



PRODUCT ARCHITECTURE

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Definition

- Product Architecture: *The arrangement of functional elements into physical chunks which become the building blocks for the product or family of products.*
- Elemen fungsional
 - Suatu kegiatan operasi dan transformasi secara individual yang memberikan kontribusi pada kinerja keseluruhan produk
 - Contoh: produk sepeda>>fungsi pengereman
- Elemen fisik
 - Part, komponen, sub-assembly yang mendukung fungsi produk
 - Contoh: produk sepeda>>kampas rem, rantai, pedal dsb.
- Chunk
 - Kumpulan elemen fisik
 - Elemen fisik produk yang diorganisasikan menjadi beberapa *building blocks*

Product Architecture Example: Hewlett-Packard DeskJet Printer



Modular vs. integrated architecture (1)

- Modular
 - Chunks implement **one or a few functional elements** in their entirety (each functional element is implemented by exactly one physical chunks)
 - The **interactions between chunks are well defined** and are generally **fundamental** to the primary functions of the products.
 - Chunk '**independen**'
 - Mempermudah perubahan desain suatu chunk tanpa merubah chunk lainnya agar produk dapat berfungsi secara baik

Modular vs. integrated architecture (2)

- Integrated
 - **Functional elements** of the product are implemented using **more than one chunk**
 - A **single chunk** implements **many functions**.
 - The **interaction between chunks are ill defined** and may be **incidental to the primary functions** of the products.
 - Produk arsitektur integral dirancang dengan kinerja yang tinggi
 - Modifikasi terhadap suatu komponen akan membutuhkan 're-design' yang mahal

Tipe Arsitektur Modular

- **Arsitektur Modular Slot**

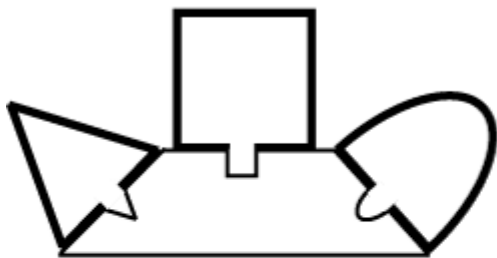
- Masing-masing penghubung antarchunk mempunyai tipe yang berbeda dari yg lain.
- Chunk tidak dapat dipertukarkan

- **Arsitektur Modular Bis**

- Chunk yang berbeda dapat dihubungkan ke produk melalui hubungan yang sama
- Beberapa chunk dapat dipertukarkan

- **Arsitektur Modular Seksional**

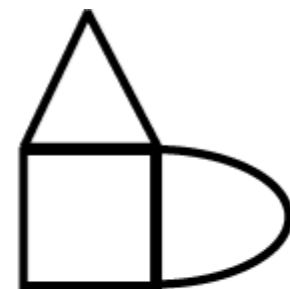
- Semua penghubung mempunyai tipe yang sama, tetapi tidak ada satu elemen tunggal yang semua chunk-chunk berbeda dapat dipasang sekaligus
- Rakitan dibuat dengan menghubungkan chunk yang satu dengan lainnya melalui penghubung yang identik



Slot-Modular
Architecture



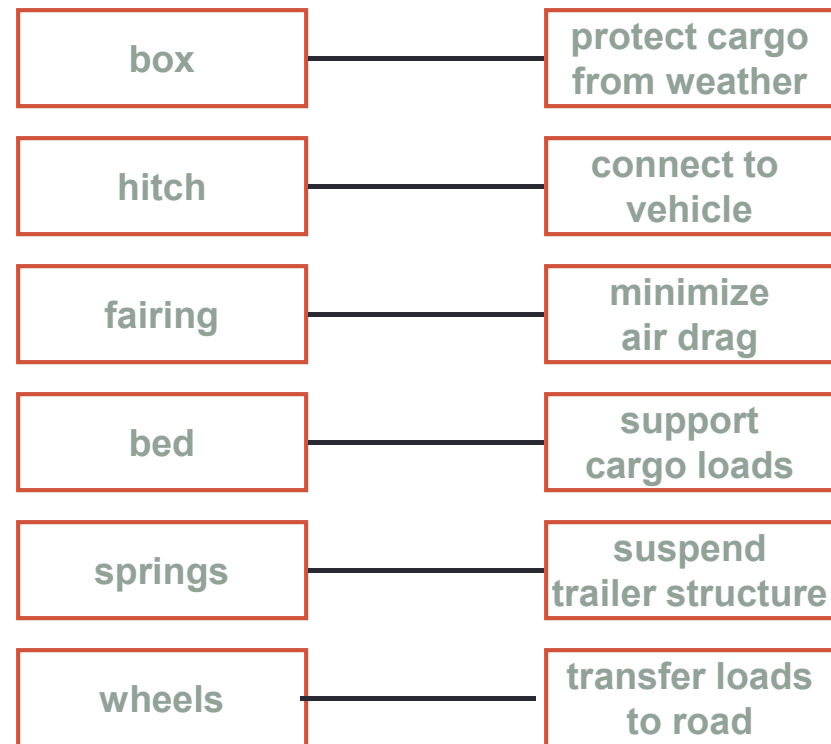
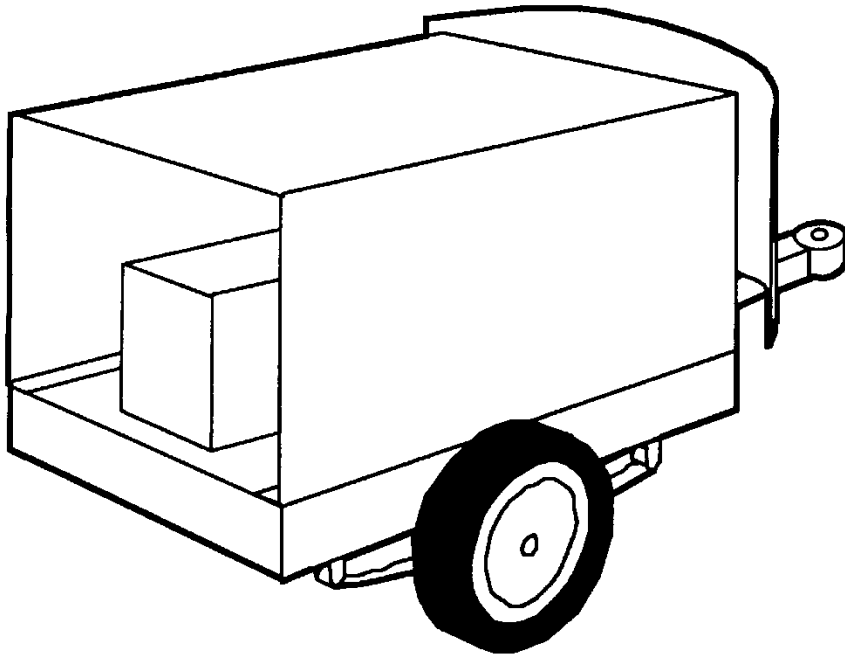
Bus-Modular
Architecture



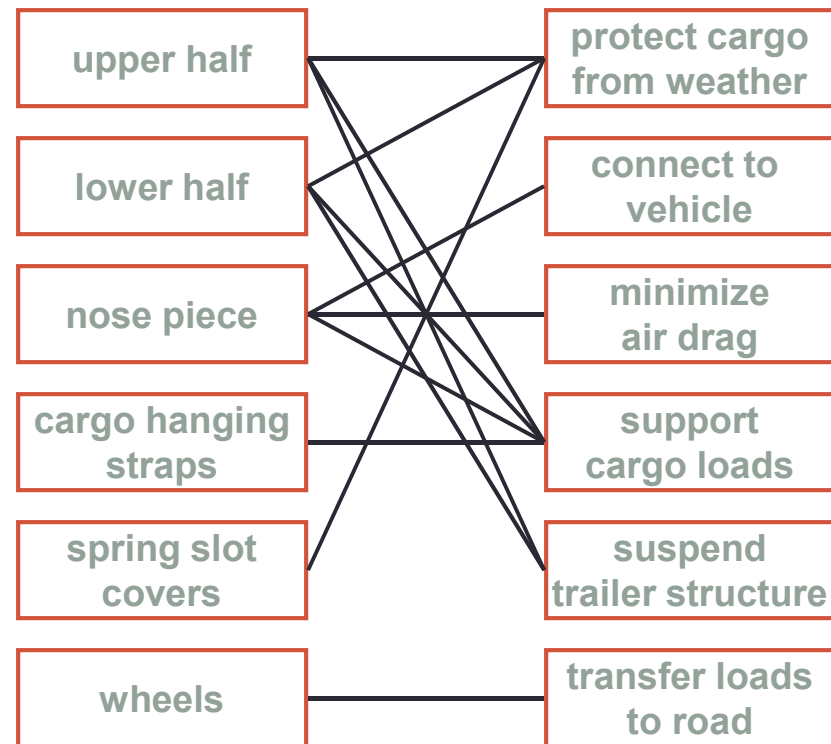
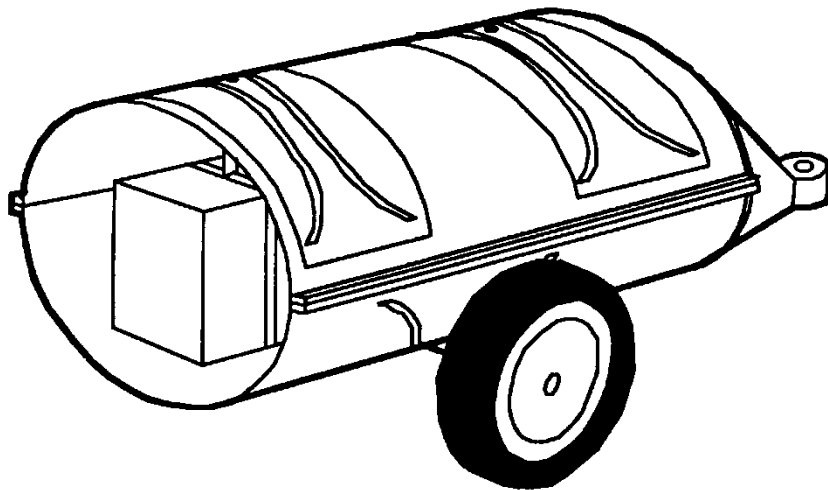
Sectional-Modular
Architecture

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

Trailer Example: Modular Architecture



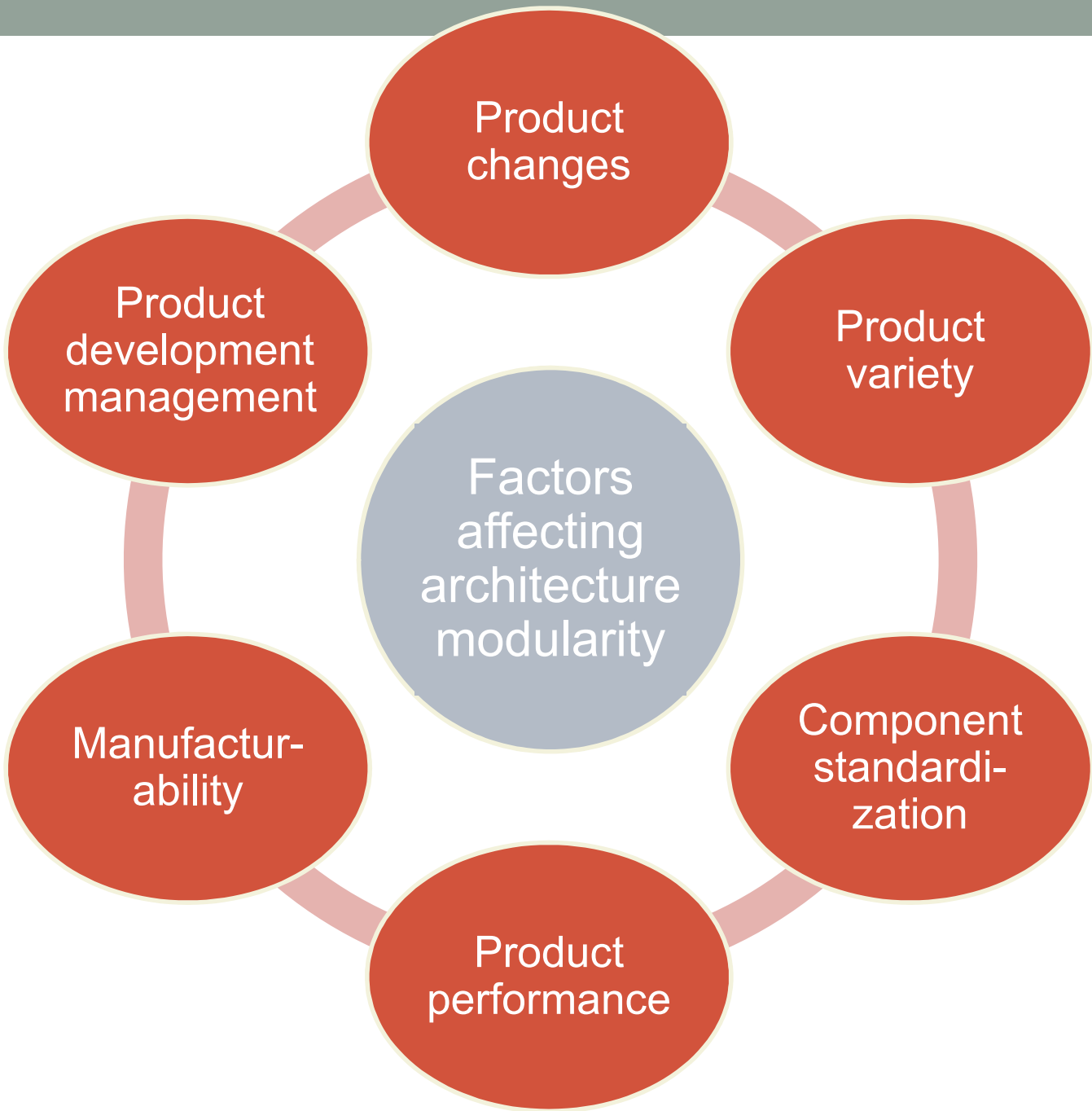
Trailer Example: Integral Architecture



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)



Product changes

Product variety

Component standardization

Product performance

Manufacturability

Product development management

Factors affecting architecture modularity

Factors affecting architecture modularity – **product changes**

Reasons for product changes

- Upgrades – peningkatan kemampuan
- add-ons – penambahan komponen
- adaptation – adapt to different operation environments
- wear – penggantian karena pemakaian (e.g., razors, tires, bearings)
- consumption – for example, toner cartridges, battery in cameras
- flexibility in use (for users to reconfigure to exhibit different capabilities)
- re-use in creating subsequent products

Factors affecting architecture modularity **product variety**

- Beberapa model dapat diproduksi untuk merespons permintaan pasar
- Dapat divariasikan tanpa menambah kerumitan terhadap sistem manufaktur

Component standardization

- Menggunakan komponen yang sama untuk beberapa macam produk
- Meningkatkan volume produksis

Factors affecting architecture modularity

product performance

- Allow optimizing the performance for an individual integrated architecture.
- Allow function sharing
- Allow for redundancy to be eliminated through function sharing and geometric nesting

Manufacturability

- DFM can be performed on the chunk-level but not across several chunks.

Factors affecting architecture modularity

product development management

- Better for modular architecture
 - Each modular chunk is assigned to an individual or a small group
 - Known and relatively limited functional interactions with other chunks
- Not as easy for integrated architecture
 - Detailed designs will require close coordination among different groups.

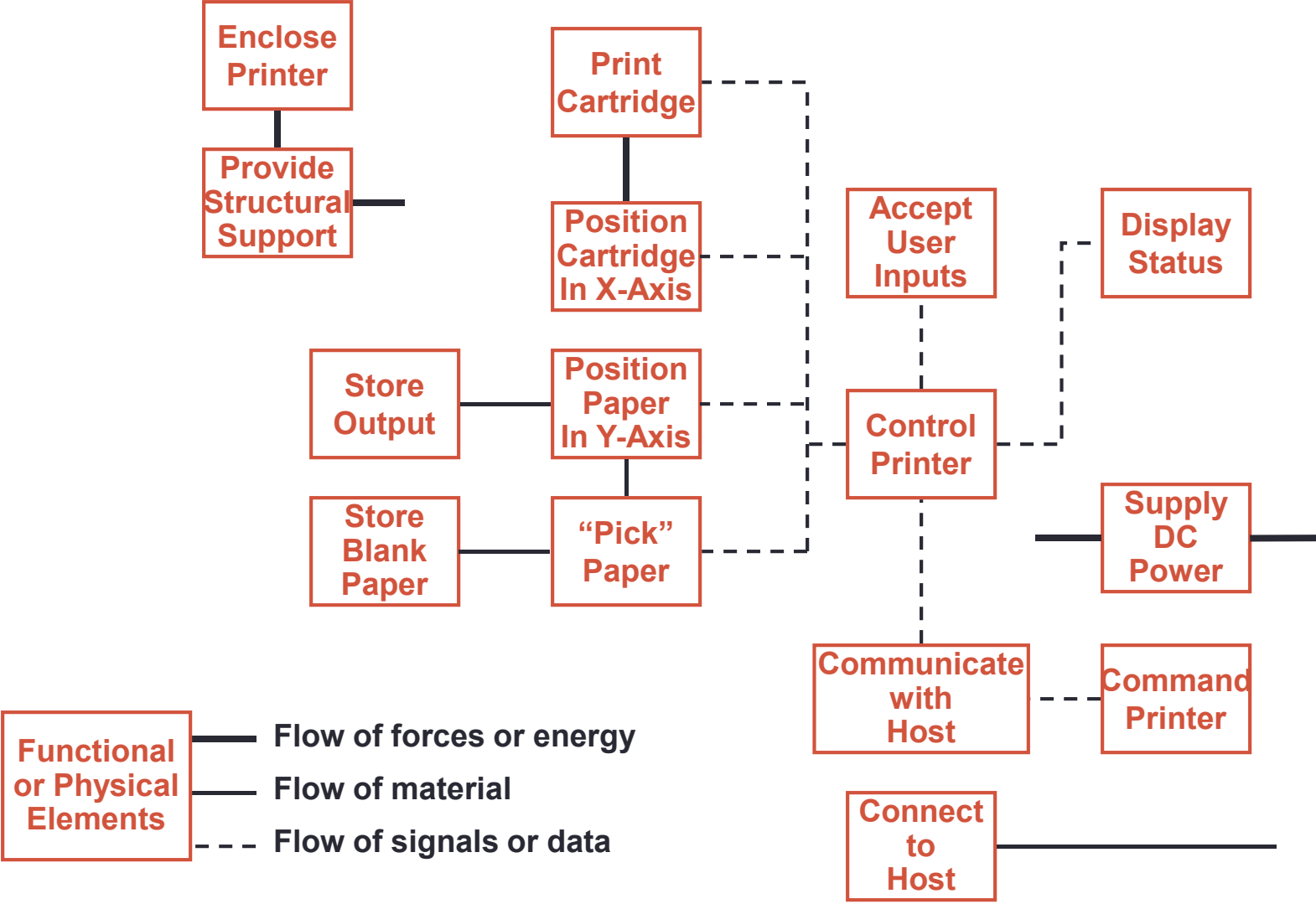
Architecture Design Process

- create a schematic of the product
- cluster the elements of the schematic
- create a rough geometric layout
- identify the fundamental and incidental interactions.

Creating a product schematic

- Create a schematic diagram representing the (physical or functional) elements of the product, using blocks, arrows, and other notations.
 - Flow of forces or energy
 - Flow of material
 - Flow of signal or data

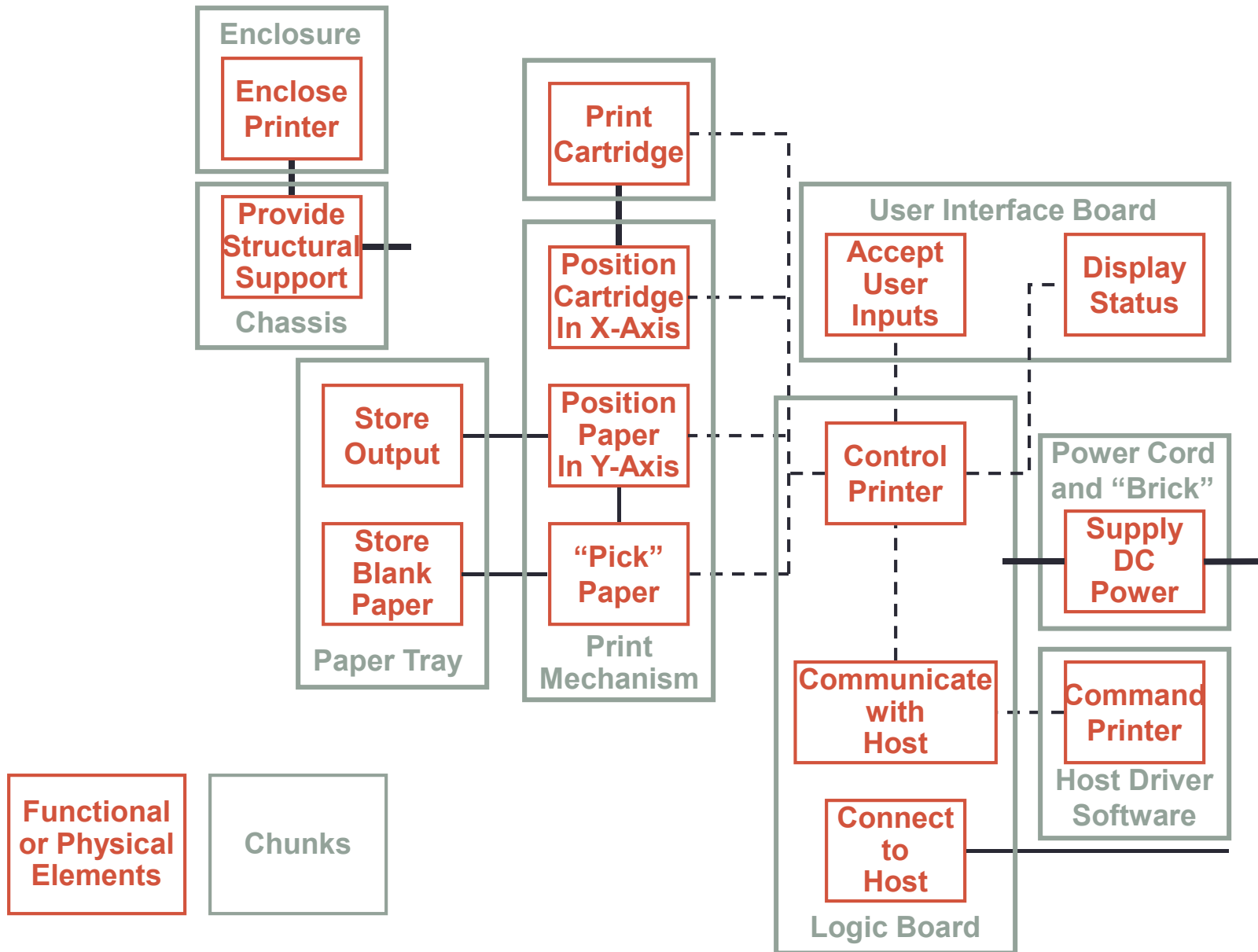
DeskJet Printer Schematic



Cluster the elements of the schematic

- Factors for considering clustering
 - Geometric integration and precision
 - Function sharing
 - Capability of vendors
 - Similarity of design or production technology
 - Localization of design (or part) change
 - Accommodating variety
 - Enabling standardization
 - Portability of the interfaces

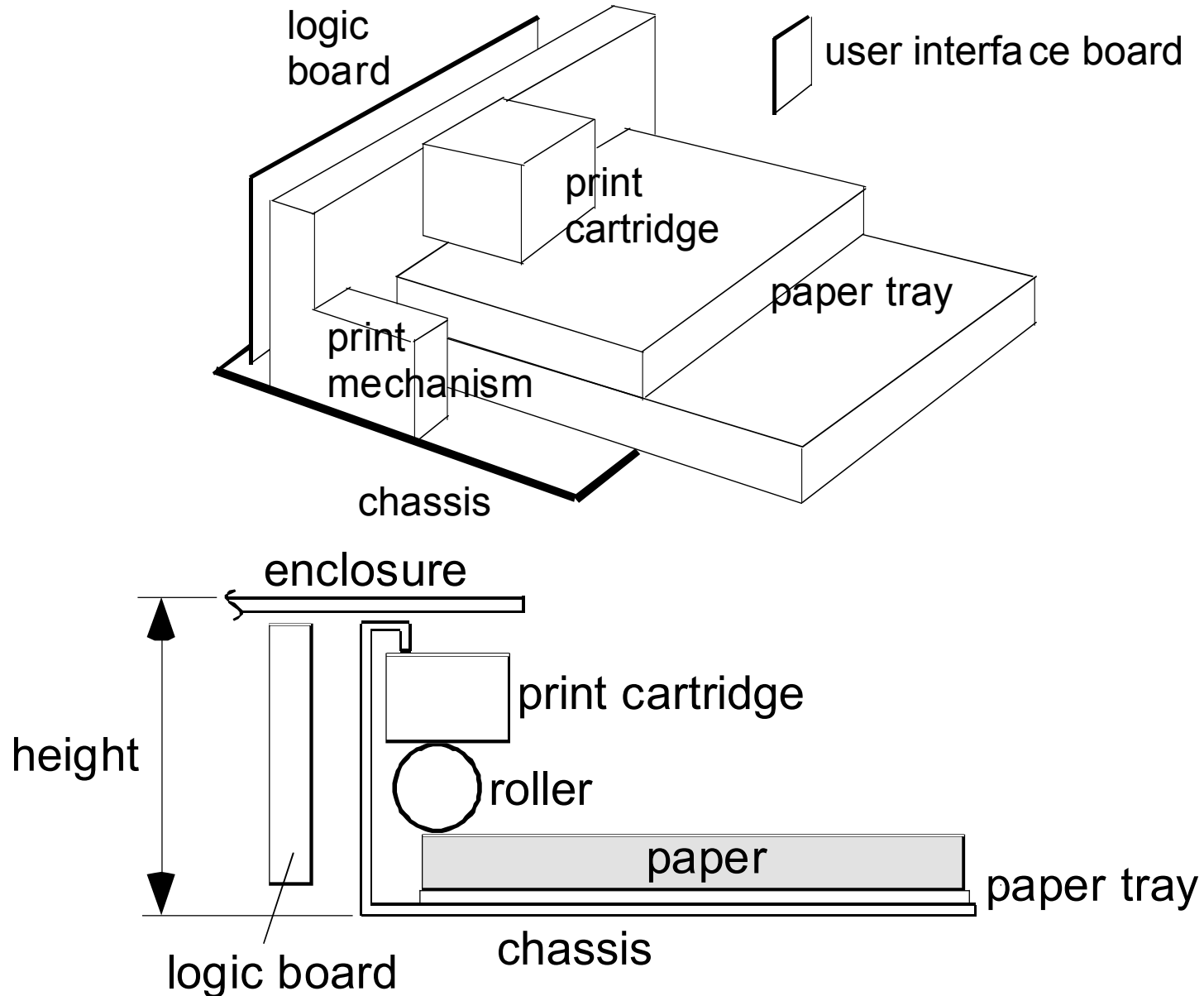
Cluster Elements into Chunks



Creating a rough geometric layout

- A geometric system layout in
 - 2D or 3D drawings,
 - 2D or 3D graphics, or
 - Physical models.

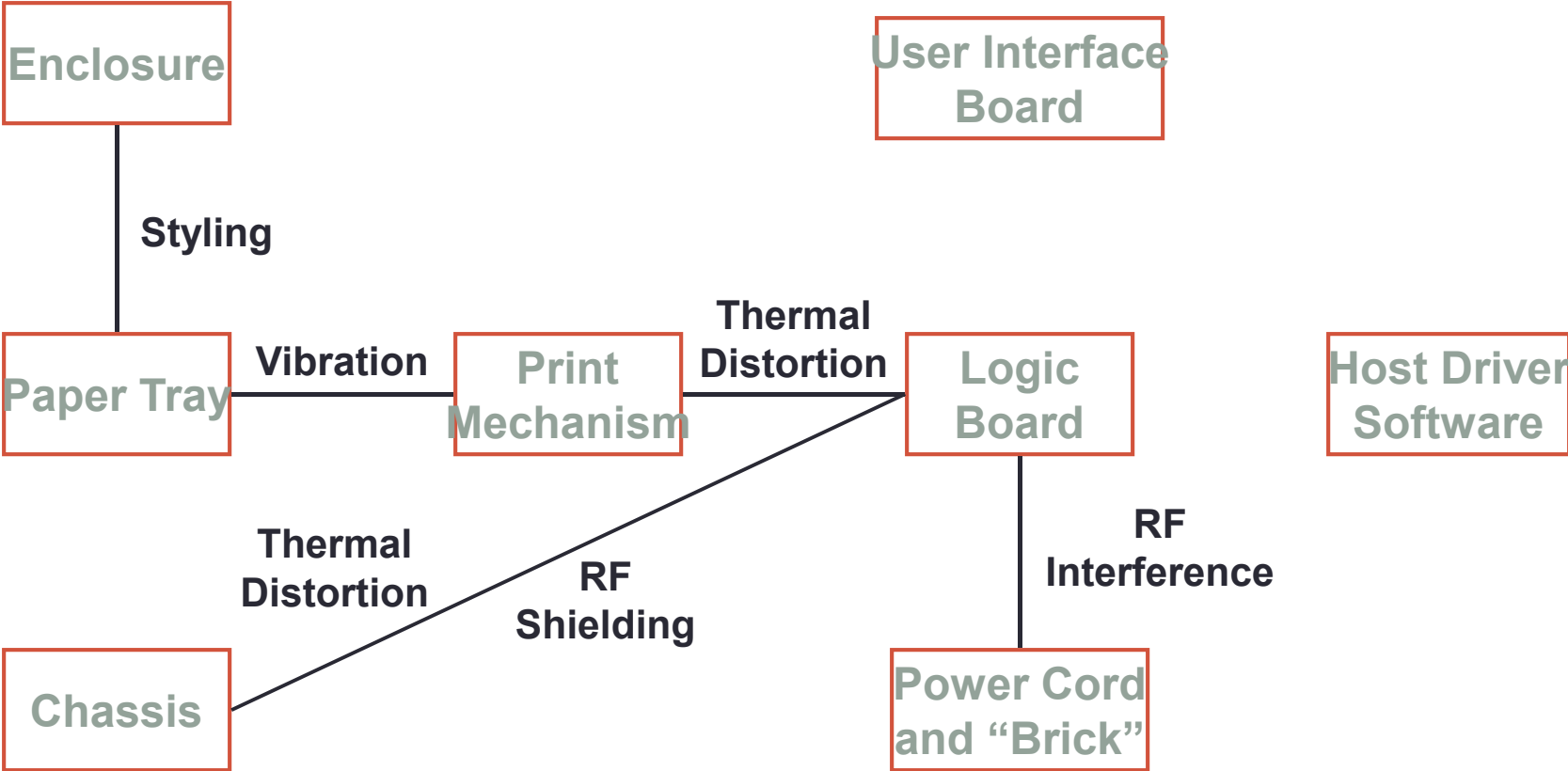
Geometric Layout



Identify the fundamental and incidental interactions

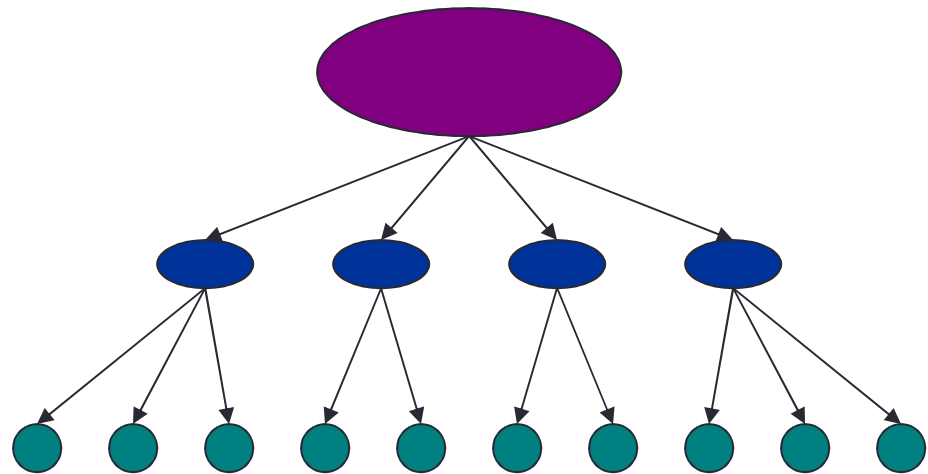
- Fundamental interactions
 - Those which connect the building blocks, such as energy flows, material flows, and data flows.
- Incidental interactions
 - Those that arise because of geometric arrangements of the building blocks, such as thermal expansion or heat dissipation.

Incidental Interactions



The concepts of integral and modular apply at several levels:

- system
- sub-system
- component

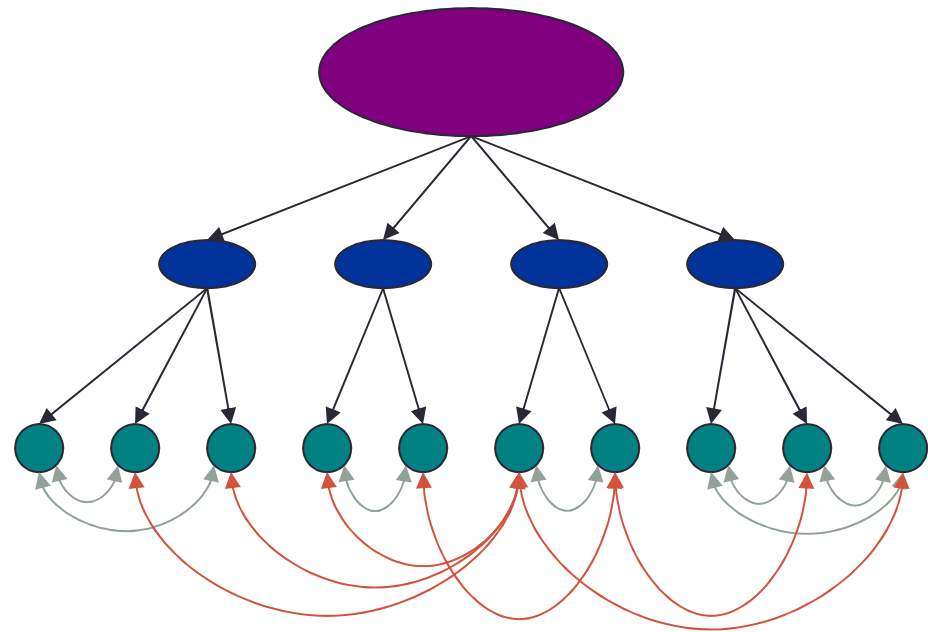


Product Architecture = Decomposition + Interactions

↔ Interactions within
chunks

- Interactions across

↔ chunks



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.



High-Performance Wheels



Compact Camera

Ford Taurus Integrated Control Panel



Modular or Integral Architecture?



Motorola StarTAC
Cellular Phone

Apple
iBook



Ford
Explorer



Rollerblade
In-Line Skates



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