IP-R&BD Business Road Map by 2021

Growth Base Establishment	Growth Visualization Phase	Stable Growth Phase
4 domestic patents and 4 overseas patents KRW 7B in Korea and USD 5M from overseas Employment: 5 persons (in 2018) and 5 persons (in 2019)	10 domestic patents and 5 overseas patents KRW 10B in Korea and USD 7M from overseas Employment: 10 persons	10 domestic patents and 5 overseas patents KRW 15B in Korea and USD 10M from overseas Employment: 10 persons

2018

- Smart Foundry 1.0 (the first year of factory automation: Targeting to build CPS, big data and the automated casting process based on the cloud)
- Development and technology transfer of hetero-junction material
- Full mass production for the North American market
- 20% or more market share in the heat resistant steel market in Korea

2019

- Smart Foundry 1.0 (the 2nd year of factory automation)
- Attract foundry production of highly functional and cutting edge materials
- Develop the flask-less molding system

2020

- Smart Foundry 1.0 (the 3rd year of factory automation)
- Fully develop the high chrome steel with high elongation (Cr 50% or more)
- Develop the molding system based on the 3D printer
- R&D alliance with recognized global hidden material champions
- Develop high cobalt steel products

2021

- Smart Foundry 1.0 (completion of the 4th year of factory automation)
- Establish excellent R&D center specialized in ACT casting material
- Apply the pattern-less production system
- Number one special material manufacturer in Korea

Korea Industrial Technology and Fairness Manager 2017

Company Name	Major Business (Year of Establishment)	Related Key Technologies and Business Area
Castec Korea co., LTD	Miscellaneous automotive part (1999)	Foundry specialized in heat resistant parts and recently developed the casting process for thin walls and wall thinning Spun off from LG Electronics
Namyang Metals	Miscellaneous automotive part (1987)	Manufacture of automotive engines, steering, braking and differential motion parts based on the medium frequency induction melting and sand mold casting technologies
Dongnam Precision co., LTD	Automotive engine part (1987)	Holds casting technology for the shock absorber tower, which is a car body part, and the all-in-one molding technology for the 4mm thin or less 8-speed transmission based on the high pressure, high vacuum die-casting technology
Myunghwa	Car body part (1957)	Manufacture of engine, transmission and chassis parts based on the aluminum and cast steel casting technologies Highly light-weight aluminum knuckle manufacture based on the casting and forging process, Coba Press
PJ Metal	Miscellaneous primary nonferrous metal (1984)	Production of heat-resistant materials for steel mills and combined-cycle power plants (sand mold casting/centrifugal casting)
Daesin Fmc co., LTD	Miscellaneous metal processing (1986)	Production of heat-resistant materials for steel mill (sand mold casting/centrifugal casting)
Kmtech	Pig cast steel casting (2009)	Production of heat-resistant materials for steel mills and plants (sand mold casting/centrifugal casting)
Boogong industrial	Ferroalloy production (1984)	Production of heat-resistant materials for steel mill (sand mold casting/centrifugal casting)
Incheon Metal	Automotive engine part (1987)	Production of heat-resistant materials for automotive parts and steel mills (sand mold casting/centrifugal casting)
Dong Joo Industrial	Cast steel casting (1989)	Production of heat-/wear-resistant materials for steel mills, mines and the cement industry (sand mold casting)
YS Special Steel	Special cast steel processing (1989)	Production of heat-/wear-resistant materials for mines and the cement industry (sand casting)
Techmetal	Cast steel casting (1992)	Production of heat-/acid-resistant materials for the petrochemical industry and the power plant industry (sand mold casting)

Introduction of Long History Casting Industry in Korea
- Korean ancient casting masterpiece

- **Why is the stainless cast steel magnetic?**

Casting product buyers often raise an issue why the CF8 (cast 304) or CF8M (cast 316) stainless steel is a little bit magnetic.

Since most products produced in steel mills such as the round bar, billet and sheet are non-magnetic, casting users often expect the processing conditions equivalent to non-magnetic products STS 304 and 316.

While the AISI class 316 and the ASTM class CF8M are called as the austenite stainless steel, the 430 and CB-30 are called as the ferrite stainless steel.

Such classification is defined by various steel crystal structures. The austenite stainless steel is ductile and non-magnetic. The ferrite stainless steel is harder, less ductile, and magnetic.

The ratio of such structures present in a particular steel is mainly determined by the chemical analysis, although other factors may need to be considered.

Of course, it can be also changed by heat treatment depending on the steel type.

CB-30 and 430 are ferromagnetic because their main phase distribution is ferrite. AISI 316 is intrinsically austenite and it hardly attracts the magnet.

CF8 and CF8M in the casting specification are generally austenite, but these contain 5 to 20% ferrite in general and thus are a little bit magnetic.

- **The composition of 304 and 316 and that of CF8 and CF8M are almost identical. Then, why do they have different codes?**

It is because that it is possible to produce plate material in the uniform quality since the plastic processing such as extrusion, drawing and rolling gets easier if the ferrite phase of 304 or 316 is reduced or removed.

Consequently, the chemical composition of the plastic processed material is a little bit adjusted when the product is produced.

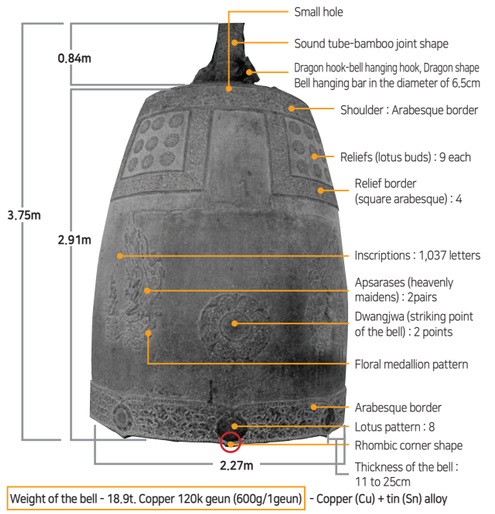
King Seongdeok Divine Bell (Emile Bell, National Treasure No. 29)

King Gyeongdeok of Silla tried to make a bell to announce virtues of his father, King Seongdeok, but failed. Since then, King Hyegong completed it in 771 and called it as 'King Seongdeok Divine Bell'.

This bell is also called as 'Bongduksa Bell' because it was first hung in Bongduk Temple, and it is also known as 'Emile Bell' after the legend of the crying of a baby who was sacrificed in it.

A sound tube is at the top of the bell, which helps sound vibration and is the unique structure found in bronze bells in Korea only. The hook of the bell, dragon hook is in the shape of a dragon's head.

Production Start	737 A.D. (Unified Silla)	Production Period	34 years	Year of Completion	771 A.D.
Weight	18.9 ton	Material	Bronze	Method	Casting
Height	365.8 cm	Main Components	Cu:85~87% , Sn:12~14%		



Weight of the bell - 18.9t. Copper 120k geun (600g/1geun) - Copper (Cu) + tin (Sn) alloy

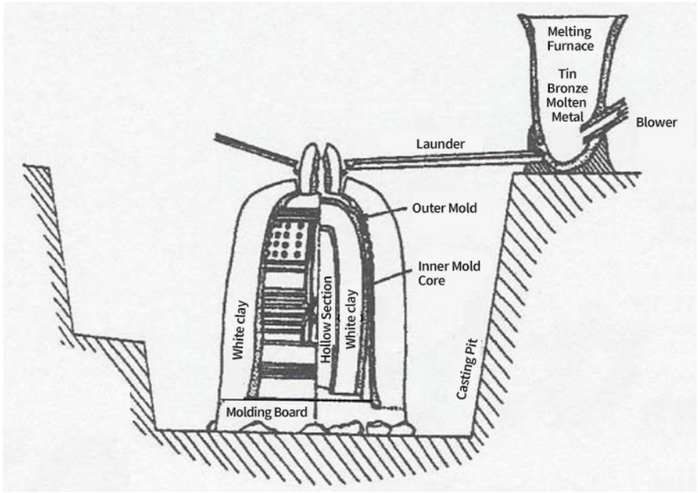
<Dragon Hook and Sound Tube>

It is presumed that a kind of the lost wax process based on wax was used. The waist of the dragon is designed to withstand the load no less than 19 tons.

< King Seongdeok Divine Bell>
- Photo taken in Chosun Dynasty

Source : Gyeongju National Museum

Buddhist Bell Casting Estimate Drawing

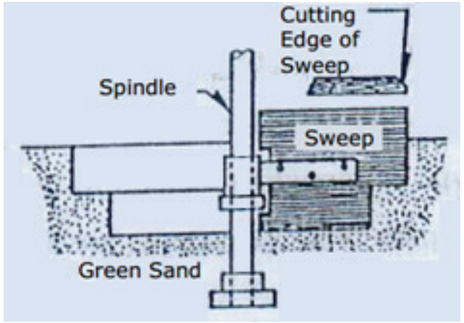


Its chemical composition is similar to that of modern materials.

Considering the content analyzer was not available, our ancestor's technical ability was amazing again how the content composition was controlled to this level.

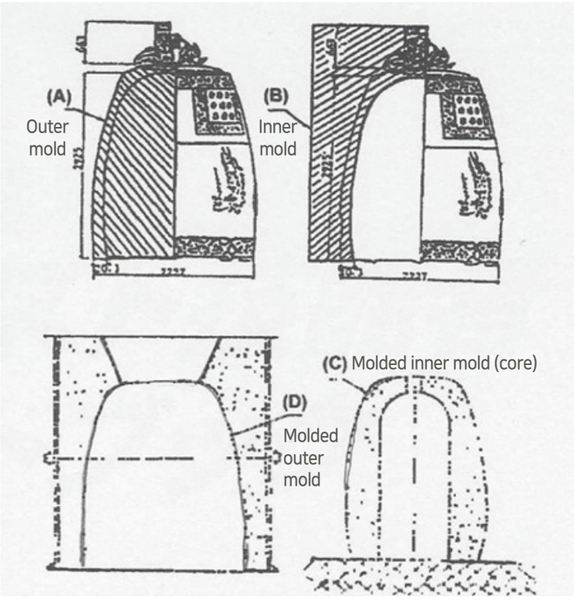
Name		Chemical Composition (Wt%)						
		Cu	Sn	Pb	Zn	S	Fe	Ni
Bongdu ksa Bell	Top	84.39	11.21	0.23	0.009	0.22	0.64	0.07
	Middle	78.56	15.51	0.45	0.009	0.22	0.30	0.07
	Bottom	83.13	12.98	0.14	0.016	0.22	0.61	0.08
JIS	CAC 503B	84~88	12~15	<0.3	<0.3		<0.2	<1.0

Mold Production Technique (Estimate)



- Sweep pattern -

Inner and Outer Sweeping Molds



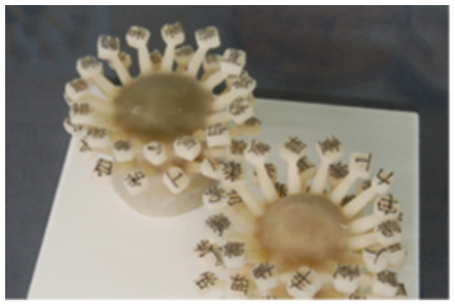
Source : Korea Foundry Society Casting Vol. 18, Issue 4

Jikji Simche Yo Jeol (Jikji) Metal Print Book

'Jikji' was found to be the oldest book in the world made of metal type.

It is now recognized for more than 70 years ahead of German 'Gutenberg metal type', which has been recognized as the oldest metal type in the world.

Time of Production	1377 (Goryeo)	Registered UNESCO World Heritage	2001. 09. 04	Ownership	The Manuscrits Orientaux Division, the National Library of France
Method	Casting	Main Components	Cu:50.9%, Zn:0.7%, Sn:28.37%, Pb:10.2%, Fe2.2% (analysis on 'Bok' and 'Jeon' types of the Goryeo Dynasty kept in National Museum of Korea)		



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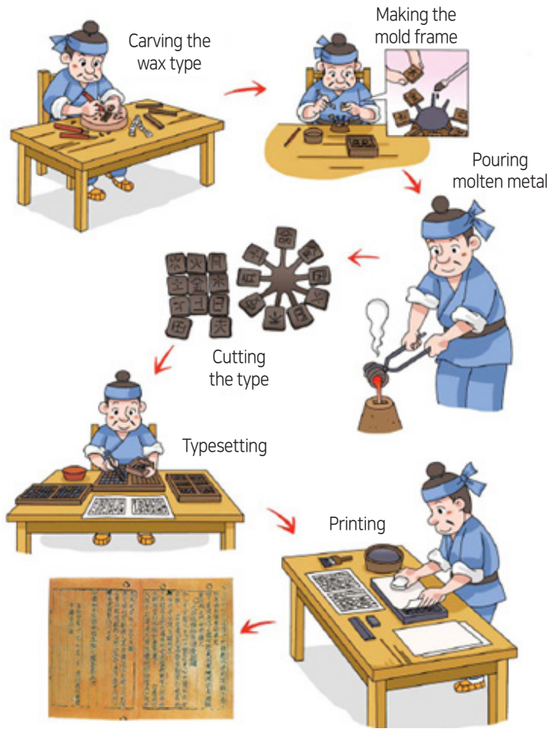

(Source : Cheongju Early Printing Museum)

※ Jikji Metal Type Printing Process

Heat Resistance Casting

JIS Spec of heat resistance steel castings

	JIS	ACI	Chemical composition							Mechanical			
			C	Si	Mn	Ni	Cr	Mo	Cu	Tensile strength	yield strength	drawing rate	Hardness (HB)
heat resistance steel castings	SCH1	-	0.20~0.40	1.50~3.00	≤1.00	≤1.00	12.00~15.00	-	-	-	≥50	-	-
	SCH2	HC	≤0.40	≤2.00	≤1.00	≤1.00	25.00~28.00	-	-	-	≥35	-	-
	SCH3	-	≤0.40	≤2.00	≤1.00	≤1.00	12.00~15.00	-	-	-	≥50	-	-
	SCH11	JD	≤0.40	≤2.00	≤1.00	4.00~6.00	24.00~28.00	-	-	-	≥50	-	-
	SCH12	HF	0.20~0.40	≤2.00	≤2.00	8.00~12.00	18.00~33.00	-	-	≥24	≥50	≥25	-
	SCH13	HH	0.20~0.50	≤2.00	≤2.00	11.00~14.00	24.00~28.00	-	-	≥24	≥50	≥10	-
	SCH15	HT	0.35~0.70	≤2.50	≤2.00	33.00~37.00	13.00~17.00	-	-	-	≥45	≥4	-
	SCH16	HT30	0.20~0.35	≤2.50	≤2.00	33.00~37.00	13.00~17.00	-	-	≥20	≥45	≥15	-
	SCH17	HR	0.20~0.50	≤2.00	≤2.00	8.00~11.00	26.00~30.00	-	-	≥28	≥55	≥5	-
	SCH18	HI	0.20~0.50	≤2.00	≤2.00	14.00~18.00	26.00~30.00	-	-	≥24	≥50	≥10	-
	SCH19	HN	0.20~0.50	≤2.00	≤2.00	23.00~27.00	19.00~23.00	-	-	-	≥40	≥5	-
	SCH20	HU	0.35~0.75	≤2.50	≤2.00	37.00~41.00	17.00~21.00	-	-	-	≥40	≥4	-
	SCH21	HK30	0.25~0.35	≤1.75	≤1.50	19.00~22.00	23.00~27.00	-	-	≥24	≥45	≥10	-
	SCH22	HK40	0.35~0.45	≤1.75	≤1.50	19.00~22.00	23.00~27.00	-	-	≥24	≥45	≥10	-