446.305A MANUFACTURING PROCESS

Chapter 1. Introduction

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Syllabus

- Team project
- Textbook - English
- Schedule
- Class projects (2006)
- Homepage http://fab.snu.ac.kr
- TAs

Can you predict the future?

Situation in the USA

- **Q: How many Levis jeans factories are in USA?**
  - 1980 → 60 factories
  - 2004 → ??

Can we beat the cheaper labor cost?

- **From The Economist March 6th, 2004**

- **Sewing machine operators minimum salaries**
  - US minimum 893.20
  - Honduras 139.00
  - Guangdong 63.75

- **Bangladesh only 18.53 per month !!**

Material Selection

- Material property (재료의 성질)
- Price and availability
- Appearance (외관)
- Life (사용수명)
- Recycling (재활용)

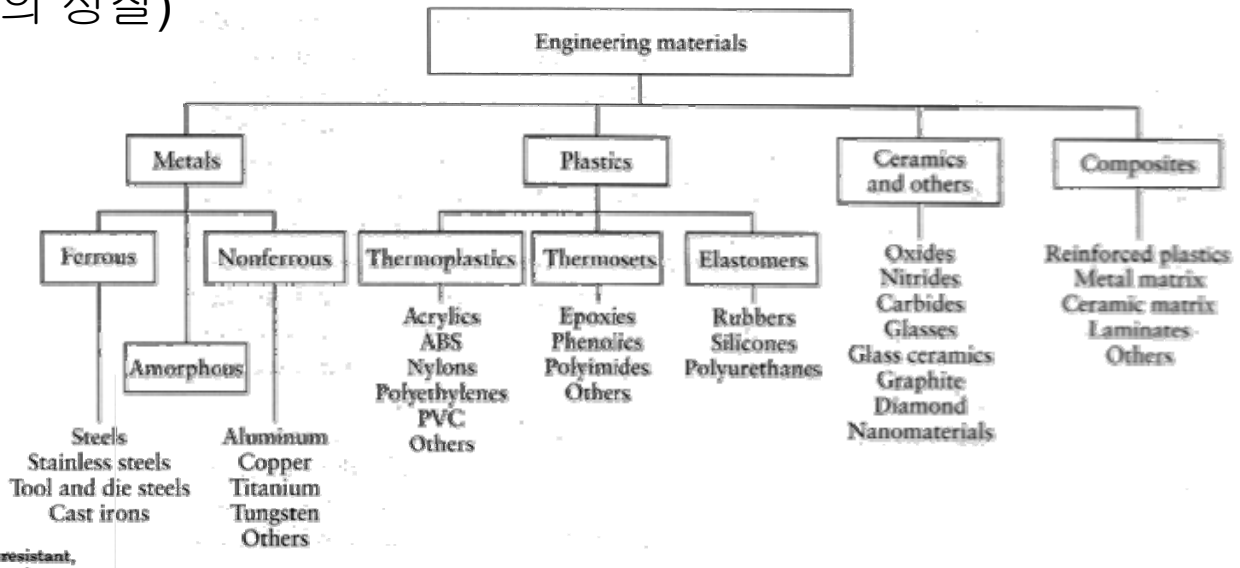


FIGURE 1.4 An outline of engineering materials.

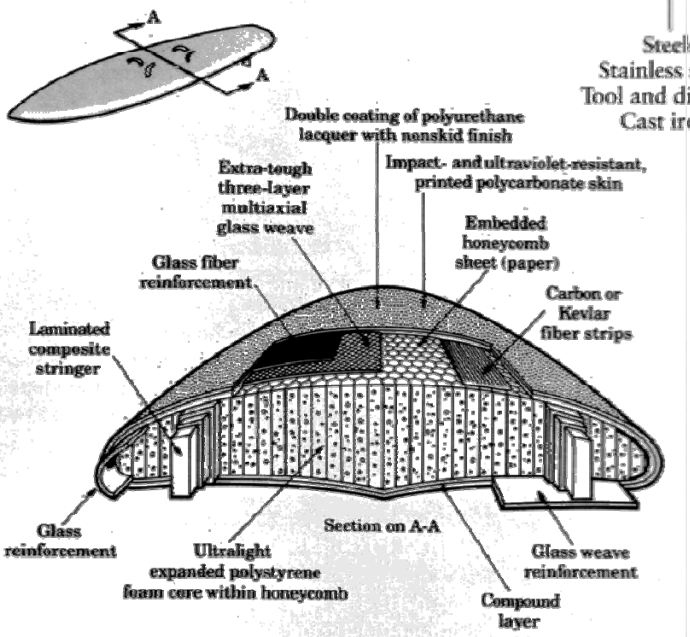
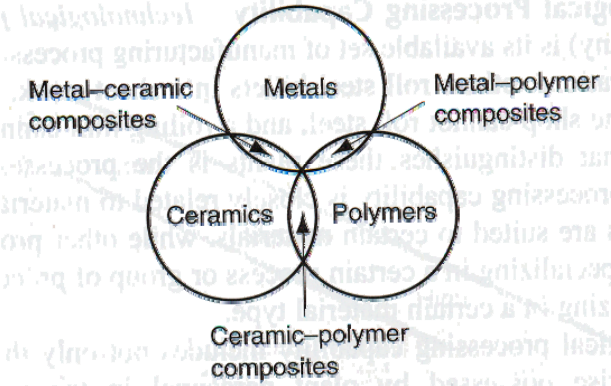


FIGURE 1.5 Cross-section of composite sailboard, an example of advanced materials construction. *Source:* Ken Easterling, *Tomorrow's Materials*, 2d ed., p. 133. Institute of Metals, 1990.



Ref.
S. Kalpakjian, "Manufacturing Processes for Engineering Materials", 3rd/4th ed. Addison Wesley

Some trends of 21st century manufacturing

- **Integration of technologies**
  - IT + BT + NT + CT + DT + ??
- **Global product development**
  - Collaboration
  - Competition
- **Mass customization**
  - Personal device
  - Adaptation of individual style and culture

The Google Guys: Search for Success

Google is one of the most successful companies

- Ph.D. research at Stanford University (1996)
- Commercialization : search technology for Web pages, facts, quotes, etc. (1998)
- Understand user's intend
  - "Judge of a man by his question, rather than by his answers." (Voltaire)
- Sales $ 8 billion (2005)

- Google Earth
  http://earth.google.com

Computer Integrated Manufacturing (CIM)

TABLE 1.3

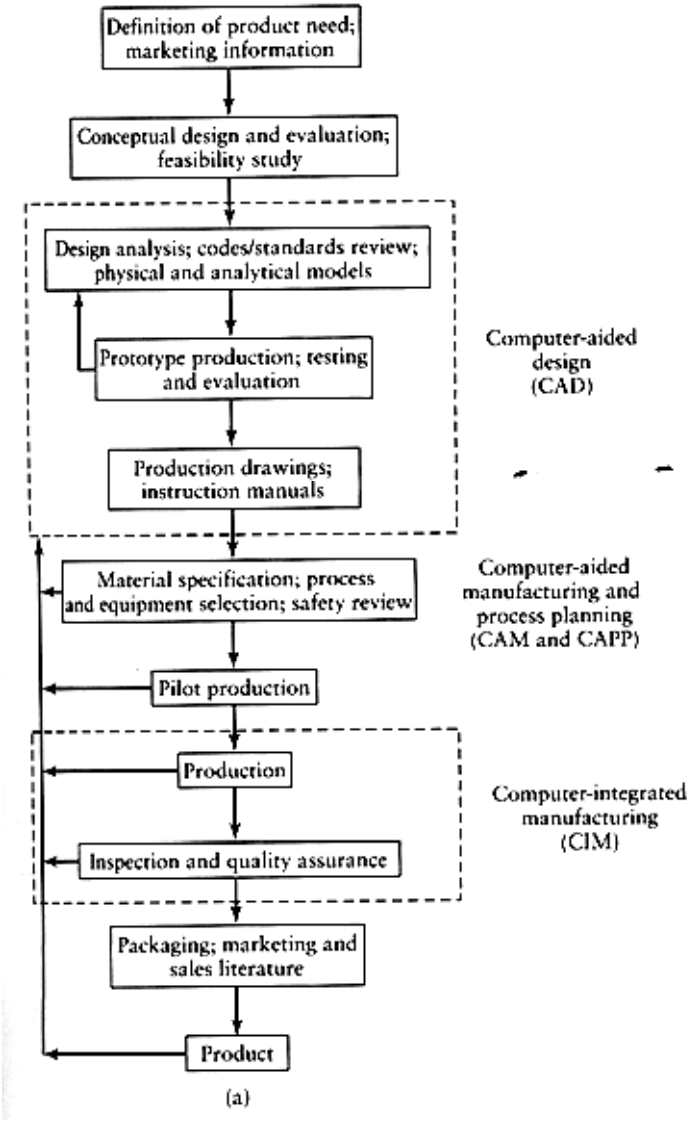
DEVELOPMENTS IN THE HISTORY OF AUTOMATION OF MANUFACTURING PROCESSES

DATE	DEVELOPMENT
1500–1600	Water power for metalworking; rolling mills for coinage strips
1600–1700	Hand lathe for wood; mechanical calculator
1700–1800	Boring, turning, and screw-cutting lathe, drill press
1800–1900	Copying lathe, turret lathe, universal milling machine; advanced mechanical calculators
1808	Sheet-metal cards with punched holes for automatic control of weaving patterns in looms
1863	Automatic piano player (Pianola)
1900–1920	Geared lathe; automatic screw machine; automatic bottlemaking machine
1920	First use of the word *robot*
1920–1940	Transfer machines; mass production
1940	First electronic computing machine
1943	First digital electronic computer
1945	First use of the word *automation*
1948	Invention of the transistor
1952	First prototype numerical-control machine tool
1954	Development of the symbolic language APT (Automatically Programmed Tool); adaptive control
1957	Commercially available NC machine tools
1959	Integrated circuits; first use of the term *group technology*
1960s	Industrial robots
1965	Large-scale integrated circuits
1968	Programmable logic controllers
1970	First integrated manufacturing system; spot welding of automobile bodies with robots
1970s	Microprocessors; minicomputer-controlled robot; flexible manufacturing systems; group technology
1980s	Artificial intelligence; intelligent robots; smart sensors; untended manufacturing cells
1990s	Integrated manufacturing systems; intelligent and sensor-based machines; telecommunications and global manufacturing networks; fuzzy logic devices; artificial neural networks

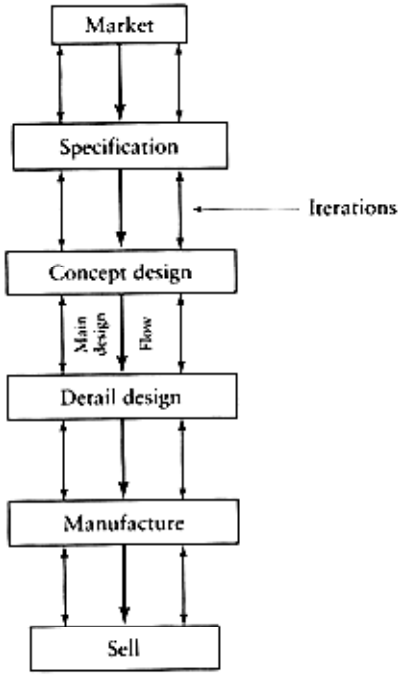
- Numerical control (NC)
- Computer numerical control (CNC)
- CAD (computer-aided Design)
- CAM (computer-aided Manuf.)
- CAPP (Process Planning)
- JIT (Just-in-time Production)
- FMS (Flexible Manuf. System)
- Expert System
- AI (Artificial Intelligence)

Ref.
S. Kalpakjian, "Manufacturing Processes for Engineering Materials", 3rd/4th ed. Addison Wesley

Concurrent Engineering



(a)

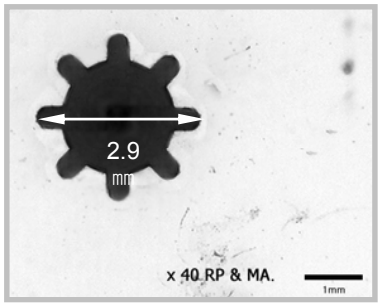


(b)

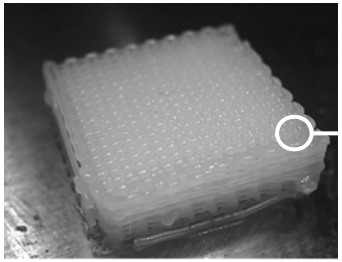
Ref.
S. Kalpakjian, "Manufacturing Processes for Engineering Materials", 3rd/4th ed. Addison Wesley

Nano Composite Parts

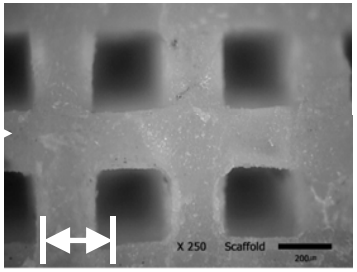
- **Micro gear**
  - Acrylated polyurethane + MWCNT (10wt%)



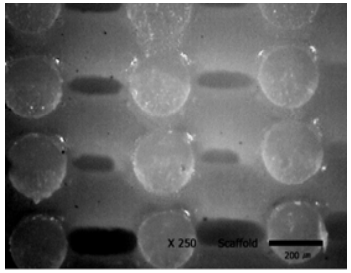
- **Scaffold**
  - Acrylated polyurethane + Hydroxyapatite (30wt%)



10 ㎜ × 10 ㎜ × 3.6 ㎜

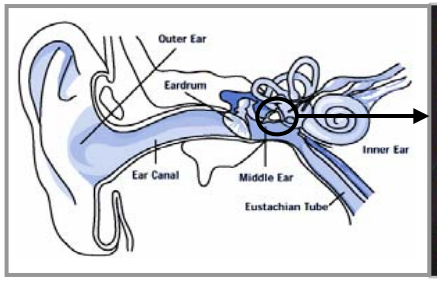


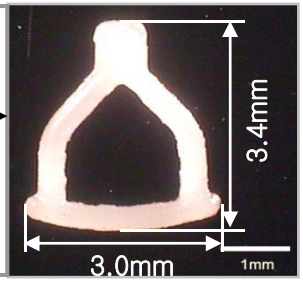
top view

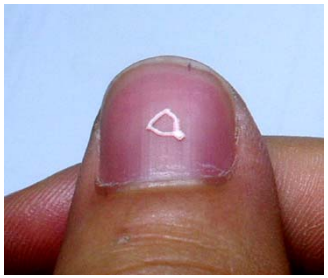


side view

- **Stapes**
  - Acrylated polyurethane + Hydroxyapatite (30wt%)







446.305A MANUFACTURING PROCESS

DFM (Design For Manufacturing)

제조고려설계

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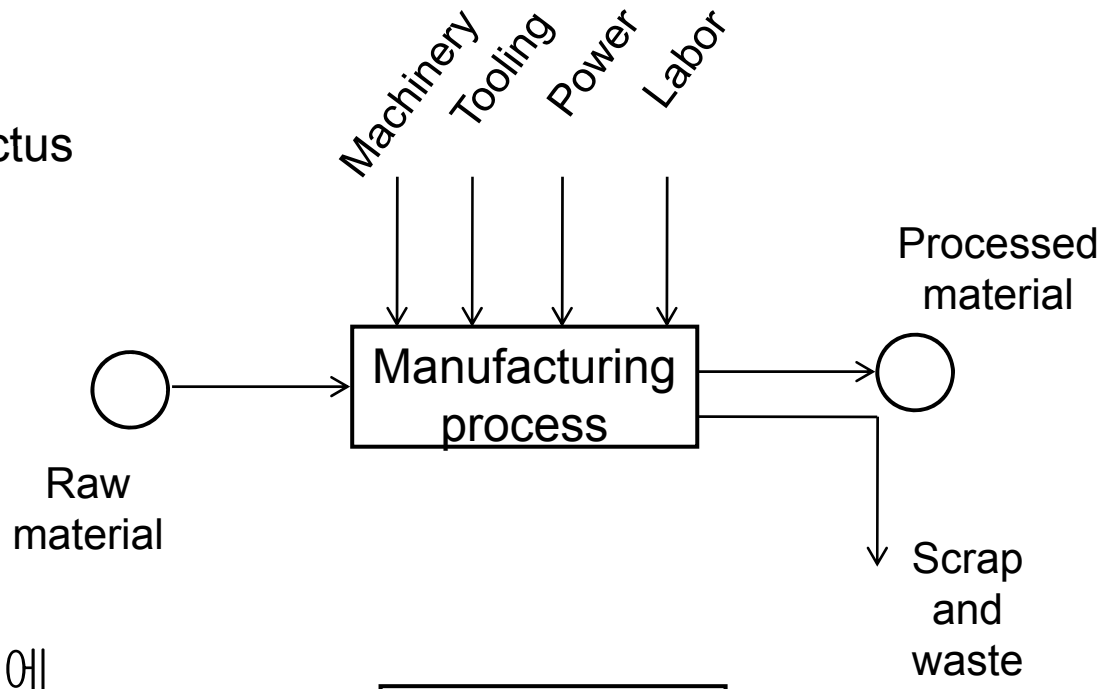
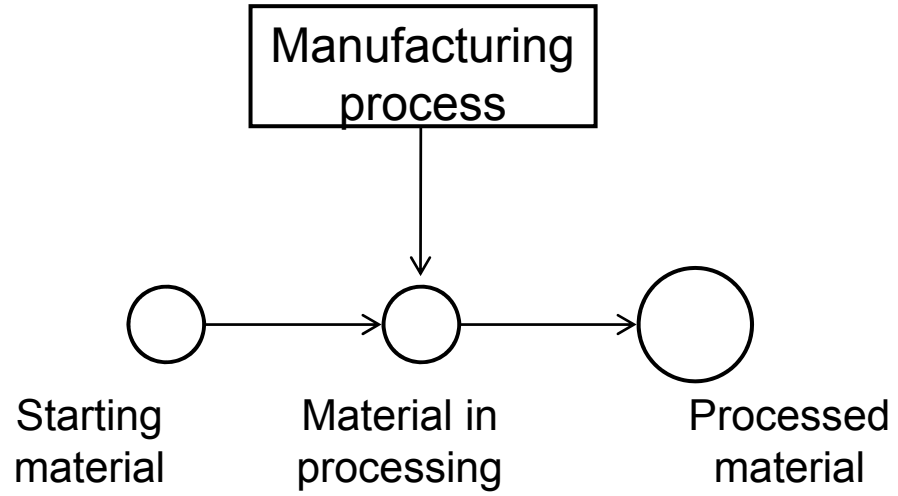
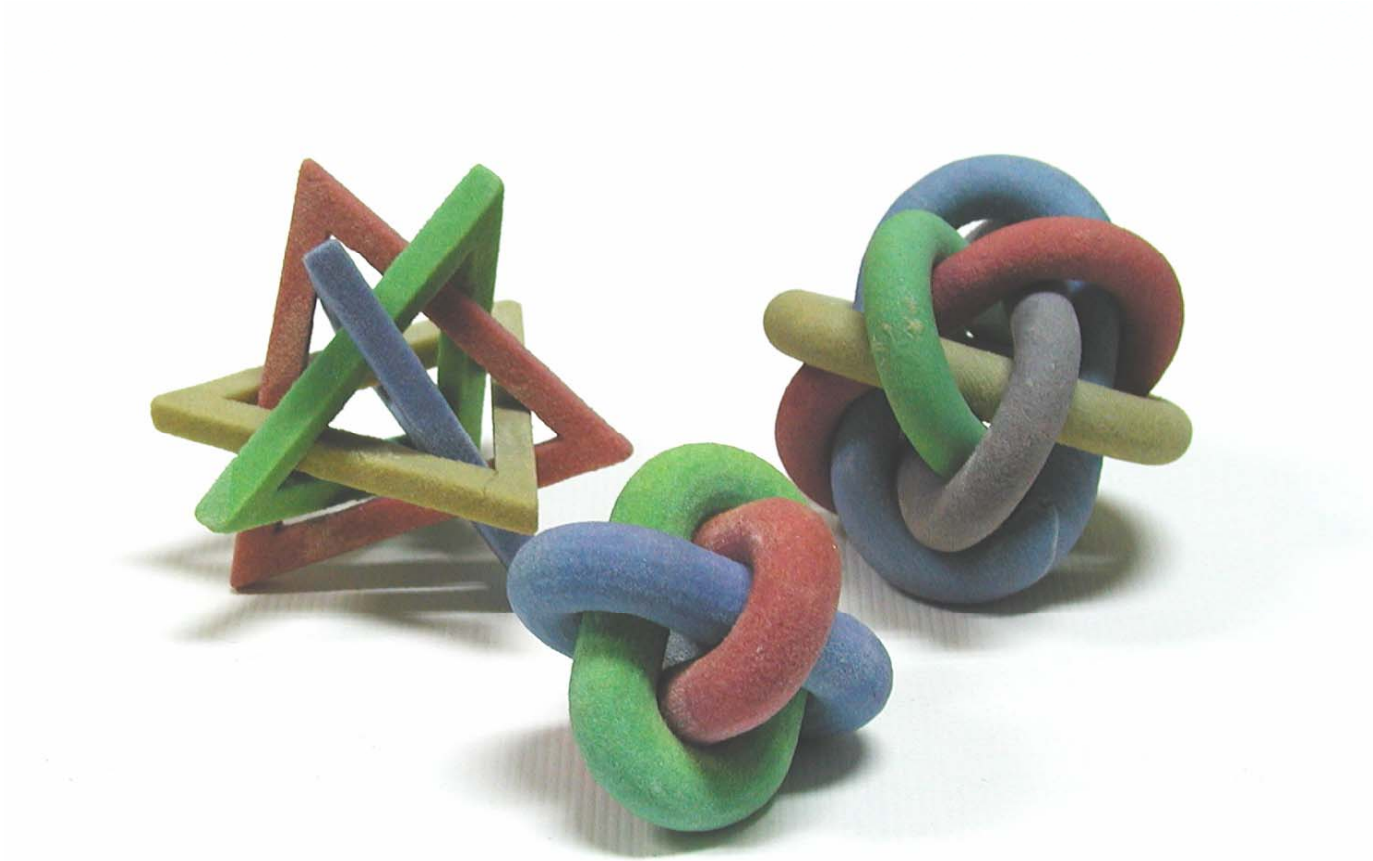
"Manufacturing"

- Manufacturing (가공)
  - Latin: manus (hand) + factus (make)
- "To make by hands or, especially by machinery, often on a large scale and with division of labor" (Webster Dictionary)
- 가공 (加工) : "원료나 재료에 손을 더 대어 새로운 물건을 만드는 일" (Yahoo dictionary)
- 제 · 조 (製造) : "원료를 가공하여 제품을 만듦"
- 생산 (生産) : "인간 생활에 필요한 물건을 만듦"



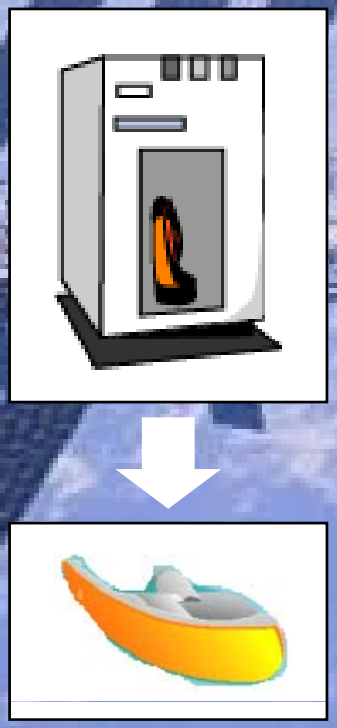


What is Manufacturability?



Do you know how to make these parts?

NASA: Fabrication in Space



FDM1600 test at zero gravity
Johnson Space Center & Marshall Space Flight Center, 2000

Design for Manufacturing (DFM)

- **More important questions**
  - How much cost?
  - How long to take?

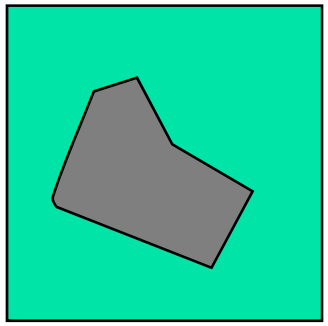
- **These issues are influenced by:**
  - Manufacturing process
  - Availability of machines
  - Material
  - Batch size (how many parts)
  - etc.

Design for Manufacturing (DFM)

- **Traditional manufacturing**

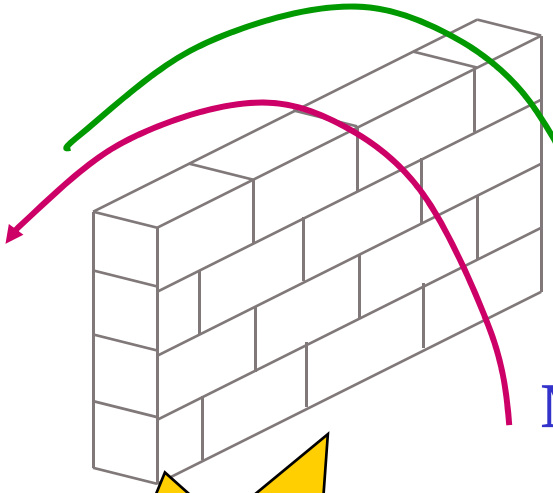
Commercial CAD (CATIA, ProE, I-DEAS, Inventor)

Design



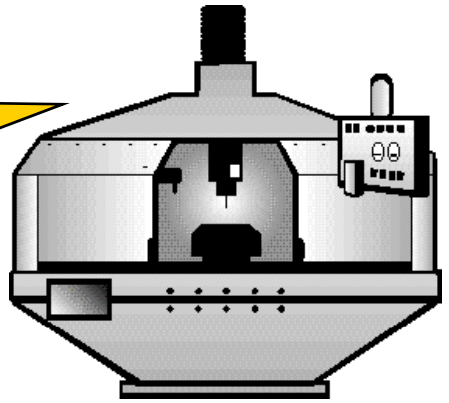
Time lost in redesign

Over-the-wall manufacturing



Manufacturing

Ouch, it's not Machinable

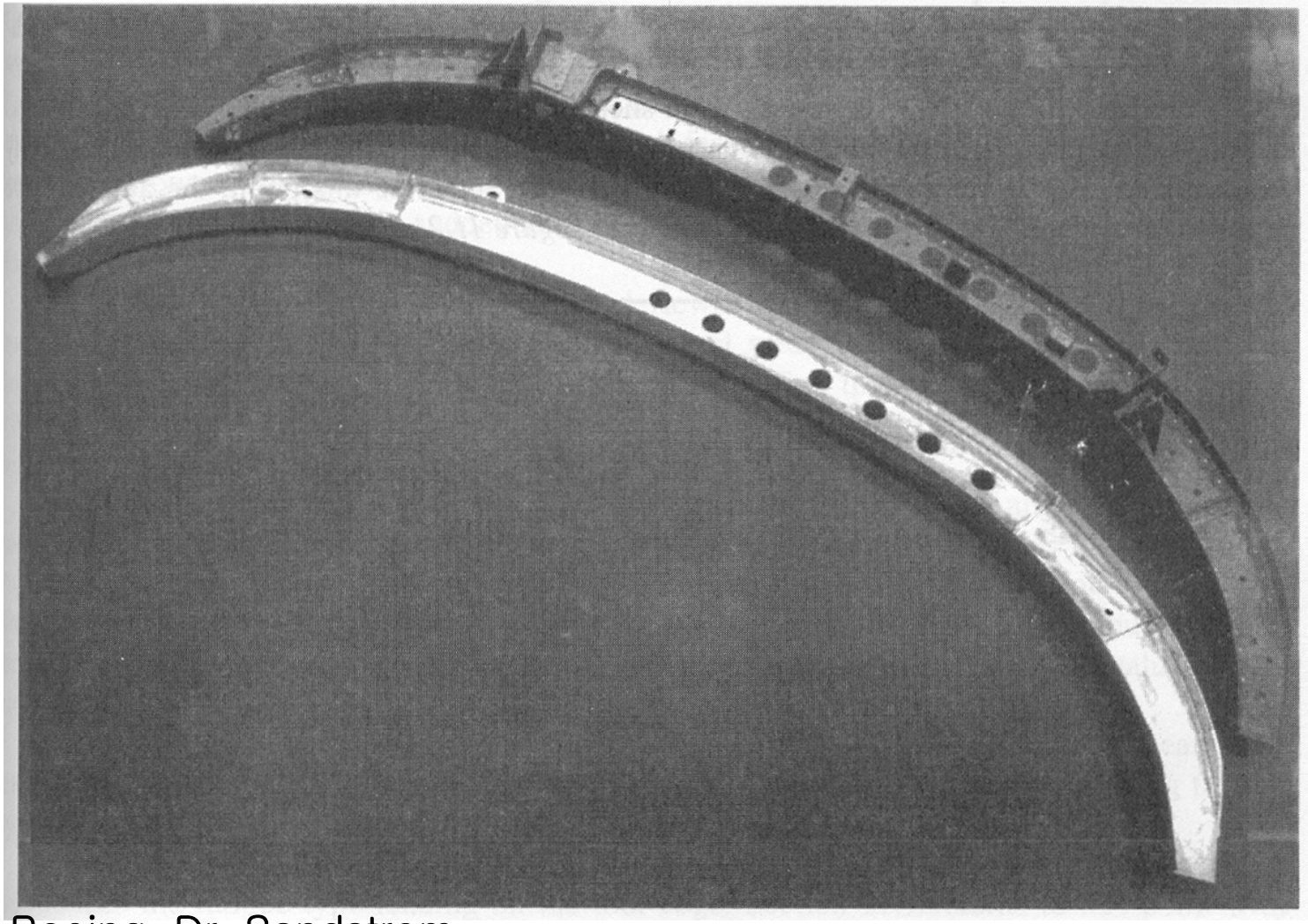


Design for Manufacturing (DFM)

- **Importance of DFM**
  1. Design decision affects manufacturing cost and productivity
  2. Designers play important role not only shaping, but also in manufacturability, cost, life cycle of products

- **In product development cycle:**
  - 80% of cost is committed at design stage
  - Cost for design is less than 10%

High speed machining vs. assembled sheets



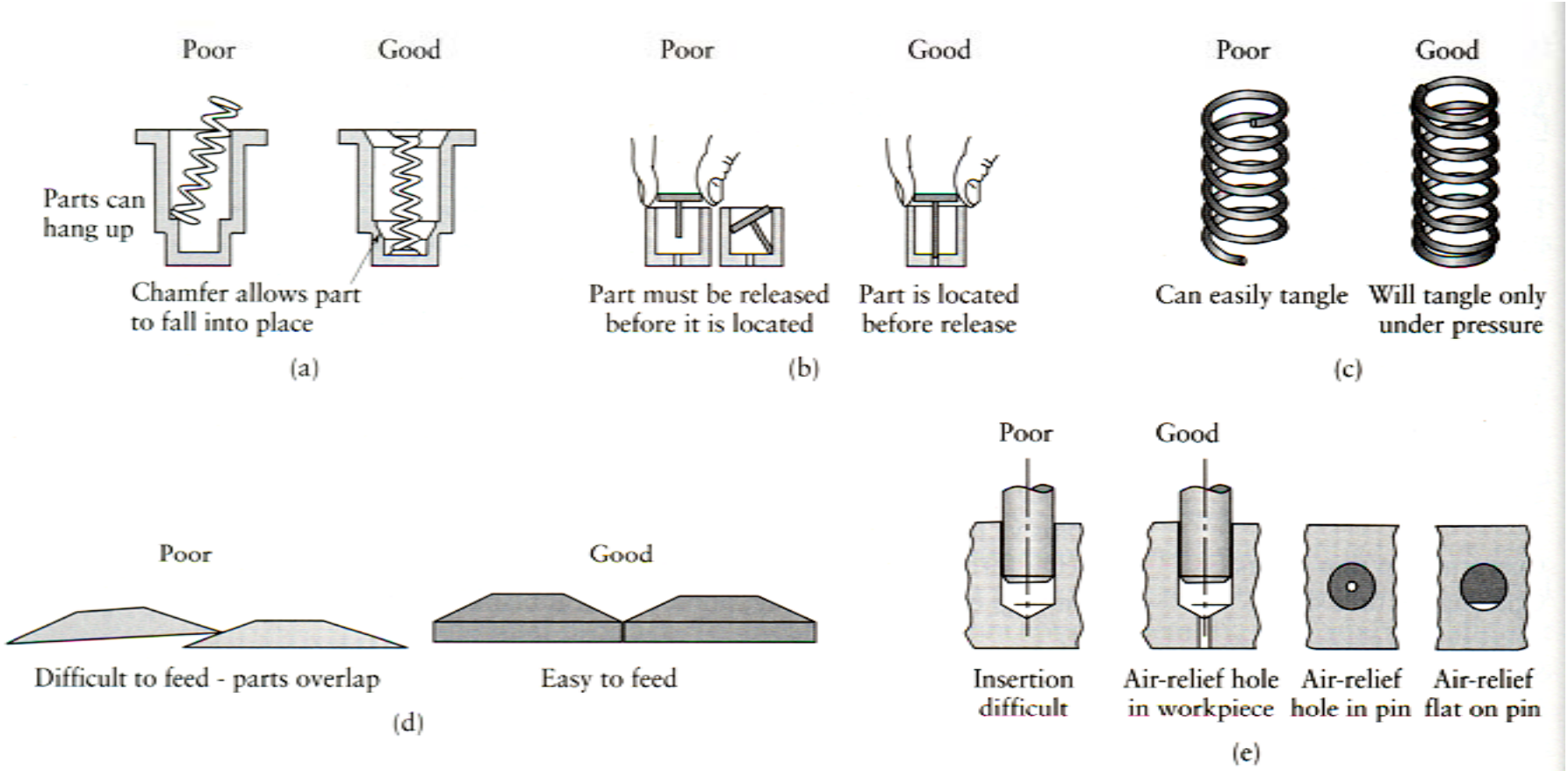
Boeing, Dr. Sandstrom

Ref.
S. Kalpakjian, "Manufacturing Processes for Engineering Materials", 3rd/4th ed. Addison Wesley

General DFM Rule

- Minimum number of parts
- Standard parts
- Modular design
- Multi-functional parts
- The same parts to various products
- Maximum surface roughness and tolerance
- Avoid secondary process
- Use materials easy to manufacture
- Consider number of parts to be manufactured
- Avoid many components
- Minimize handling of parts

Design for Assembly (DFA)



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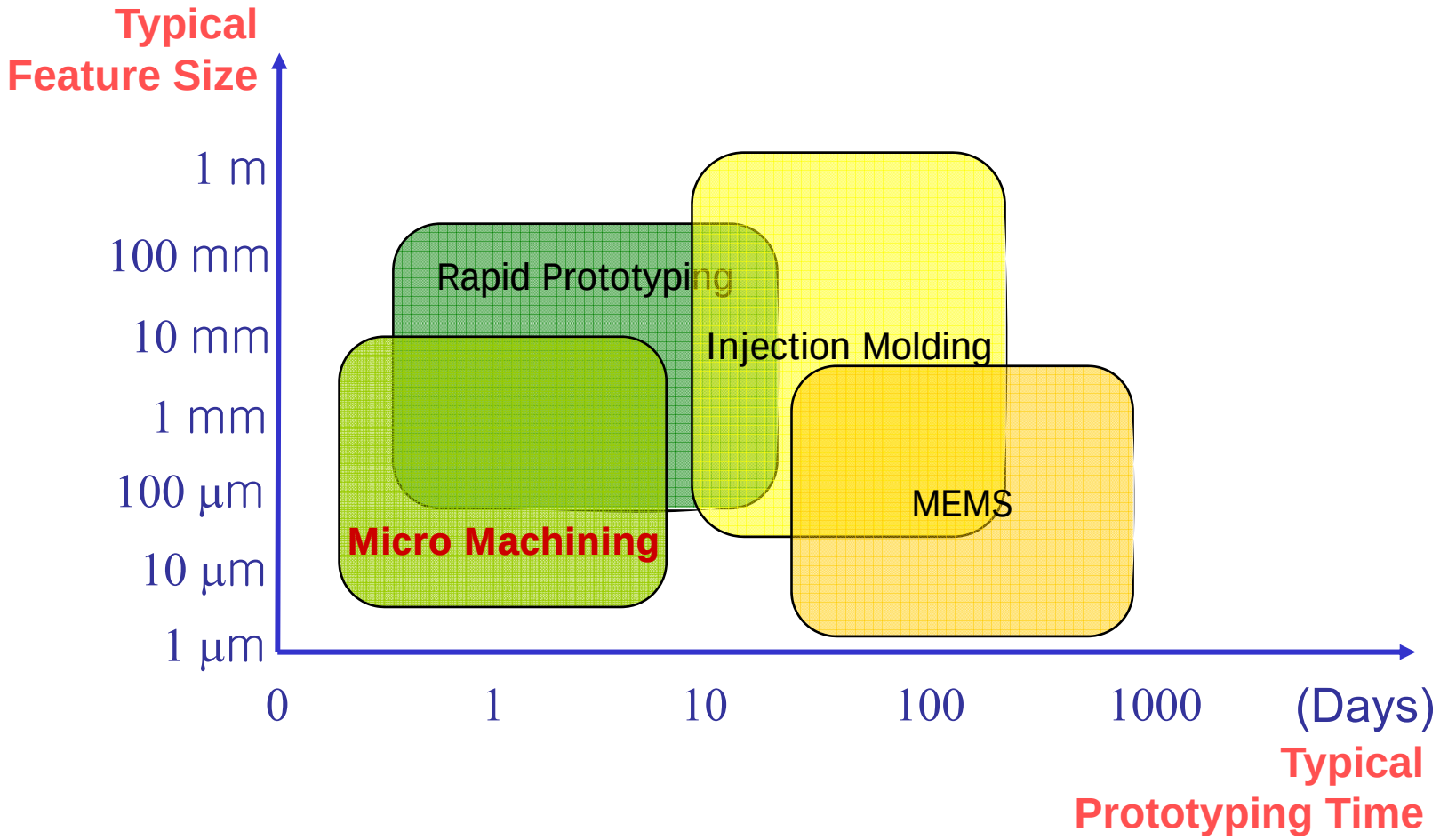
Comparison of processes

- **Prototyping Size & Time**



Selection of Manufacturing Process

- Manufacturing process
  - Casting (주조)
  - Forming and shaping (소성가공)
  - Machining (기계가공)
  - Joining (접합)
  - Finishing (마무리 작업)
- Dimension, surface roughness(치수, 표면 거칠기)
- Considerations for process and cost(작업, 비용상 고려사항)
- Net shape manufacturing (정형가공)

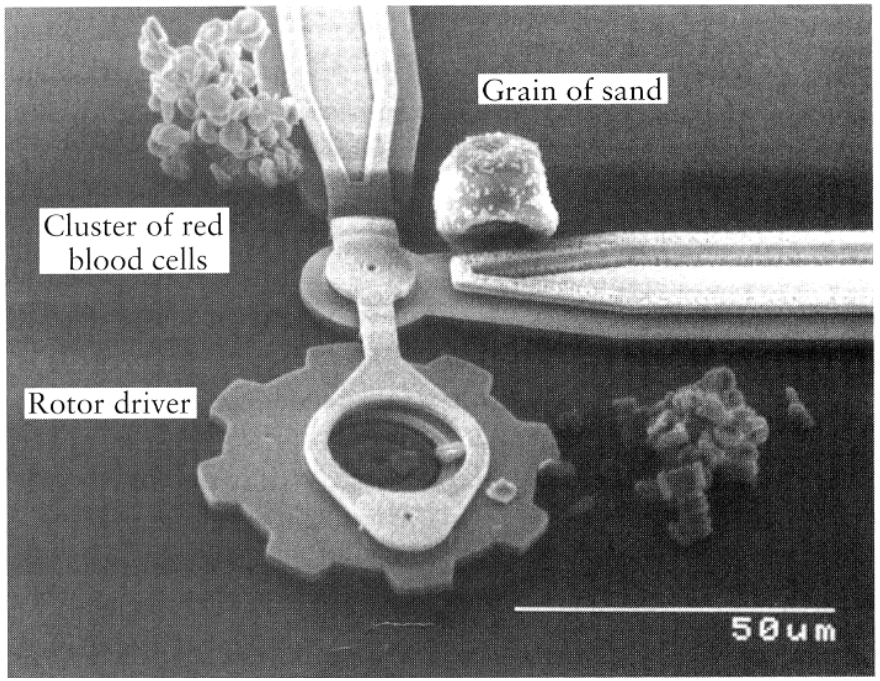
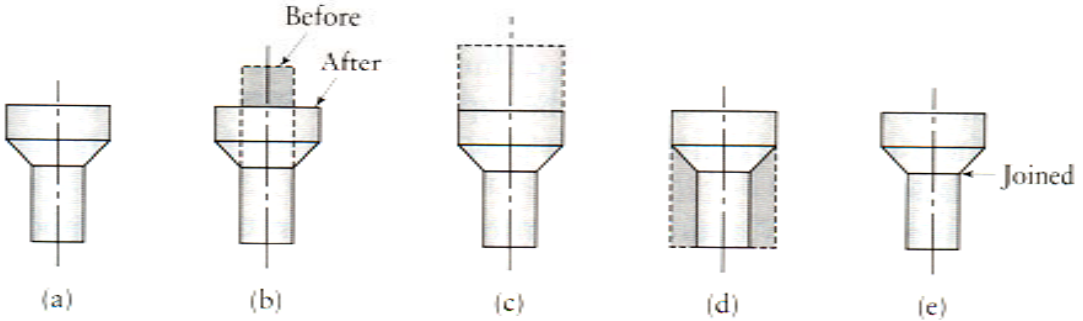


FIGURE 1.6 Various methods of making a simple part: (a) casting or powder metallurgy, (b) forging or upsetting, (c) extrusion, (d) machining, (e) joining two pieces.



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Ultimate manufacturing process