UNIVERSITY OF TRENTO

ICT Innovation – Spring 2017

MSc in Computer Science and MEng Telecom. Engineering
EIT Masters ITA, S&P,SDE

Lecture 08 – Design for Manufacturing

Prof. Fabio Massacci

Product Development Process

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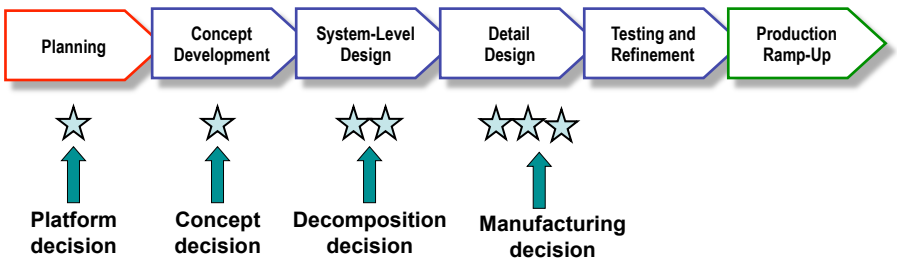
- Product architecture is determined early in the development process
- Detailed design is important for manufacturing



How to actually manufacture the product?

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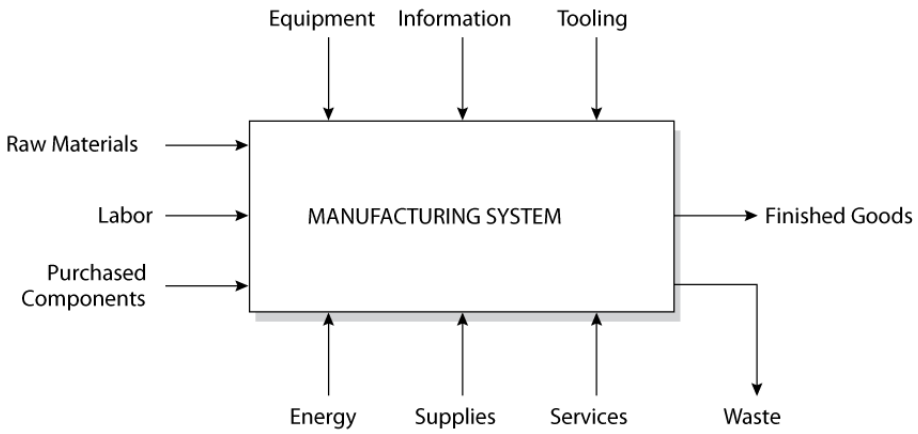

From *Product Design and Development* by Karl Ulrich and Steven Eppinger (McGraw-Hill/Irwin)

Understanding Manufacturing Costs

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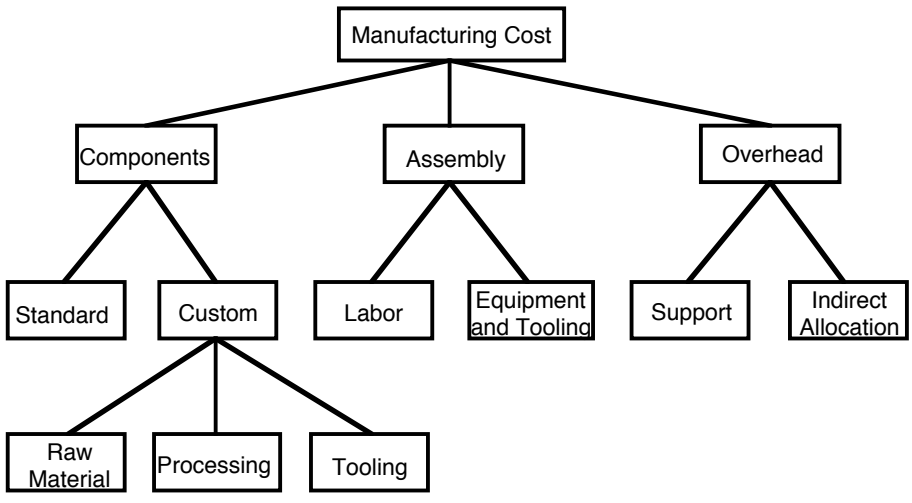

Is optimizing manufacturing worth?

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- 2 billion worldwide annual volume
- 7 major producers of 1/2" cassette shells
- JVC licenses the VHS standard
  - dimensions, interfaces, light path, etc
- VHS cassette shells cost ~$0.25 each
- What is a $0.01 cost reduction worth?

Design for manufacturing

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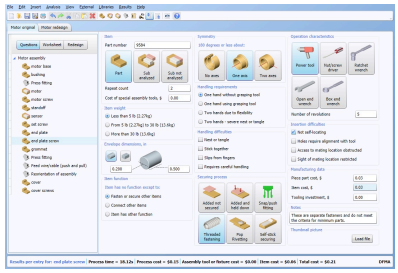
- Product development practice emphasizing manufacturing issues.
- Successful DFM results in lower production cost without sacrificing product quality.
- Obtained through
  - Cross-Functional Teams
  - Specialized Design Rules
  - CAD Tools
    - E.g.Boothroyd-Dewhurst DFMA
    - http://www.dfma.com



Example DFA guidelines from a computer manufacturer.

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- Minimize parts count.
- Encourage modular assembly.
- Stack assemblies.
- Eliminate adjustments.
- Eliminate cables.
- Use self-fastening parts.
- Use self-locating parts.
- Eliminate reorientation.
- Facilitate parts handling.
- Specify standard parts.

Example of times for fastening parts

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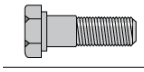
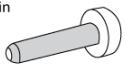
- Different tools for fastening parts differs in
  - Time to fasten
  - Time to unfasten (if at all)
  - Precision
  - Robustness to tear and wear
  - Ability to adjust

Component	Time (Seconds)		
	Min	Max	Avg
Screw 	7.5	13.1	10.3
Snap-fit 	3.5	8.0	5.9

Component	Time (Seconds)		
	Min	Max	Avg
Pin 	3.1	10.1	6.6
Spring 	2.6	14.0	8.3

From *Product Design and Development* by Karl Ulrich and Steven Eppinger (McGraw-Hill/Irwin)

Design for Assembly

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- **Key ideas of DFA:**
  - Minimize parts count
  - Maximize the ease of handling parts
  - Maximize the ease of inserting parts
- **Benefits of DFA**
  - Lower labor costs
  - Other indirect benefits

$$\text{DFA index} = \frac{(\text{Theoretical minimum number of parts}) \times (3 \text{ seconds})}{\text{Estimated total assembly time}}$$

From *Product Design and Development* by Karl Ulrich and Steven Eppinger (McGraw-Hill/Irwin)

Method for Part Integration

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- **Ask of each part in a candidate design:**
  - Does the part need to move relative to the rest of the device?
  - Does it need to be of a different material because of fundamental physical properties?
  - Does it need to be separated from the rest of the device to allow for assembly, access, or repair?
- **If not, combine the part with another part in the device.**

$$\text{Total unit cost} = \frac{\text{Setup costs} + \text{Tooling costs}}{\text{Volume}} + \text{Variable costs}$$

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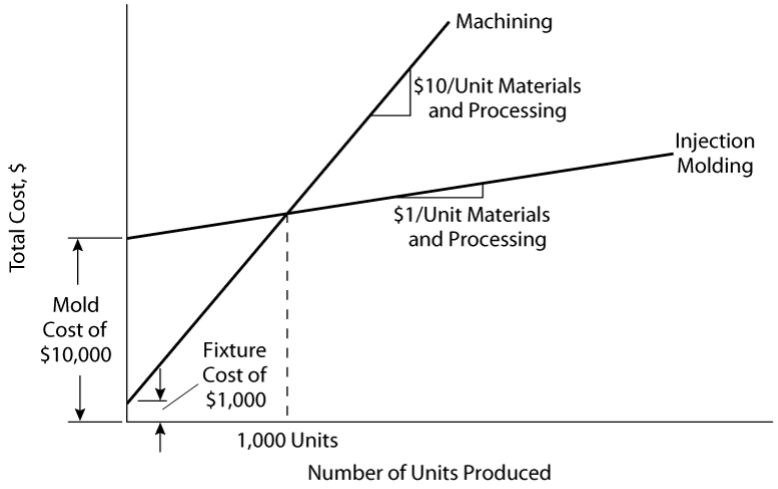
Different technologies works differently at scale



From *Product Design and Development* by Karl Ulrich and Steven Eppinger (McGraw-Hill/Irwin)

Practical Concerns

- **Planning is essential to achieve the desired variety and product change capability.**
- **Coordination is difficult, particularly across teams, companies, or great distances.**
- **Special attention must be paid to handle complex interactions between chunks (system engineering methods).**

Product Architecture: Conclusions

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- **Architecture choices define the sub-systems and modules of the product platform or family.**
- **Architecture determines:**
  - ease of production variety
  - feasibility of customer modification
  - system-level production costs
- **Key Concepts:**
  - modular vs. integral architecture
  - clustering into chunks
  - planning product families

Textbook

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Product Design and Development
Karl T. Ulrich and Steven D. Eppinger
5th edition, Irwin McGraw-Hill, 2012

1. Introduction
2. Development Processes and Organizations
3. Opportunity Identification
4. Product Planning
5. Identifying Customer Needs
6. Product Specifications
7. Concept Generation
8. Concept Selection
9. Concept Testing
10. Product Architecture
11. Industrial Design
12. Design for Environment
13. **Design for Manufacturing**
14. Prototyping
15. Robust Design
16. Patents and Intellectual Property
17. Product Development Economics
18. Managing Projects