PRODUCT ARCHITECTURE

Team 5:

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FIRST THOUGHTS

- What do you think is the aim of product architecture?

Product chang

Product develc

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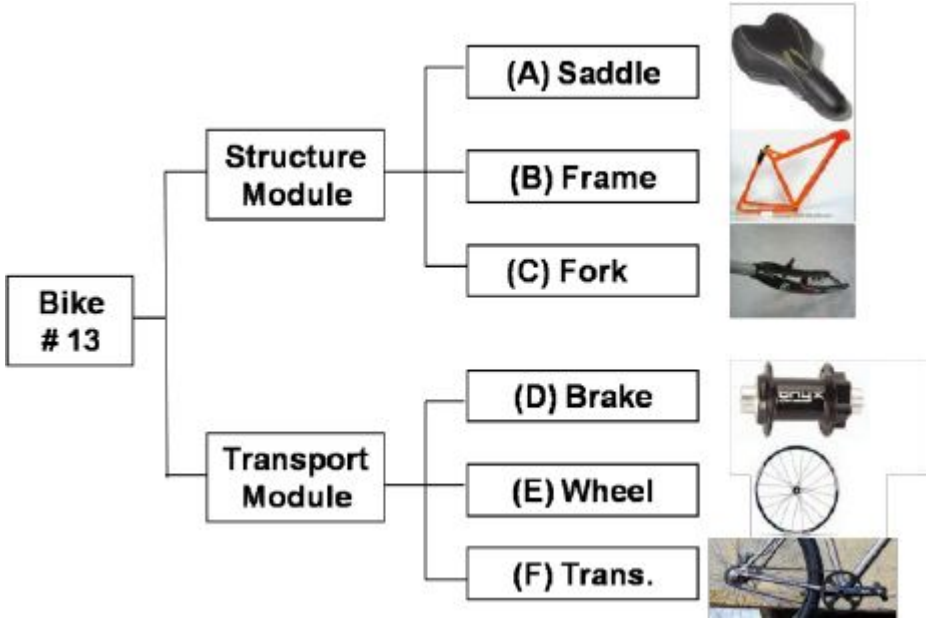
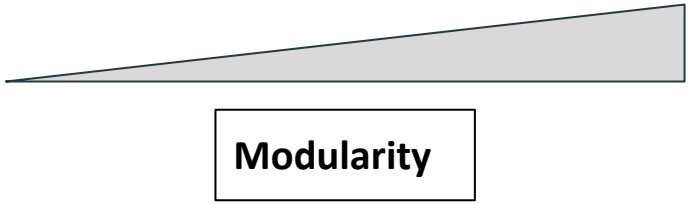
WHAT IS PRODUCT ARCHITECTURE?

- Functional and physical elements
- Chunks
- Modularity

"The architecture of a product is the scheme by which the functional elements of the product are arranged into physical chunks and by which the chunks interact."



IMPORTANCE OF MODULARITY



Modularity

Integral architecture

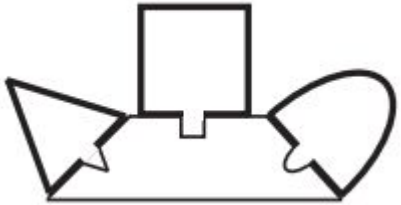
- Many functional elements per chunk
- Interactions between chunks may be incidental

Modular architecture

- One or a few functional elements per chunk
- Interactions between chunks are well defined

TYPES OF MODULARITY

- Slot-modular



- Bus-modular

- Sectional-modular

IMPLICATIONS OF THE ARCHITECTURE

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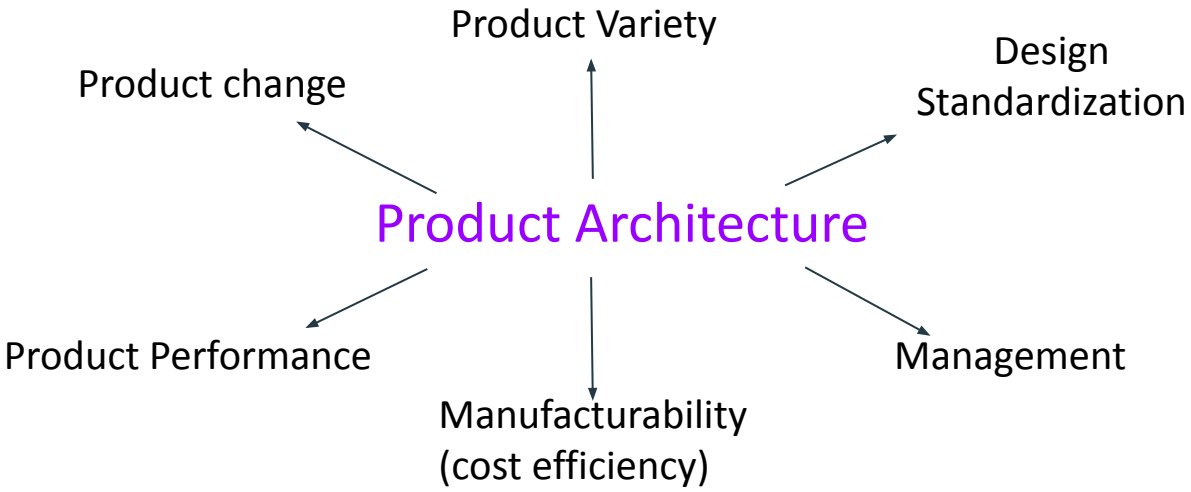


IMPLICATIONS

Product change

- Customization and upgradation
- Adaptation
- Wear and consumption

Product variety

- Different product models

IMPLICATIONS

Product Performance

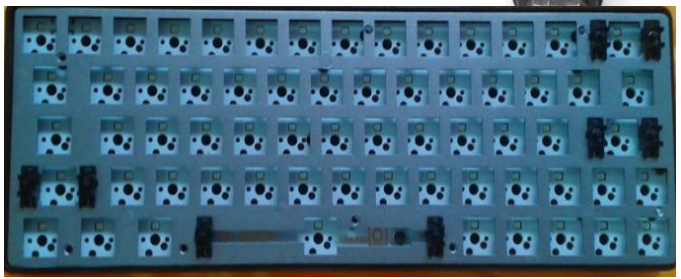
IMPLICATIONS

Design Standardization

- Same chunk for different products
- High volume production

Manufacturability

- Cost efficiency
- Quality control



IMPLICATIONS

Product Development Management

- Workload for each chunk
- Development time
- Group coordination and interaction

IMPLICATIONS

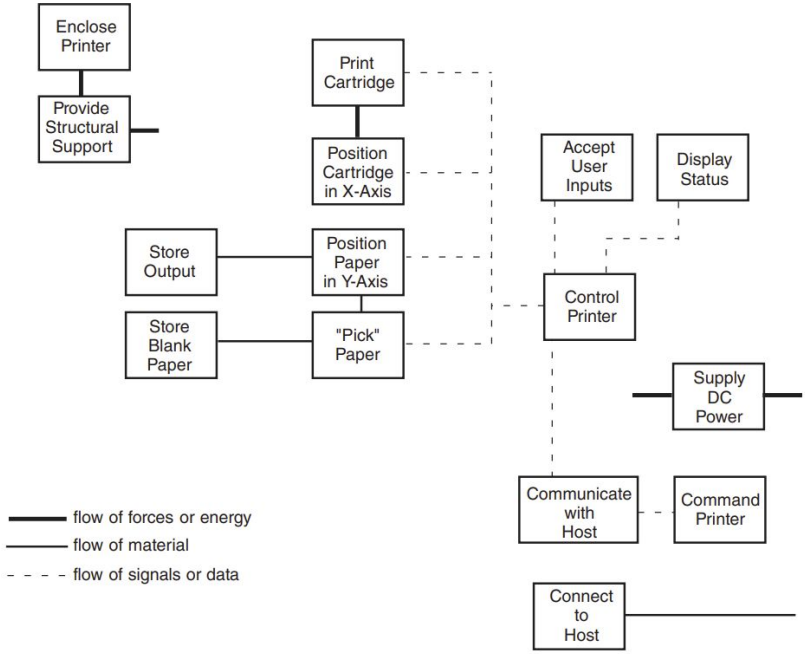
Which architecture offers more advantages?

	Architecture	
Product change	Modular	
Product variety	Modular	
Product performance		Integral
Standardization	Modular	
Manufacturability	Modular	
Maintenance	Modular	
Cost efficient	Modular (standardization)	Integral (less material)

ESTABLISHING THE ARCHITECTURE

Step 1 - Create a Schematic of the Product

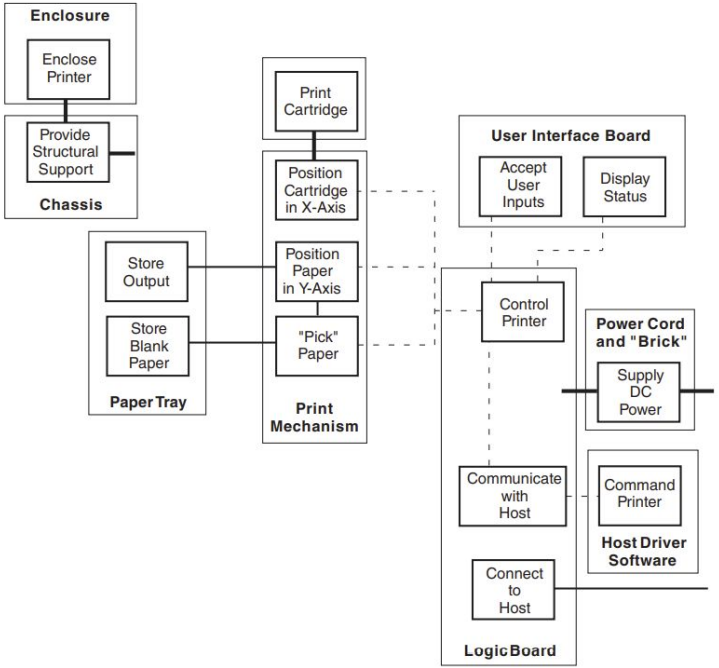
- State of the product
- Elements:
  - Physical concepts
  - Functional



ESTABLISHING THE ARCHITECTURE

Step 2 - Cluster the Elements of the Schematic

- Assign each element of the schematic to a chunk
- Start considering 1 element = 1 chunk, then cluster



ESTABLISHING THE ARCHITECTURE

Step 2 - Cluster the Elements of the Schematic

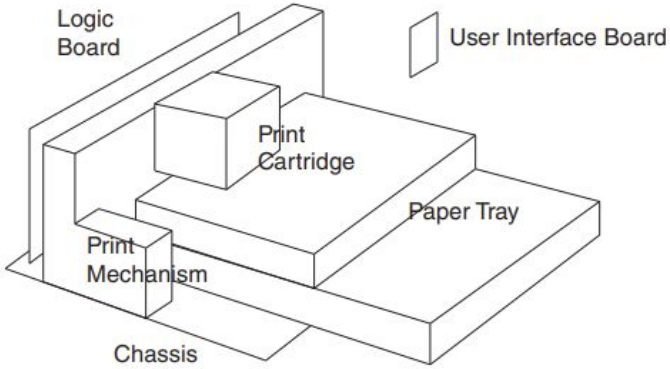
There are different factors to be considered:

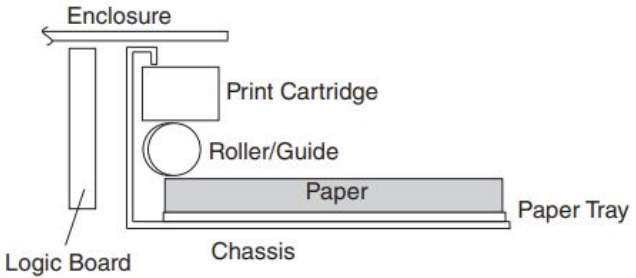
- Geometric integration and precision
- Function sharing
- Capabilities of vendors
- Similarity of design of production technology
- localization of change
- Accommodating variety
- Enabling standardization
- Profitability of interfaces

ESTABLISHING THE ARCHITECTURE

Step 3 - Create a Rough Geometric Layout

- Drawing, computer models or physical models
- Basic dimensional relationships among chunks
- Can create different layouts for challenging dimension relations, to then choose the one that fits best
- Linked to clustering in step two

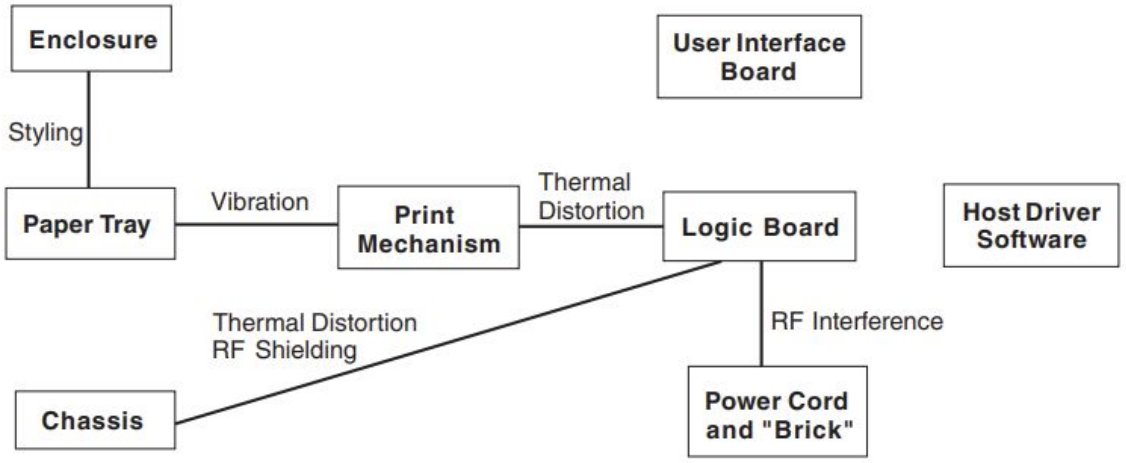




ESTABLISHING THE ARCHITECTURE

Step 4 - Identify the Fundamental and Incidental Interactions

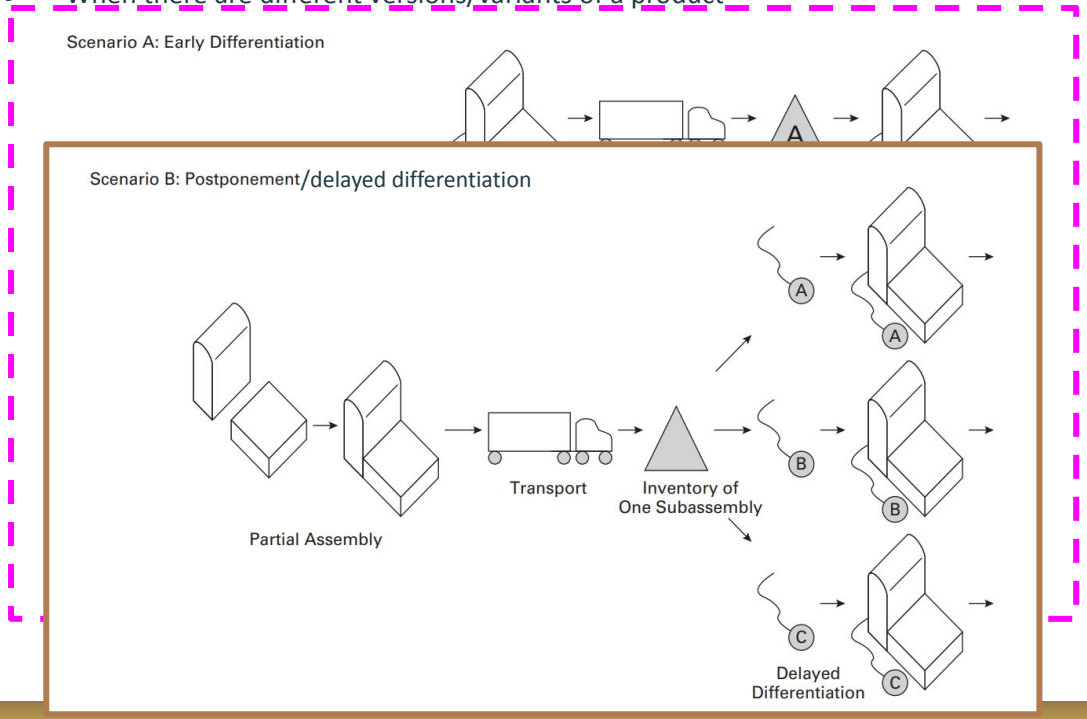
- Interaction between the chunks
- There are two main categories for interaction between chunks:
  - *Fundamental interactions*
  - *Incidental interactions*



Incidental interaction graph

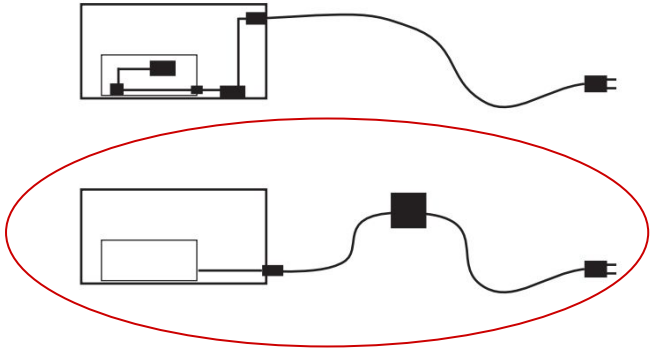
DELAYED DIFFERENTIATION

- Postponing variant specific changes to a product until late in the supply chain
  - First, what is early differentiation?
    - When there are different versions/variants of a product



Principles of DELAYED DIFFERENTIATION

1. Differentiating elements of the product must be concentrated into one or a few chunks
    a. maximize common components and minimize chunks needed to be touched twice to keep price down
2. Differentiating elements can be added to the product near the end of the supply chain
    a. product must be designed such that the changes can be added quickly to meet demand



Which of these products is a result of delayed differentiation?

DELAYED DIFFERENTIATION
examples

- The chassis can still be used for a left and right hand drive vehicle
- Different models of car use this same frame
- Chassis ready to be used in a coming EV model that has not been fully developed yet

- On every vehicle the heated seats are installed but the button is missing if the package was not purchased
- Different and transmission options are both capable of fitting in the same chassis

DELAYED DIFFERENTIATION
examples

- Tube should be stocked in long lengths and cut to order so that the right size is always available

- The shirt can be made in large quantities in white, and then dyed to the colors that are selling the most

DELAYED DIFFERENTIATION
interactive

Task: Identify some opportunities for delayed differentiation

Blind spot monitoring system

Sunroof button space

One way mirror display for backup camera

Warning labels for different regions

PLATFORM PLANNING

- What is a product *platform*?

PLATFORM PLANNING

Differentiation Plan

Differentiating Attributes	Sporty Coupe	Family Sedan/Station Wagon	Importance to Customer
Curvature of window glass	More curvature	Straight, vertical	• • •
Styling of instrument panel	Evocative of English roadster	Highly functional	• • •
Relationship between driver and instrument panel	Driver sits low to ground, distant from steering wheel, with seat reclined.	Driver sits higher, closer, more upright.	• • •
Front-end styling	Shorter nose; vehicle appears to attack the road.	Longer nose, more substantial look	• • •
Colors and textures	Darker colors and mix of leather and textiles	Practical surfaces and colors	• •
Suspension stiffness	Stiff, for improved handling	Softer, for improved comfort	• •
Interior noise	Some engine noise desirable, 70 decibels	Noise minimized, 60 decibels	•

PLATFORM PLANNING

Commonality Plan

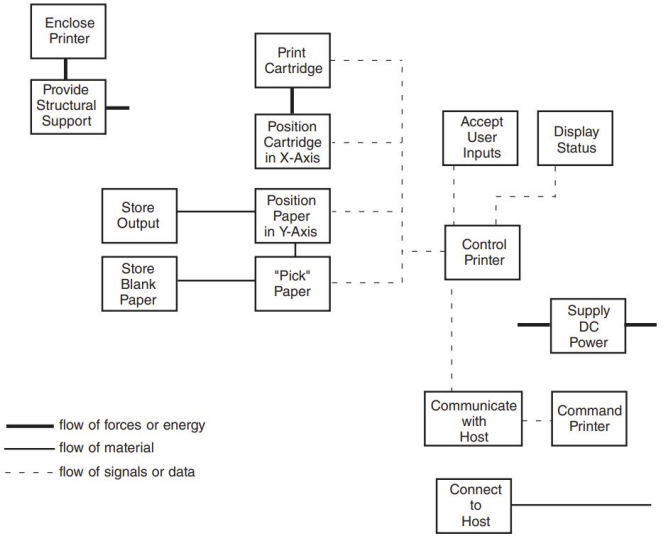
Instrument Panel Chunks	Sporty Coupe				Family Sedan/Station Wagon				Comments
	Number of Unique Parts	Development Cost ($ millions)	Tooling Cost ($ millions)	Manufacturing Cost	Number of Unique Parts	Development Cost ($ millions)	Tooling Cost ($ millions)	Manufacturing Cost	
HVAC system	45	$ 4	$ 9	$ 202	35	$ 3.8	$ 7.5	$ 200	Duct work and support structure different Share motors and other components.
Dash cover and structure	52	$ 4	$ 7	$ 123	48	$ 3.8	$ 6.5	$ 120	Share some brackets and components.
Electrical equipment	115	$ 4	$ 2.2	$ 420	65	$ 2	$ 2.1	$ 430	Share switches, wiring, and central module.
Cross-car beam	12	$ 2	$ 2	$ 35	12	$ 2	$ 2	$ 35	Cross-car beam entirely different.
Steering system and airbags	26	$ 2	$ 0.1	$ 200	26	$ 2	$ 0.1	$ 195	All components different.
Instruments and gauges	16	$ 1	$ 0.2	$ 22	13	$ 0.8	$ 0.2	$ 20	Can share some instruments.
Molding and trim	10	$ 0.4	$ 0.2	$ 11	10	$ 0.4	$ 0.2	$ 10	All molding and trim different.
Insulation	3	$ 0.2	$ 0.2	$ 8	1	$ 0.1	$ 0	$ 10	Change insulation in coupe to let in more engine noise.
Audio and radio	8	$ 0.2	$ 0	$ 300	0	$ 0	$ 0	$ 300	Same radio option in all vehicles.
Total	287	$ 17.8	$ 20.8	$ 1,321	210	$ 14.9	$ 18.5	$ 1,320	

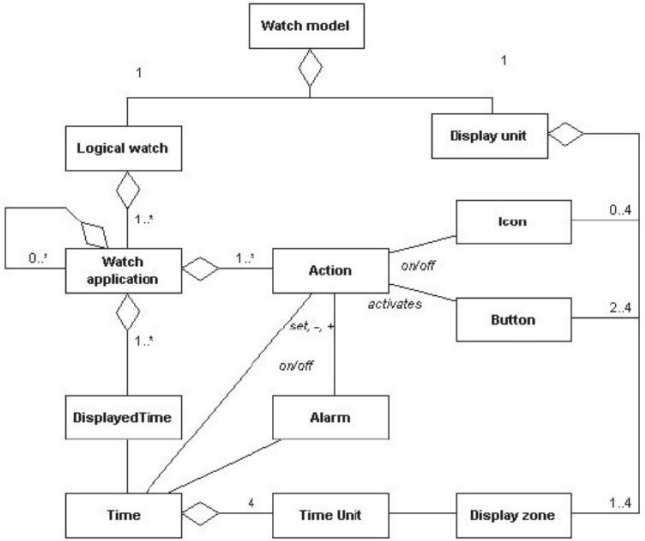
PLATFORM PLANNING

- How do we solve the tension between the differentiation and the commonality plan?
    - Platform planning decisions should be informed by quantitative estimates of cost and revenue implications.
    - Iteration is beneficial.
    - Modular architecture

Related System-Level design Issues

- Defining Secondary Systems





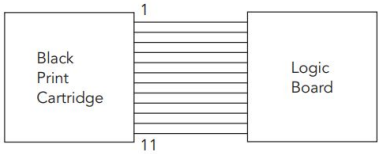
Related System-Level design Issues

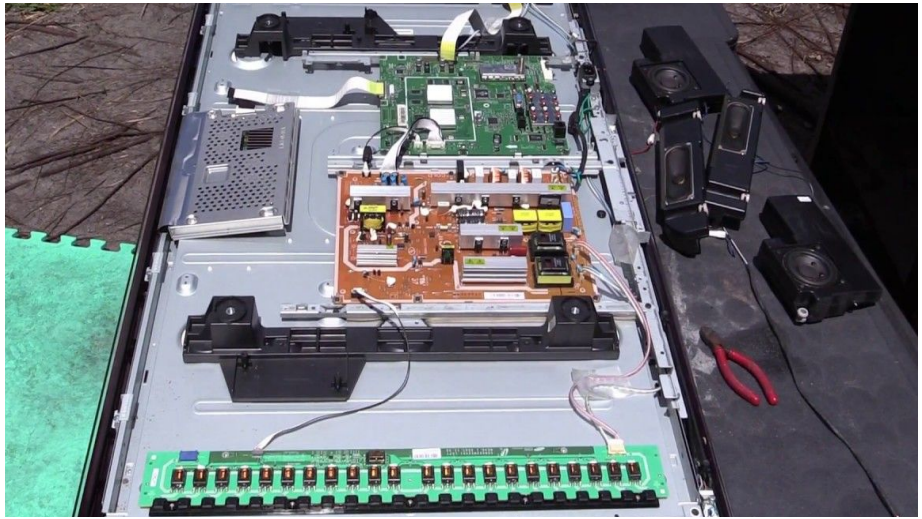
- Define the Architecture of the Chunks

Related System-Level design Issues

- Creating Detailed Interface Specifications

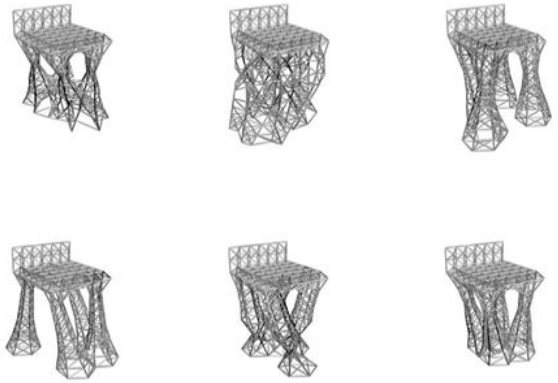
Line	Name	Properties
1	PWR-A	+12VDC, 5mA
2	PWR-B	+5VDC, 10mA
3	STAT	TTL
4	LVL	100KΩ-1MΩ
5	PRNT1	TTL
6	PRNT2	TTL
7	PRNT3	TTL
8	PRNT4	TTL
9	PRNT5	TTL
10	PRNT6	TTL
11	GND	





What does the Future holds for Product Architecture?

Degenerative Design



Virtual Reality and
Augmented Reality

3D printing

Overview

ARCHITECTURE DETERMINES

-Ease of production variety

-Feasibility of further modifications in products

-Production costs

KEY CONCEPTS

-Four-Step Method for establishing the product architecture

-Modular vs. Integral architecture

-Inputs from marketing, manufacturing, and design are essential