

GLOBAL MANUFACTURING

ARAUJO, Anna Carla AUG, 2015 Mechanical Engineering Department – POLI/COPPE/UFRJ



Course Objectives

- Overview of Manufacturing Processes for Mechanical Engineering
- Work over a mechanical workpiece from the begining to the end (Manufacturing Process Project)
- Think about the global manufacturing and the applicability to the processes

Bibliography (Main References):

- Fundamentals of Modern Manufacturing: Materials, Processes, and Systems -Mikell P. Groover
- De Garmo's Materials and Processes in Manufacturing" JT Black and Ronald Kohser
- The Global Manufacturing Revolution: Product-Process-Business Integration and Reconfigurable Systems" Yoram Koren

Study Plan

Class#	Date	Planning
1	10/8	Global Manufacturing?
2	12/8	Manufacturing Processes (Begin project)
3	17/8	Steel Making
4	19/8	Casting Processes
5	24/8	Fabrication of Plastic, Ceramics and Composites
6	26/8	Additive Manufacturing
7	31/8	Metal Forming Processes
8	02/9	Powder Metallurgy
9	09/9	Machining Processes
10	14/9	Welding Processes
11	16/9	Joining Processes
12	21/9	Measurement and Inspection / Quality
13	23/9	Surface Engineering
14	28/9	Presentation – Project – Part A
15	30/9	Presentation – Project – Part B



What is Global Manufacturing ? [#1]



What is Globalization?

"Globalization is the integration and interdependency of world markets and resources in producing consumer goods and services"

[Talk about]

Why globalization effects Manufacturing?

- "Globalization has created a new, unprecedented landscape for the manufacturing industry, one of fierce competition, short windows of market opportunity, frequent product introductions, and rapid changes in product demand.
- To capitalize on the opportunities, industry needs to offer products that are **innovative** and also can be made to appeal to buyers from many cultures so they can be sold all over the globe.
- The challenge, however, is to succeed in a turbulent business environment where all competitors have **similar opportunities**."

Manufacturing Systems after Globalization

Charles R. Darwin's statement in his book On the Origin of Species^{*}: "It is not the strongest species that survive, nor the most intelligent, but the ones most responsive to change," is now valid for global manufacturing enterprises.

- Systems that can change product quantities (changed capacity)
- Systems that can mix products (changed functionality)

Responsive manufacturing and business model:

- expand into global markets by **developing products that fit the culture of those markets** and can be sold there.
- must encompass not only selling, but also the international buying of components, and establishing **global supply chains**.

The global enterprise should more closely integrate product design with its manufacturing systems and its global business model.

IMPORTANCE OF MANUFACTURING TO SOCIETY

- Why are we worried about manufacturing in the twenty-first century?
- Isn't manufacturing an "old-economy" profession that should be relegated to only poor countries?
- Is manufacturing really so important for a fully developed nation in the global economy?

Cornerstone to economy (impels stimulates all other sectors in economy)

Create wide variety of Jobs (in different levels)

Creates wealth (abundance of valuable resources)

IMPORTANCE OF MANUFACTURING TO SOCIETY

Only art, agriculture, construction, and manufacturing, and more recently the software industry, **create something of value from nothing**.

What it is the difference in these industries?

An important advantage of manufacturing is that it creates a whole range of diverse jobs. Whereas agriculture and construction generate lots of lowskilled jobs, and art and software create a few jobs for higher-skilled elites, manufacturing calls on the skills of everyone from entry-level factory workers to scientists, engineers, and business professionals.

Gains in manufacturing productivity pass down to other sectors, building wealth and generating employment through the whole economy. No other sector can replace! [Finished Goods ; Intermediary level goods (pumps, motors, ecc) ; Tooling, Equipments and Infrastructure; Transportation;]

WHAT IS VALUE TO THE PRODUCT? HOW CAN IT MAKE VALUE?

"Improving economic growth and employment requires more than the "spark of imagination," said Larry Burns, former corporate vice president of R&D at General Motors. A new paradigm is needed for **making value**, which he clarified is larger than "**making things**." Making things (i.e., manufacturing) is often an important part, but making value requires an integrated system of understanding customers, R&D, design, manufacturing, and the delivery of products and services.



"MakingValue: Integrating Manufacturing, Design, and Innovation to Thrive in the Changing Global Economy THE NATIONAL ACADEMIES PRESS 2012

Manufacturing Market Share Evolution*



Figure 1.1 Manufacturing share of the U.S. Gross Domestic Product, 1950–2007 (as a percentage of the private industry). *Source*: U.S. Department of Commerce, Bureau of Economic Analysis.



Manufacturing still remains the largest productive sector in the overall U.S. economy. * USA





THE BASICS OF MANUFACTURING IN LARGE QUANTITIES

Product development

Manufacturing Process Sold to the Customers

Important factors for product developers to consider:

- How products look,
- How product work,
- How the user interacts with products.

Product prototype: is often constructed and tested to validate the design and product functionality (one-of-a-kind, a work of art, a lot of time and labor)

Large quantities of products: manufacturing system capable of mass production [If large quantities were produced in the sameway as the prototype, each product could be 10–20 times more expensive than the ones produced manufacturing system.]



FIGURE 1-2 Research issues, technical focus, and attributes of process sensors and controls. Unit manufacturing process categories are taken from NRC (1995).

"MANUFACTURING PROCESS CONTROLS FOR THE INDUSTRIES OF THE FUTURE"- NATIONAL ACADEMY PRESS Washington, D.C. 1998

THE BASICS OF MANUFACTURING IN LARGE QUANTITIES

The goal of a manufacturing system is to produce high-quality products at a fraction of what it took to build the prototype, so they can be sold at a marketable price.

The manufacturing system achieves "economies of scale" that the prototype shop cannot, neither in output nor in consistency. In a globally competitive environment, designing a cost-effective manufacturing system and operating it efficiently is a key competitive challenge especially when competitors have an advantage in countries where labor costs are substantially smaller.



Figure 1.3 Examples of multi-stage manufacturing systems: six stages (top) and five stages (bottom).

When did the era of globalization begin?

Three forces generated these events:

- governments (marked 1–5),
- Manufacturing enterprises (e.g., Boeing, General Motors),
- and new technology (undersea fiber-optic cables, a–h).

Brazil and South America were connected to the United States in 2002.)

TABLE 1.2		Significant Events Marking a Decade of Intensified Globalization	
1	1991	India was opened to foreign investments by "economic liberalization package," initiated by Dr. Singh, at that time India Finance Minister (he later became Prime Minister)	
2	1992	The European Union was created	
3	1992	Russia's prices were freed and President Yeltsin started enterprise privatization	
	1993	Boeing Design Center was established in Moscow with 350 engineers	
4	1994	NAFTA (North America Free Trade Agreement—US, Canada, Mexico) was formed	
	1994	GM decided to build engine parts in China	
	1995	Ford India was established as a joint venture with Mahindra to assemble the Ford Escort	
	1995	Delphi Automotive opened its first factory in China (producing batteries)	
	1997	General Motors Shanghai (GMS) was established as a 50–50 joint venture partnership with Shanghai Automotive Industry Corp. In 2005, GMS sold 325,000 vehicles in China	
	1998	DaimlerChrysler was formed by a merger of Daimler–Benz (the manufacturer of Mercedes–Benz, Germany) and the Chrysler Corp. (USA)	
	1999	Ford India bought out a majority stake from Mahindra and started to produce the Ikon, Fusion, and Fiesta	
5	2001	China joined the World Trade Organization	
a-h	1992– 2001	High-capacity Transoceanic fiber-optic cable deployments around the world (see Table 1.3)	



Figure 1.5 The major government initiatives in five global regions that created the modern globalization era (1–5 on the map) occurred during a single decade (1991–2001); at the same time, high-capacity fiber-optic cables were laid across the oceans (**a**–**h** on the map).

The global manufacturing revolution started in the last decade of the twentieth century with evolutionary, and largely independent, developments in three important areas:

- (1)Governmental policy changed in several regions around the globe opened India, China, and Russia to free trade, and created new multi-country free-trade zones including NAFTA and the EU.
- (2)Global expansions of the manufacturing industry exponentially increased the potential manufacturing capacity available to all.
- (3)The laying of a huge network of transoceanic fiber-optics cables increased the volume of inexpensive information flow around the world.



Waste and Energy

"The Office of Industrial Technology (OIT-USA) focused on seven energy- and waste-intensive materials processing industries: aluminum, chemicals, forest products, glass, metal casting, steel, and petroleum refining.

These industries, designated "Industries of the Future" (IOF), use about 80 percent of the energy (Figure 1-1) and produce more than 90 percent of the manufacturing waste in the entire U.S. industrial sector. The petroleum refining industry elected not to participate in the IOF program, and, in 1997, the agriculture industry, specifically renewable bio products, was added to the group."



FIGURE 1-1 Manufacturing energy use (1994). Total energy use is 22.4 Quads (quadrillion BTUs). Source: Office of Industrial Technologies (DOE, 1997) (based on Energy Information Administration data).

"MANUFACTURING PROCESS CONTROLS FOR THE INDUSTRIES OF THE FUTURE"- NATIONAL ACADEMY PRESS Washington, D.C. 1998

THE GLOBAL MANUFACTURING REVOLUTION

- Globalization created a new type of market dynamic driven by fierce worldwide competition among companies that are located in different countries and produce similar products (e.g., cars, furniture, refrigerators, and shoes).
- A large global excess capacity, with supply much greater than demand, destabilized the market with large fluctuations in product sales per company.
- Global enterprises must carefully monitor currency exchange rates. A company's profit margin, say 9%, in one country can be completely wiped out by an equal fluctuation of 9% in the exchange rate of the country in which products are sold.
- The fortunes of global manufacturing enterprises are also strongly impacted by changing prices (as oil price, principally).

THE GLOBAL MANUFACTURING REVOLUTION

That manufacturing needs to be responsive!

Domestic production should :

- (a) scale back on excess production volume and
- (b) introduce new innovations to compete with a resurgent importation (personalized products)
- Globalization reduces manufacturing costs by utilizing low labor-cost countries.
- Globalization reduces business risk and filters currency exchange fluctuations.
- Globalization is a source for enterprise growth, achieved by accessing new markets.

Manufacturing Sites (Network for supply)

"A further distinctive feature is the geographic spread of the network. It reflects the worldwide distribution of the manufacturing sites. There are four stages of geographic spread, based upon the location of sites from the perspective of the headquarters: national, regional, multinational and global. Miltenburg calls the national and regional spread a "simple network", whereas he calls the multinational or global spread a "complex network".

Miltenburg, J. (2009). Setting manufacturing strategy for a company's international manufacturing network. International Journal of Production Research, 47(22), 6179–6203.

Rudberg, M., & Olhager, J. (2003).Manufacturing networks and supply chains: An operations strategy perspective. Omega, 31(1), 29–39.

Thomas Friedli • Andreas Mundt • Stefan Thomas 2014, "Strategic Management of Global Manufacturing Networks







The global manufacturing revolution should stand on four fundamentals:

- 1. Innovative products for global markets and for personalization in domestic markets
- 2. Reconfigurable manufacturing systems
- 3. Global business strategies with rapid responsiveness to customers and markets
- A solid integration between product, process (i.e., manufacturing system), and business





Coffee Break and Debate