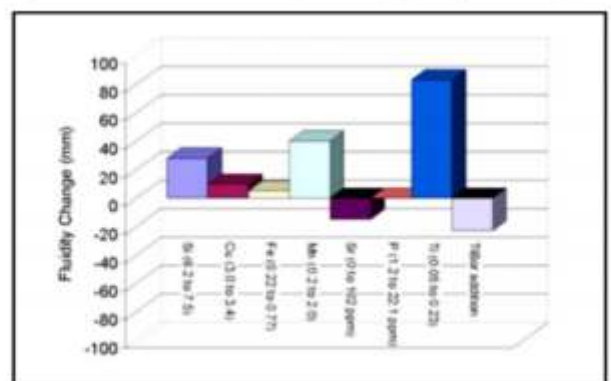
## Foundry Fluidity – Definition and process parameters

Foundry Fluidity – Effects of alloying elements Effect of Alloy Elements Alloying elements such as Cu or Si significantly



### Foundry fluidity of Al with Si or Cu content

Foundry fluidity of Al with Si or Cu content. Elements modifying the eutectic morphology (e.g. Sr), grain refiners (Ti, TiB, etc.) and impurity elements such as Fe also impact fluidity.



#### Effects on AA 320 alloy of changes in trace elements or master alloy additions

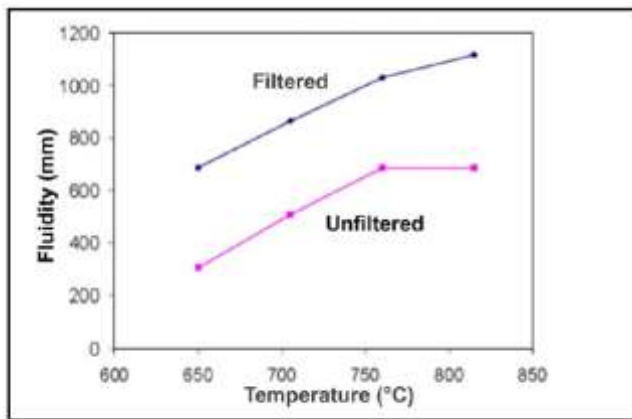
Effects on AA 320 alloy of changes in trace elements or master alloy additions High Purity Metal The fluidity of aluminium is very sensitive to chosen purity level as shown in the schematic diagram below. This is most important when casting electrical motor rotors or conductors.





Rapid change in fluidity of pure Al with impurity content

Another important parameter which affects fluidity is the cleanliness of the metal, which is indirectly related to composition. This can be seen in the below diagram. Too much of scrap usage can lead to dirty metal which has adverse effect on fluidity.



Filtered (Clean) versus Unfiltered (Dirty) metal fluidity comparison

### Shrinkage: Influence of alloying elements:

Aluminium shrinks during solidification, as its density in the liquid state is 6.5 % less than in the solid state. Cast parts generally solidify from the surface to the centre. Therefore, any lack of material will appear there if not compensated by feeding (mould design, alloy selection, temperature, etc.).

The composition of the alloy has an influence on the volume and type of the shrinkage, see table: silicon is the only suitable additional element that reduces shrinkage as silicon expands 8 % when solidifying; Alloys having a low eutectic ratio present scattered "micro-shrinkage" and "collapsing"; elements such as phosphorus, sodium, antimony and strontium, which determine the shape of silicon particles during solidification of the aluminium-silicon alloys, have at the same time an effect on the type of shrinkage observed in alloys with high silicon contents.

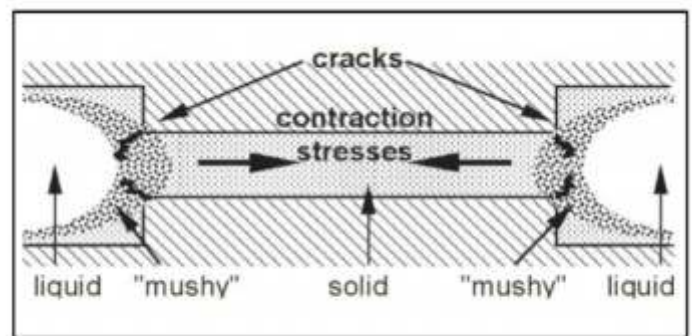
### Hot tearing:

Cracks (hot tearing) may appear in cast parts after solidification. Stresses applied on still "mushy" areas are generated by the contraction of already solidified zones. Cracks appear when the "mushy" zone is too thick and the quantity of liquid available is too small to fill the resulting gap. The composition of the alloy has a major influence on this phenomenon, as the selected alloy determines the possibility for the liquid eutectic phase to progress through the solidifying metal - "mushy" zone - to feed stressed areas.

There are also other factors that the foundry man will take into account to control the "hot tearing" defect, among which are: design of the part, grain refinement of the alloy, stiffness of the mould.

### Hot Tearing – Influence of alloying elements:

The sensitivities of main alloys to hot tearing, coded from 0 to 6, are compared in the table.



Shrinkage stresses causing hot tearing

The relation between sensitivity and the ratio of eutectic phase and the freezing range of the alloy is obvious. Silicon plays a major role in this respect, as it is the only practical alloying element that reduces the contraction of the alloy in the solid state.

### Mould sticking :

Mould sticking is a defect observed in pressure die casting which leads to surface defects on the part and progressive deterioration of the mould. "Mould sticking" may be in fact the consequence of four different phenomena, as shown below: cavitation, erosion, chemical soldering, friction.

### Mould Sticking – Influence of alloying elements:

The composition of the alloy may have an influence on mould sticking with two elements: Iron is generally considered to be a harmful impurity in gravity casting, mainly towards ductility. For pressure die casting applications, on the other hands, the solubility for iron originating from the mould in liquid aluminium lowers with

the iron content of the molten alloy, and 0.5 % is considered as a minimum towards problems of sticking by soldering of the steel mould. In newer alloy developments, iron is partially replaced by manganese which has a similar effect and reduces also mould sticking with less deterioration of the mechanical properties. Silicon content may have an effect on sticking by friction as it modifies the contraction factor: a high content lowers the contraction of the part.

### Castability of aluminium silicon alloys can be seen in the below diagram:

#### Influence on Other properties of cast parts

Different other properties of cast parts are also depending on the composition of the alloy. Typical values for electrical resistivity, thermal conductivity and thermal expansion are indicated in table for the as cast condition. Thermal conductivity and electrical resistivity, which are correlated, depend also on the temper: thermal conductivity is maximal in the as cast (and annealed) condition and minimum after a solution treatment, and the opposite for resistivity.

#### Influence of Fe-content on mechanical properties:

##### Effects of AlFeSi intermetallic phases:

Fe is the main trace impurity responsible for degrading

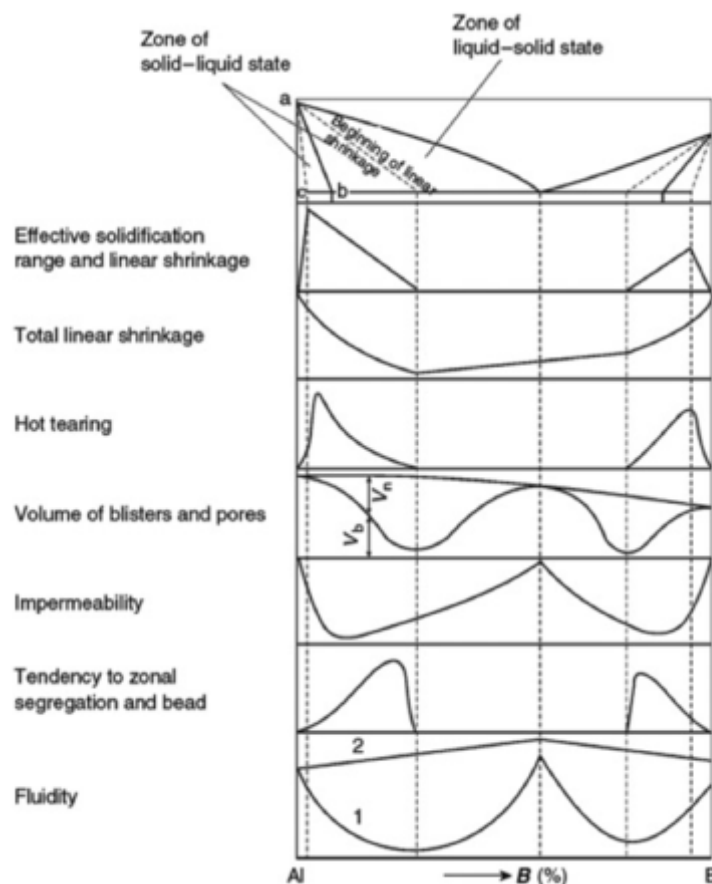
the ductility of conventional casting alloys. The phase which forms from the liquid in high Si foundry alloys, is  $\beta$ -AlFeSi. Acicular, or needle-like, in morphology, these particles are commonly referred to as  $\beta$ -AlFeSi needles, but they are actually plates. Adding Mn at levels equal to roughly half the Fe content corrects the phase to script  $(\text{Fe,Mn})_3\text{Si}_2\text{Al}_{15}$  or  $\beta$ -AlFeSi.  $\beta$ -AlFeSi needles Alpha-Fe Script Phase  $(\text{Fe,Mn})_3\text{Si}_2\text{Al}_{15}$  in 357 Less harmful than  $\beta$ -AlFeSi needles but still embrittling  $\beta$ -AlFeSi needle length. The length of the  $\beta$ -AlFeSi needles is a function of the cooling rate (of which the secondary dendrite arm spacing is a measure). The  $\beta$ -AlFeSi needle length also increases with the Fe content.  $\beta$ -AlFeSi needle length as function of secondary dendrite arm spacing.

#### Impact of Fe on mechanical properties:

The presence of  $\beta$ -AlFeSi needles will degrade the mechanical properties of the alloys. The ductility is the most strongly impacted property, particularly in secondary alloys with high Fe-content.

#### Comparison table of casting characteristics of major aluminium casting alloys:

This table will help in selecting right alloy for the improved properties or improvement of castability in above parameters.

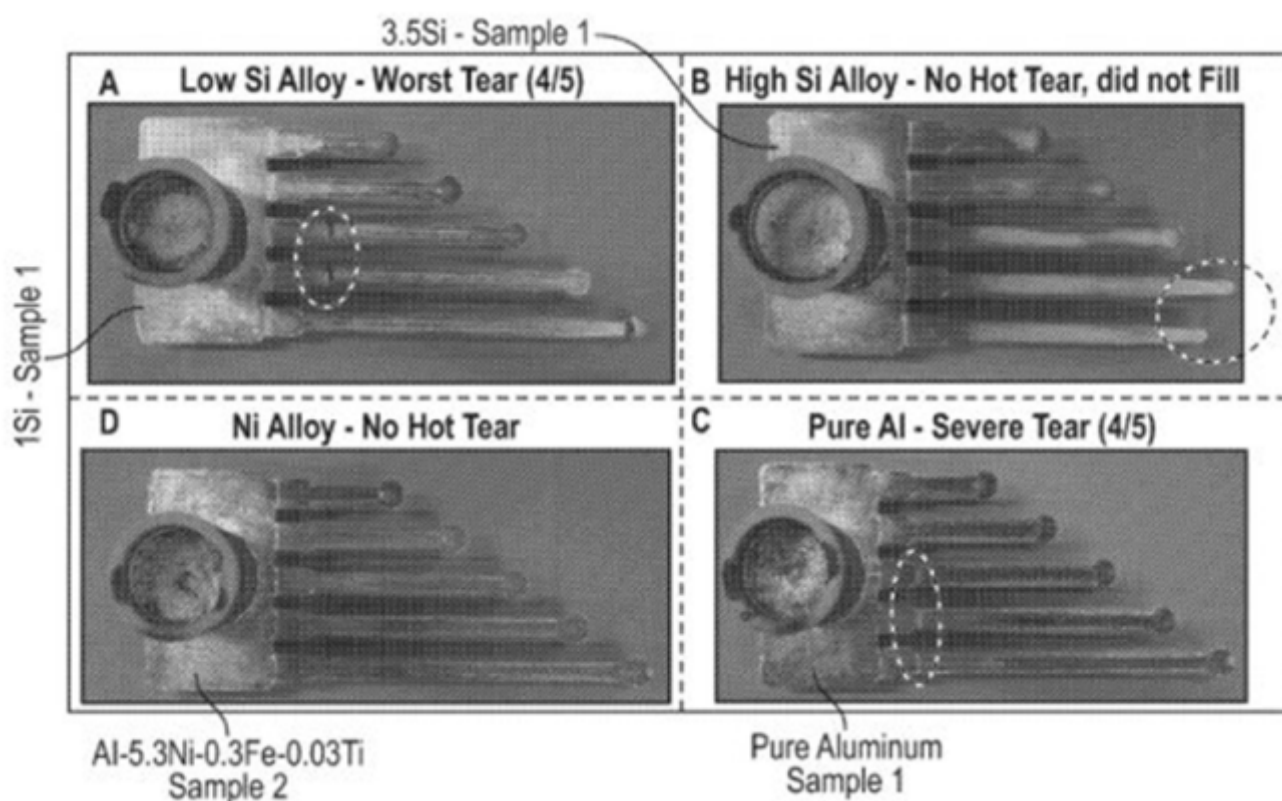


	LM5	LM6	LM9	LM16	LM24	LM25	LM27	LM31
Tensile Strength (N/mm <sup>2</sup> )	140-170	160-190	95-120	170	180	130-150	140	215
Elongation (%)	3	5	03/05/03	2	1.5	2	1	4
Freezing temp (degC approx.)	642-580	575-565	575-550	620-550	580-520	615-550	605-525	615-570
Freezing Range	62	10	25	70	60	65	80	45
Hot Tearing Tendency	4.2	0	0	2.8	0	0	0	5.6
Total Shrinkage%	6.4	4.2	4.8	5.5	5.0	5.1	5.1	6.3
Type of shrinkage	Micro, sponge	Macro or collapse	Micro, sponge	sponge	sponge	sponge	sponge	Micro, sponge
Thermal Con (cal/cm <sup>2</sup> /cm/deg C @ 25degC)	0.33	0.34	0.35	0.34	0.23	0.36	0.37	0.35
Electrical Con (% copper std. @ 20degC)	31	37	38	39	24	39	27	35
Machinability	E	P	F	G	G	G	G	G
Corrosion Resistance	E	E	G	G	F	E	G	E
Electro Plating Suitability	F (2)	F (1)	F (1)	F (1)	F	F	G	F
Casting Characteristics - Sand Casting	F	E	G	G	F*	E	G	G
Casting Characteristics - Gravity Die Casting	F	E	G	G	F	E	E	F
Casting Characteristics - High Pressure Die Casting	F	G	*	*	E	G	G	F
Weighted Material Cost	113	100	99	99	90	96	90	113

E = Excellent, G = Good, F = Fair, P = Poor, U = Unsuitable, \* = Not normally used in this form, 1 = These alloys, containing Silicon, require a modification treatment for good adhesion, 2 = Can be plated, but not recommended

### New Alloy Development:

For electric vehicles' components like rotors, inverter properties of high conductivity along with high strength that too at elevated temperature are required. Tesla has developed alloy of Al-5.3Ni-0.35Fe-0.03 Ti which has the required high strength along with high conductivity (48 to 55% IACS conductivity & min 90 MPa strength) & good castability. This alloy can be cast at low as well as high pressure. High Nickel content has given elevated temp strength without much affecting conductivity of pure aluminium, Ti content has given improved fluidity & iron content has given ability to pressure die cast. This alloy exhibit good castability with respect to fluidity & hot cracking tendency. Below diagram shows this alloy superiority over pure Al & Al-Si alloys



**SHRI. MANOHAR KABIRDASS**

23/07/1963 - 22/06/2020

We are deeply saddened to announce the sudden demise of our beloved Shri. Manohar Kabirdass due to brief illness. Always alive in our hearts.

Fondly loved & cherished by  
Family, Friends, Relatives and Employees of  
Best Cast Pvt Ltd | Kabirdass Aluminium Pvt Ltd,  
Chennai



# Reduction of Oxide Inclusions in Aluminum Cylinder Heads through Autonomous Designs of Experiments

Lubos Pavlak and Jörg C. Sturm, MAGMA GmbH, Aachen, Germany

Continued from December 2020 issue.....

## Optimization Evaluation

### Velocity Reduction in the Runner

The melt front velocity of aluminum alloys is not to exceed 50 cm/s, to avoid instabilities and surface turbulence at the melt front<sup>1</sup> which lead to an increase of the free surface area of the melt, which results in oxides inclusions. The velocity reduction can also support the creation of the desired vertical melt flow direction exiting the gates.

The evaluation shows a clear dependency of the melt velocity at the control point on the evaluated design and process variables (Figure 17). Versions 4A through 4D are the best, as they are showing velocity values very close to the goal of being below 50 cm/s, which is a reduction of 50% compared to the starting configuration (A1 with 105.7 cm/s).

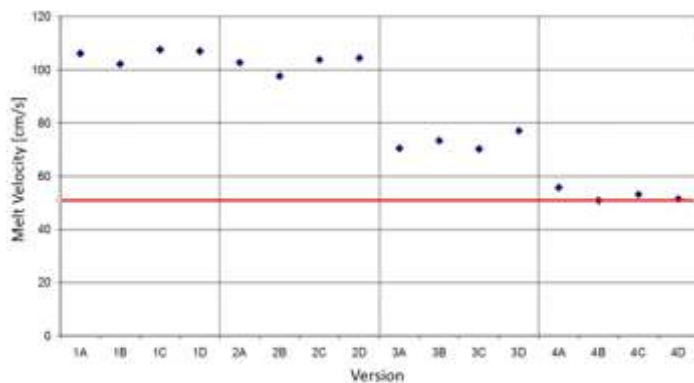


Figure 17. Average melt velocity at transition between pouring basin to runner (control point C1) for all evaluated designs: The red line depicts the desired critical value of 50 cm/s melt velocity.

### Controlling the melt flow direction out of the gates

The second goal was to establish a vertical flow of the melt out of the gates into the casting without hitting any of the cores. The melt not flowing in the desired z-direction is shown for all versions in Figure 18. It is clearly shown that the melt flow direction in gate A1

deviates from the desired z-direction the most of all versions. This is caused by the pressures and kinetic energy values, which decrease from gate to gate. The evaluation also shows that for all “D-versions”, meaning independent from the pouring basin geometry and its connection to the runner, show the least melt volume deviating from the desired flow direction. Version 4D is best, as only 52 cm<sup>3</sup> melt from all three gates is deviating from the desired flow direction. A closer evaluation of the simulation results of that version also shows that the melt is only barely touching the channel core sides (Figure 19).

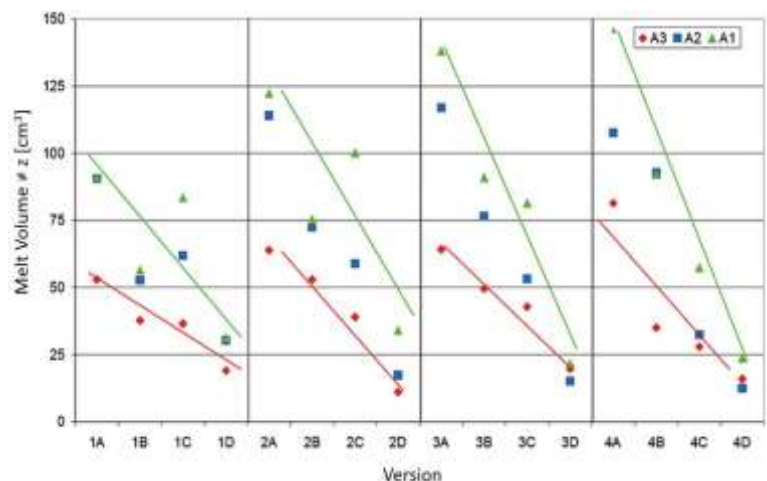
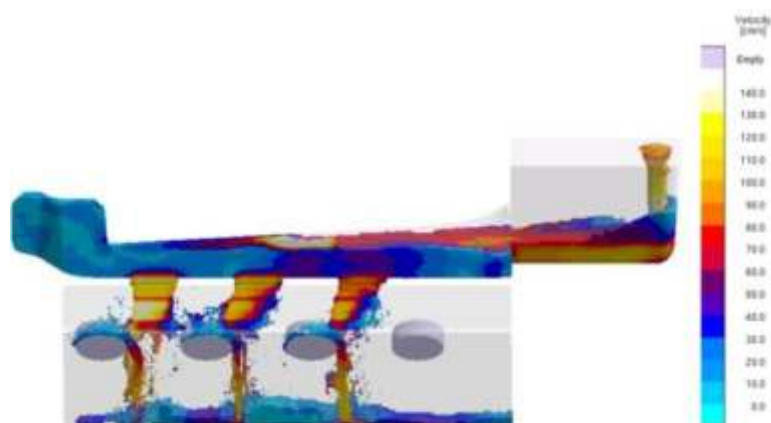
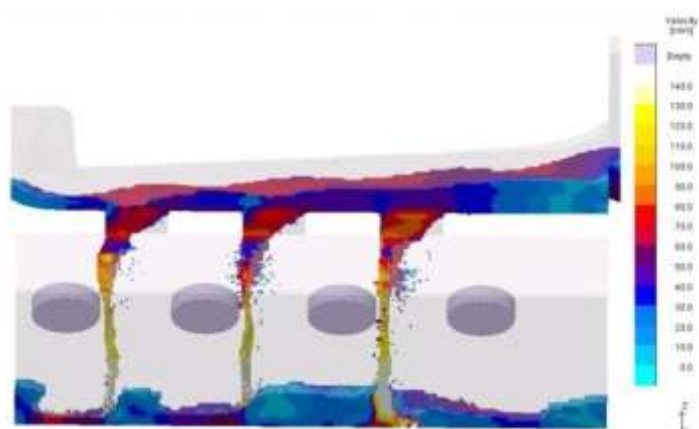


Figure 18. Melt volume [cm<sup>3</sup>] deviating from the vertical (desired) flow direction in gates A1 through A3 for all 16 versions



Version 1A; 2.67 s



Version 4D; 3.84 s

Figure 19. Comparison of melt velocities and direction for versions 1A and 4D at the same point in time

### Reduction of Free Melt Surface

The criteria “free surface” in MAGMASOFT® measures the melt in contact with air during the mold filling process. This criterion can be used at specific times during the mold filling process (Figure 20) or show accumulated values over the entire filling process (Figure 21). The geometry changes in the gating system lead to differences in volume and weight between the versions. The melt volume in version 4D is 4.48 liters and is, in comparison to versions 1A with 2.82 liters, about 62% bigger. Despite that fact, the accumulated free surface shrinks by about 5% from 120,678 mm<sup>2</sup> of version 1A to 114,944 mm<sup>2</sup> in version 4D. The oxide creation risk is thereby significantly reduced (Figure 22).

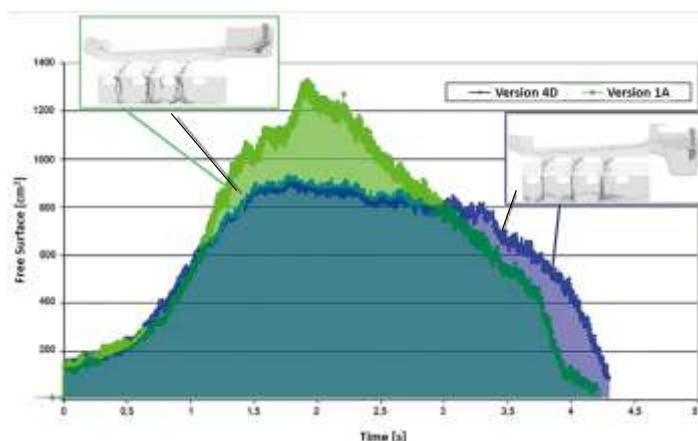


Figure 20. Free melt surface as function of time for version 1A and 4D

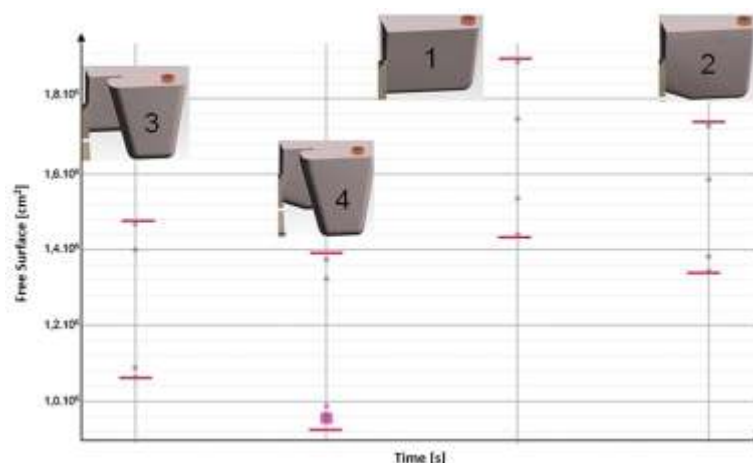


Figure 21. Over entire mold filling process accumulated “free melt surface” [cm²] for different pouring basin geometries and variations of its transition to the runner

### Evaluation of relationships between process parameters and goals

The significance of the relationships between the different modified process parameters and the evaluated goal functions can be displayed by the software through “main effect diagram” (Figure 22) and easily evaluated.

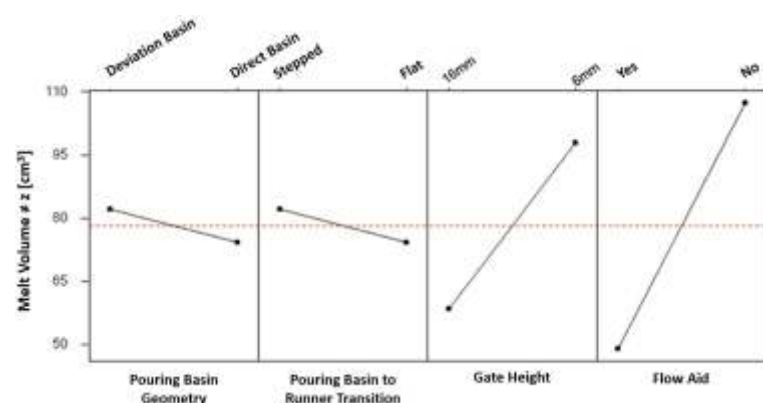
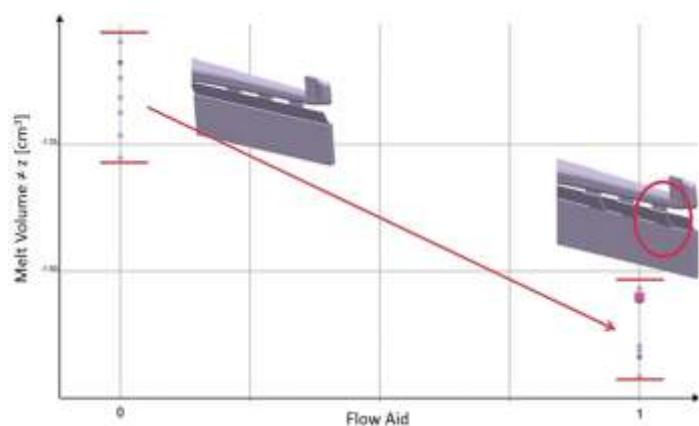


Figure 22. The main effect diagram of the impact of each variable on the goal function “melt volume with undesired flow direction” for gate A1

The y-axis displays the melt volume streaming through gate A1, which is not flowing in the desired flow direction. The lines show the impact of the four variables on the evaluated goal function. Shallow line angles in the windows for “pouring basin geometry” and “transition pouring basin to runner” indicate that these two parameters have only a small impact on this goal function. “Gate height” and the “presence of filling aids” have a much bigger impact.

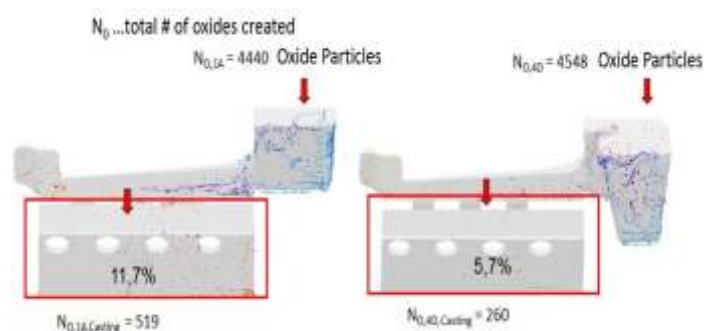
The impact of filling aids on the flow direction in the desired z-direction is shown in a scatter chart in Figure 23. The cuts that are machined in have a significant impact on accomplishing the desired flow in z-direction.



**Figure 23. Impact of flow aids on the melt volume flowing in the desired z-direction (0 = no flow aids, 1 = flow aids present)**

In parallel to the discussed three goals, virtual particles (tracers), representing oxide particles already present in the melt and not created during the mold filling process, were evaluated. These particles were assigned to the density of aluminum oxide and the typical size of oxide skins. The tracers move mostly due to flow dynamics inside the melt, but also experience buoyancy resulting from the density difference between melt and oxide skins. As the final melt quality is strongly dependent on the transfer processes experienced by the melt before entering the mold, it was evaluated, how significant the amount of entrained oxide particles is for each evaluated version.

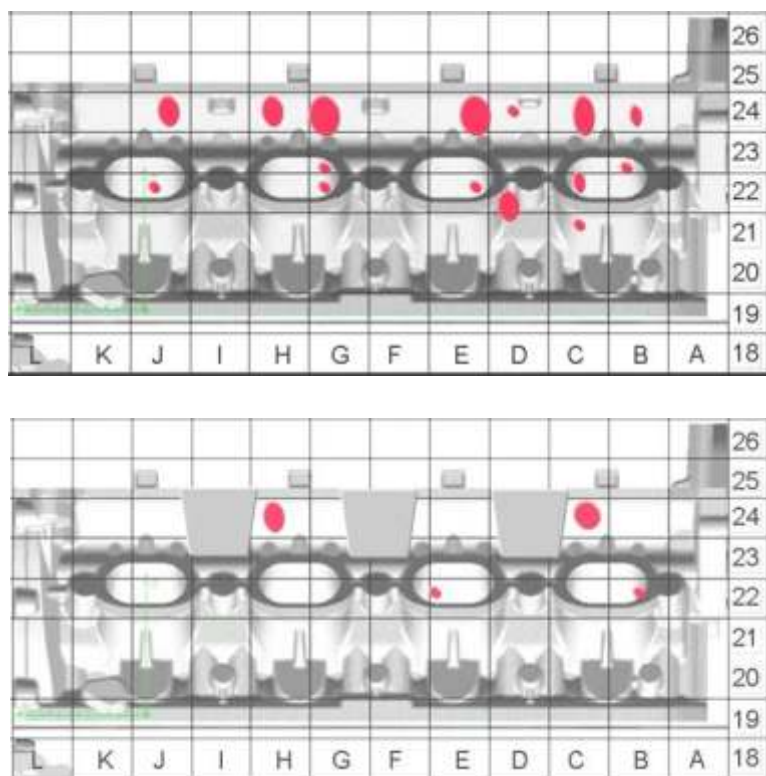
The evaluation of the number of oxide particles inside the casting for the original version 1A and version 4D (best version for all other quality criteria) clearly shows the impact of the pouring basin geometry and its transition to the runner (Figure 24). Even if the total amount of oxide particles in version 4D is larger, due to its larger melt volume less oxides enter the runner and the casting, due to the optimized pouring basin design and the stepped transition between the deviation basin and the runner. The fraction of oxides inside the casting is cut in half coming from 11.7% down to 5.7%.



**Figure 24. Total amount of oxide particles  $N_{O, \dots}$  total amount of oxide particles in casting  $N_{O, \dots, \text{Casting}}$  and percentage value of oxide particles, which are found inside the casting at the end of the mold filling process (for versions 1A and 4D)**

## Comparison of simulation results with real castings

Version 4D is the best solution for all evaluated quality criteria to reduce oxide inclusions. Therefore, this version was implemented in a real world casting to compare it to the original version. Cylinder heads produced by both versions were examined using standard methods to find leakers. The statistical evaluation shows a clear reduction of oxide inclusion related leakers and confirms the validity of the chosen quality criteria (Figure 25).



**Figure 25. Evaluation of leakers due to oxide inclusions of cylinder heads of version 1A (left) and version 4D (right). The red dots depict the location and frequency of leakers.**

## Summary

Casting process simulation was used to analyze potential sources for oxide creation during the semi-permanent mold casting process of cylinder heads. The experimental evaluation of the impact of melt transfer processes on melt quality using the PREFIL measurement method, confirmed that the free fall of the melt during melt transfer processes and the related free melt surface turbulence bares a high risk for oxide creation. Using the filling of a pouring ladle as an example, it was shown how the integration of autonomous DOE's in MAGMASOFT® aids in varying process parameters to efficiently and quickly reduce the risk of oxide creation. It was demonstrated that through the utilization of the simulation tool MAGMASOFT® and its fully integrated autonomous DOE functionality, it is possible to efficiently evaluate ideas for the improvement of gating systems and process parameters early in the casting process

development process for a new part. Beyond providing solutions for cylinder heads discussed in this paper, this new methodology provides comprehensive knowledge of quantifiable relationships between process parameters and quality criteria. This enables designers and foundry engineers to pursue several, even conflicting, goals at the same time.

This publication is based on the dissertation of Dr.-Ing. Lubos Pavlak<sup>8</sup>, and extended work at MAGMA Gießereitechnologie GmbH, Aachen. The authors are thanking Nemak GmbH in Wernigerode and Otto-von-Guericke-University Magdeburg for their support.

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.....Concluded

- \* Great Companies are built on great products  
- Elon Musk
- \* Nike doesn't want to make products for everyone; they want to make products for champions  
- Simon Sinek





## Cyber Crimes and Self Defense

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Cyber Security Mentor

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Every day that you open a newspaper, you come across a news item about cybercrime. There is some variation about the modus operandi, however the main theme remains the same. The victim trusts an unknown person and is gullible enough to send money or give up complete control of the mobile phone or computer thereby losing his/her life savings. The victims are not only old people but even smart businessmen who would usually be expected to be more careful. Such is the skill of these cybercriminals that they can deceive anyone.

The reason behind the success of the cybercriminals is the abundance of information available on the Internet. Our entire life history can be traced. Our Facebook and LinkedIn accounts provide enough information about our personal and professional life. We have to keep submitting various identification information like PAN, Aadhar card, driving license to innumerable agencies who may not be keeping them securely. With little research, our financial information could also be obtained. Equipped with all the information, a criminal can easily convince us that he is an employee of a bank / insurance company / mobile telephone company or any other role that he/she chooses. The dialogue will be designed to convince you about the genuineness of the call followed by a request to part with information like OTP or downloading an app to help you meet KYC or any such compliance requirement. Once the criminal overcomes your initial resistance, rest is cake walk.

I have suggested a two-pronged strategy to safeguard ourselves from such attack.

- A. Adopt a system of self-defense by segregating your mobile phones.
- B. Train yourself in the art of self-defense.

### A. Self-defense by segregating your mobile phones.

A few years back we used our mobile phone only for making and receiving calls. It was just a replacement of our landline phone and provided us with a lot of freedom of movement. For our computing needs we used our PCs or laptops. With increased processing power, our mobile phones became digital assistants and slowly became so powerful that they are now able to do everything that the computer can do. The telephony seems to be a very minor function of the mobile phone. This has resulted in many security issues:

- The banking transactions are done from the same phone where the OTP is received. There is no segregation of devices. This was not the case with computers. A transaction on the computer needed to be confirmed by OTP received on mobile. So, a thief needed to have access to both devices.
- Various apps on the mobile open multiple channels to download viruses on mobile.
- Your mobile phone number will be widely publicized and circulated among friends as well as casual acquaintances. The mobile phone number is also used as identification for all financial transactions. So, everyone knowing this important number is really not a good idea.

You should adopt a two-phone strategy. Keep two phones with you. One phone should be a pure 'Communication Phone' where you can download all communication apps like various Google apps, Facebook, Twitter, WhatsApp and so on and share this number with everyone that you wish to keep contact with. However, this phone should not have any banking or payment app.

Your second phone should be strictly a 'Banking and Payment' phone. As the name suggests, it should have only the banking apps installed, like YONO, Axis Bank and any other bank where you have your account and payment apps like BHIM, G-Pay, Paytm. Do not install any communication app on this phone. You will have to install Google Play Store but no need to have Gmail. Do not use this phone to surf the Internet.

Do not have any other Google apps or Facebook, Twitter, WhatsApp etc. Do not even register this number for WhatsApp, unless you want to get some notifications on WhatsApp. Do not click on any links sent to you through sms. The link may lead to a website that could download viruses on your phone. Give this number only to banks and other places where you must do financial transactions. Otherwise, keep it as secret as possible. This will improve the security of your financial transactions. Since you will not share this number with others, you are less likely to get unwanted calls on this number. In fact, you should ignore calls from unknown numbers on this phone.

## **B. Train yourself in the art of self-defense.**

Despite having two separate phones, you are still not safe if you do not practice the art of self-defense. The steps described below should become part of your life.

### **1. Use Passphrase, not Password.**

We are always asked to use long complicated passwords consisting of capital and small letters, special characters, and numerals. We are further instructed to use different passwords for different websites and change the passwords frequently. We are also warned never to write down these passwords but memorize them. Most of us access more than 20 websites and it is indeed difficult to follow all the suggestions. This leads to selection of weak passwords and same password being used at multiple websites. To overcome this major hurdle, I am suggesting a time-tested scheme for selection of secret passwords. This approach was used by spies during the second world war. It could also serve us today.

Use a book of verses, poems, old songs or any such publication. Have more than one book that you may refer to select a passphrase that is a sequence of words, like words of a song or poem. You can select two or three words as the pass phrase. You can devise a scheme to remember the location of this passphrase in a book. One of the suggested schemes is to identify location by book number, page number, line number, word number and number of words in the passphrase. This could be written down in your diary. It will look like a random and meaningless number. It will be impossible to locate the passphrase from this number, unless you reveal the scheme of locating the passphrase and the book name belonging to the book number. You can further strengthen passphrase by inserting separators in between the words. The separator could be a special character or a numeral.

If the book chosen by you is non-English, it will further complicate the passphrase. You will have to write the non-English passphrase using Roman alphabets.

This scheme will provide an unlimited source of passphrases. When you change the passphrase, you have to only change the relevant numbers in your diary. You may have to practice this approach and, in the beginning, may appear difficult but you will soon get used to it and may even recollect the passphrase just looking at the number.

### **2. Block out CVV number on the Credit / Debit cards.**

There is a three-digit CVV (Card Verification Value) number printed at the back of your Credit or Debit card, next to the space meant for your signature. This is an important number and is like a secret password, displayed so openly. This number is asked to you when you make an on-line payment. The number proves that the card is indeed in your possession for a CNP (card not present) payment. In India, an on-line payment is verified by an OTP (one-time password) that we receive by sms. However, this system is not followed abroad. So, if someone copies your Credit / Debit card number and the CVV, your card can be used abroad for any online purchase, payments, or e-commerce transaction. No OTP will be required.

You can safeguard yourself by blocking out this number by a thick black pen or a sticker which will prevent someone noting it down and use it later.

### **3. Set your Credit/Debit card limits & permissions for on-line, ATM, contact less, POS spending.**

Your bank and other Credit / Debit card issuing organizations offer a system to set various limits on spending money on these cards. They also allow you to block and unblock the cards for specific types of transactions. For example, you may block it for domestic or international transactions, ATM, Point of Sale as well as e-Commerce (card not present) transactions. Familiarize yourself with this system and use it fully. In fact, you can even unblock the card just before a transaction and immediately block it afterwards. So, you may unblock the card just before using the ATM and block it immediately after using it. So, no one will be able to use it. These facilities are also provided through your banking mobile app.

### **4. Enable two factor authentication on all apps – Google, WhatsApp, LinkedIn, FaceBook, Amazon.**

Along with all the banks, almost all major websites provide two factor authentication. For example, Google,

WhatsApp, Facebook, LinkedIn, Amazon provide this security feature. When you login from a new device or want to make any changes to your profile like your address, phone number or any such important information, an OTP will be sent to you to verify you. This is in addition to any secret questions that you may have set. Make use of this facility. Many persons complain that their account was hacked and is not accessible as the password has been changed. This would not be possible if the two-factor authentication is enabled. Someone who has stolen or guessed your password, cannot change it unless he/she has also stolen your mobile phone.

#### **5. Remotely securing the phone**

Google provides a facility to remotely find, lock and erase the contents of your mobile phone. Make yourself familiar with this feature. If your mobile phone is lost or stolen but it is still connected to the Internet and the GPS location service is on, the exact location of the phone will be shown to you on a Google map. You can send a command to play loud tones on the phone, even if it is on mute and also to display a message. This will alert everyone around the phone. You can remotely lock the phone and even completely erase the content of your mobile phone. No information on the phone will be accessible to the thief. So even before you rush to the police station, use this facility to remotely secure the phone. Also make sure that you write down the IMEI number of your phone and report this number to the service provider and police. IMEI (International Mobile Equipment Identity) is a 15-17-digit code that is given to every mobile phone. This number is used by service providers to uniquely identify valid devices. In most mobile communications devices, the IMEI appears on the display when the user enters the character sequence \*#06# into the keypad. After the IMEI number is blacklisted, the set will, in most cases, become useless -- even if someone swaps out the unit's SIM card.

#### **6. Take mobile backup. Sync with Google.**

Everyone uses Google, without exception. Google provides several free services. Syncing is one of them. Use this service to sync your calendar, contacts, and many other things. This will be extremely useful if you lose your mobile or your mobile crashes. You can sync the new phone and download all the contacts, calendar etc. on the new phone.

#### **7. Open a separate account in a different bank.**

If you are really scared with the thought of exposing your bank balance to various payment apps, you may even consider opening an account in a different bank and keep just the minimum balance in this account. Then link all the payment apps to this account. This will reduce your risk of losing large sums.

#### **8. Don't talk to strangers.**

Finally, don't talk to strangers. In the virtual world of today, you never know who is calling you. You should not trust someone just because the person claims to be from your bank, sounds very responsible, authoritative, convincing as he/she has a lot of information about you. This information might have been collected from the Internet. The advice that we give to our children, we should follow it ourselves. Just refuse to get drawn in any conversation and disconnect the phone. Do not even bother to ask for any information or try to ascertain genuineness. For that you may contact your bank or the agency the caller claimed to represent and ask them if someone did really call you. In all probability they will reassure you that they never call the customer.

Make these suggestions part of your day-to-day life. We are going to depend more and more on the digital world. We need to equip ourselves against all the dangers of this virtual world and at the same time take full advantage of the great facilities that it provides us.

“Everything we do in the digital realm - from surfing the web to sending an e-mail to conducting a credit card transaction to, yes, making a phone call - creates a data trail. And if that data trail exists, chances are someone is using it - or will be soon enough”.

Douglas Pushkoff  
Author of “Throwing Rocks at the Google Bus”.

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# Annual Virtual Conference GDCTECH 2021 - Report

Great Diecasting Technology Forum (GDCTECH FORUM) had organised Virtual Annual Conference GDCTECH 2021 - 11<sup>th</sup> & 12<sup>th</sup> February 2021.

Mr. Sanjay Mathur, President of the Forum, inaugurated the Virtual Conference.

The 1st day was Project Competition Presentations Day and selected projects were presented by seven companies.

Mr. Anand Joshi, Chairman Project Competition Committee, welcomed the participants and the delegates. In his introductory speech he briefly covered the objectives and people development aspect of the project competition. He said as the competition enters eight year, the presentations show that many companies, people are well versed with various problem solving tools – data collection, why–why, Pareto Analysis, Ishikawa diagrams and so on. It's time however, now to see whether all this has become a part of company culture.

He also appealed to the industry to encourage women's participation in the Projects Competition. “Due to pandemic situation we are conducting virtual competition. But we do look forward to meet you as usual in next competition”, he concluded.

10 selected project presentations were:

- **Product Quality Improvement**  
Aakar Foundry Pvt. Ltd.
- **To Achieve "Zero Breakdown In 840t-2 Die Casting Machine (Buhler)**  
Ashley Alteams India Ltd
- **Innovative Metal Pouring Technique For Gravity Casting Process.**  
Pyrotek India Pvt Ltd.
- **Improving Yield By Changing Process Concept.**  
Roots Cast Pvt. Ltd.
- **Non Filling Defect Elimination Through Pm Analysis**  
Sigma Electric Manufacturing Corporation Pvt. Ltd.

- **Productivity Improvement At Paint Shop**  
Sigma Electric Manufacturing Corporation Pvt. Ltd.
- **Average Shots Improvement In Die-Casting**  
Sigma Electric Manufacturing Corporation Pvt. Ltd.
- **Productivity Improvement In Md13 Bracket Rear**  
Sundaram Clayton Limited -
- **Die Casting Productivity Improvement Through Cycle Time Reduction**  
Sundaram Clayton Limited -
- **Modification Of Gating System To Eliminate Casting Defects Of Ecp32c Nde Bracket**  
United Metallurgicals Pvt. Ltd.

Following companies' project presentations were declared Award Worthy.

- Aakar Foundry Pvt. Ltd.
- Ashley Alteams India Ltd
- Roots Cast Pvt. Ltd.
- Sigma Electric Manufacturing Corporation Pvt. Ltd.

The competition is sponsored by OMR BAGLA AUTOMOTIVE SYSTEMS INDIA LTD., Naming **Raj Narayan Bagla Award for Best Innovative Project.**

Mr. Anil Kulkarni, Vice President summarised the project competition with his opinion and remarks.

On second day of the conference was a Technology Day, and there were 6 paper presentations including 4 by International companies.

Dr. Aniruddha Karve Chairman, Technology Day welcomed the delegates and briefed about the conference. In his opening remarks he talked about “Pandemic situation and its after effects”. He also mentioned, “Next couple of years we need to be quite alert on market situation. Three primary things we need to focus on are Next Generation of Customers Requirements, Become Globally Comparative and How Can We Support Global Requirements. The six presentations will cover on all these three aspects”. With this he started the proceedings.

## Following were the Presentations.

No Hit & Trial, Optimize Process Planning Robustness  
Urs Brandenberger,  
VISIOMETA GmbH

Tool Technology for Foundry Industry  
Roberto Di Giulio, Sales Manager,  
Krämer & Grebe GmbH & Co KG

Combicore Core Technology for Foundry,  
Dr. Susanne Rupp , CEO  
COMBICORE GmbH

Closed Loop Die Thermal Management  
Randy Ryder – CEO  
Die Therm Engineering, LLC

Jet Cooling  
Prateek Sachdeva,  
Raga Group

Structural Casting Process  
Kedar Vaidya, Head of Advanced Materials, South Asia  
Buhler (India) Pvt. Ltd.



Urs Brandenberger  
VISIOMETA GmbH



Roberto Di Giulio  
Sales Manager  
Kramer + Grebe



Dr. Susanne Rupp  
CEO  
Combicore GmbH



Randy Ryder  
CEO  
Die Therm Engineering, LLC

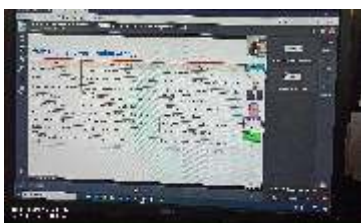


Prateek Sachdeva  
Manager Sales & Marketing  
Raga Engineers



Kedar Vaidya  
National Manager -  
Head of Business - Die Casting  
Buhler (India) Pvt. Ltd.

Tehnology Day was sponsored by MDS Engineering Solutions. Total 55 delegates attended the programme. Mr. R.T. Kulkarni, Vice Chairman, proposed vote of thanks to all participants and assured to meet this year again.





## The Way Forward is Digital

**Jeetendra Shende, Founder & CEO**

### Transform to Perform, Pune

We live in a Digital age, an era of immense transparency, visibility & social media explosion wherein businesses, personalities, brands & customers are subjected to a constant barrage of impressions, Information & instances which define as well as influence Choice. Over the last two decades, we have moved and progressed into an existence of ERPs and integrated systems that drive our key business processes, financial transactions and even people capability. India Inc. has incorporated global practices, quantifiable mechanisms & accelerated goals as the only way of being competitive & stay in the business. It took many years for the small businesses vendors & their supply chains to adopt these same initiatives, invest in technologies & work hand in hand seamlessly in sync with their large corporate clients & OEMs. We are now in a stage where perhaps the gaps have minimised, understanding is at par & there is acceptance of this new nature of business.

But Change is the only constant and the world is evolving at a pace like never before. The rate of change from the 80s to the 2000s and now from 2010s to these times have perhaps quadrupled and this has put immense pressure on the product development cycles, scalability & cost of growth. In the midst of this, the new age of social networks, interest based groups and like minded collaborations has exploded in the system. Facebook, LinkedIn, Instagram & a plethora of other mediums have become the daily dose of inputs not only for social updates but has become a valid and solid source for connecting people, businesses, opportunities & alliances. In the backdrop, it has become a necessity for SMEs to re-look at their digital

strategy and dovetail their personal & business profiles as an integrated part of their branding mechanism. The world has shrunk and no longer the boundaries of state, country nation or even continent can keep a business from constantly growing, evolving & morphing into a new existence. Sourcing and Engineering professionals all over the world are constantly cued in to scan and assess sources which will deliver products as well as services at a scale, cost & innovation which will help accelerate their organisations Vision & Goal. Everything is just a click away, and it is in the interests of the SMEs to arm themselves with the necessary tools, technology & presence which will help them to be visible, available & relevant. The Digital footprint is the most important tool in the armoury of any business, irrespective of size, industry type or location.

All of this may not or cannot be achieved only through a person based approach, but now it is imperative that investment is made in harnessing the full potential of this mechanism with the help of experts, the digital marketing companies. Usually run by the young and technology proficient start-ups, these companies offer services at a pace, cost & efficiency like never before. It will be a crime and foolishness not to evolve and harness this capability. Countries like China, Vietnam & other smaller nations have already embarked on the same and if you ever wonder how these vendors found their way into the Indian markets, one of the main weapons of choice is and was the digital Social Media marketing strategy. We live in a world where the old method of conferences, seminars, exhibitions and symposiums will slowly cease to be the places for business and now it will be done on the virtual world of the internet. Thus the only way forward is Digital & its never too late....Right now is the right time !



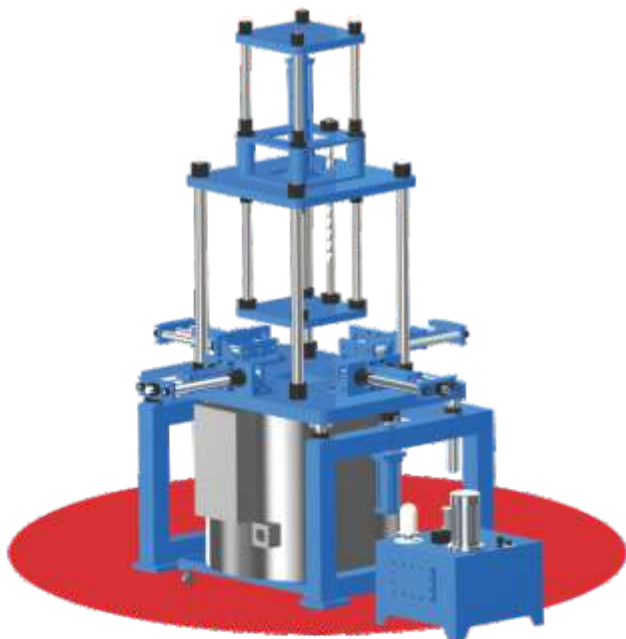
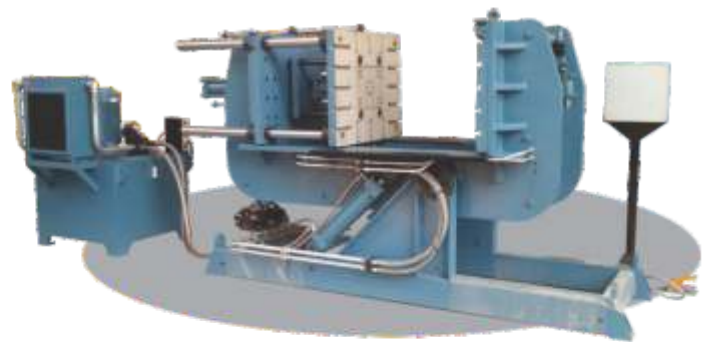
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1. Defect Analysis And Remedial Measures – 22 & 24 July 2020  
Faculty : Mr. V. G. Patil, Consultant (Ex – KOEL)
2. Importance Of Release Agents In Aluminium Die Casting Process - 11<sup>th</sup> August 2020  
Faculty : Mr. Ashok Konduskar, Technical Manager -India, Middle East & Africa region , AAC Surface Treatment/Cleaners & Lubricants
3. Casting Defects In Aluminium High Pressure Die Casting (Two Sessions). - 19<sup>th</sup> & 20<sup>th</sup> August 2020  
Faculty: Mr. Rajesh R Aggarwal, Director, TechSense Engineering Services
4. Machining & Automation Solutions For The Die Casting Industry. - 24<sup>th</sup> August 2020  
Faculty: Mr. Jagannath V, Business Head, m2nxt Solutions – A BFW subsidiary
5. Practicing Of OEE (Overall Equipment Efficiency) Matrix And Cost Reduction - Operating Expenses Reduction" - 4<sup>th</sup> September 2020  
Faculty : Aasheem Samadarr, Founder-CEO, EBIT>Management Consultant
6. Panel Discussion for Auto Comp manufacturers, theme was "GO GLOBAL INDIA Demonstrate Competitiveness & Capabilities" . - 6<sup>th</sup> September 2020  
Panelist are:
  - Mr. Hrishikesh Kulkarni, Valeo Group Purchasing Director India, VALEO INDIA PVT. LTD.
  - Mr. Mohan Kadam, General Manager, DANA INDIA PVT. LTD.
  - Mr. Nagaraj P. SONALIKA ,
  - Mr. Shankhadeep Mukherjee, Team Leader, CRU ANALYSIS & CONSULTING (INDIA) PVT. LTD.
  - Mr. R. Pattabhiraman, Tech Expert - Casting & Forgings , Global Core Powertrain STA, FORD MOTOR PVT.LTD.Panel Co-ordinator :
  - Mr. Deepak Mahajan, Management consultant, domestic & international business development for auto component manufactures
7. Die Coating Basics, Composition and Application  
12<sup>th</sup> September 2020  
Faculty: Shrikant Bhat, Head Non-Ferrous Foundry, FOSECO INDIA
8. NEW PRODUCT DEVELOPMENT. - 18<sup>th</sup> September 2020  
Faculty : Sanket Anil Kulkarni. Director operations, Pooja Castings Pvt Ltd.
9. METHODING OF GRAVITY DIE CASTING COMPONENTS. - 6<sup>th</sup> & 7<sup>th</sup> October 2020  
Faculty : U. M Nadgar, Consultant
10. NON DESTRUCTIVE TESTING FOR ALUMINIUM CASTINGS". - 27<sup>th</sup> October 2020 –  
Faculty : Mr. Sunil Gophan, Chairman Of ISNT Pune Chapter.
11. Panel Discussion  
Theme: Uncertainty in Manpower, Demand, Capacity, Utilisation and Quality Demands " On 1st Nov. 2020  
Panellist :
  - Mr. Umesh Sholapurkar, Sourcing Manager, ATLAS COPCO (INDIA) LTD.
  - Mr. Samir Kukade, President – Human Capital, PRAJ INDUSTRIES LTD.
  - Mr. M. M. Umadi, Executive Director, SIPRA ENGINEERS PVT LTD.
  - Mr. Jitendra Lakhotia, Chief Executive Officer, AAKAR FOUNDRY PVT. LTD.
  - Mr. Kishor Dukare, Vice President (2W Alloy Wheel Division), MINDA INDUSTRIES Ltd.,
  - Mr. Shrirang Tambe, GM, Global Purchasing Office, MTU India Pvt. Ltd.Panel Co-ordinator :  
Mr. Deepak N. Mahajan, DEEPAK MAHAJAN & ASSOCIATES

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