# PRODUCT ARCHITECTURE AND VARIETY



## Relation to assignment



- Your project will be for a *product family*
- Businesses can't be based on a single product, must be based on a stream of products
- Need to
  - plan this stream
  - leverage product development resources by planning product architecture
- Many approaches to product plans
  - Need to select the best approach for your *business*

## Types of Projects



- **Completely new platform**
  - HP InkJet
  - Double Insulation
  - *Ford Truck*
- **New Platform**
  - Clean sheet design based on existing technology
  - one or two key parts/systems are shared
  - *Ford Explorer*
- **Platform Extension**
  - Subsystem changed and enhanced
  - A portion of the parts/processes shared
  - *New "rounded design"*
- **Derivatives**
  - Quality and cost reductions
  - Added functionality
  - A majority of the parts/processes



## Shared Parts [1] Product Platform



- **Standard parts**. Common agreement on standard parts.
  - Screws
  - Motors
  - Materials
- **Product Architecture**. Common agreement on sub-assemblies and architecture

## Core benefit proposition for arch.



- Leverage fixed investments over multiple products
  - tooling
  - development
  - marketing
  - sales
- During project
  - what are the expensive fixed costs that can be spread among products



## Types of Variety



- Across vertical market segments
  - Quality & functionality upgrades
- Across horizontal market segments
  - Different applications
- Through time
  - upgrades
  - additional product offerings
- Real time variety (user created)

# Types of variety



| | | Customer Indoor | Customer Outdoor | Automotive | International |
|---|---|---|---|---|---|
| Tiers | Best | Market:<br>Features:<br>Cost: | | | |
| | Mid | | | | |
| | Budget | | | X | |



# Horizontal Platforms

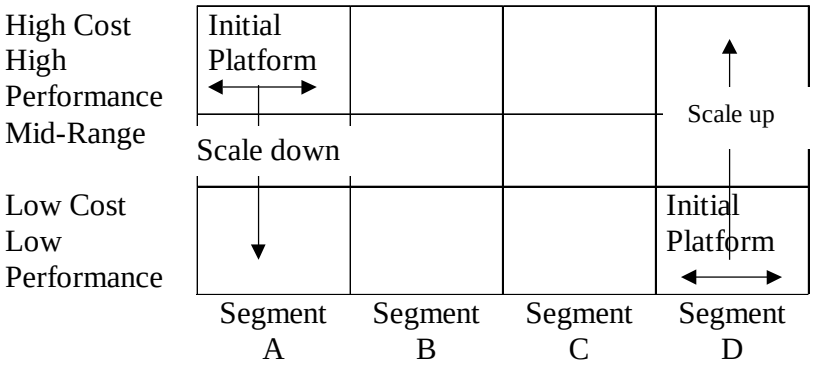


| | | | | |
|---|---|---|---|---|
| High Cost<br>High Performance<br>Mid-Range | ← | High-End | Platform | → |
| | | | | |
| Low Cost<br>Low Performance | ← | Low-End | Platform | → |
| | Segment A | Segment B | Segment C | Segment D |

Examples:
Automotive, others?

# Vertical Platforms

IPPD 2/3 Product Architecture




Examples: Camera equipment, medical equipment, GPS, night vision goggles, others?

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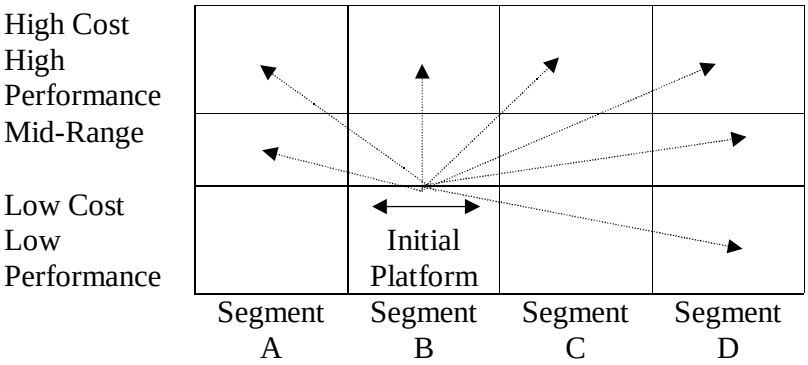
# Horizontal and Vertical

IPPD 2/3 Product Architecture




Examples: Black and Decker, Computers, others?

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**Performance:** ability to tailor interactions between products to improve product performance (size, weight, features, etc)

**Expandability:** ability to change or add a feature of a product

Product Performance

**Integral**
Aircraft design

**Slot**
Automotive Stereo

**Bus**
Computer

**Sectional**/
wine rack

*Modular*

Expandability/Changeability

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## Part and Process Commonality

2/3 Product Architecture

29.00

44.95

39.95

54.95

37.95

Features:

Battery life

Auto reverse

Mega Base

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3 Product Architecture

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# Process Commonality

IPPD 2/3 Product Architecture

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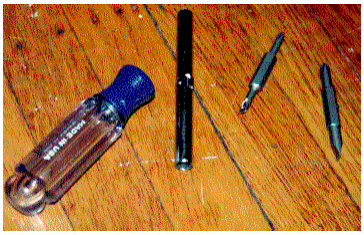
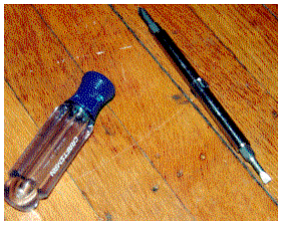
# Slot Architecture

IPPD 2/3 Product Architecture





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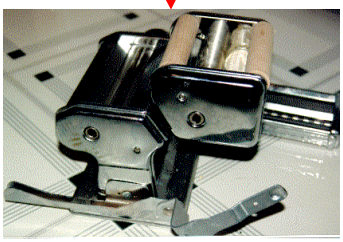
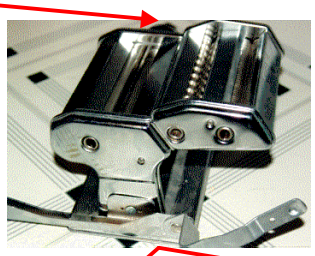
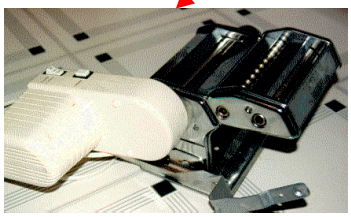
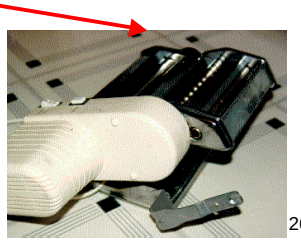
IPPD 2/3 Product Architecture









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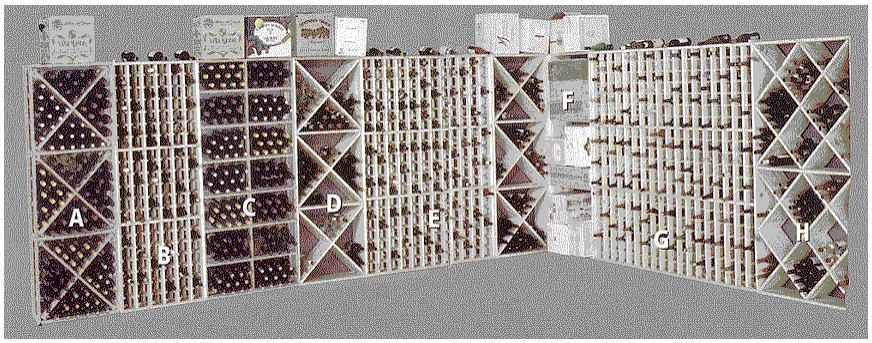


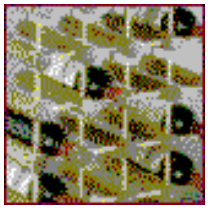

# Sectional Design

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## Inside/out vs. outside/in architecture

IPPD 2/3 Product Architecture

- Inside/out - the core technology stays the same. The outside is adjusted
  - HP Inkjet
  - Sony walkman
- Outside/in - the outside stays the same but the internal technology is changed
  - Cars
  - Computer memory/processors

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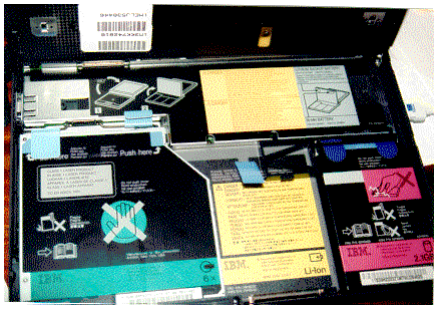
# Outside/In Architecture

IPPD 2/3 Product Architecture



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# Inside/out Architecture

IPPD 2/3 Product Architecture

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## Interfaces



- Interfaces are required to enable rapid product change



## Design the interfaces to



- Allow for
  - redesign/replacement of functional elements
  - within a set of “rules” that are set by the interfaces between parts
- Enables
  - standard assembly processes
  - rapid redesign and debug

## Interface types



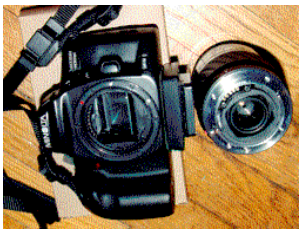
- Energy (plug)
- Material (ink cart.)
- Information (bus arch of a computer)
- Physical (universal motor)



## Interface types



Semi Product Specific



Product Specific

Standard

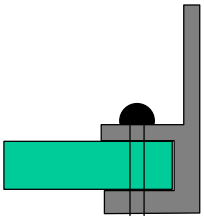
## Coupled

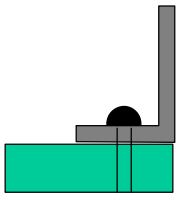
- Chunk A must be adjusted if Chunk B is.
- Examples
  - Car doors
  - Aircraft wings

## Uncoupled

IPPD 2/3 Product Architecture

- Side A and B can be changed independently as long as interfaces are kept the same
  - Camera Bodies
  - Headphones





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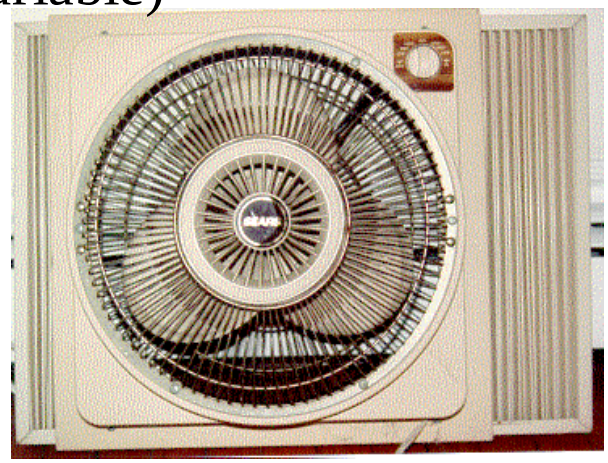
## Adjustable Interface (used when the mating part is variable)

IPPD 2/3 Product Architecture



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## Three levels



- Standard
- Open Product Specific
- Closed Product Specific



## Approaches to architecture



- Razor/razor blade model
  - Sell the unit at low cost, make money on razors
  - Can back-fire if the razor can be made by another org. (ink cartridge)
- Upgrade/new toy model
  - Buy the common system and then add bells
    - Camera
    - KitchenAid Mixer

## Complexity and mix



## Complexity



- X Features (air-conditioning,stereo, seat material, etc).
- $N_i$ options per feature
- Maximum variety =
  - $N_1 * N_2 * \ldots N_X$

## Benefits of product variety



- Address more markets
- Leverage distribution channel, sales force etc.

- Question for project
  - How much variety is needed and what is the cost/benefit argument for additional variety



## Important note:



- Variety can be generated through non-physical “parts”
  - Software
  - Service
  - etc...

## How does this relate to TE



- Appropriability
  - Ability to copy/compete with you
  - Modular designs are easier to copy than integral
- Competition
  - Ability to rapidly address customer needs through product introduction





## Summary

## Product Questions



- How is the product line going to change/expand over time
- How are the interfaces going to constrain the product over time
- How can the functionality be increased or decreased to introduce derivative products
- How are cost reductions going to be implemented



## Process Questions



- Where is manufacturing equipment going to be expensive and/or time-consuming to adapt.
- Where is the current manufacturing process too expensive/difficult and need new approaches
- Where are small batch sizes too expensive (set up/tooling)
- Where is variety expensive (tooling)
- Where are cost reductions going to be implemented

## Risks



- Interfaces are wrong
- Core technology becomes old
- Core technology won't be ready in time
- Product line is not expandable enough
- Won't be followed through
  - investment justification depend on the continual use of the approach



## Part commonality



- Benefits
  - Lower inventory
  - Higher volumes
- Problems
  - Use the "highest common denominator"
  - May sacrifice overall performance
    - size
    - weight

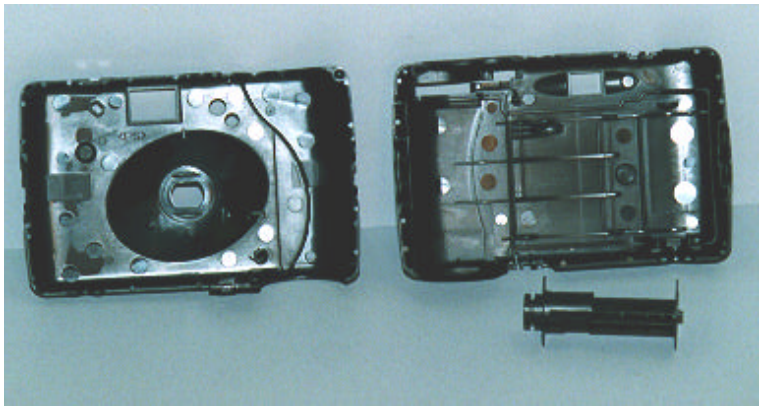
## Design Process for Product Line

Evolution is apparent in camera designs.

- Outdoor - many intricate pieces, difficult assembly
- Flash - no improvements made, circuitboard, flash, and battery added
- Panoramic - fewer pieces, easy assembly, panoramic viewfinder added
- Waterproof - similar to Panoramic, clear plastic box, large winding knob, and rubber button, and rubberband handle added

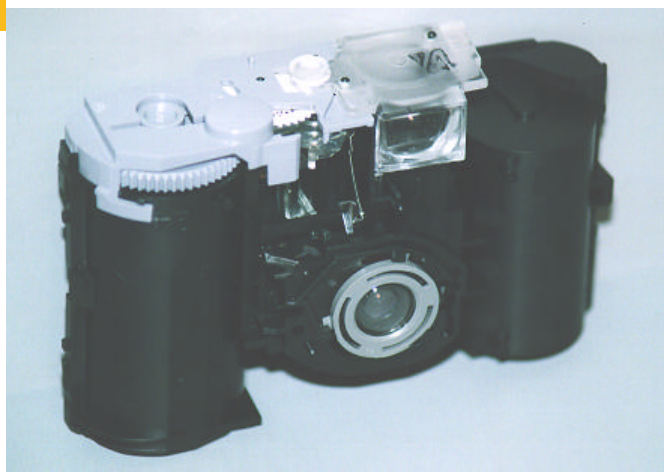
## Platform 1

## Platform 1



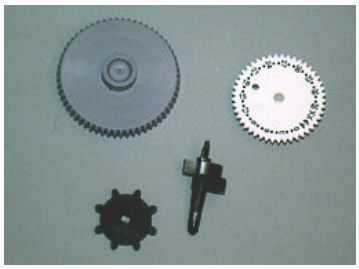
Front and back body pieces that enclose the center piece; film spool

## Platform 1



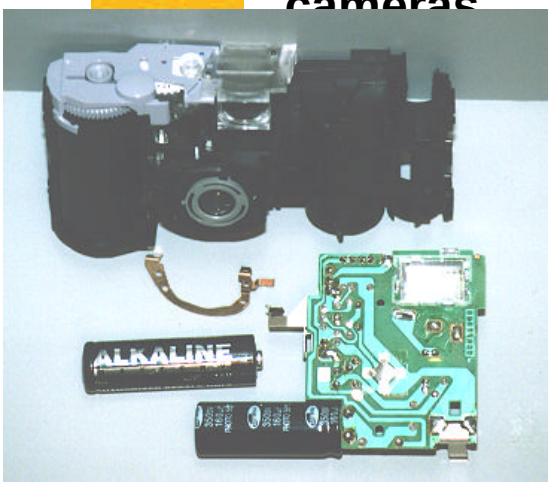
Center includes lens/shutter and gears/viewing lenses

## Platform 1



All cameras have similar gears, cams, and springs

## Modularity between Outdoor and Flash cameras




Outdoor and Flash cameras have identical part lists, excluding the circuitboard, flash and battery

## Platform 1

- Many small parts that could be eliminated
- Difficult assembly process requires camera be assembled from many sides
- No improvements made between Outdoor and Flash cameras

## Platform2: Kodak Panoramic and Waterproof Cameras

Body design for both Panoramic and Waterproof cameras

- Fewer, more compact pieces
- Simple assembly, allowing most pieces to be dropped into the top of the camera
- Camera is in a cardboard carton, removing the need for a smooth surface finish

## Steps to define architecture

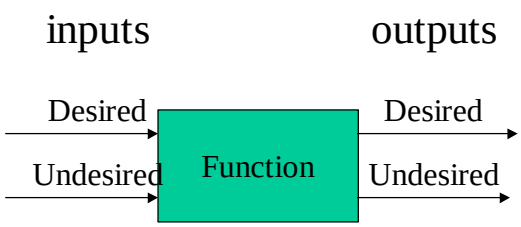


- Define the functional structure of the product
- Map the function to physical components
- Specify the interfaces between the parts
- Evaluate for
  - product performance
  - expandability
  - reusability
  - manufacturability



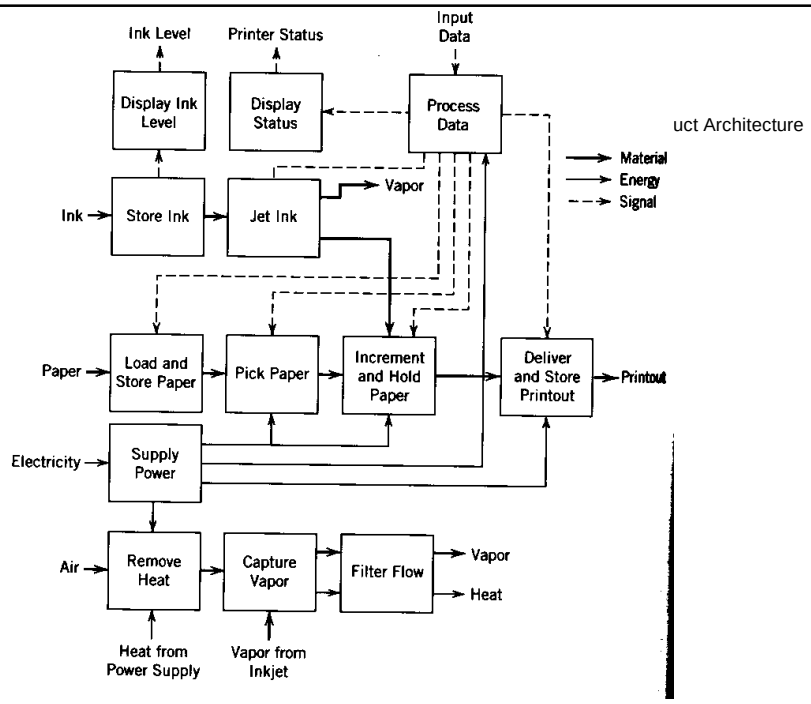
## Functional Model






Interface types:

- Energy
- Material
- Information
- Physical




uct Architecture

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# Warning!

IPPD 2/3 Product Architecture

**There are more than one way to model the function structure.**

**Different models will result in different architectures**

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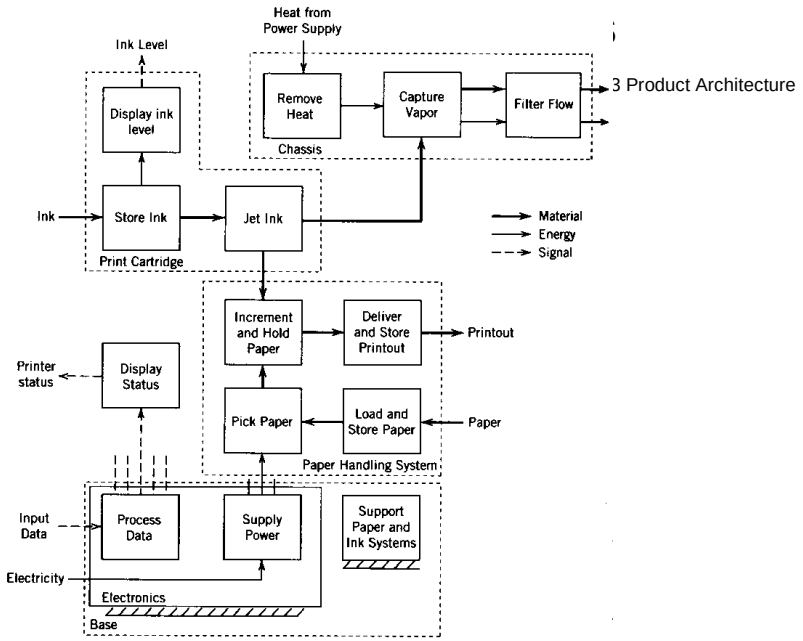


3 Product Architecture

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# Guidelines

IPPD 2/3 Product Architecture

- Create chunks where interfaces are tightly coupled
  - design out interfaces
- Create interfaces where
  - features are added
  - parts may be changed

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## What did you learn?



- A set of approaches to create product variety at lower cost
  - Different architectures
  - Different introduction plans
- Understand the benefit and limitations of each approach



## How does this relate to your assignment



- Need to design a business around a product family
- Need to design the appropriate product architecture
  - Where is variety generated
  - How much variety are you creating
  - When is the variety generated
    - User or Range of product offerings or Upgrades
- Need to justify the business case for these decisions

## Next Thursday: Assignment 0



- Teams of 2
- Written document and presentation
- Generate three technology ventures/product families. These ideas should:
  - Be feasible within the scope of the course
  - Have an architecture that allow product variety to be created
  - Have a reasonable market and competitive capability



## Assignment



- Describe
  - the product family
  - the product architecture and the product variety enabled by the architecture
  - Why this technological development is necessary and how it will be used by the customer
- Analyze your concept:
  - Feasibility
  - product risks
  - business risks
- Present your concepts:
  - Briefly describe the three ideas (one slide each)
  - For one idea prepare a detailed presentation.