



CAST MAN



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- **Copper Die-casting**
- **Brass Die-casting**
- **Salt-core Die-casting**
- Competitive Power

- **Location**

- Seoul Office : Seoul, Korea
- Factory/HQ : Hwaseong-si, Gyeonggi-do, Korea

- **Business Fields**

- Copper(Brass) Die casting
- Salt core Die casting (Aluminum alloy)

- **Competitive Edges**

- Mass production performance for Copper die-casting
- Leading-edge technology for Salt core
- Optimized Design Capability for mass production
- Numerical analysis : CFD, FEA



Preparing

1997. 11 STI C&D CO., LTD. Established

☞ Engineering consulting in casting & fluid dynamics & heat transfer

Beginning

2010. 09 CASTMAN CO., LTD. Established

☞ Copper rotor R&D request from KERI

2011. 05 R&D Center Established

2011. 06 ISO 9001, ISO 14001 Certificates acquired

2015. 06 Mass production for Copper rotor

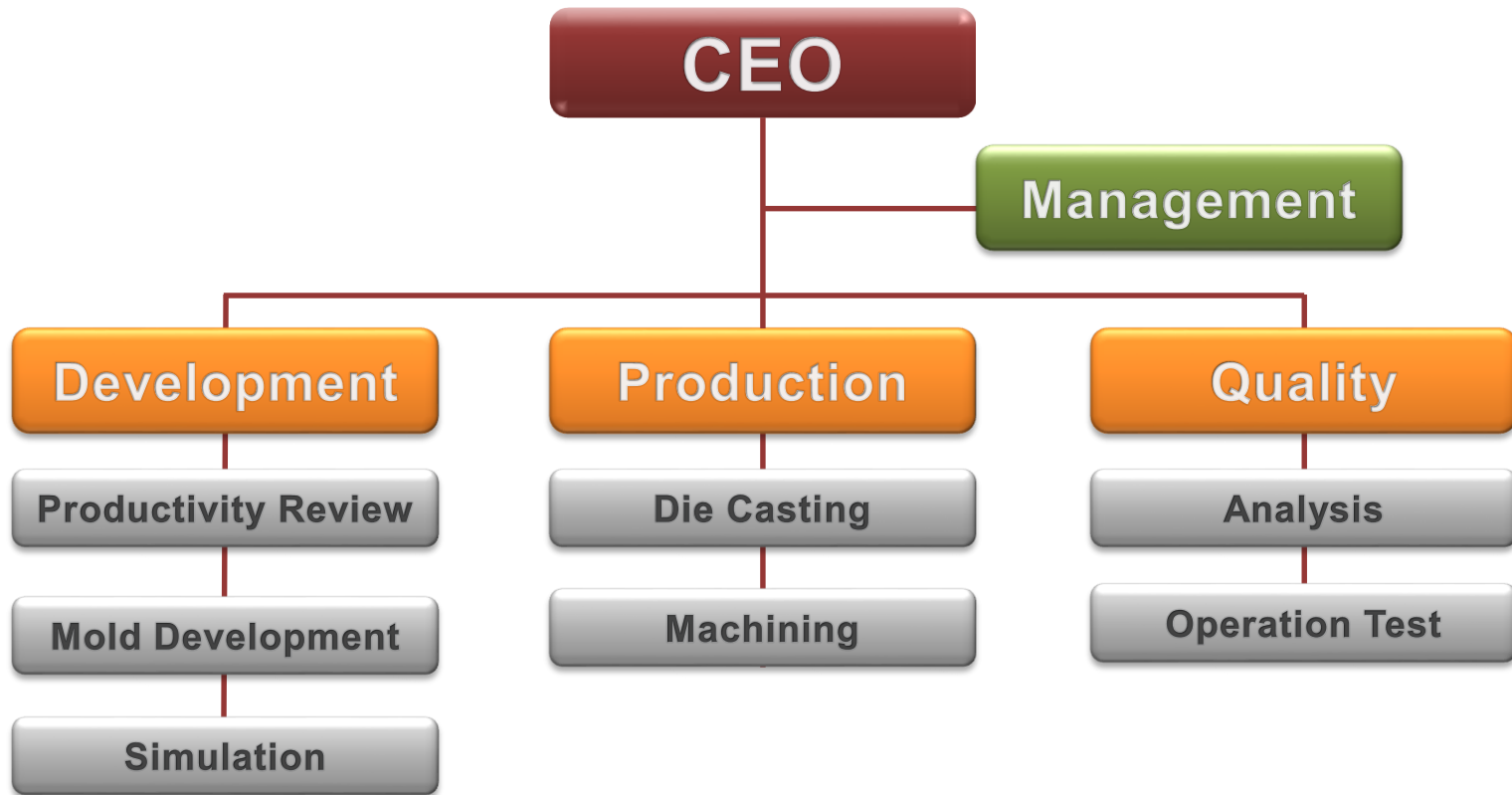
2016. 06 Mass production for Brass Part

2017. 12 NET certification from Government (Salt core)

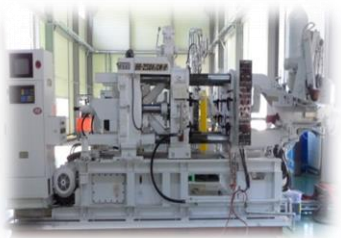
2019. 04 Mass production for Copper heat sink (Cu Die casting)

2019. 11 Mass production for Salt core part (Al Die casting)

Growth



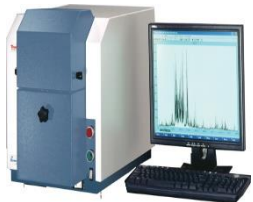
Equipment (Production)



Field	Machine	Spec.	Qty	Note
Casting	High Pressure	125 ton	1	Al
		250 ton	1	Cu
		350 ton	1	Cu
		350 ton	1	Al
		650 ton	1	Al
Machining	Salt casting	-	1	Salt
	MCT	-	1	-
	Tapping Center	-	4	-
	Lathe, Milling, EDM	-	1	Mold repair
Finishing	Grinding	-	1	-
	Shot blaster	-	1	Hanger, Apron

Equipment (Quality)

Field	Item	Spec.	Qty	Vendor
Analysis	X-ray (CT)	160KV	1	SEC Co., Ltd.
	3D measuring instrument	700X800X500(mm)	1	Dukin Co., Ltd.
	Component Analysis M/C	Al & Cu Alloy	1	ARL
	Pin-hole Tester	Decompression	1	KN Tech
	Casting Simulation S/W	FLOW-3D	1	FLOW SCIENCE
	Microscope	250X150X200(mm)	1	3D FAMILY
	Universal tensile tester	100kN	1	KMT
	Electro-Conductivity meter	60KHz	1	FIRST ELECTRONIC
	Infrared Thermometer	-40°C~1,500°C	1	-
	Slot Inspector	Cu & Al	1	-
	Digital Thermometer	-200°C~1,360°C	1	-



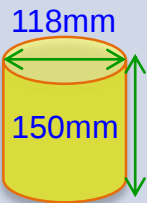
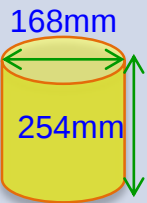
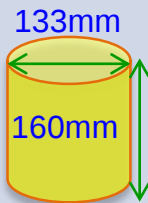
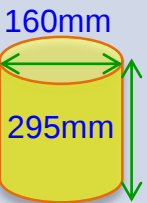
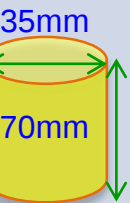
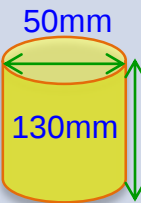
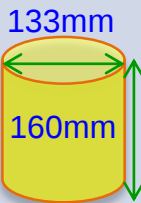
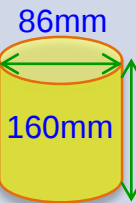
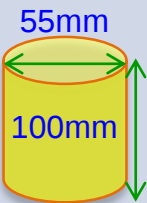
Copper / Brass Die Casting

Copper Rotors –History

Year	Clients	Application	Spec.
2010	KERI	High speed	3KW,10KW
2012	KERI	EV	30KW
2012	Hyundai	EV	100KW
2013	KERI	High speed	60KW
2014	GEM	High speed	2.5KW
2014	Hyosung	Industrial	2.2KW,15KW
2014	KERI	High speed	30KW
2015	Hyosung	Industrial	1.5KW*,2.2KW,4KW
2015	EV	EV	EV
2016	Hyundai	Generator/starter	-
2016	KERI	EV	59KW
2018	KERI	EV	100KW
2018	KITECH	Industrial	IE4

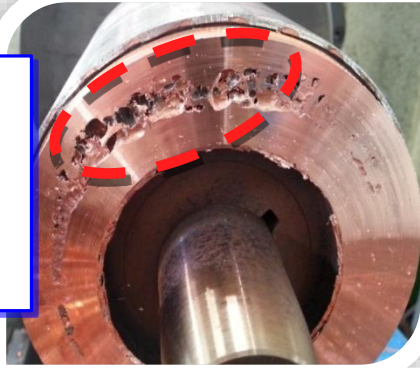
* Mass product

Copper Rotors - Size

App.	Industrial		EV		High Speed					Comp ressor
										
	2.2KW	15KW	30KW	100KW	2.5KW	3KW	10KW	30KW	60KW	0.75KW
Clients	Hyosung	Hyosung	KERI	Hyundai	GEM	KERI	KERI	KERI	KERI	Japan
Size										
Casting M/C	350T	650T	350T	650T	250T	250T	350T	350T	350T	250T

Copper Rotors – Porosity

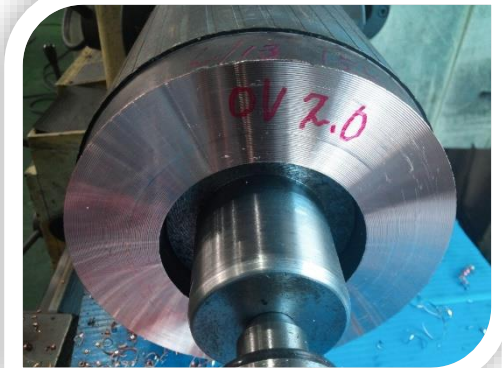
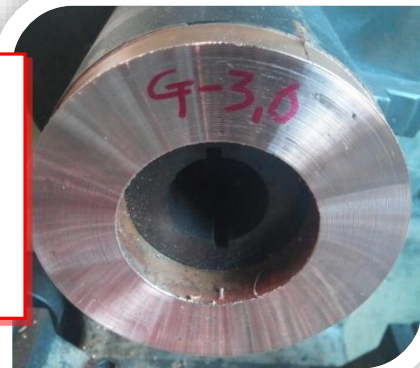
China Y



Europe S



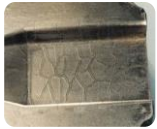
CASTMAN



➤ CASTMAN : smaller & less porosity

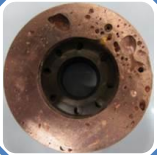
Difficulties in Cu HPDC

Mold Life



- Damage to die due to continuous exposure to thermal stress
- Thermal stress due to temperature difference in die and molten metal
- Melt temperature : 1350°C, Die temperature : 2~300 °C
- Temperature difference of approx. 1000°C
- Shorter die life span compared to dies for aluminum die-casting

Porosity



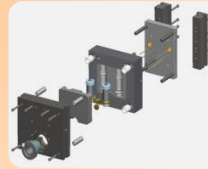
- Absence of copper die-casting designs
- Unstable die filling due to high temperature of molten metal
- Increase in shrinkage defects and porosity

Operation Condition



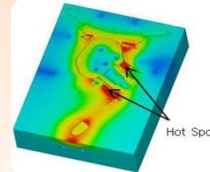
- Difficulty in operability due to high working temperature
- Absence of standards in copper die-casting process standards
- Difficulty in building specialized equipment for copper die-casting

Increase Mold Life



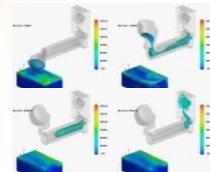
- Development of surface treatment technology for die life extension
- Research and selection of die metal
- Structural design of dies and computer simulation

Decrease Porosity



- Preliminary research through computer simulation
- Heat flow, Solidification, Structural Analysis
- Optimized copper die-casting designs

Process Optimization



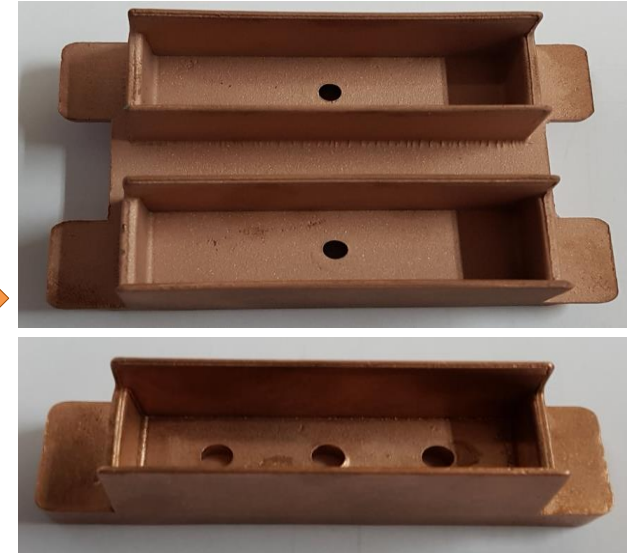
- Optimization of copper die-casting variables
- Preliminary research of copper die-casting processes
- Standardization of copper die-casting processes

Copper Parts – Battery module

Extrusion



Die casting



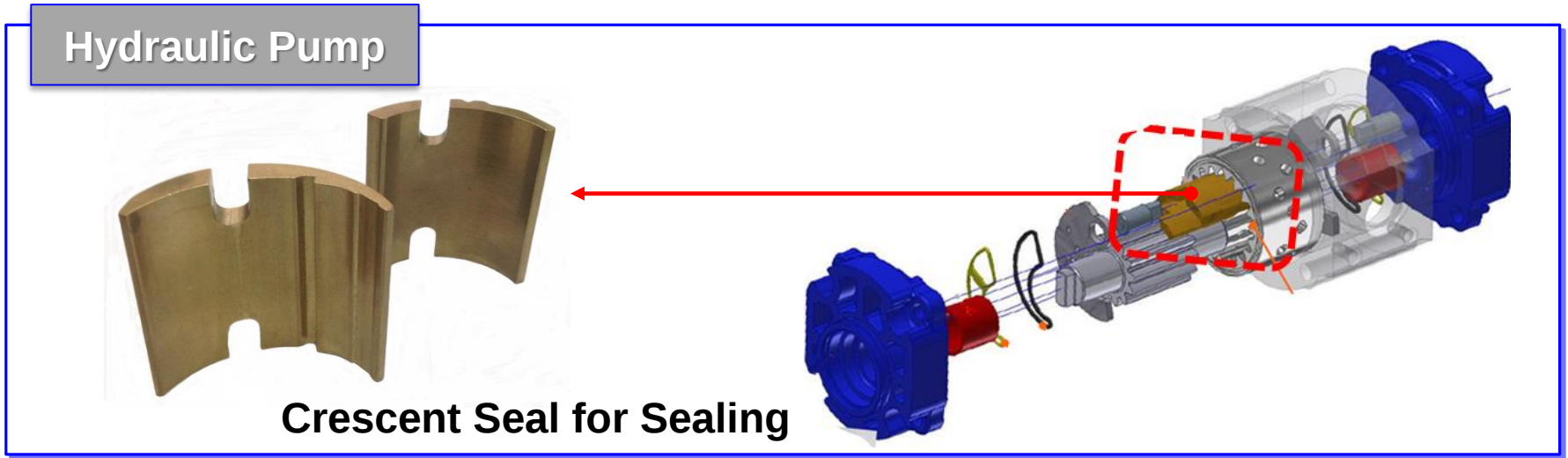
- Shape change for reinforcement
- Weight reduction
- Mass production

Copper Parts – Heat sink



- Heat sink for super-computer
- Replacing machined workpieces with casting + machining
- Cost reduction
- Design change suitable for casting
- Mass production

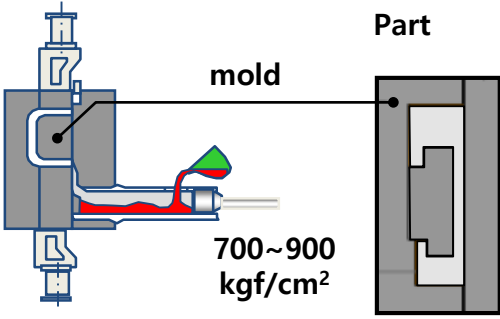
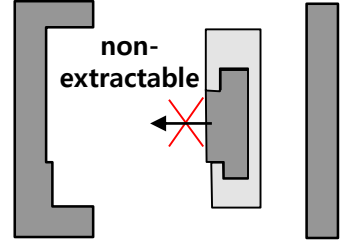
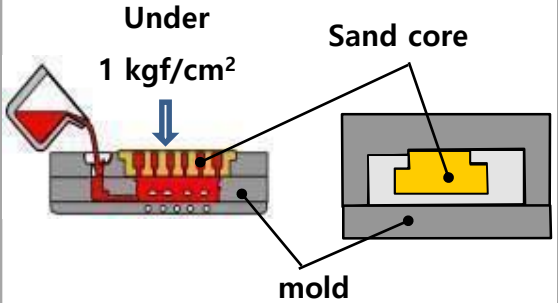
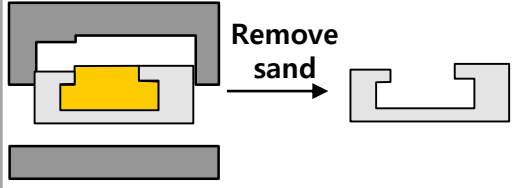
Brass Parts : Seal



- Crescent Seal in hydraulic pump
- Replacing machined workpieces with casting + machining
- Cost reduction
- Mass production

Salt Core

Salt core – Comparison to gravity casting

-	Schematic diagram	Under cut	Cycle Time	-
High pressure Die casting		unable under-cut shape 	Under 60sec	High speed High Pressure → Sand core crushed
Gravity Casting		Under-cut  Remove sand Remove the sand core by vibrations	About 500sec	Low speed Low press → Sand core

Salt core – High strength salt core

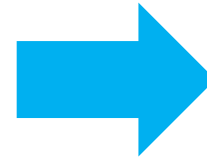
HPDC vs LPDC/Gravity casting

Productivity ↑
Thickness

+

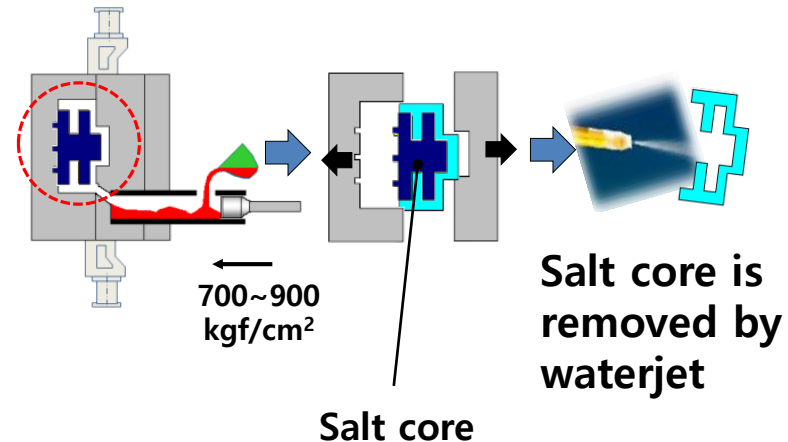
Design freedom

-	High pressure	Low pressure Gravity
Productivity	++	-
Thickness	+	-
Roughness	+	-
Precision	++	-
Design	-	++
Material	--	+



?

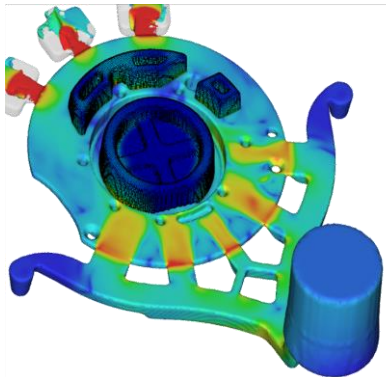
High strength salt core
(a mixture of industrial salts)



- ☐ Increase freedom of design
 - ☞ under-cut is acceptable in die casting
- ☐ Cost reduction
 - ☞ assembly cost (2piece → 1piece)
 - ☞ machining cost (assembled face, near net shape)
- ☐ Improved reliability
 - ☞ 2piece → 1piece
 - ☞ water proof, leaking
- ☐ Weight reduction by thin wall
 - ☞ 4~8mm → 2mm~4mm
- ☐ Better surface roughness

Salt core – proto type

Oil pump Housing



Turbo charger housing



Knuckle

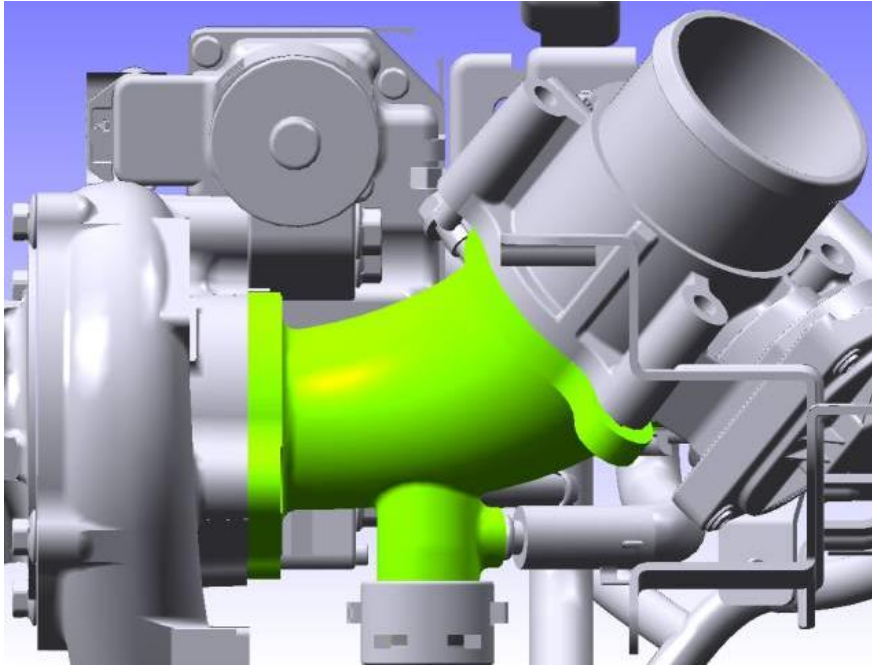


Water pump housing



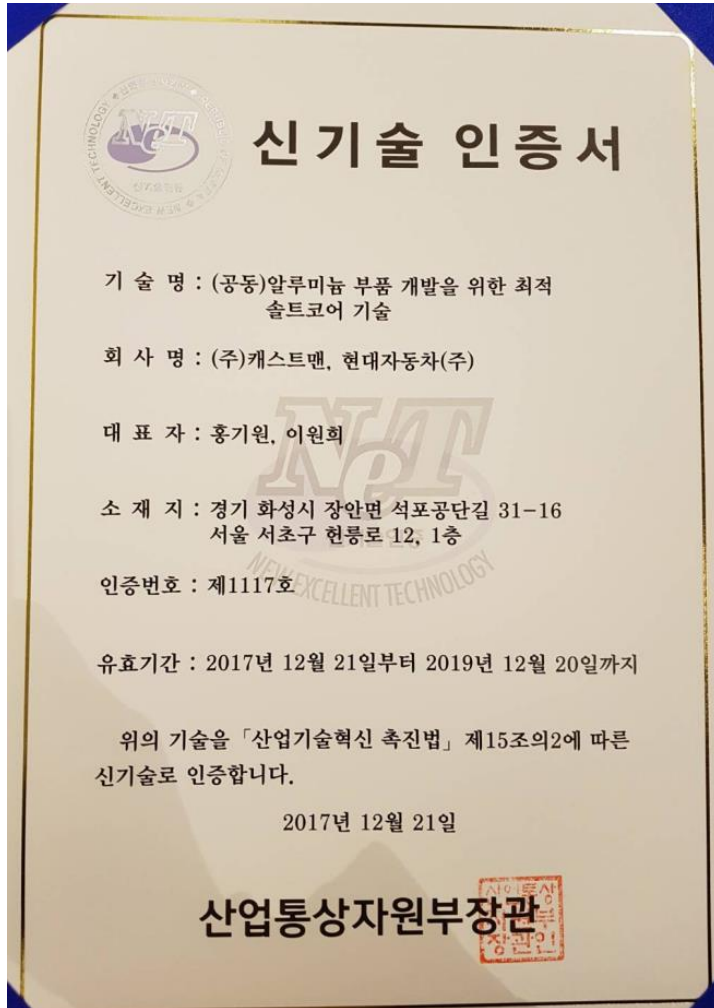
More than 10 items with Hyundai Motors

Salt core – EGR Mixer



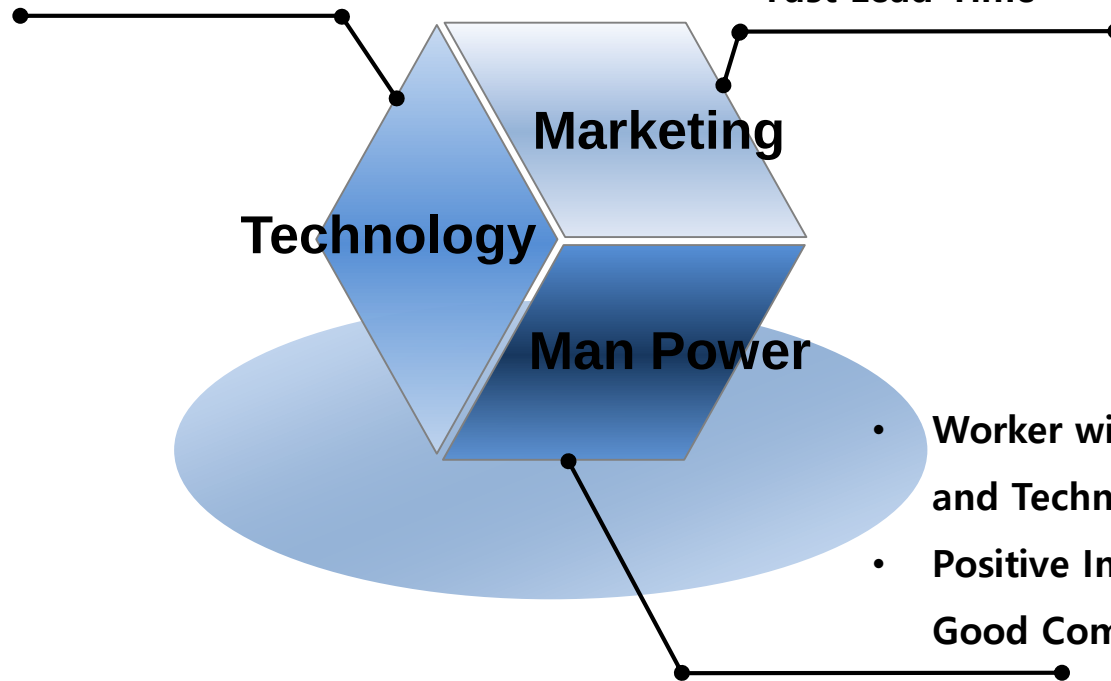
- EGR Mixer for turbo charger (Hyundai Motors)
- Replacing gravity casting with high pressure die casting
- Cost reduction
- Mass production

Salt core – NET certification (2017.12)



Competitive Power

- **Vertical Integration**
(Mold Design, Simulation, Die Casting, Machining)
- **Total Solution Provider (Cu, Brass, Salt, Al)**
- **Analysis Equipments(CT, Spectrometer, CMM)**
- **Cost price competitiveness**
High Yield Rate and High Operation Ratio
- **Fast Lead-Time**



Competitive Power : High Quality

Automotive

Pinion housing



Weight: 2,000g

Connector Housing for EV car



Weight: 97g

Spool for Safety Belt



Weight: 110g

Connector Housing for EV car



Weight: 85g

Competitive Power - Quality



**ISO 14001
Quality Management
System**



**ISO 9001
Quality Management
System**



**IATF 16949
Quality Management
System**

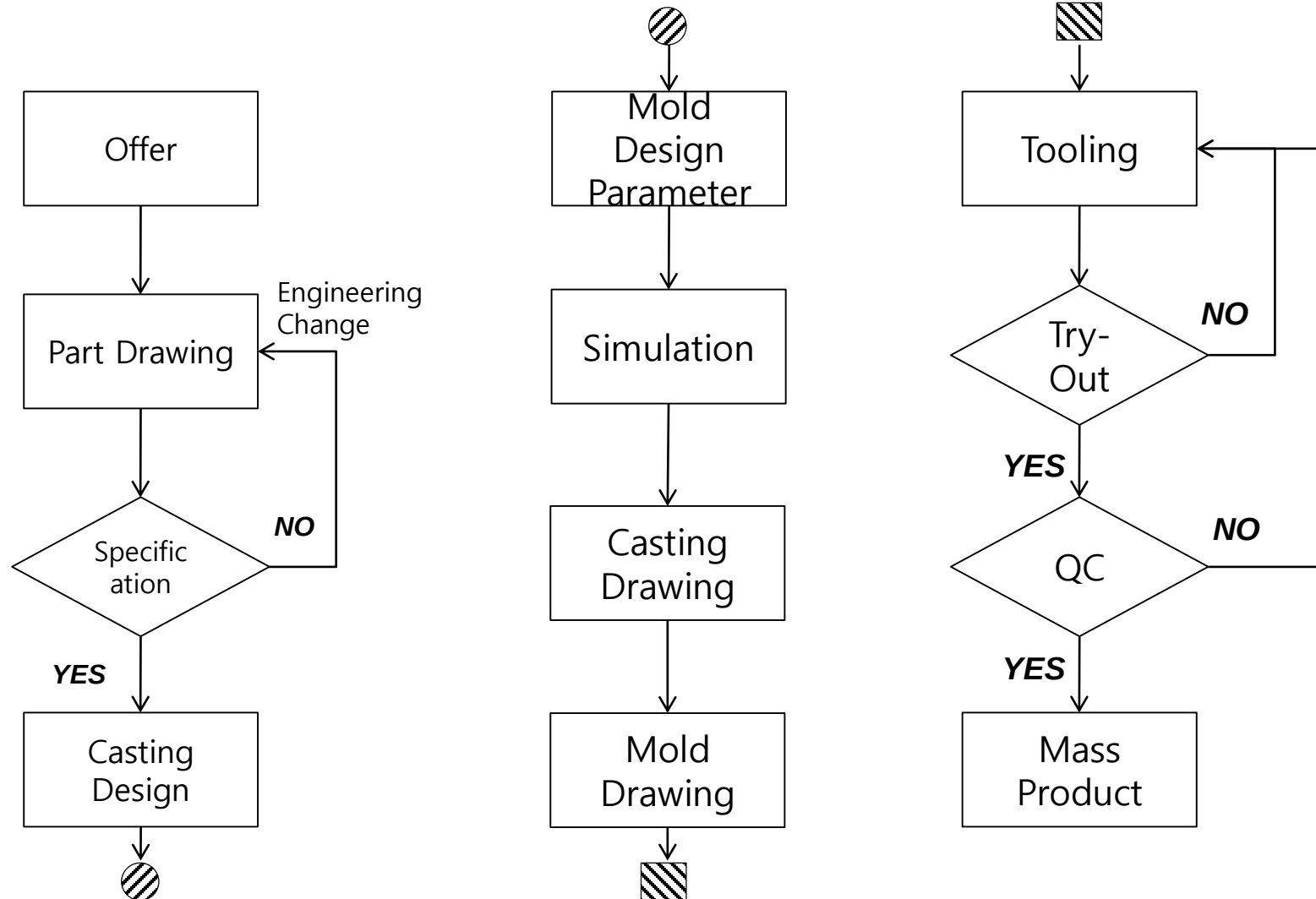
Thank you

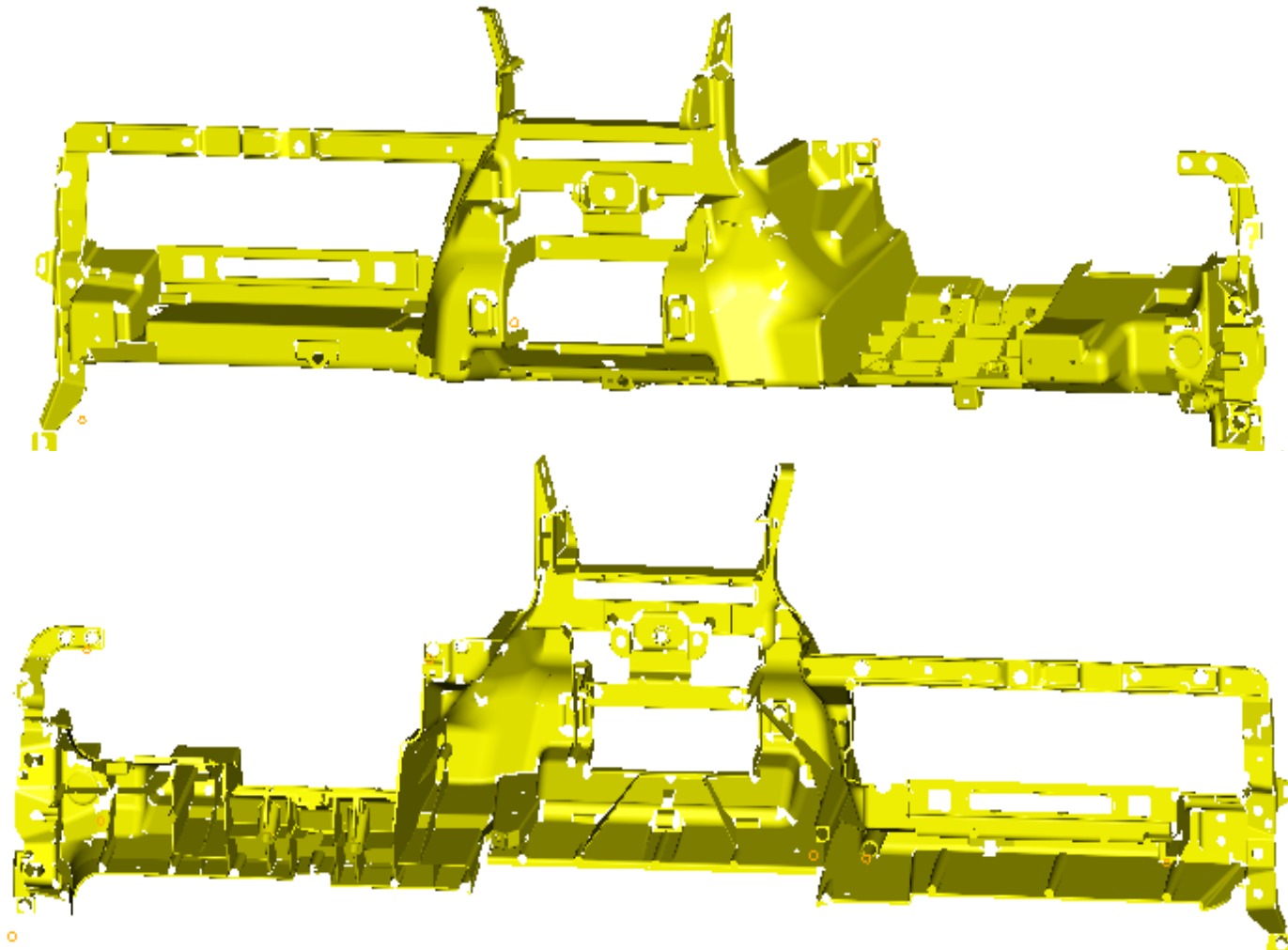


Appendix

Development Process

Development Process : Flow Chart



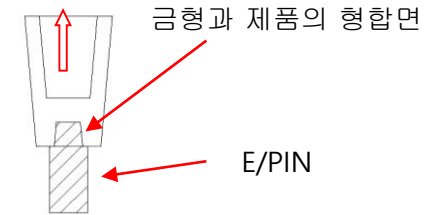
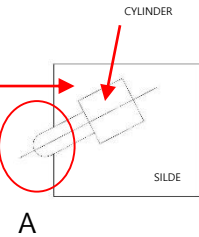


13) 1안
SILDE 안에 CYLINDER 설치
금형 구조가 복잡해지나 이론적으로 가능

=>설비의 CYLINDER 작동 순서를
정의해야함
정의 안될때 A부 PIN 파손될 가능성 있음

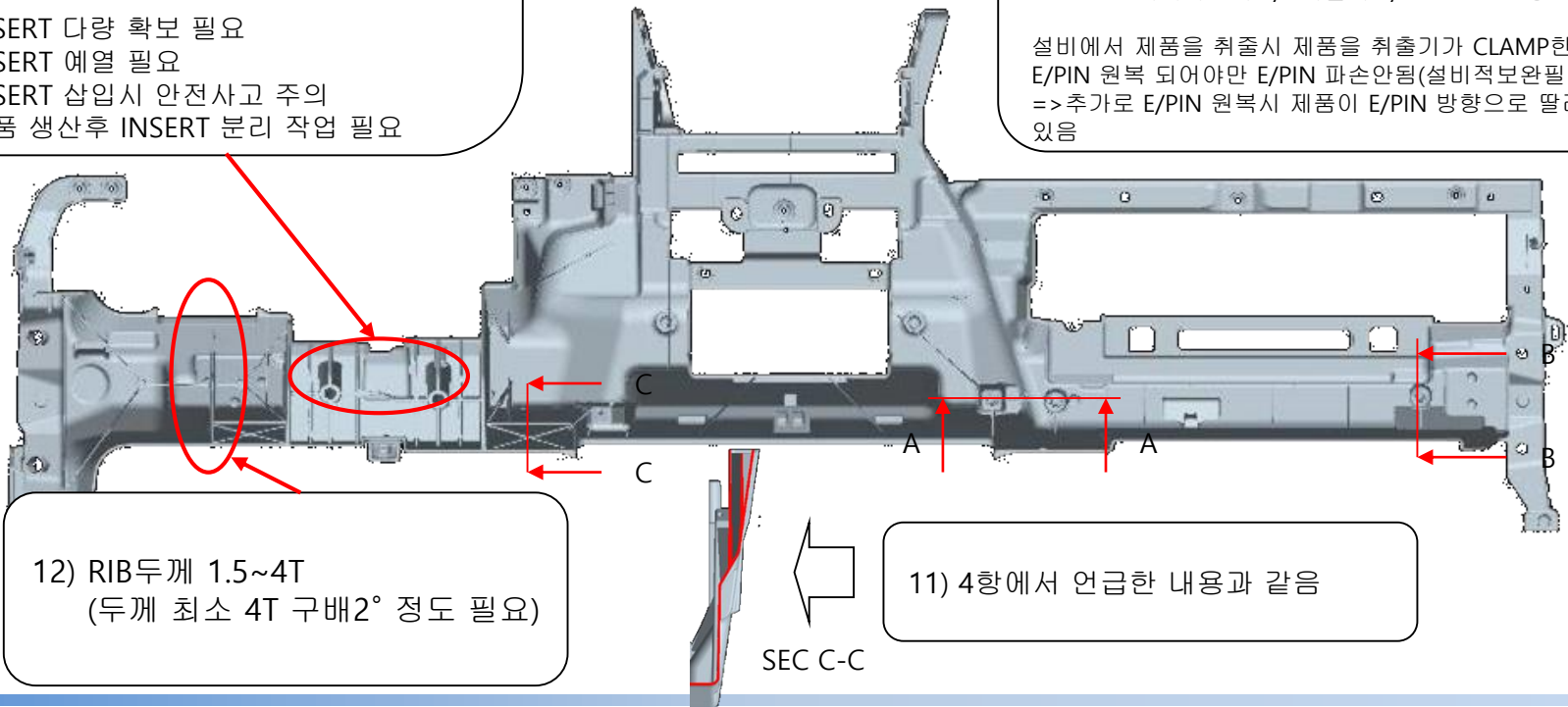
2안
INSERT를 삽입후 생산

=>INSERT 다량 확보 필요
INSERT 예열 필요
INSERT 삽입시 안전사고 주의
제품 생산후 INSERT 분리 작업 필요



10) *고정축 BOSS 형태로 구조 취약
파손 가능(4항과 동일현상)
*성형 불량 예상(AIR VENT 부족)
*가동축 E/PIN 설치시 CORE 형상
포함 되어야하며 E/J 취출시 E/PIN 파손 가능

설비에서 제품을 취출시 제품을 취출기가 CLAMP한후
E/PIN 원복 되어야만 E/PIN 파손안됨(설비적보완필요)
=>추가로 E/PIN 원복시 제품이 E/PIN 방향으로 떨어울수
있음



12) RIB두께 1.5~4T
(두께 최소 4T 구배 2° 정도 필요)

11) 4항에서 언급한 내용과 같음

SEC C-C

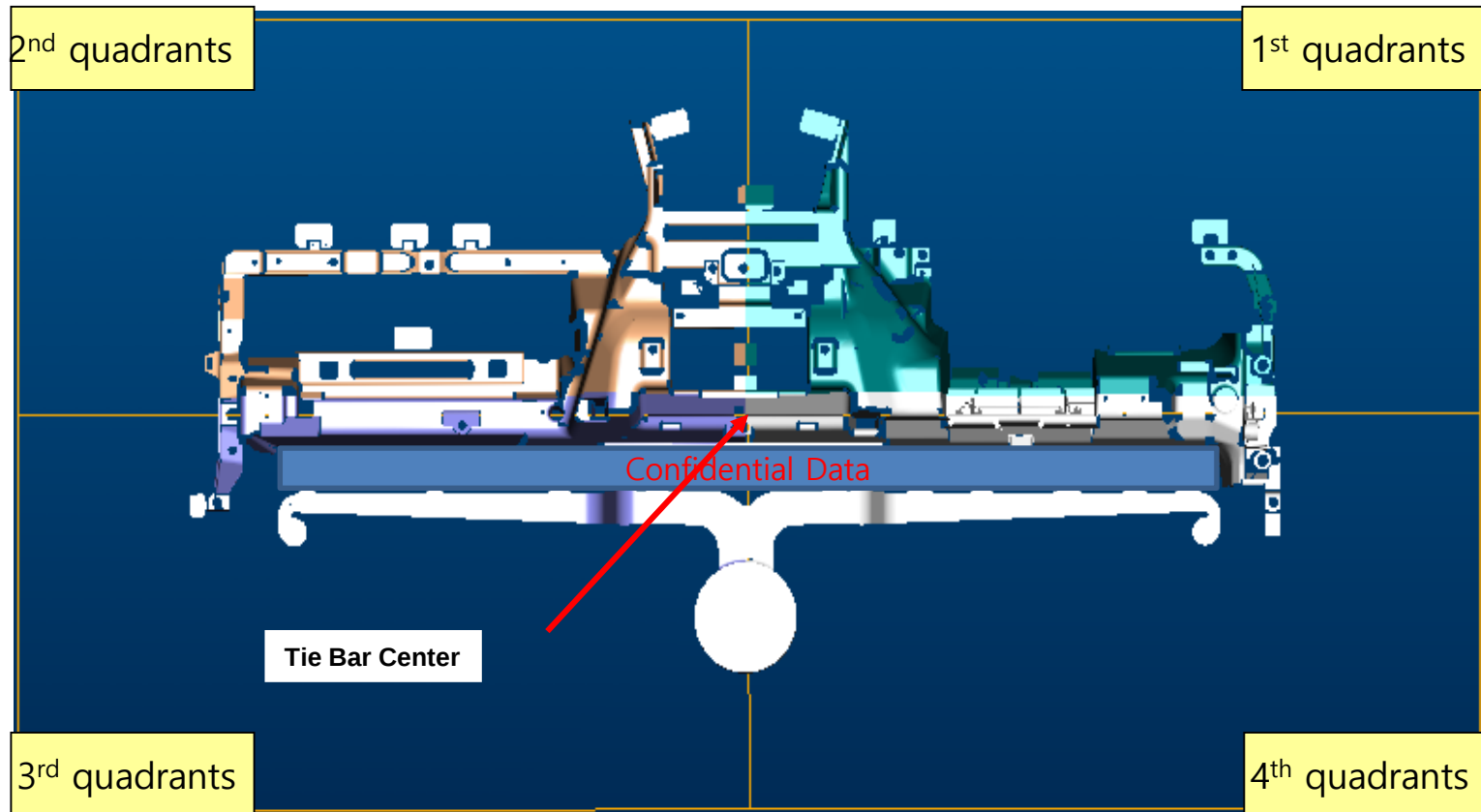
Development Process : Parameters for Mold design

- Runner and gate system
 - Area, filling time, gate speed, plunger speed, ...
- Cooling system
 - Cooling channel : diameter, length, type (spot, line)
 - Coolant temperature, mold temperature, melt temperature
- Thermal expansion & deformation
- Clamping force (Tie bar component)
- Mold base thickness & Deformation
- Eject pin force
- Casting conditions
- Etc.

Development Process : Parameters for Mold design

Index	Result
Part Weight	6.1kg
Mean Thickness	3.0mm
Sleeve Diameter	140mm
Gate Area	1492.5mm ²
Gate Size(t x w)	2.5mm x 597mm
Plunger High Velocity	3000mm/sec
Gate Velocity	70000mm/sec

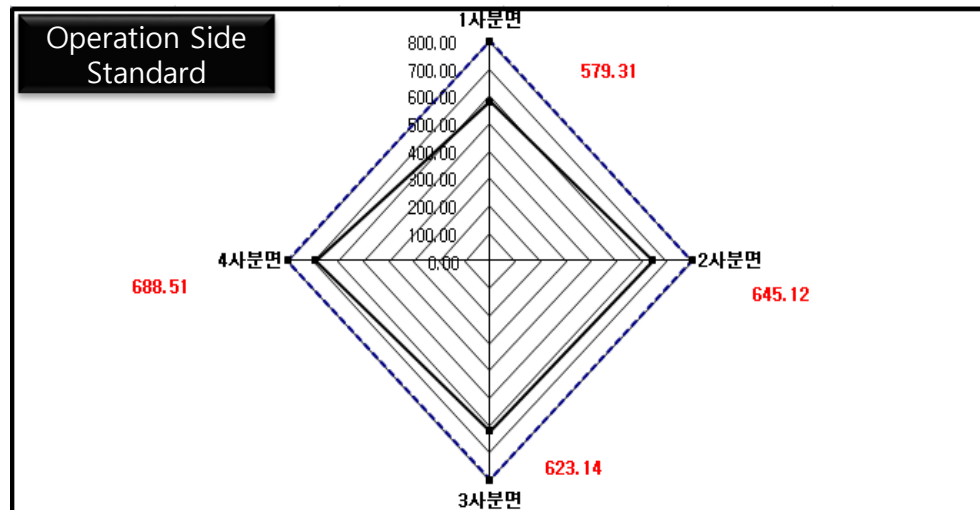
Development Process : Tie Bar Clamping Force



Development Process : Tie Bar Clamping Force

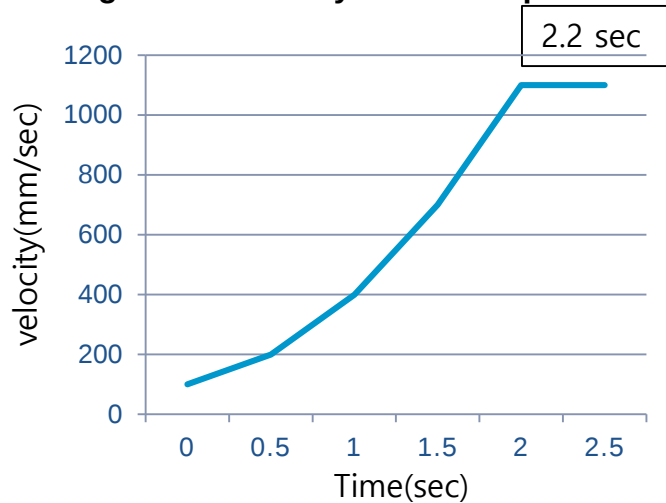
Casting Pressure : 700Kgf/cm²

Index	Tie Bar Force / Safety Factor 20%(ton)	Clamping Force Rate(%)	Clamping Force Rate(%) (Safety Factor 20%)
1 st Quadrant	579.31 / 695.17	72	87
2 nd Quadrant	645.12 / 774.14	81	97
3 rd Quadrant	623.14 / 747.77	78	93
4 th Quadrant	688.51 / 826.21	86	103



Material : AM60

Plunger Low Velocity : Multi Step

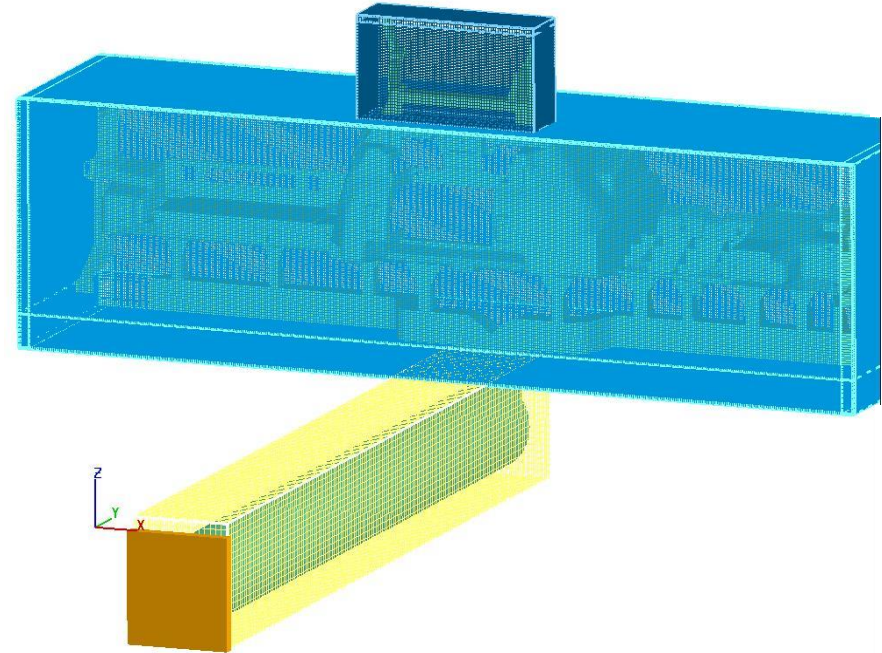


Plunger High Velocity : 3,000mm/sec

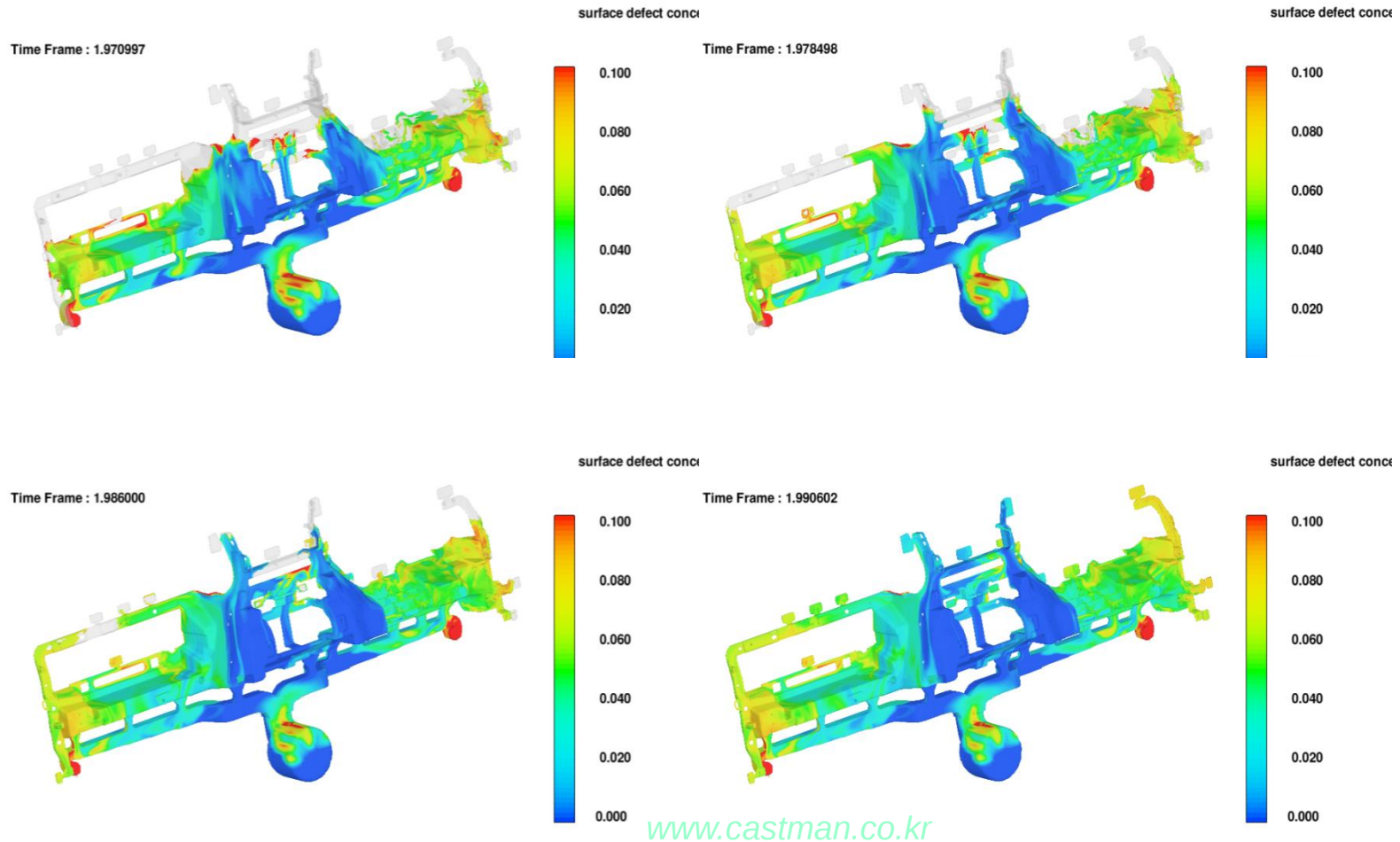
Molten Metal : 680 °C

Mold Temp. : 250 °C

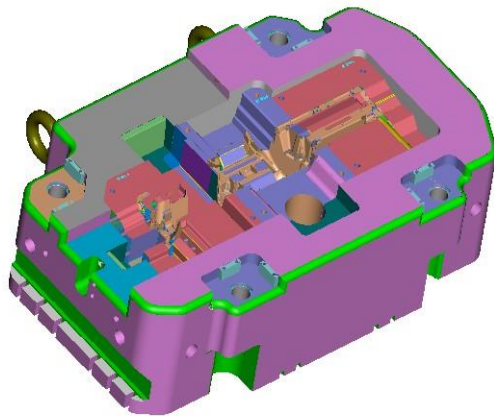
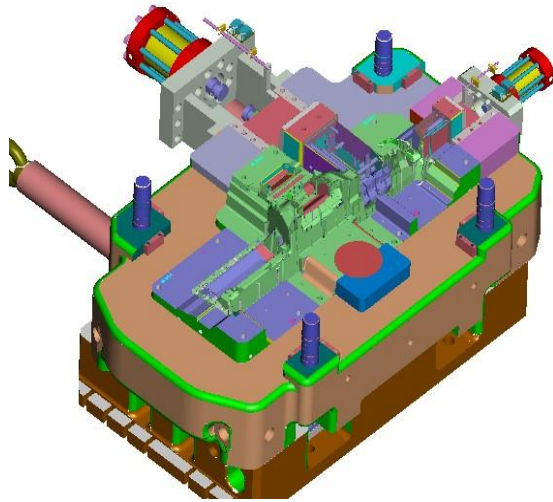
Filling Rate : 40%



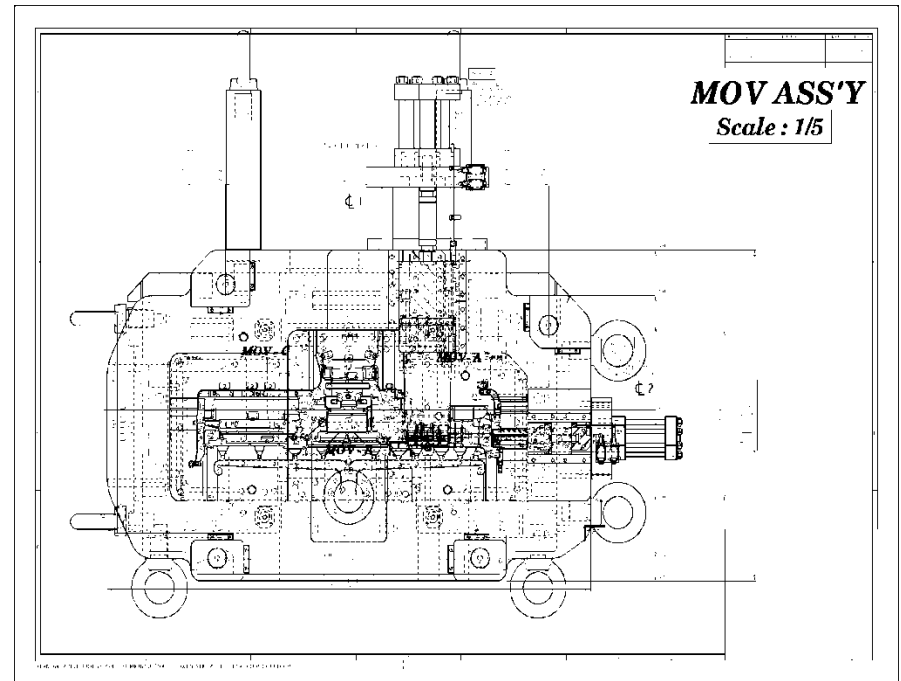
Total Cell : 32,000,000 EA



Development Process : Mold Design

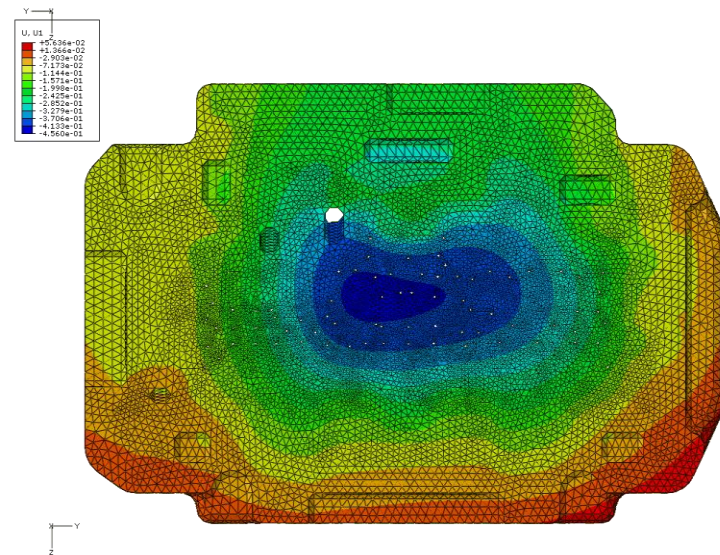
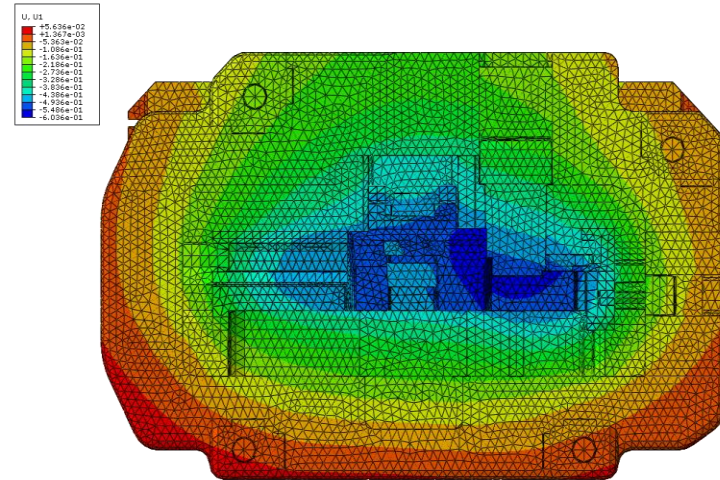
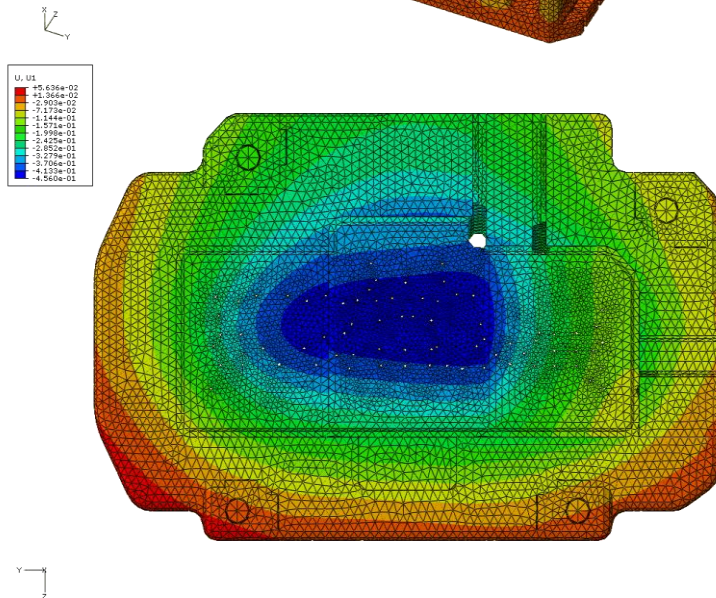
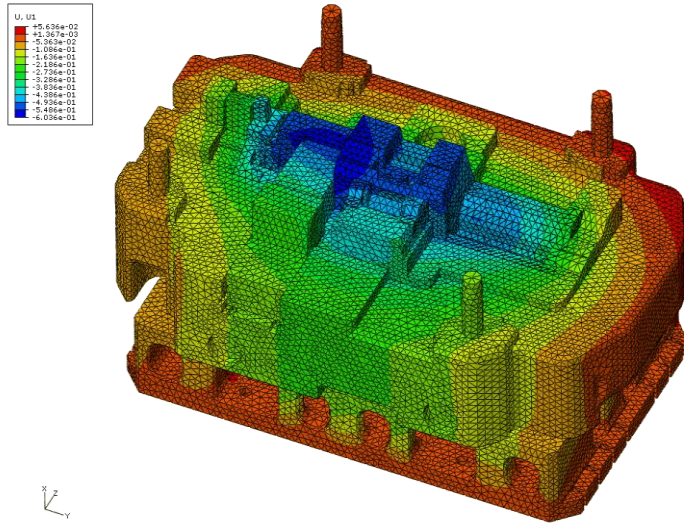


<3D Mold Modeling>

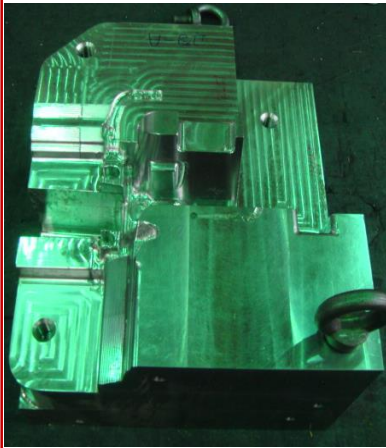
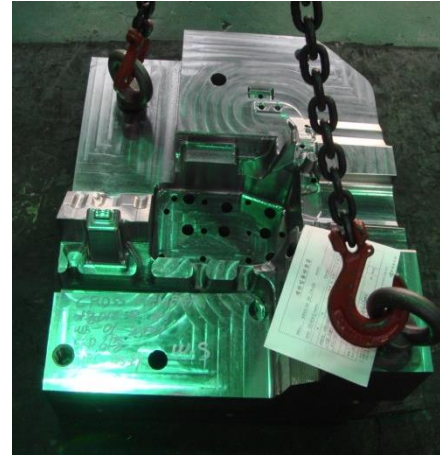


<2D Mold Drawing>

Development Process : Mold FEA



Development Process : Mold Manufacturing



Development Process : Try-out

