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 ≠ 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

<table>
<thead>
<tr>
<th>Tiers</th>
<th>Customer Indoor</th>
<th>Customer Outdoor</th>
<th>Automotive</th>
<th>International</th>
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</thead>
<tbody>
<tr>
<td>Best</td>
<td>Market: Features: Cost:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid</td>
<td></td>
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<tr>
<td>Budget</td>
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Horizontal Platforms

<table>
<thead>
<tr>
<th>High Cost</th>
<th>High Performance</th>
<th>Mid-Range</th>
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</thead>
<tbody>
<tr>
<td>Low Cost</td>
<td>Low Performance</td>
<td>Low-End Platform</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low-End Platform</td>
</tr>
</tbody>
</table>

Examples:
Automotive, others?
**Vertical Platforms**

- High Cost
  - High Performance
  - Initial Platform
  - Scale down
  - Scale up

- Low Cost
  - Low Performance

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

**Horizontal and Vertical**

- High Cost
  - High Performance
  - Initial Platform

- Low Cost
  - Low Performance

Examples: Black and Decker, Computers, others?
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

Integral Aircraft design

Slot
  Automotive
  Stereo

Bus
  Computer

Sectional/wine rack

Modular

Expandability/Changeability

Part and Process Commonality

3.2/3 Product Architecture

29.00

44.95

39.95

54.95

37.95

Features:
  Battery life
  Auto reverse
  Mega Base
Process Commonality
Slot Architecture
Inside/out vs. outside/in 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
Outside/In Architecture

Inside/out Architecture
**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)
Coupled

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

Uncoupled

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

Adjustable Interface (used when the mating part is variable)
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 \times N_2 \times \ldots \times 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

Platform 2: Kodak 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

Body design for both Panoramic and Waterproof cameras
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

<table>
<thead>
<tr>
<th>inputs</th>
<th>outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desired</td>
<td>Desired</td>
</tr>
<tr>
<td>Undesired</td>
<td>Undesired</td>
</tr>
</tbody>
</table>

Function

Interface types:
- Energy
- Material
- Information
- Physical
Warning!

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

Different models will result in different architectures
Guidelines

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