

MAGMA

Digital casting process development – optimizing quality and economics of a rear axel shaft housing

Jan Eilers

AFI Conference 2026



SPEAKER

- Jan Eilers
- Joined MAGMA in 2010 in Singapore
- Studied Business and Marketing in Munich, Germany
- Lived in Singapore, Germany, Japan, China
- General Manager of Singapore office, the ASEAN+ANZ HQ
- (First time back in Australia after 25 years)



WHY USE SIMULATION?

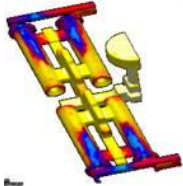
COMPETITIVENESS



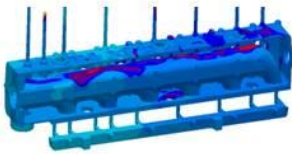
QUALITY IN CASTINGS – IRON AND STEEL

High diversity of defects

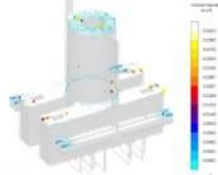
Cold Lap



Air entrapment



Dross / Inclusions



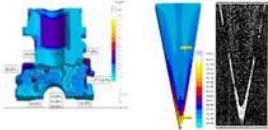
Porosity



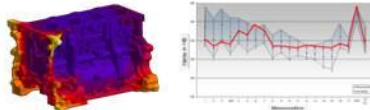
Microstructure



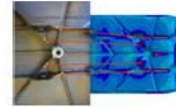
Graphite Formation



Properties



Cracks



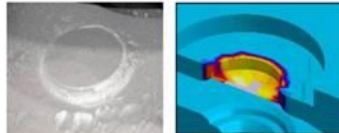
Distortion



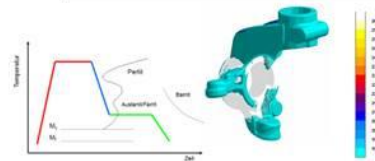
Core gas



Mold defects



Heat treatment



AGRICULTURAL MACHINERY



On average, 70% of a tractor's weight is made up of cast parts.



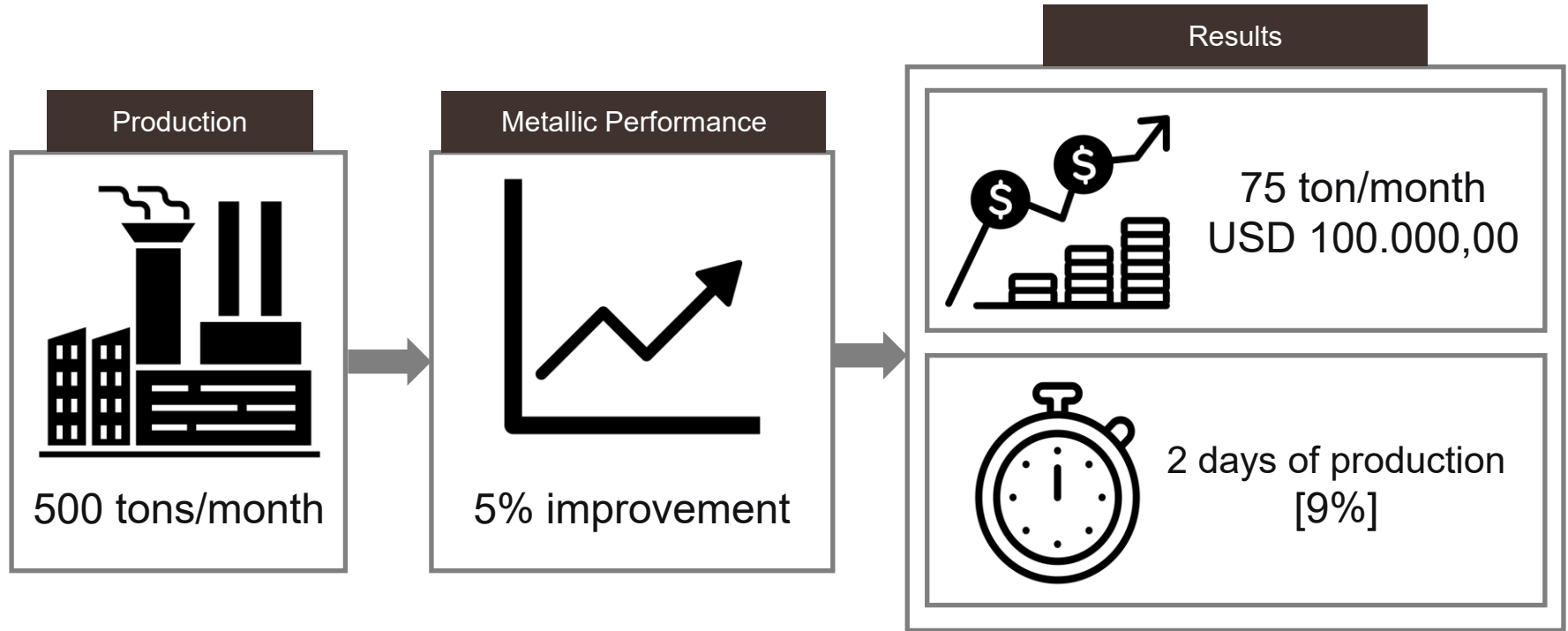
<http://www.satpcl.co.th/en/products/product-showroom/agricultural-machinery/tractor-parts>



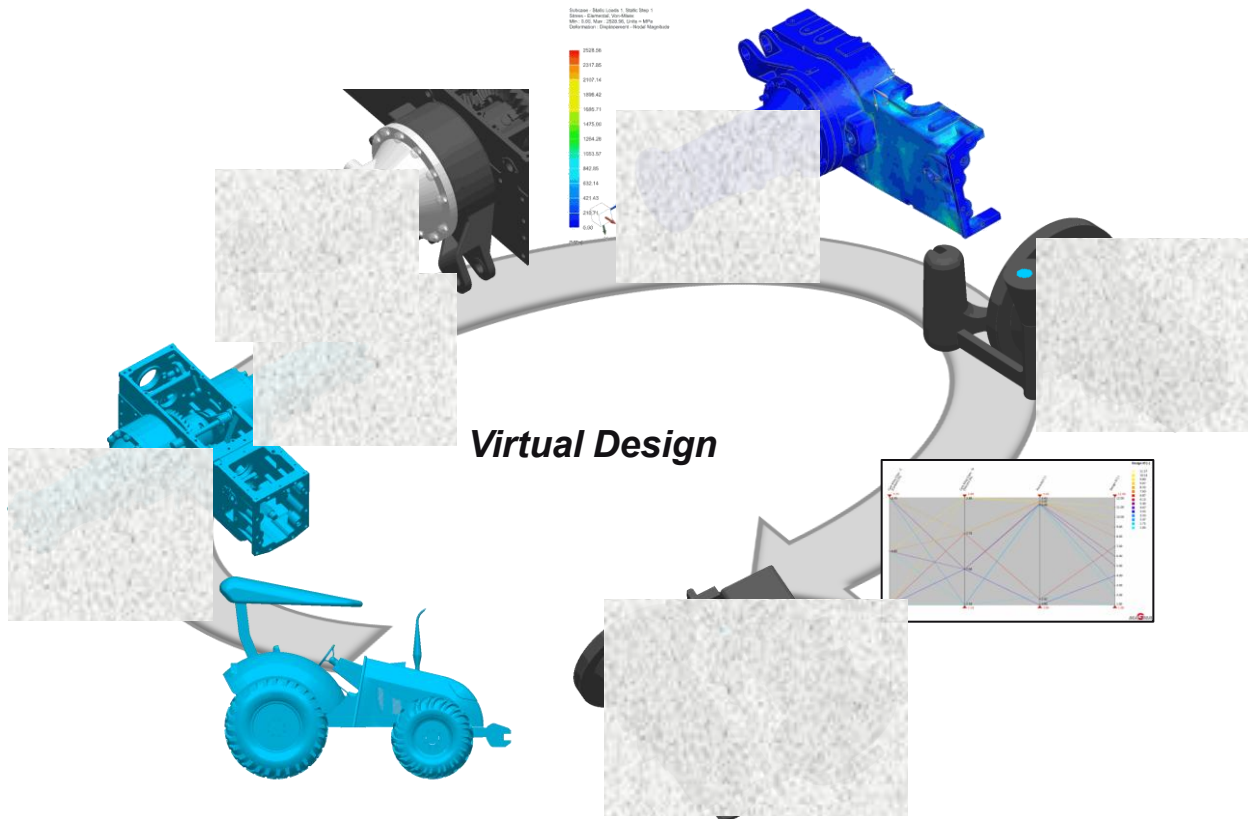
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MAGMA

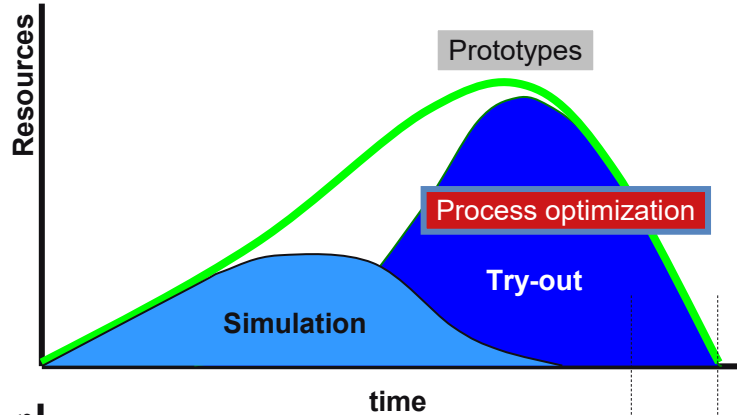
PROFIT POTENTIAL IN A FOUNDRY



PROJECT AND PROCESS DEVELOPMENT

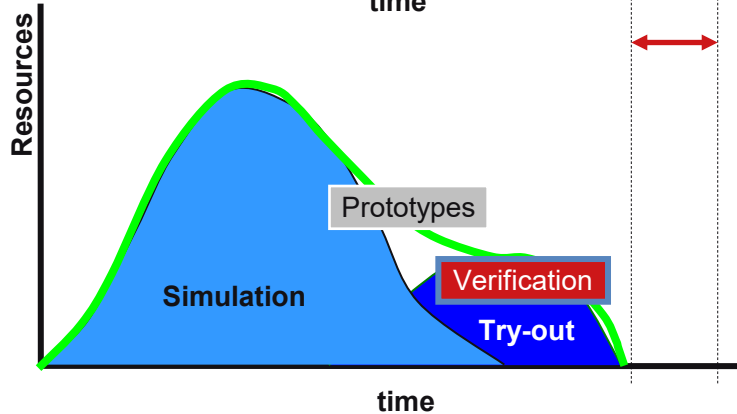


SIMULATION OF THE CASTING PROCESS WITH MAGMASOFT®



Conventional Development

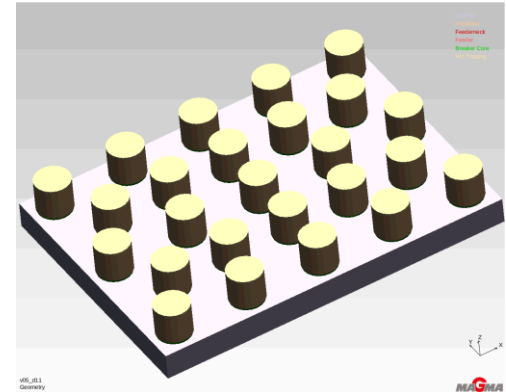
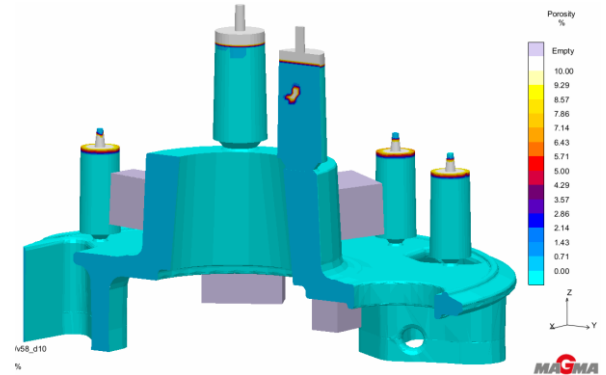
- Based on practical tests
- Sequential optimization



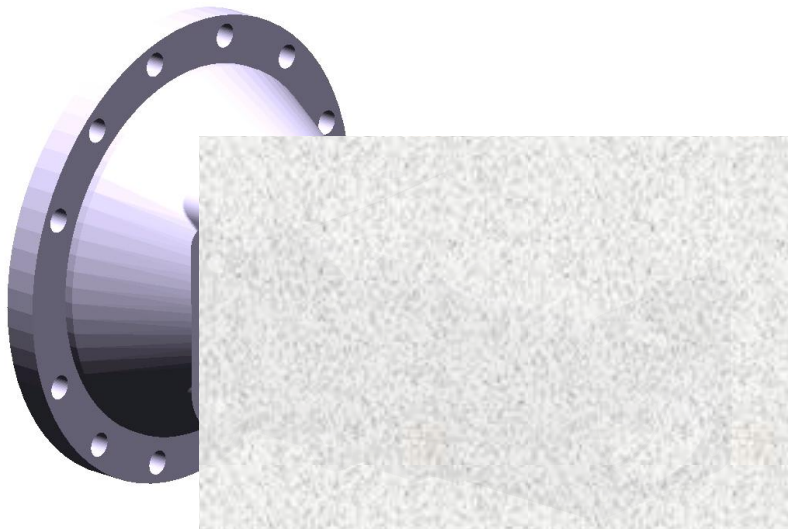
Reduce time and cost

Development Optimized

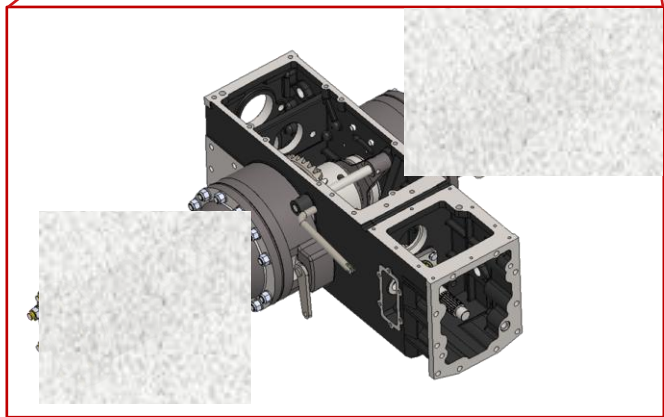
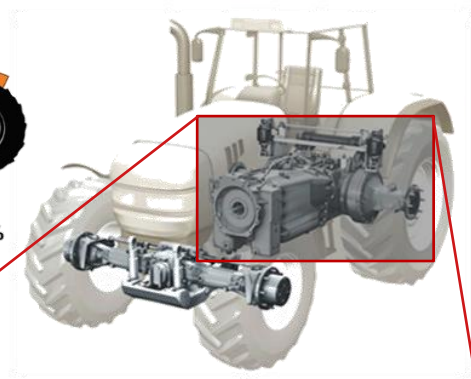
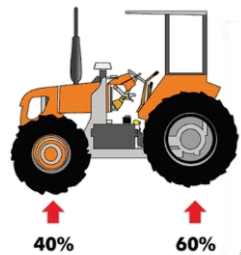
- Simultaneous optimization
- No prototypes



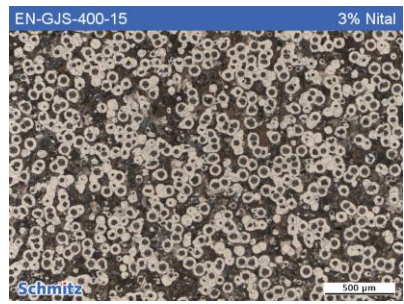
REAR AXLE SHAFT HOUSING



Casting
Core
Sand Mold
Feeder
Runner
Machining Allowance
Pouring Basin



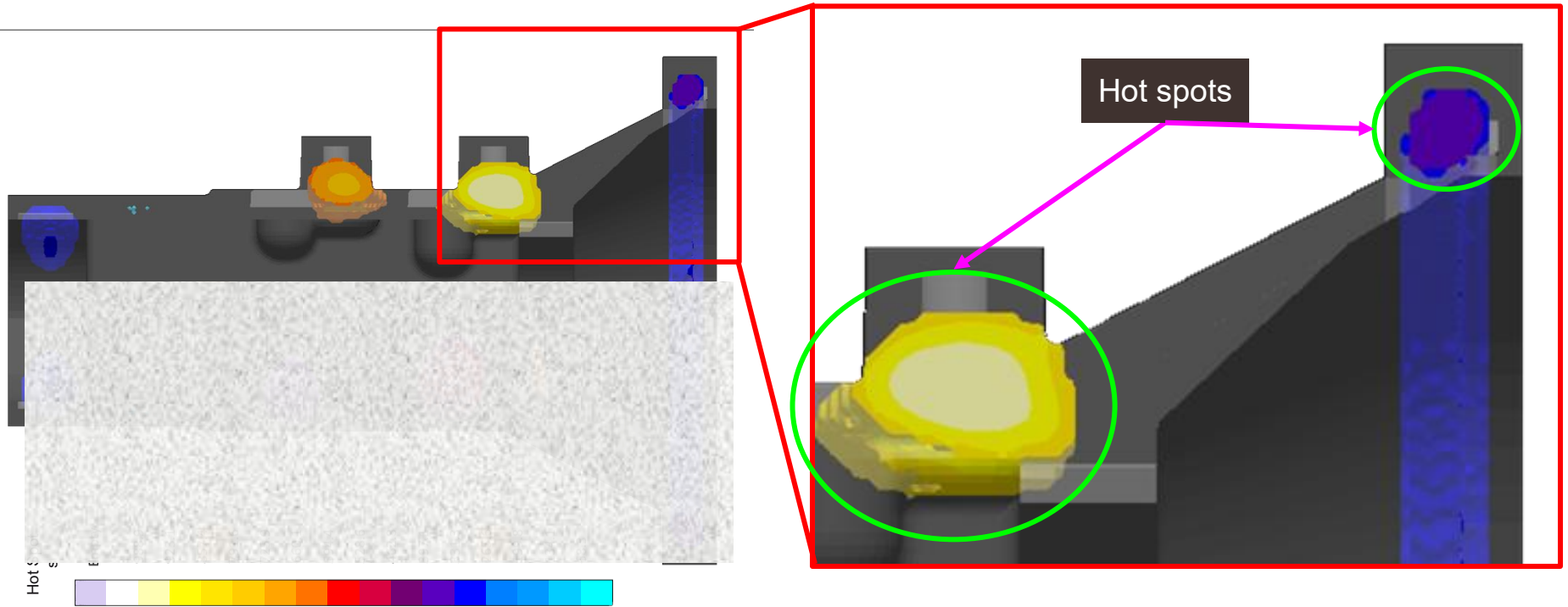
v08
Geometry



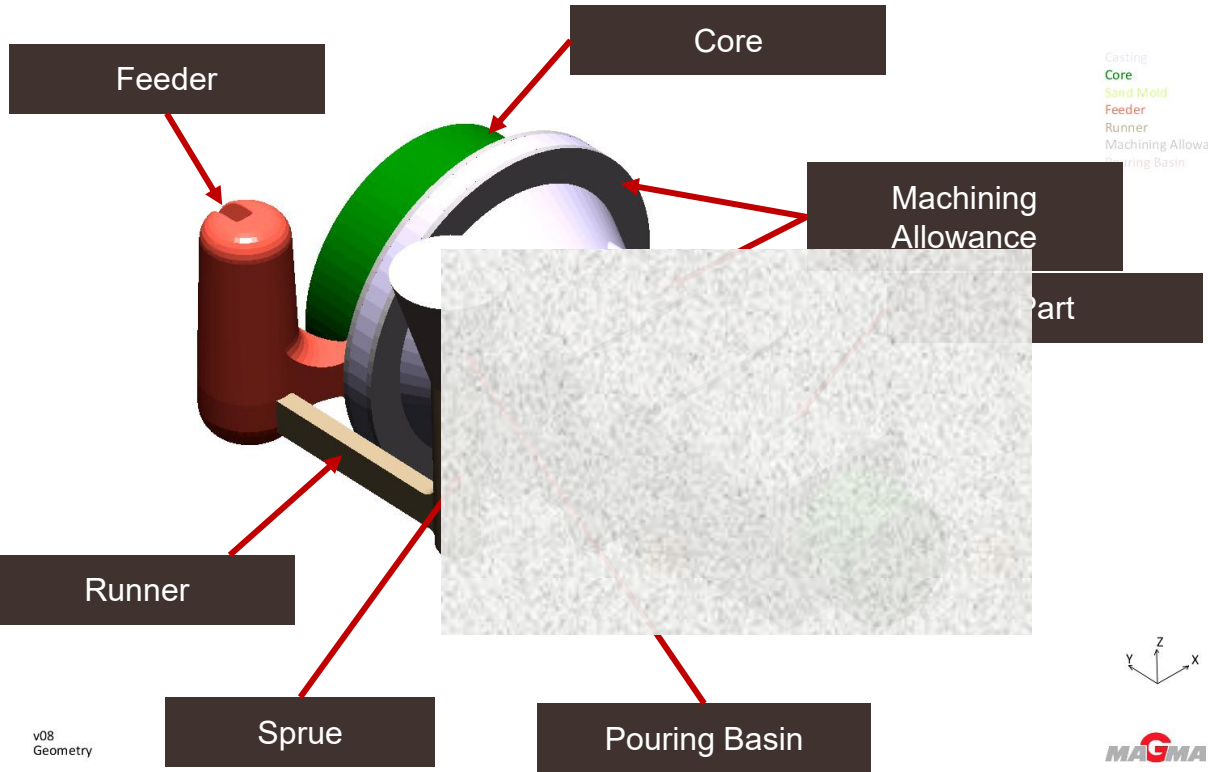
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INITIAL ANALYSIS – NATURAL SOLIDIFICATION



FEEDING ANALYSIS – PROJECT “A”



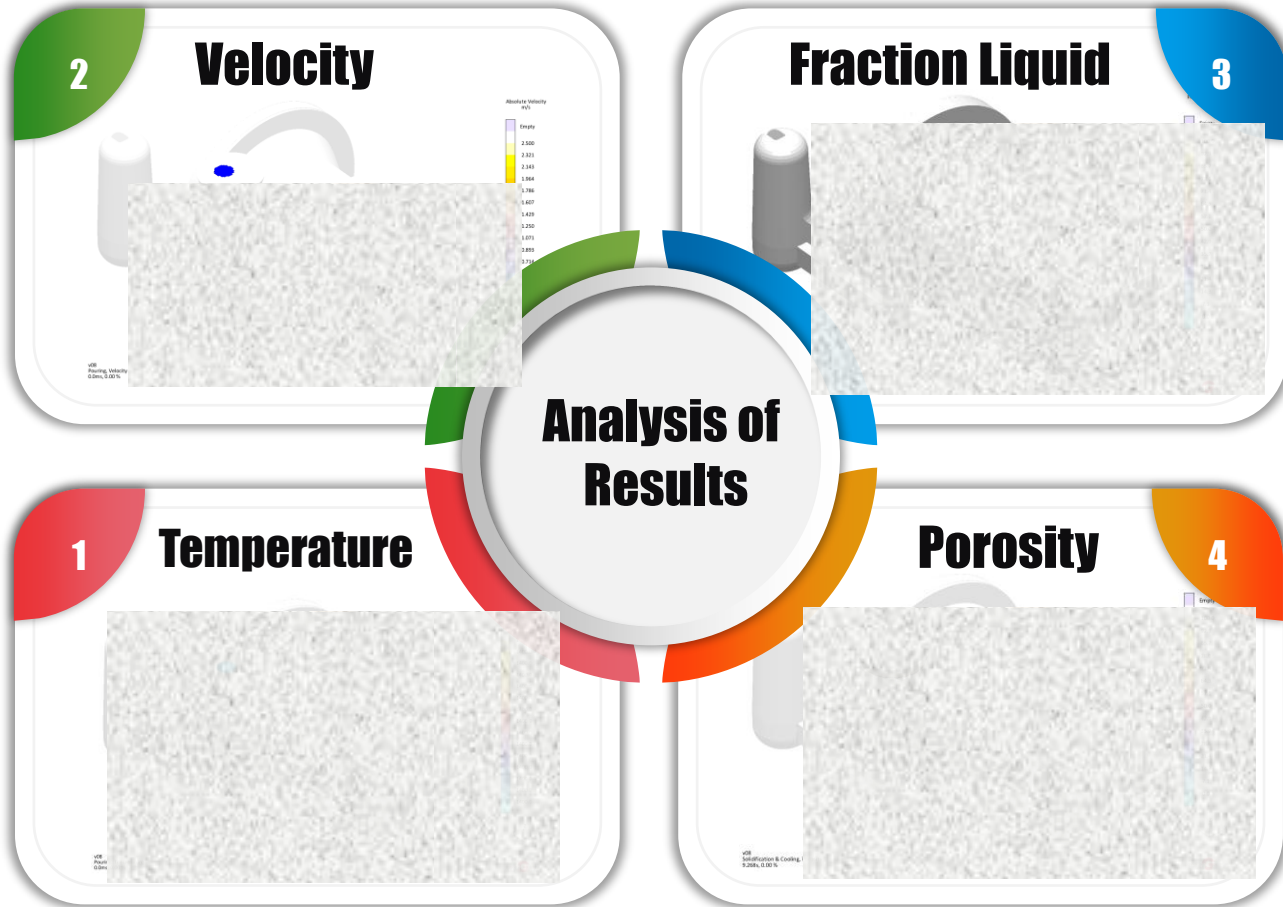
Machined weight: 23.0 kg

Gross weight: 28.5 kg

Casting system weight: 11.00 Kg

Metal yield: 72.1%



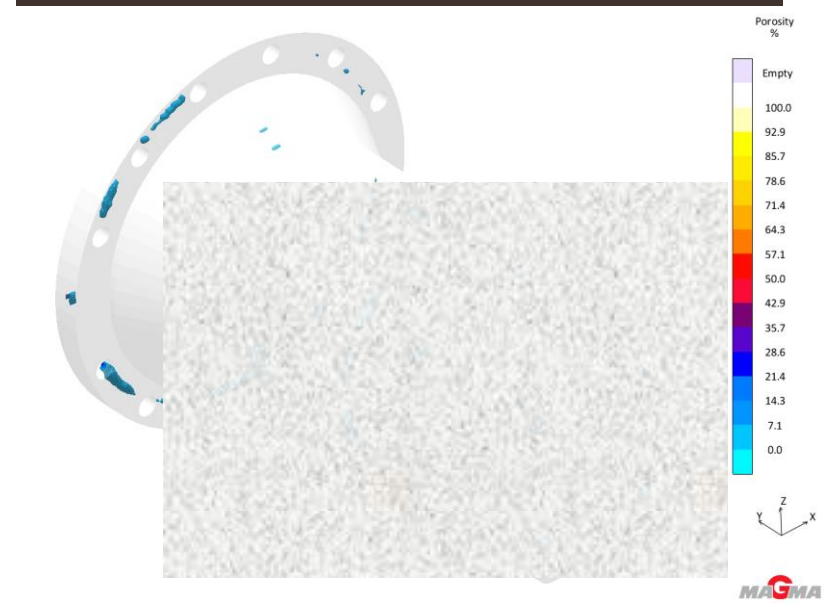


FILLING ANALYSIS

Shrinkage Porosity [%] – Casting raw material

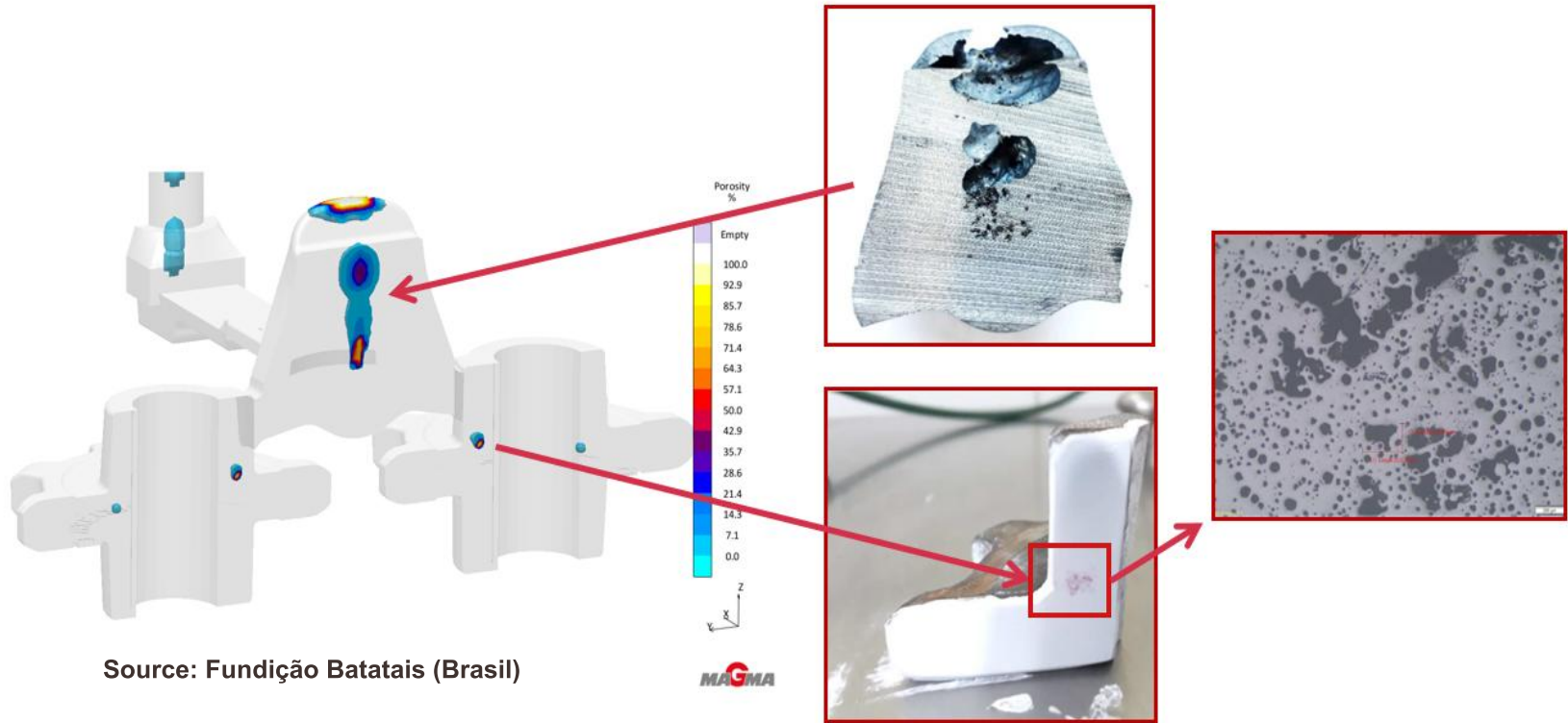


Shrinkage Porosity [%] – Machining

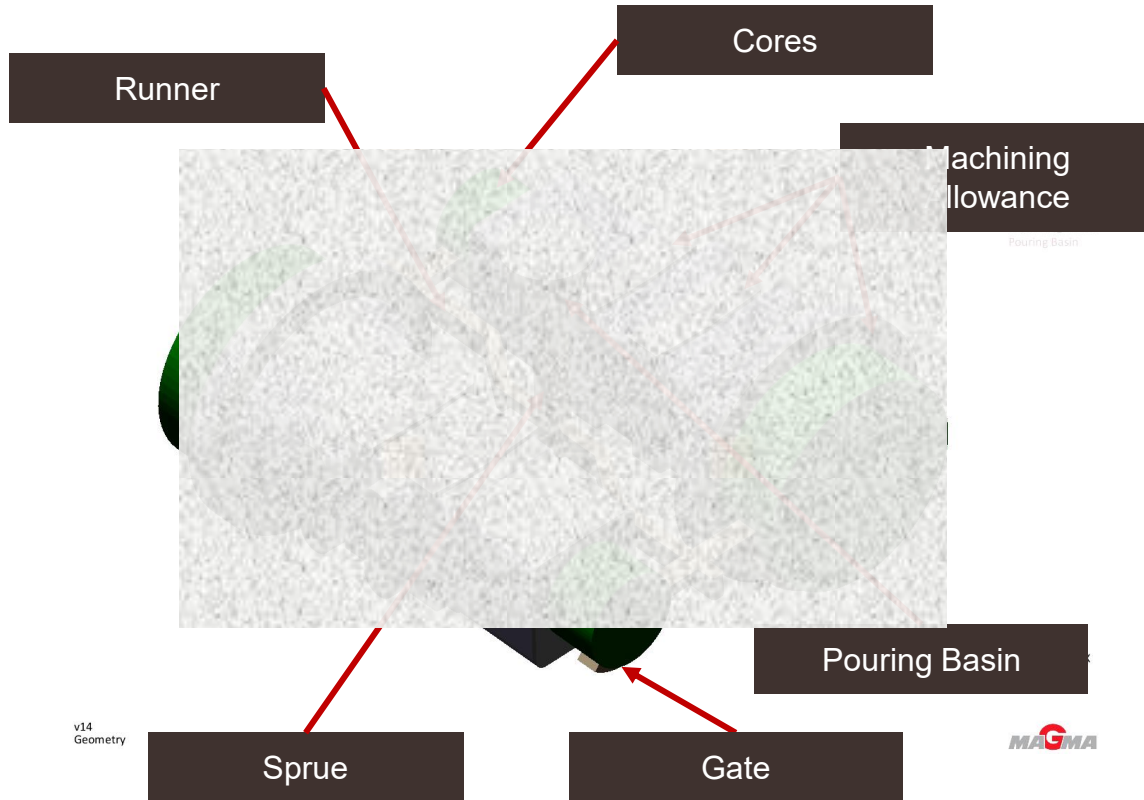


CORRELATION

Shrinkage porosity observed comparatively between simulation and casting practice



FILLING ANALYSIS - OPTIMIZED



Machined weight: $23,0 \text{ Kg} * 2 = 46,0 \text{ Kg}$

Gross weight: $28,5 * 2 = 57,0 \text{ Kg}$

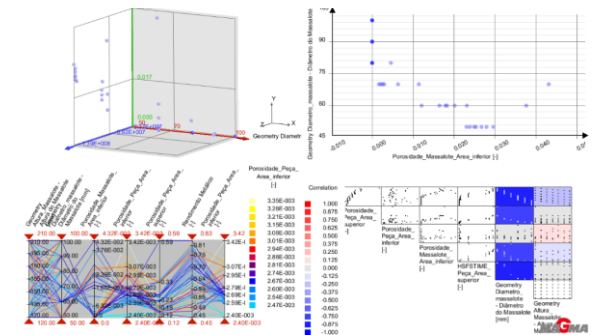
Casting system weight: $7,6 \text{ Kg}$

Metallic yield: $88,2\%$



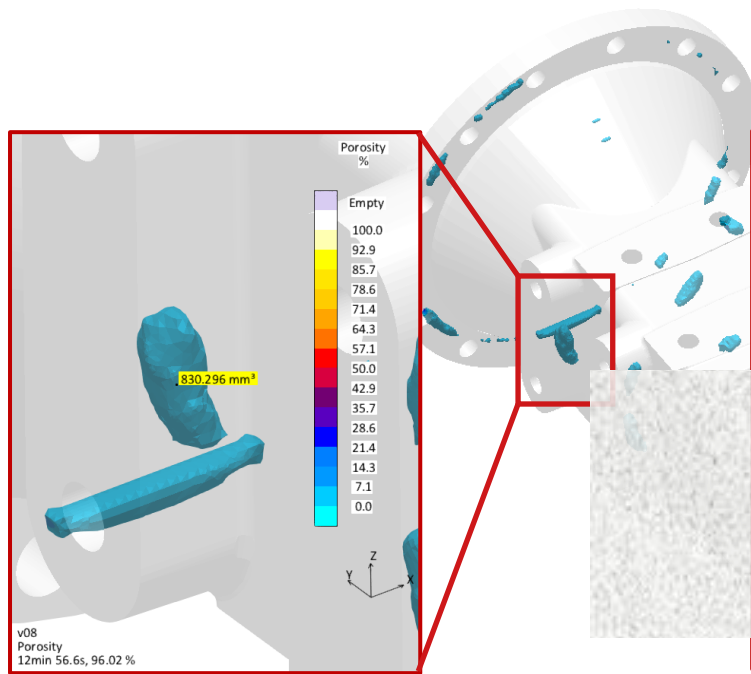
Design Variables

Design Variable	Lower Limit (%)	Upper Limit (%)	Step (%)
☒ Cast Alloy Class - C (Carbon)	3.5	3.7	0.1
☒ Cast Alloy Class - Si (Silicon)	2.5	2.8	0.1



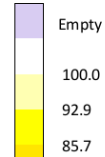
FILLING ANALYSIS – SHRINKAGE POROSITY

Original project

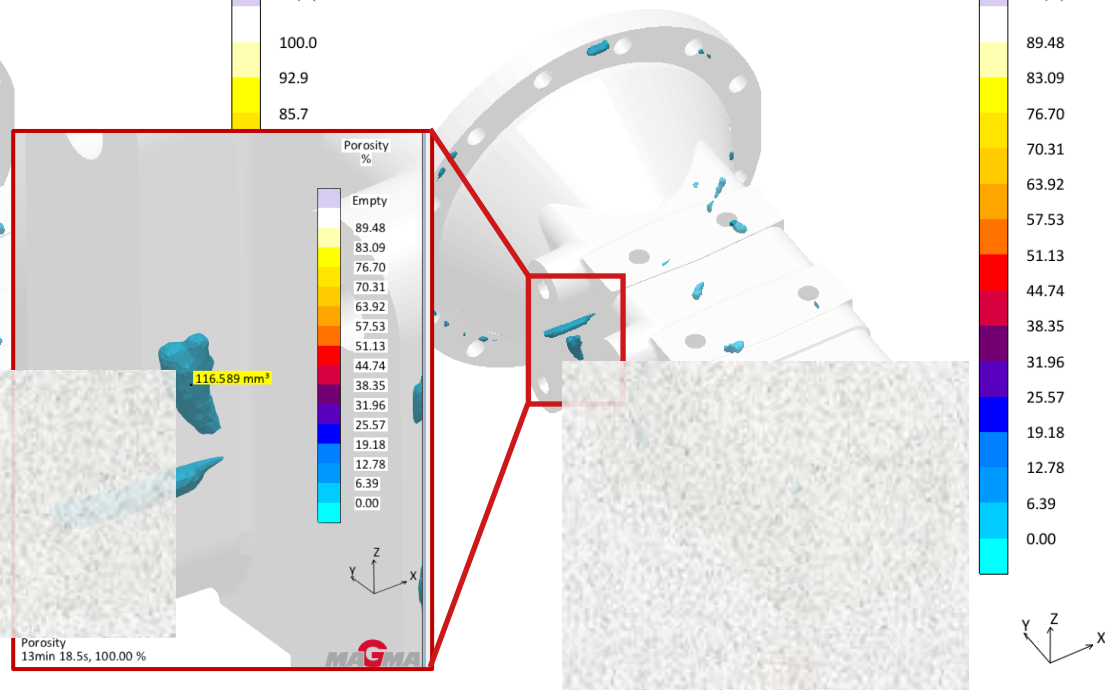


Volume: 830.296 mm³

Porosity %

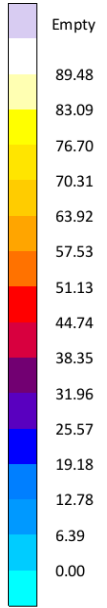


Optimized project



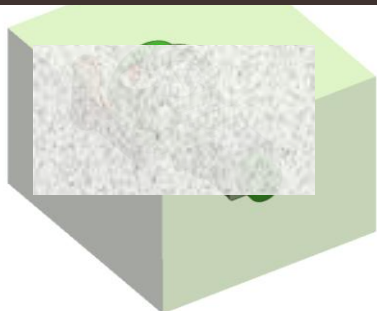
Volume: 116.589 mm³

Porosity %

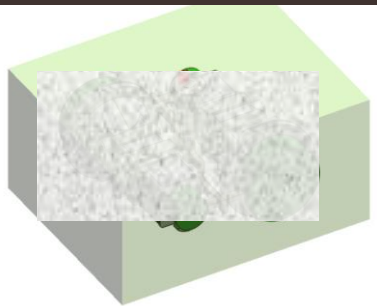


SAND/METAL RATIO - COMPARATIVE

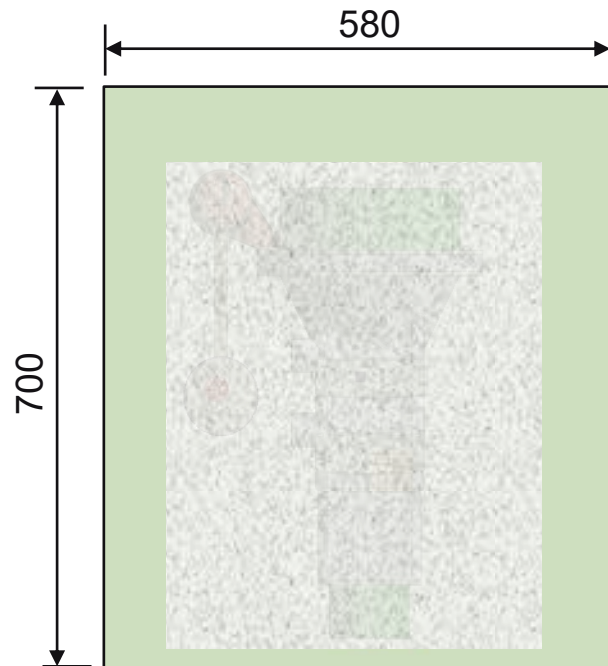
Original project



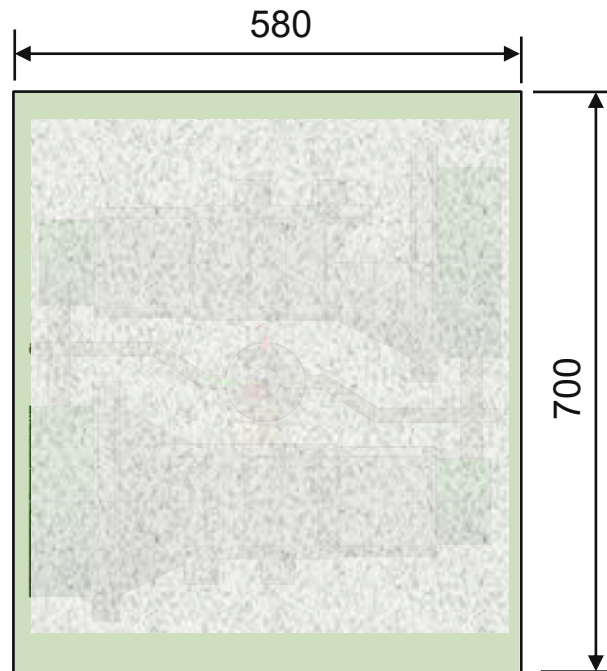
Optimized project



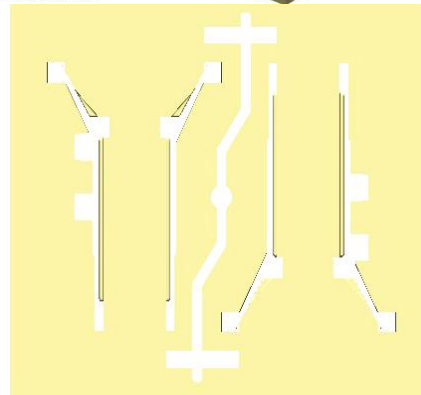
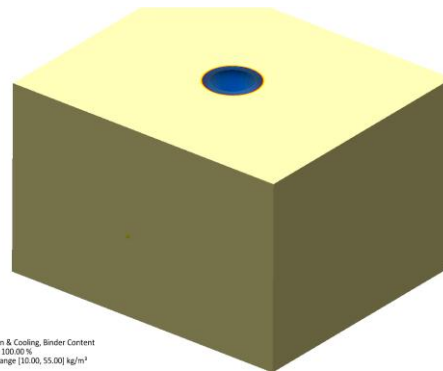
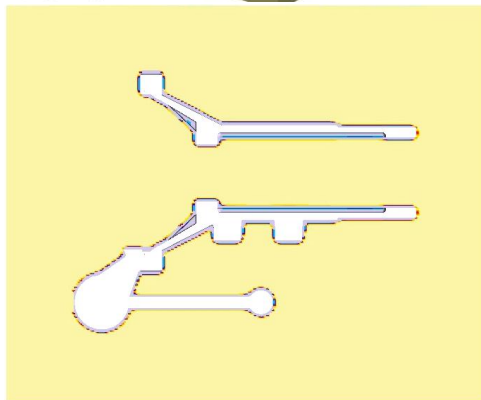
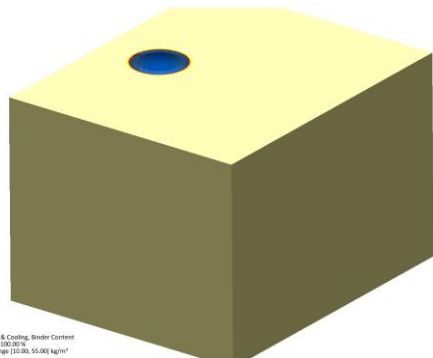
Original project



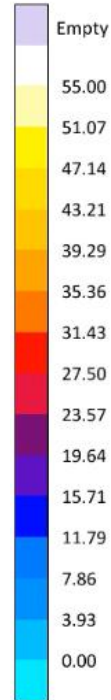
Optimized project



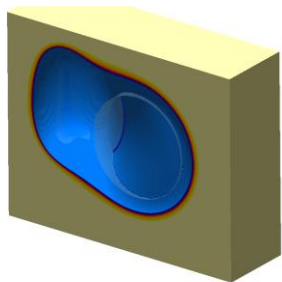
SAND/METAL RATIO



Binder Content
kg/m³



SAND/METAL RATIO



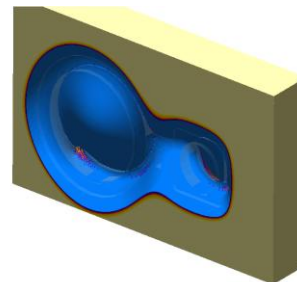
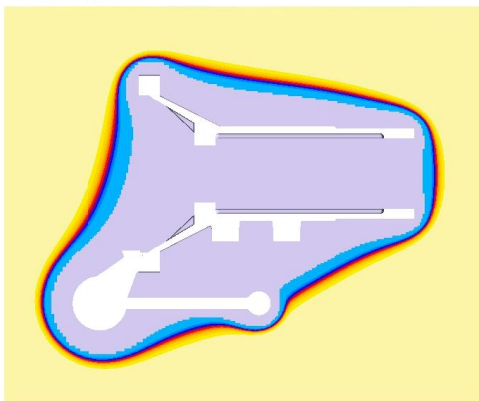
Dimensions:
700 x 580 x 470

Weight:
297,00 Kg

Resin burning:
7,5 / 1

Binder content:
20 %

v37
Solidification & Cooling, Binder Content
3h 50min 0s, 100.00 %
X-Ray on, range [10.00, 55.00] kg/m³



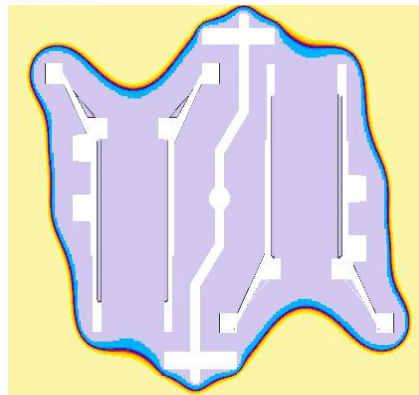
Dimensions:
700 x 580 x 470

Weight:
212,00 Kg

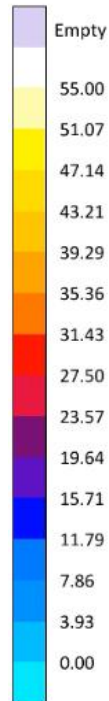
Resin burning:
3,3 / 1

Binder content:
68 %

v39
Solidification & Cooling, Binder Content
3h 50min 0s, 100.00 %
X-Ray on, range [10.00, 55.00] kg/m³



Binder Content
kg/m³

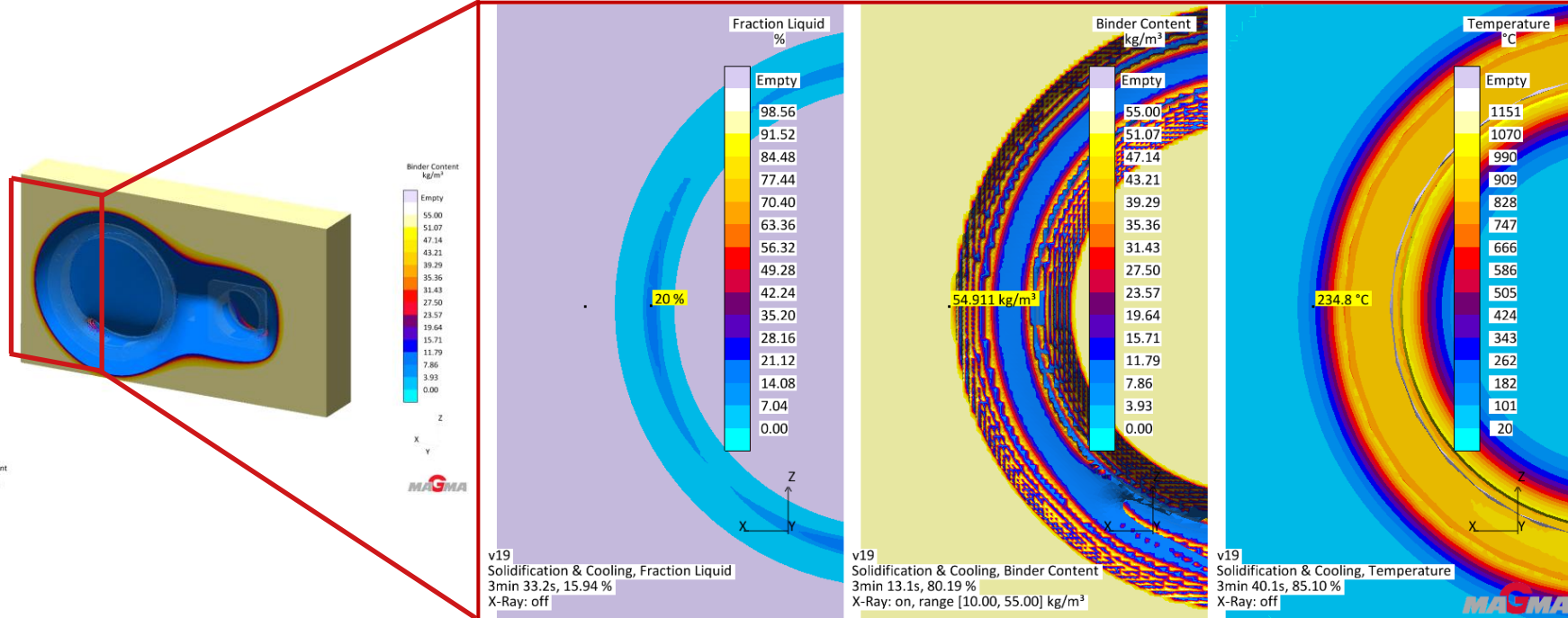


SAND/METAL RATIO

Fraction Liquid

Binder Content

Temperature



TECHNICAL/FINANCIAL RESULT

Original



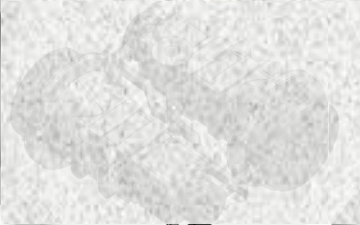
1
Parts /
mold

72,1%
Metallic
Yield

7,5/1
Sand/Metal
Ratio

20 %
Resin
burning

Optimized



2
Parts /
mold

88,2%
Metallic
Yield

3,3/1
Sand/Metal
Ratio

68 %
Resin
burning

MAGMA ECONOMICS

Identifying costs

1° step:

- Identification of costs associated with the manufacturing process

> Total cost of casting alloy

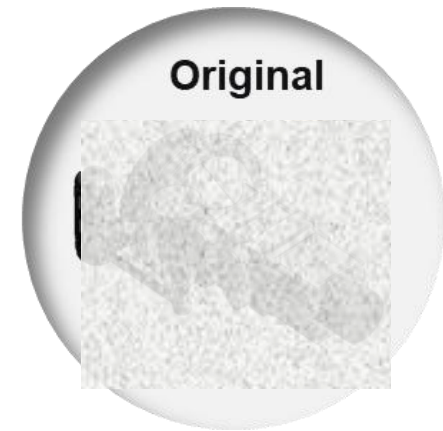
> Total costs of molding

> Total cost of cores

> Total costs of feederneck cleaning

> Total melting costs

> Total melting costs of clamping load



2° step:

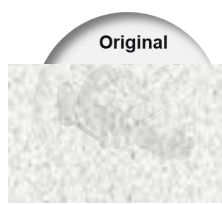
Definition of the costs of each stage

MAGMA ECONOMICS

Separating costs

→ 2° step:

→ Definition of the costs of each stage



▼ Total cost of casting alloy	$f(x)$	278.9624	R\$
▼ Total cost of casting alloy per tone		4,370	R\$/t
Mass of Casting All IDs		23.8036	kg
▼ Total cost raw material		4,370	R\$/t
Mass of Cast Alloy		40.0322	kg

▼ Total cost of molding	$x)$	262.9985	R\$
▼ Unit cost of molding		1	R\$/kg
Mass of Cope Box All IDs		0	kg
Mass of Drag Box All IDs		0	kg
Mass of Sand Mold All IDs		262.9985	kg

▼ Total cost of cores	$x)$	26.7677	R\$
▼ Unit cost of cores		1	R\$/kg
Mass of Core All IDs		26.7677	kg
Mass of Chill All IDs		0	kg

▼ Total cost of feederneck area cleaning		66.5038	R\$
▼ Unit cost of per feederneck area cleaning		0.06	R\$/mm2
Number of Casting Materials		1	

▼ Melting costs	$i)$	40.03	R\$/part
Cost per hour of furnace		1,000	R\$/hour
Melting performance per hour		1,000	kg/hour
Melting costs per part		40.03	R\$/part

▼ Melting costs of the clamping load	$f(x)$	0.3755	R\$
Melting loss		8	%
▼ Costs of the clamping load	$f(x)$	0.751	R\$/kg
▼ Melting costs of the clamping load	$f(x)$	0.671	R\$/kg

> Total cost of casting alloy	$f(x)$	278.9624	R\$
> Total costs of molding	$f(x)$	262.9985	R\$
> Total cost of cores	$f(x)$	26.7677	R\$
> Total costs of feederneck cleaning	$f(x)$	66.5038	R\$
> Total melting costs	$f(x)$	40.03	R\$/part
> Total melting costs of clamping load	$f(x)$	0.751	R\$

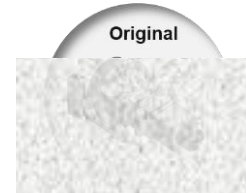
MAGMA ECONOMICS

Separating costs

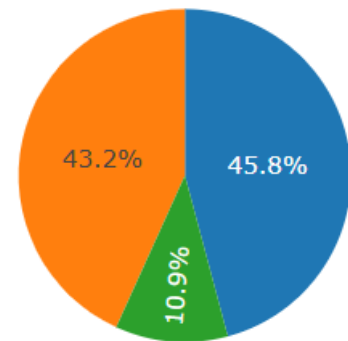
→ 2º step:

→ Definition of the costs of each stage

Total manufacturing cost per part
R\$ 676,01 = USD 112,67



Total cost of manufacturing per part



- Total cost of cast alloy
- Total cost of molding
- Total cost of feederneck area cleaning

▼ Total cost of casting alloy	$f(x)$	278.9624	R\$
▼ Total cost of casting alloy per tone		4,370	R\$/t
Mass of Casting All IDs	🔄	23.8036	kg
▼ Total cost raw material		4,370	R\$/t
Mass of Cast Alloy	🔄	40.0322	kg

▼ Total cost of molding	$f(x)$	262.9985	R\$
▼ Unit cost of molding		1	R\$/kg
Mass of Cope Box All IDs	🔄	0	kg
Mass of Drag Box All IDs	🔄	0	kg
Mass of Sand Mold All IDs	🔄	262.9985	kg

▼ Total cost of cores	$f(x)$	26.7677	R\$
▼ Unit cost of cores		1	R\$/kg
Mass of Core All IDs	🔄	26.7677	kg
Mass of Chill All IDs	🔄	0	kg

▼ Total cost of feederneck area cleaning	$f(x)$	66.5038	R\$
> Unit cost of per feederneck area cleaning		0.06	R\$/mm2
Number of Casting Materials	🔄	1	

▼ Melting costs	$f(x)$	40.03	R\$/part
Cost per hour of furnace		1,000	R\$/hour
Melting performance per hour		1,000	kg/hour
Melting costs per part	$f(x)$	40.03	R\$/part

▼ Melting costs of the clamping load	$f(x)$	0.3755	R\$
Melting loss		8	%
▼ Costs of the clamping load	$f(x)$	0.751	R\$/kg
▼ Melting costs of the clamping load	$f(x)$	0.671	R\$/kg



Cost comparisons

MAGMA ECONOMICS

Cost comparison

Part 38% cheaper

Original



Total cost of casting alloy	$f(x)$	278.9624	R\$
Total costs of molding	$f(x)$	262.9985	R\$
Total cost of cores	$f(x)$	26.7677	R\$
Total costs of feederneck cleaning	$f(x)$	66.5038	R\$
Total melting costs	$f(x)$	40.03	R\$/part
Total melting costs of clamping load	$f(x)$	0.751	R\$
Total cost of manufacturing per part	$f(x)$	676.0133	R\$

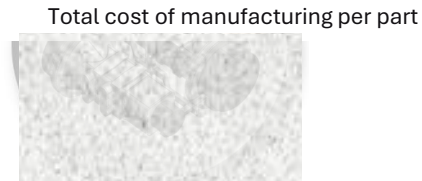
Metal yield
72%
USD 112,67 / part



Total cost of casting alloy	$f(x)$	543.2523	R\$
Total costs of molding	$f(x)$	240.1403	R\$
Total cost of cores	$f(x)$	53.7018	R\$
Total costs of feederneck cleaning	$f(x)$	130.8119	R\$
Total melting costs	$f(x)$	76.8	R\$/part
Total melting costs of clamping load	$f(x)$	0.3755	R\$
Total cost of manufacturing per part	$f(x)$	522.5409	R\$

Metal yield
75%
USD 87,09 / part

Optimized



Total cost of casting alloy	$f(x)$	497.346	R\$
Total costs of molding	$f(x)$	210.5545	R\$
Total cost of cores	$f(x)$	53.5008	R\$
Total costs of feederneck cleaning	$f(x)$	0	R\$
Total melting costs	$f(x)$	66.26	R\$/part
Total melting costs of clamping load	$f(x)$	0.3755	R\$
Total cost of manufacturing per part	$f(x)$	414.0184	R\$

Metal yield
88%
USD 69,00 / part



CO₂ Emissions

MAGMA ECONOMICS

42% less CO₂ emissions

Original

> 	Estimated CO ₂ per part	6.776	kg CO ₂ eq/part
> 	Estimated CO ₂ per melting	10.724	kg CO ₂ eq/part
> 	CO ₂ emission estimation during filling and solidification	1,072.968	kg CO ₂ eq/part
	Estimated CO ₂ emission per part	1,090.468	kg CO ₂ eq/part

USD 105,20 / part
CO₂eq 1090 kg / part

> 	Estimated CO ₂ per part	t	6.784	kg CO...
> 	Estimated CO ₂ per melting	t	12.958	kg CO...
> 	CO ₂ emission estimation during filling and solidification	t	1,296.375	kg CO...
	Estimated CO ₂ emission per part	t	1,316.117	kg CO...

USD 78,41 / part
CO₂eq 658 kg / part

Total costs of feederneck cleaning

Optimized

> 	Estimated CO ₂ per part	6.771	kg CO ₂ eq/part
> 	Estimated CO ₂ per melting	12.43	kg CO ₂ eq/part
> 	CO ₂ emission estimation during filling and solidification	1,243.539	kg CO ₂ eq/part
	Estimated CO ₂ emission per part	1,262.74	kg CO ₂ eq/part

USD 71,13 / part
CO₂eq 631 kg / part

MAGMA TODAY

Where you find Castings, you find MAGMA!

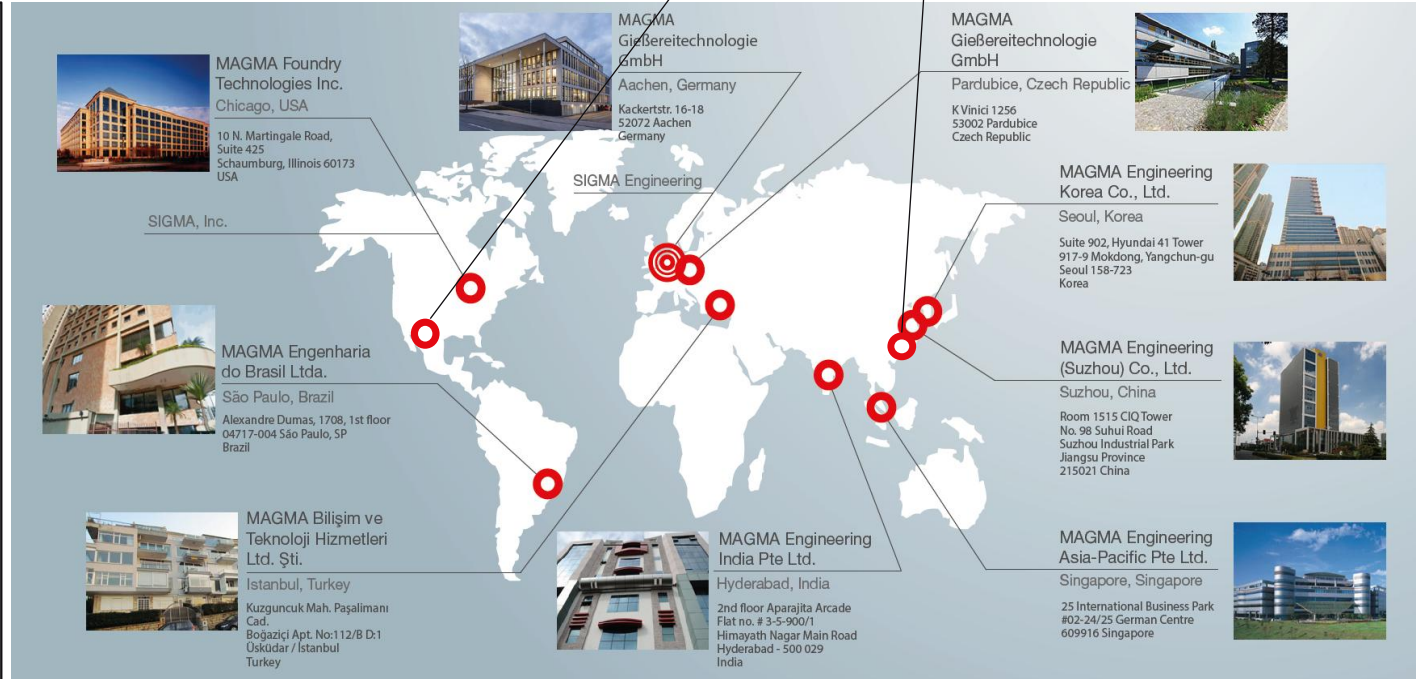
2025
New Mexico and
Ningbo (China) offices

10 subsidiaries, 350+ employees, 20 distributors

65 software developers + R&D cooperations

Up to 10 funded R&D projects simultaneously

Founded in 1988, today **Dr. Flender Holding**, (MAGMA, SIGMA, Flow Sciences)



Thank you for your attention.

Jan Eilers

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