Product Architecture
Product Architecture Example: Hewlett-Packard DeskJet Printer
Product Architecture: Definition

The arrangement of functional elements into physical chunks which become the building blocks for the product or family of products.
Trailer Example: Modular Architecture

- **box**: protect cargo from weather
- **hitch**: connect to vehicle
- **fairing**: minimize air drag
- **bed**: support cargo loads
- **springs**: suspend trailer structure
- **wheels**: transfer loads to road
Trailer Example: Integral Architecture

- upper half
- lower half
- nose piece
- cargo hanging straps
- spring slot covers
- wheels
- protect cargo from weather
- connect to vehicle
- minimize air drag
- support cargo loads
- suspend trailer structure
- transfer loads to road

Protect cargo from weather, connect to vehicle, minimize air drag, support cargo loads, suspend trailer structure, transfer loads to road.
What is this?
Nail Clippers?
Modular Product Architectures

- Chunks implement one or a few functions entirely.
- Interactions between chunks are well defined.
- Modular architecture has advantages in simplicity and reusability for a product family or platform.

Swiss Army Knife

Sony Walkman
Platform Architecture of the Sony Walkman
Integral Product Architectures

- Functional elements are implemented by multiple chunks, or a chunk may implement many functions.
- Interactions between chunks are poorly defined.
- Integral architecture generally increases performance and reduces costs for any specific product model.
Choosing the Product Architecture

Architecture decisions relate to product planning and concept development decisions:

- Product Change (copier toner, camera lenses)
- Product Variety (computers, automobiles)
- Standardization (motors, bearings, fasteners)
- Performance (racing bikes, fighter planes)
- Manufacturing Cost (disk drives, razors)
- Project Management (team capacity, skills)
- System Engineering (decomposition, integration)
Ford Taurus
Integrated Control Panel
Modular or Integral Architecture?

Motorola StarTAC Cellular Phone

Ford Explorer

Rollerblade In-Line Skates

Apple iBook
The concepts of integral and modular apply at several levels:

- system
- sub-system
- component
Product Architecture = Decomposition + Interactions

- Interactions within chunks
- Interactions across chunks
Establishing the Architecture

To establish a modular architecture, create a schematic of the product, and cluster the elements of the schematic to achieve the types of product variety desired.
DeskJet Printer Schematic

Flow of forces or energy
Flow of material
Flow of signals or data

Functional or Physical Elements

Enclose Printer
Provide Structural Support

Print Cartridge
Position Cartridge In X-Axis

Position Paper In Y-Axis
“Pick” Paper

Store Blank Paper
Store Output

Accept User Inputs

Control Printer

Supply DC Power
Command Printer

Display Status

Connect to Host
Communicate with Host

Accept User Inputs

Connect to Host
Geometric Layout

- Logic board
- Print mechanism
- Print cartridge
- Paper tray
- User interface board
- Enclosure
- Print cartridge
- Roller
- Paper
- Paper tray
- Chassis
- Height
Incidental Interactions

- Enclosure
- Paper Tray
- Chassis
- Print Mechanism
- Logic Board
- User Interface Board
- Host Driver Software

Relations:
- Styling
- Vibration
- Thermal Distortion
- RF Shielding
- RF Interference
- Power Cord and “Brick”
System Team Assignment Based on Product Architecture

Planning a Modular Product Line: 
Commonality Table

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<tr>
<th>Chunks</th>
<th>Number of Types</th>
<th>Family</th>
<th>Student</th>
<th>SOHO</th>
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<tr>
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<td>2</td>
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<td>&quot;Picasso&quot; Cartridge</td>
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<tr>
<td>Print Mechanism</td>
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<td>Narrow &quot;Aurora&quot; series</td>
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<tr>
<td>Paper tray</td>
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<td>Front-in Front-out</td>
<td>Tall Front-in Front-out</td>
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<td>&quot;Next gen&quot; board</td>
<td>&quot;Next gen&quot; board</td>
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<td>3</td>
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<td>Version B-PC</td>
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<tr>
<td></td>
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<td>Version A-Mac</td>
<td>Version B-Mac</td>
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</tr>
</tbody>
</table>

**Differentiation versus Commonality**

Trade off product variety and production complexity
Product Model Lifetime

Types of Modularity

Swapping Modularity

Sharing Modularity

Sectional Modularity

Bus Modularity

Fabricate-to-Fit Modularity

Mix Modularity

Audio System Exercise: Where are the Chunks?

- Cellular Phone
- AM/FM Antenna
- Antenna Motor
- Power Amplifier
- Tuner
- Cassette
- CD Changer
- Display
- Rear Controls
- Rear Headphones
- RF Speaker
- LF Speaker
- LR Speaker
- RR Speaker
- Microphone
- Cellular Antenna
- Rear Controls
- Display
- 104.1 FM
- Front Controls
Fundamental Decisions

- Integral vs. modular architecture?
- What type of modularity?
- How to assign functions to chunks?
- How to assign chunks to teams?
- Which chunks to outsource?
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

- 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
Other Images
From *Product Design and Development* by Karl Ulrich and Steven Eppinger (McGraw-Hill/Irwin)
Slot-Modular Architecture

Bus-Modular Architecture

Sectional-Modular Architecture

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Scenario A: Early Differentiation

Assembly

Differentiation

Transport

Inventory of Three Models

Scenario B: Postponement

Partial Assembly

Transport

Inventory of One Subassembly

Delayed Differentiation

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