An Overview of the Current State of US Permanent Magnet Production

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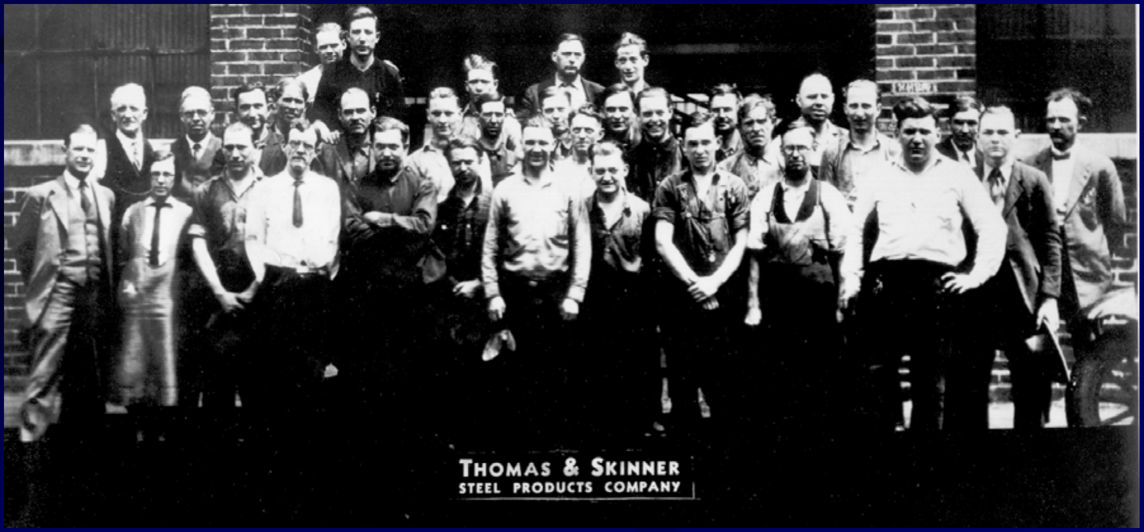
US MAGNETIC MATERIALS ASSOCIATION

Thomas & Skinner, Inc.

1901 **Company founded by John Esterline, EE professor at Purdue University**

1923 **James Thomas & O.H. Skinner acquired magnetics division**



Thomas & Skinner, Inc.

Today **Employee-owned manufacturer of magnetic materials headquartered in Indianapolis, Indiana.**

Markets:

Aerospace ***Industrial*** ***Defense*** ***Oil Exploration*** ***Medical***

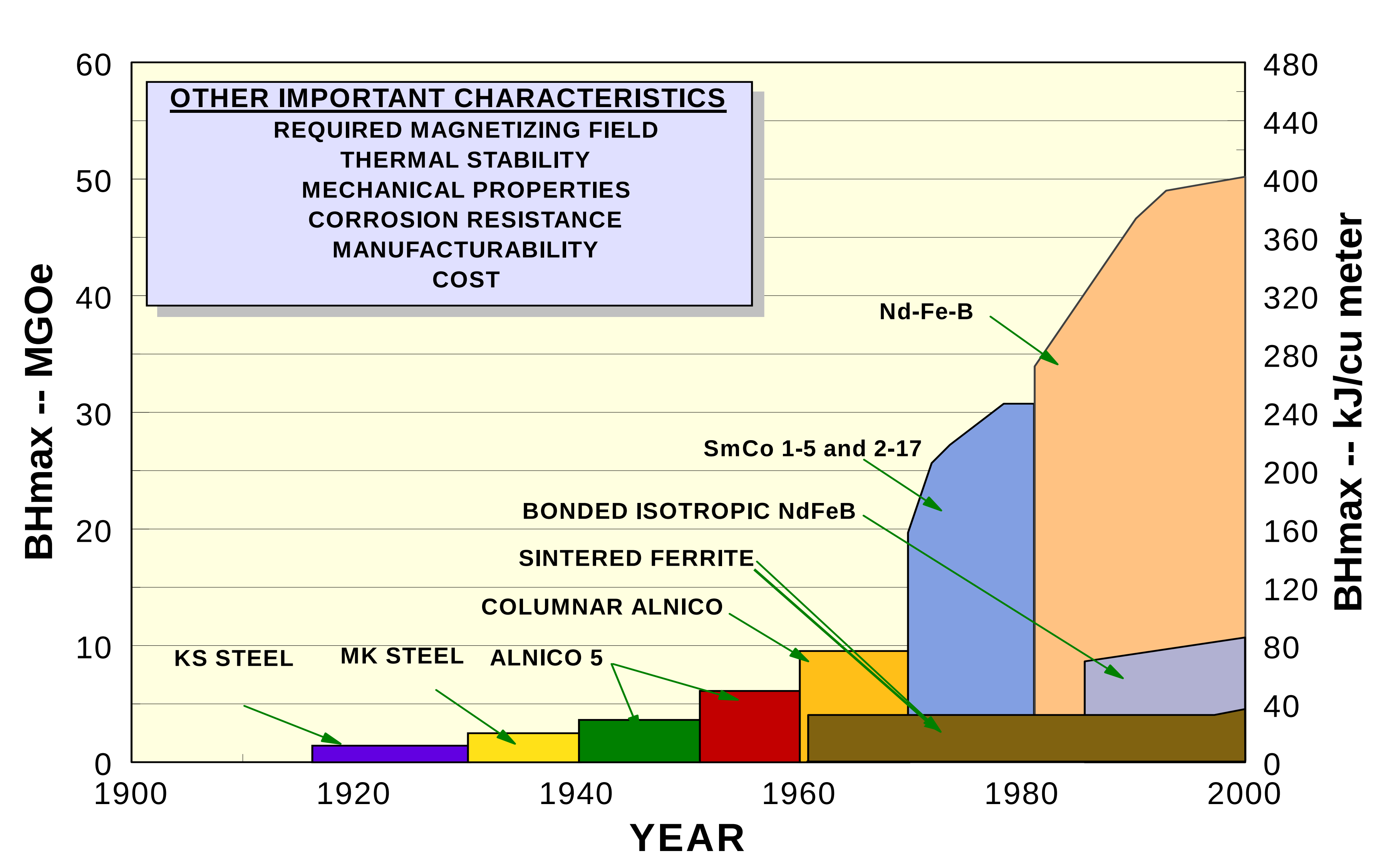
Mission

The mission of the United States Magnetic Materials Association is to promote domestic production of the entire supply chain of materials used in magnet systems production to serve our nation’s defense needs.

Four Types of Permanent Magnets Commercially Available Today

Alnico	Samarium Cobalt
Ferrites	Neodymium Iron Boron

Improvements in Magnet Strength



Four Types of Permanent Magnets Commercially Available Today

Highest Temperature	Alnico	Samarium Cobalt	High Temp / High Max Energy Product
Lowest Cost	Ferrites	Neodymium Iron Boron	Highest Maximum Energy Product

Four Types of Permanent Magnets

Alnico	**Samarium Cobalt**
Ferrites	**Neodymium Iron Boron**

Rare Earth

Not Domestically Produced

Specialty Metals Clause

Defense Federal Acquisition Regulation Supplement
(or DFARS 252.225-7014)

The purpose of this law is to maintain and support the defense industrial base for those items it covers.

Specialty Metals Clause Applies to <u>Some</u> Magnet Materials, Not All

<u>Hard (Permanent) Magnets</u>

- Four general types:
  - Alnico
  - Rare Earth
    - SmCo
    - NdFeB
  - Hard Ferrites

Covered by the Specialty Metals Clause

Current State of US Magnet Production

U.S. Manufacturers in <u>1990s</u>

NdFeB (dense) Magnets

- Ugimag (IG Tech.)
- Hitachi
- Crucible
- Magnequench

Sintered Ferrite Magnets

- Arnold
- Hitachi (Edmore, China Grove)
- TDK
- Crucible Magnetics
- General Magnetic
- Sumitok
- Kane (Stackpole)

→

U.S. Manufacturers in <u>2011</u>

NdFeB (dense) Magnets

- (none)

Sintered Ferrite Magnets

- Hitachi (China Grove)
- TDK

Current State of US Magnet Production

U.S. Manufacturers in <u>1990s</u>

Alnico Magnets
- Arnold
- Crucible Magnetics
- Hitachi
- Permanent Magnet Company
- Thomas & Skinner

SmCo Magnets
- Arnold
- Crucible (1-5)
- EEC
- Hitachi
- IG Technologies (Ugimag)

U.S. Manufacturers in <u>2011</u>

Alnico Magnets
- Arnold
- Permanent Magnet Company
- Thomas & Skinner

SmCo Magnets
- Arnold
- EEC

China Dominates Magnet Materials

2010 Worldwide Total Market Size for Magnet Materials = $7.5B

- **Projected $8.8B 2015**
- **Projected $15.5B 2020**

Produce over 75% of world's NdFeB magnets

- **Japan produces 22%**

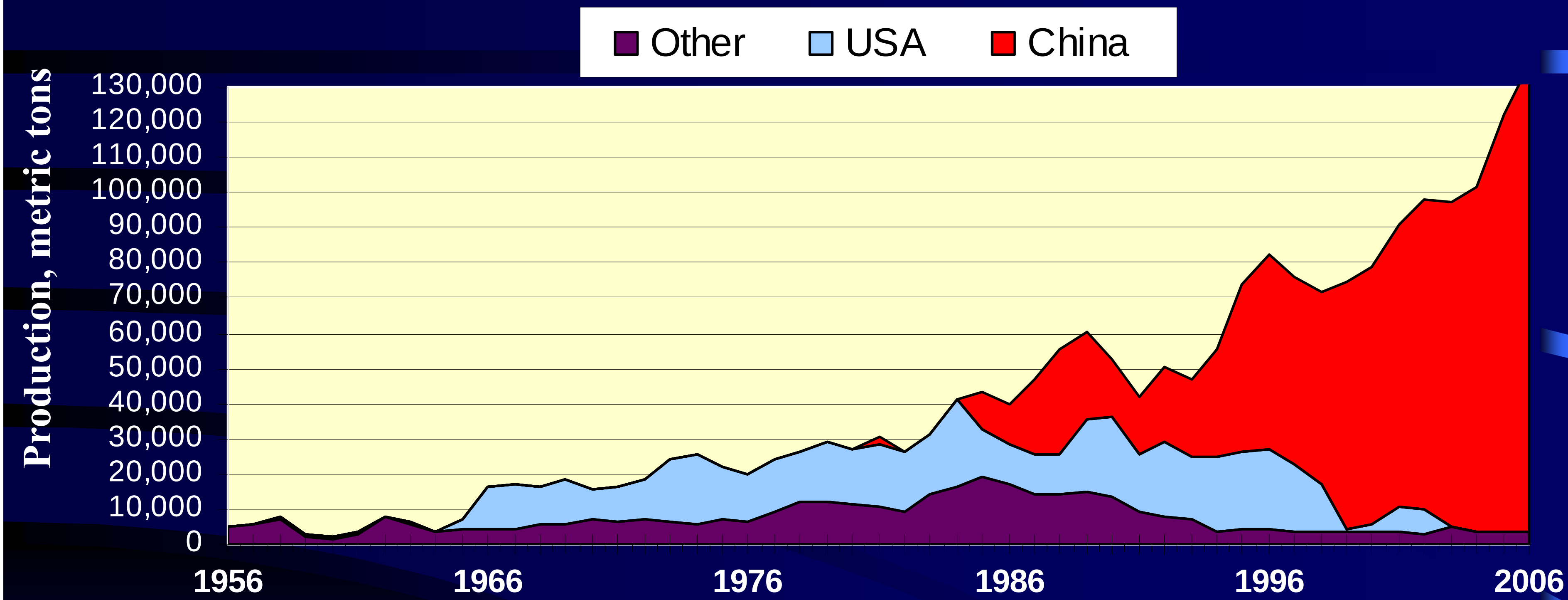
Starting in the late 1990's, Japan, US and European producers close plants and move production to China

Rare Earth Oxide Ore production = 94% of global demand

- **well over 50% of global reserves**

Over 50% of worldwide Alnico & SmCo production

REE Production Trends



Monazite-placer era | Mountain Pass era | Chinese era

Strategic Economic Weaponry

"There is oil in the Middle East; there are rare earths in China. We must take full advantage of this resource."

President Deng Xiaoping 1992

"Improve the development and applications of rare earth, and change the resource advantage into economic superiority."

President Jiang Zemin 1999

China: Controlling the RE Market

“Rare Earths Industry Development Plan in 2009-2015”

- Drafted by China’s Ministry of Industry and Information Technology.
  - “Mining of rare earths should seriously abide by production quotas.”
  - Beijing will also restrict exports of rare earths in the next six years,
    - annual export quota will be below 35,000 tpy and exports of dysprosium, terbium, thulium, lutetium and yttrium ***will be prohibited***

China: Controlling the RE Market

"We think prices rising this year (2006) is the comprehensive effect of many factors. ***It is the result of macro control of Chinese government*** and stable growth of Chinese economy. Self-adjustment of the RE industry and other factors from Chinese and oversea markets have a conjunct effect to the prices as well."

Source: China Rare Earth Information Center (September 2006)

Neo Magnets in Energy and Defense Applications

- Wind Turbines
  - Generator

- Hybrid Vehicles
  - Generators and Drive Motors

- Guidance systems
  - JDAM

- Computer Hard Drives

Impact of Offshoring Neo Production on US Innovation is Clear

- Current technology for neo magnet windmills came from Europe
  - They are years ahead of us in terms of installations
  - Europe has maintained neo magnet production
- Current hybrid car technology using neo magnets comes from Japan
  - They are years ahead of US producers
  - Japan has maintained neo magnet production

Innovation

- Critical to US economy
  - <u>Innovation</u> is a key trait of the companies listed in the Business Week 50, an annual ranking of the top-performing companies in America (BW, 6/17/10)

For the US magnet industry to be <u>relevant</u>, it has to be a part of <u>innovative activity.</u>

An Important Study

- **"Offshoring technology innovation: A case study of rare-earth technology"**, Fifarek, Veloso and Davidson, Journal of Operations Management, Vol. 26, 2008
  - Analyzed how offshoring affects the rate of innovation
    - *Looked at results from R&D efforts conducted collectively by firms at their home location*.
  - Specifically cited the departure of the rare earth magnet manufacturing base from the US as an example of innovation capability that has been lost.

Offshoring Manufacturing: *Immediate Impact*

Optimizing global production

↓

Round-the-clock shifts and lower costs

↓

Expanded markets, lower prices for consumers and the creation of new business opportunities for existing firms and new entries.

Source: Fifarek, Veloso and Davidson

Offshoring Manufacturing: *Long-term Effects?*

Manufacturing moves overseas

↓

Engineering work and R&D follow

↓

Jeopardizing the ability of home economies to maintain economic growth and leadership.

Source: Fifarek, Veloso and Davidson

Neo Magnet Production: The Clock is Ticking

- Last neo production was in 2005
  – Hitachi Edmore, Michigan plant
- The longer the gap between the end of production and a restart, the more difficult the startup will be
  – Capital assets are gone.
  – Human capital is drifting away

What's Happening Now

- December 21, 2011
  - Hitachi Announced New US Neo Magnet Plant
    - China Grove, NC
    - To produce sintered neo magnets from imported powder
      - Will <u>not</u> produce alloy
    - At mass production capacity, will produce 40 tons/month
    - Built to service the automotive market
- Focus of mining efforts on Heavy Rare Earths
  - Dysprosium

The Bottom Line

- Segments like the Loudspeaker Industry need a diversified and healthy magnet value chain
  - Innovation in the industry depends on it.
- What can the Loudspeaker Industry do?
  - Buy local
    - Innovation efforts will be enhanced by using a value chain that is close, can respond quickly, and is able to assist you with design
  - Compensate and reward for a <u>secure, diversified value chain</u>, and not just the <u>lowest cost</u>

Reference Information

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