

Casting Overview

to

SMART Wind Mechanical Systems Subgroup

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Background

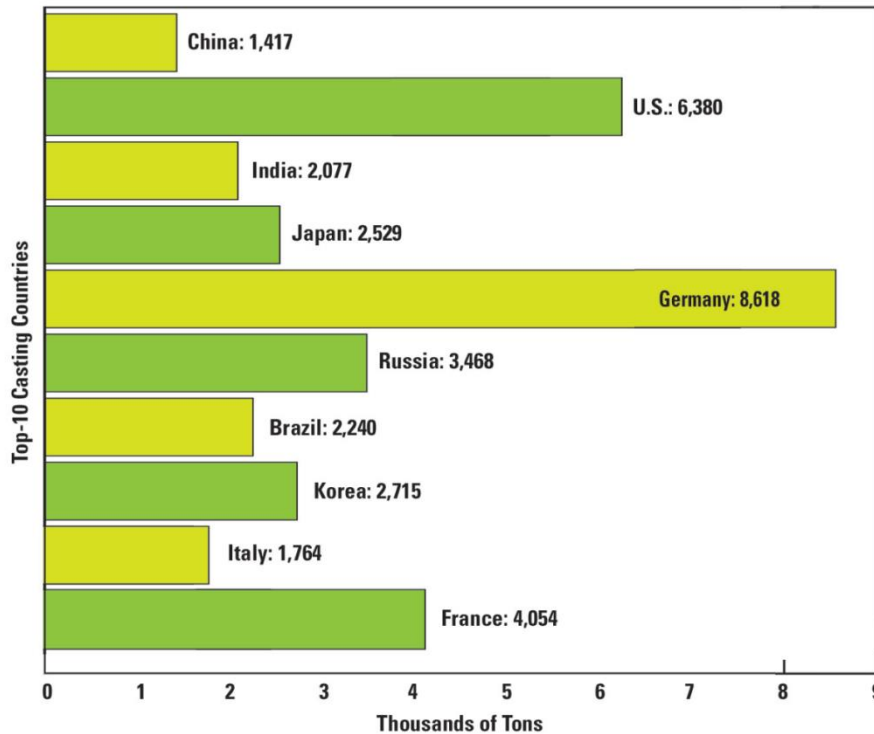
- 35+ Years in foundry and related industry
- 12 Years with The Edison Materials Technology Center
 - Cutting Edge Technologies and Manufacturing Assistance
 - Rapid Prototypes, CT Scanning, Solidification Modeling
- Start up of FOPAT foam pattern production facility
- Managed the engineering and assembly of (TacFab) a mobile foundry for the U.S. Army
- Active with AFS, OCMA, and NADCA trade organizations
- Currently Independent Sales Rep for Cast Inc.

Foundry Industry Demographics

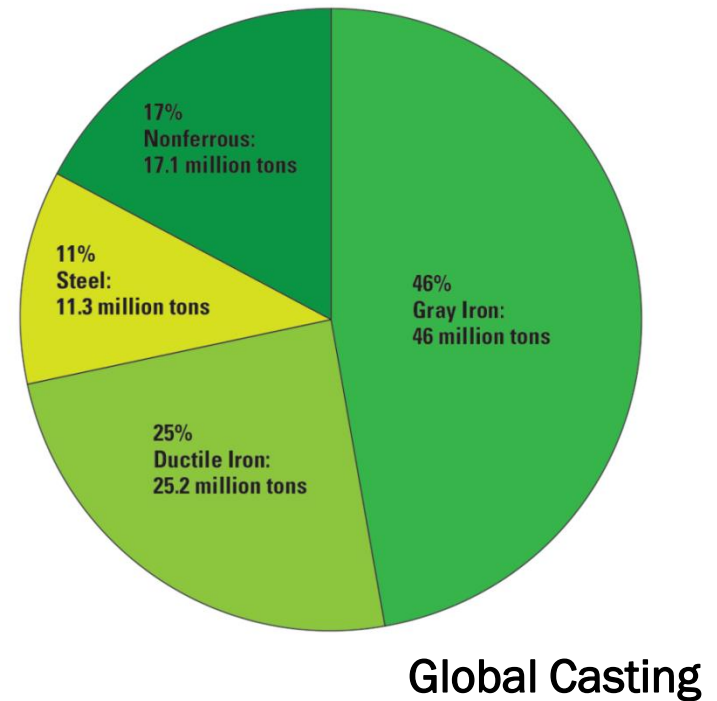
- **1,978**—Number of metalcasting facilities in the U.S. In 1991 there were 3,200 plants and in 1955, 6,150 plants.
- **>25,000** in China
- **80%**—Percentage of firms that are small businesses (less than 100 employees).
- **200,000+** —Number of people employed by the U.S. metalcasting industry.
- **90%** of all manufactured goods contain some metal castings.
- The U.S. is the **global leader** in casting applications and second in production.
- You are **rarely more than 10 ft.** from a metal casting in the United States.

Production & Applications

- **12 million**—Total U.S. tonnage of castings produced in the U.S. in 2012.
- **\$34+ billion**—Total value of all castings produced in the U.S. in 2012.



Production Per Plant



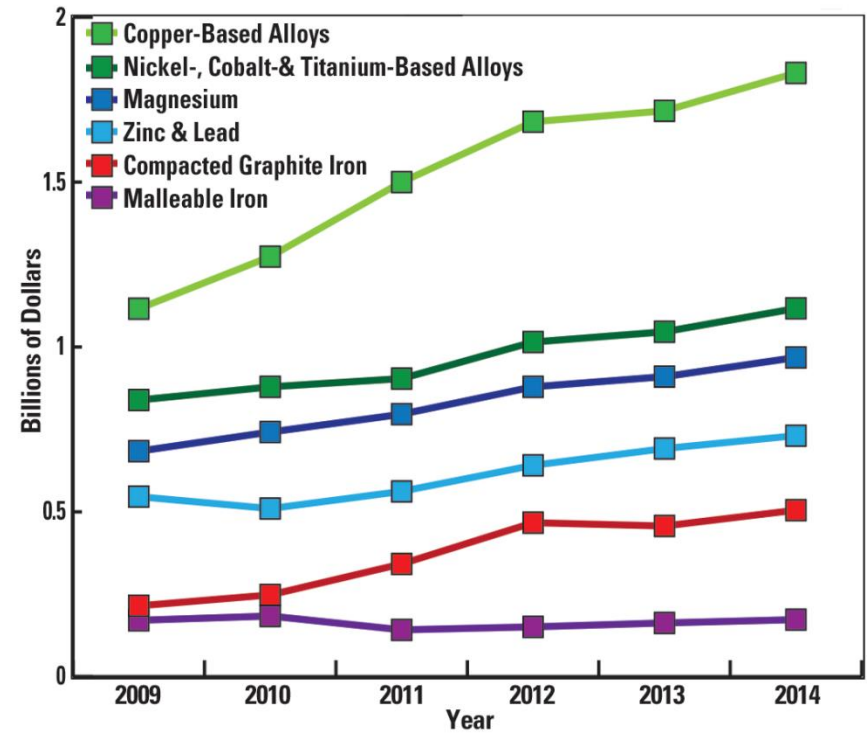
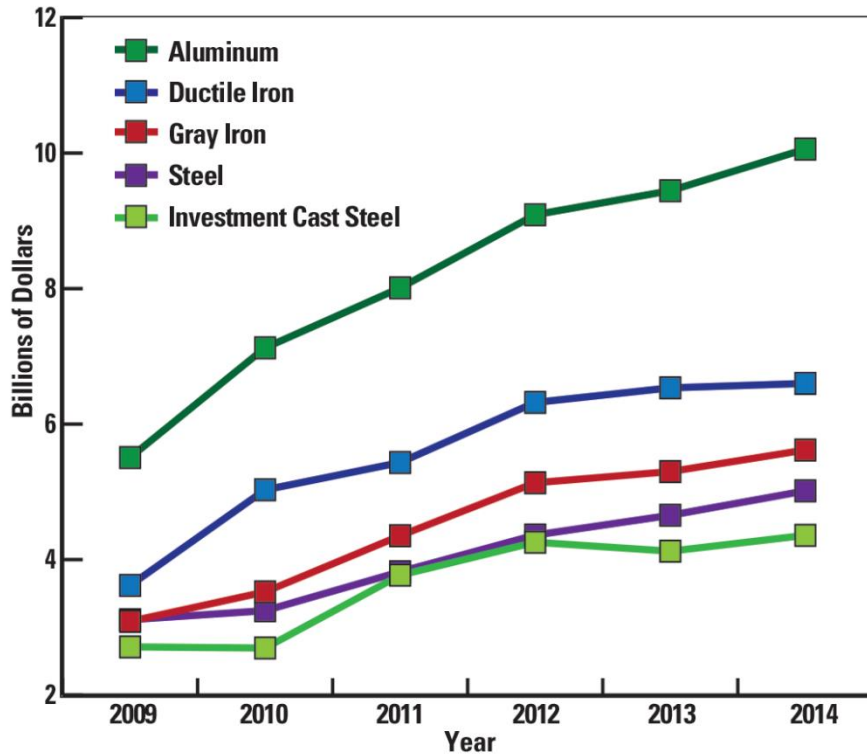
Data from
American Foundry Society 12/2013

U.S. Metal Casting Shipments

- 2007 – Shipped \$31.5 billion
- 2009 – Bottomed at \$21.6 billion
- 2010 - Rebound \$25.46 billion
- 2011 - \$29.6 billion
- 2012 - \$34 billion
- 2016 – Projected \$37.5 billion

Data from
American Foundry Society
12/2013

Steady Rebound from Recession



Data from
American Foundry Society 1/2014

History – Wind and Foundry

Anecdotal Impressions of the Large Wind Turbine OEM

- Require large castings - Some > 10 Ton
- Foundries Invested-Higher Volume Did Not Materialize
- No loyalty
- Tight alloy specifications
- Low profit margin with high liability
- OEM is a difficult partner

Common Issues

The main reason US foundries are increasingly reluctant to pursue contracts like yours is that it is very low margin business for them. Due to high taxes, regulatory burdens, and high energy and labor costs in the US, it's hard for domestic foundries to make a profit competing against foreign companies. The domestic foundries are not getting out of the business, they're just going after contracts that have a greater potential profit margin.

I design sand cast aluminum housings for aircraft gearboxes. These castings are very complex and must be of extremely high quality. The number of US foundries that are qualified for this kind of work is very limited. It is currently somewhat difficult to find one willing to take on my development projects due to the amount of existing production work they have. The first question they always ask is, "How many castings will you need?" When I say, "Four", they say "No thanks".

Casting Options

- Aggregating – No advantage unless parts are same design
- Rapid Prototyping – Additive Manufacturing
 - Commonly used for foundry prototypes
 - Good for small volumes
 - Sand printing – Newest development
- Casting Types
 - Sand, permanent mold, investment, die casting, plaster.
 - Casting type, alloy, quantity, properties
 - Find foundry “sweet spot”

Recommendations

- Solid Modeling
 - Expedites quoting – known weight and volume
 - Reduces tooling cost, facilitates solidification modeling
- Part Design
 - Simplify, reduce cores
 - Collaborate with foundry to create “casting friendly” design
- Use Common Alloys
 - Unique alloys increases foundries responsibility
 - Expedites quoting
- CNC Machining
 - Solid modeling
 - Involve machine shop in design

Closing Thoughts

- Casting production continues to increase as orders increase
- Foundries at or near capacity
- Wary of wind power castings
- Adherence to government regulations
- New foundry startups require significant financing
- Adding automation and efficient melting
- Potential for collaboration is very good

Questions
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QUESTIONS

TacFab Mobile Foundry

