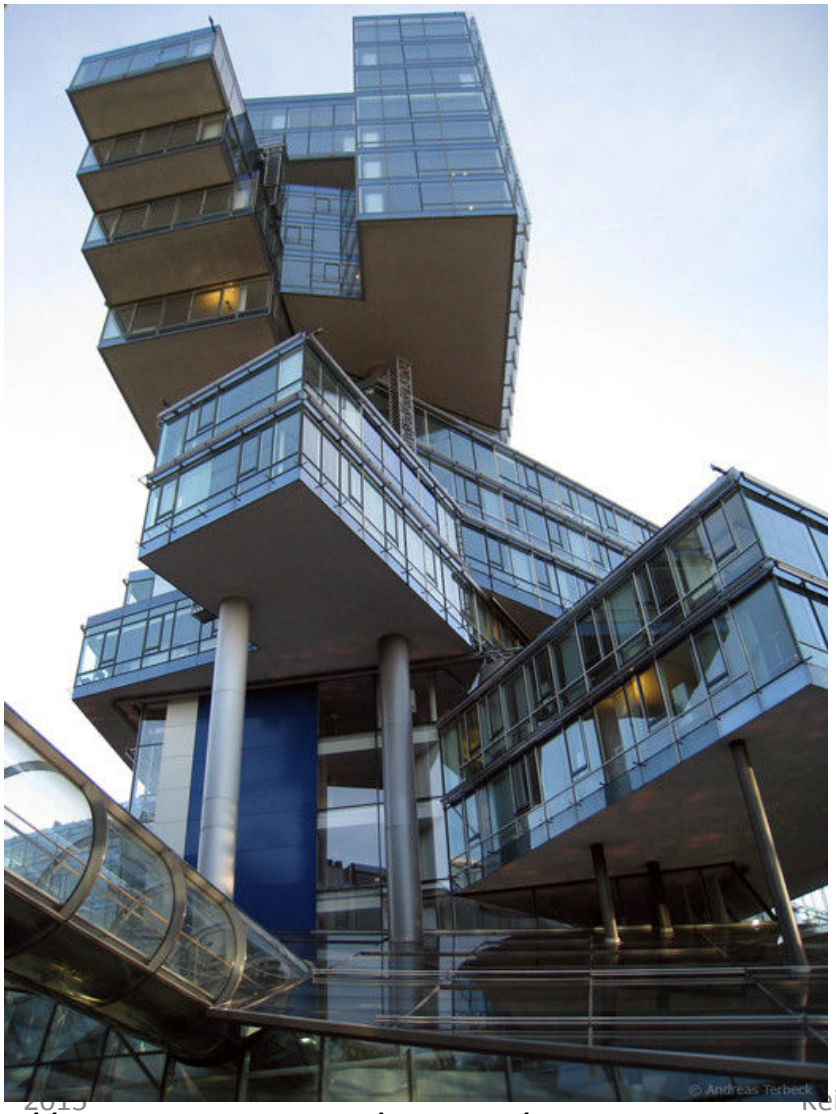
Systems Approaches we talk about today

- **Function and Physical Architecture**
  - function and physical viewpoints
  - functions and physical structures
- **Value Graph (upper half)**
  - purpose and alternative viewpoint
  - higher purposes/value and alternative ideas
- **Causal Loop Diagram**
  - cause-and-effect viewpoint
  - causes and effects
- **Customer Value Chain Analysis (CVCA)**
  - value chain viewpoint
  - stakeholders and their values

Architecture？



www.intel.com

http://www.amd.com/

http://slowbuddy.com/design/modern-architecture/

Definitions of System Architecture

- The **arrangement** of **function** and **feature** that maximizes some **objective**.
  (Jack Ring, "*Discovering the Architecture of Product X*", 2001)

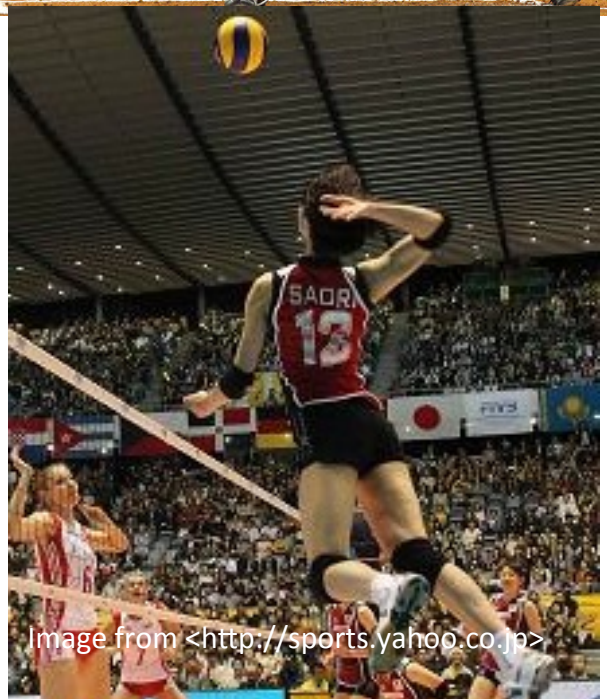
- Fundamental organization of a system embodied in its **components**, their **relationships** to each other, and to the environment, and the **principles** guiding its design and evolution.
  (*ISO/IEC/IEEE 24765 Systems and software engineering - Vocabulary*, 2010)

- Relationship between **system and its context** and **elements** which constitute a system and **the relation between elements**.
  (Shirasaka, 2011)

Which of following have the same **architecture**?


Image from <http://sports.yahoo.co.jp>


Image from <http://www.takaphoto.com/>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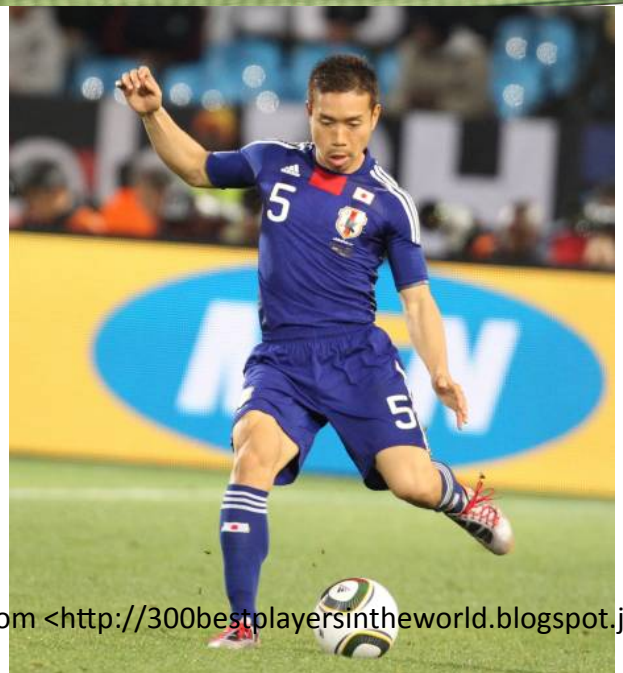


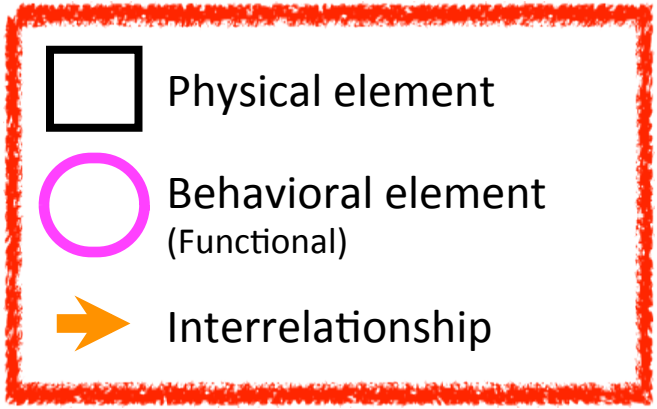
Image from <http://300bestplayersintheworld.blogspot.jp/>

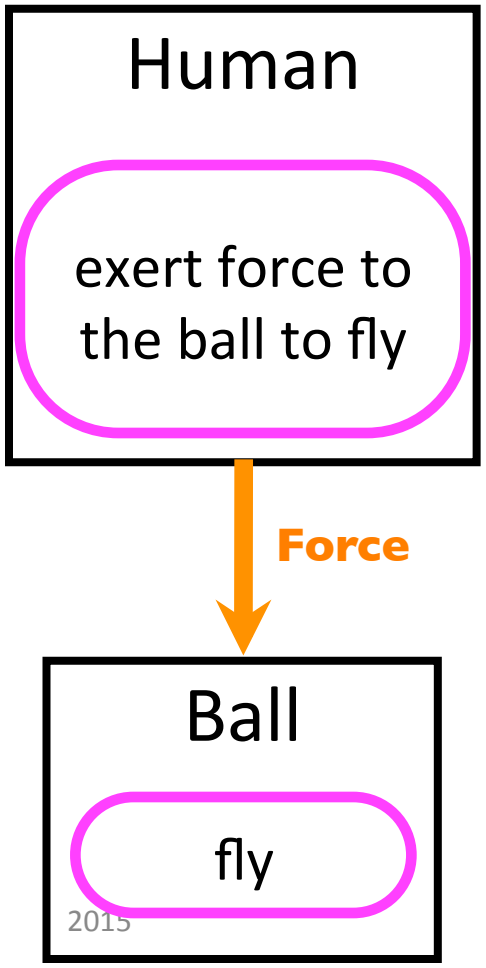
Which of following have the same **architecture**?

Architecture that human and a ball interact directly.

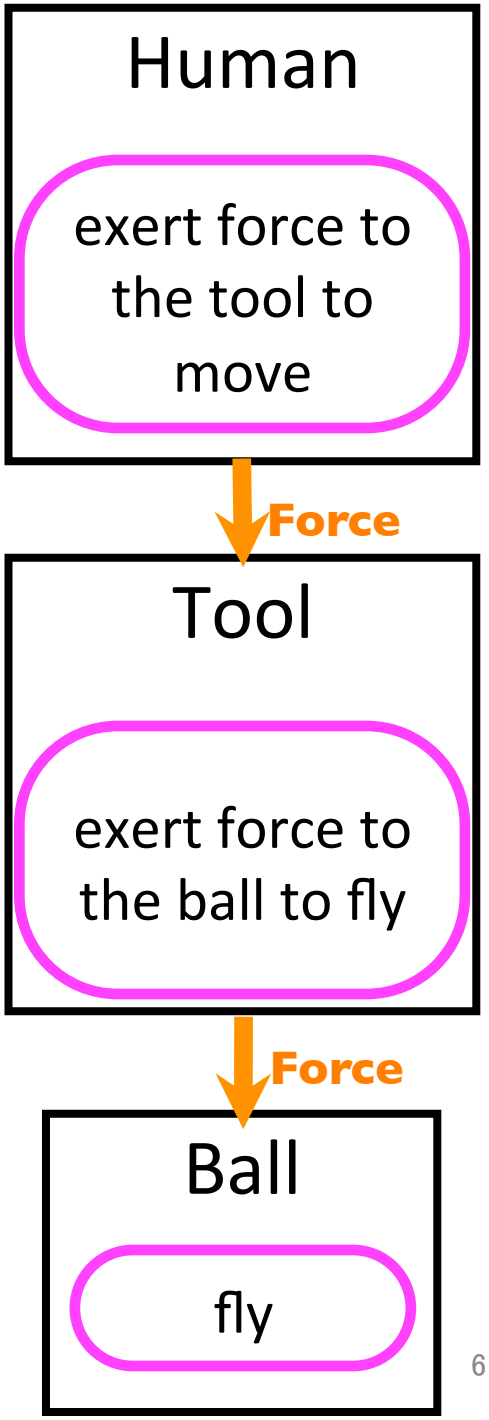
Architecture that human and a ball interact with a tool in between.

An example of system architecture description





Human exerts force to the ball.
Ball flies.



Human exerts force to the tool.
Tool exerts force to the ball.
Ball flies.

An example of system architecture description

Physical element

Behavioral element
(Functional)

Human

exert force to the tool to move

Force

Tool

exert force to the shuttle to the ball to fly

Force

shuttle

fly

Human

exert force

Force

Ball

fly

image from <http://en
uncategorized/2012/0

Image from <http://www.sports-online.biz/>

Definition of **System Architecture**

MIT Engineering Systems Division

System architecture is an abstract description of the **entities** of a system and the **relationships** between those entities.

de Neufville, R., et al. "*THE INFLUENCE OF ARCHITECTURE IN ENGINEERING SYSTEMS*." (2004)

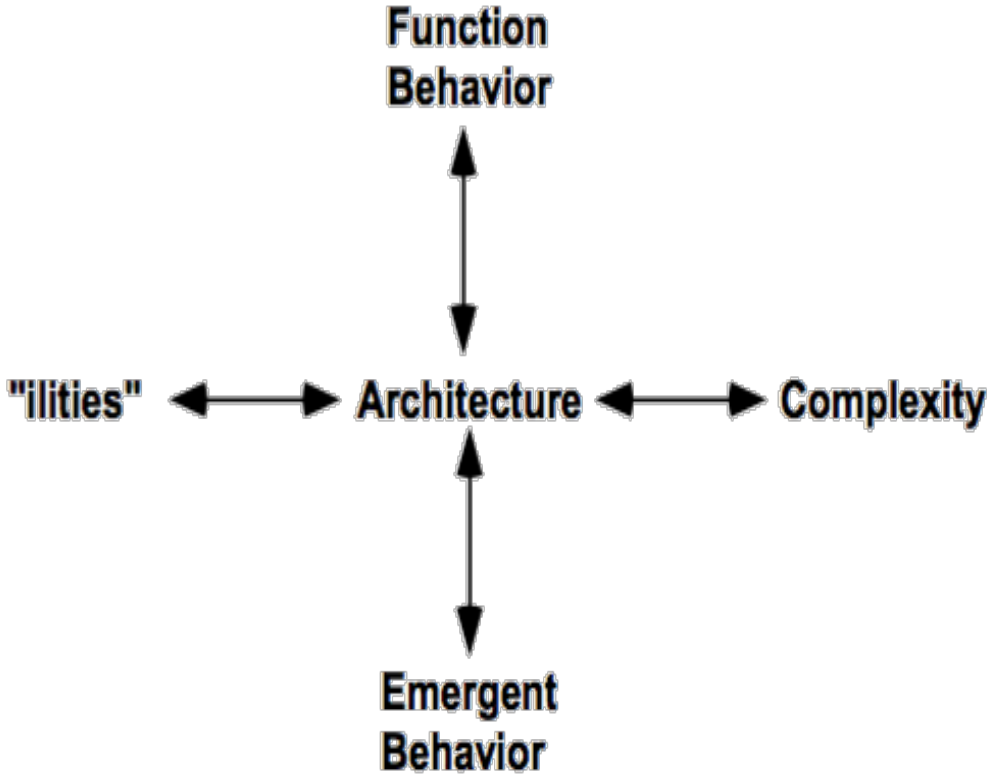
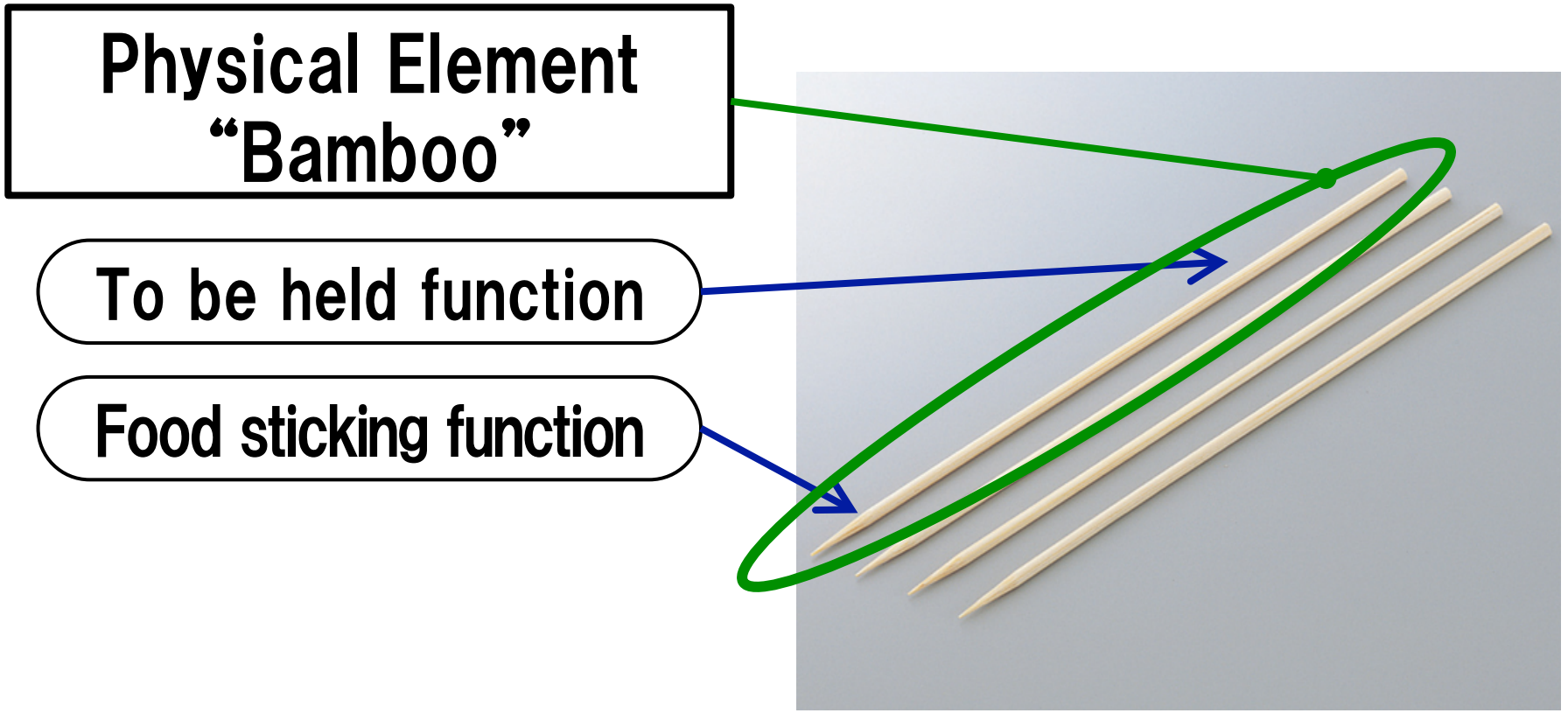


Figure 1: Architecture Plays a Central Role in Giving a System Its Behavior and "Ilities," as Well as Generating Emergent Behavior and Complexity

[Pop QUIZ 1]

Describe the **architecture** of following **system.**



[Pop QUIZ 1]

Describe the **architecture** of following **system.**

Physical Element
"Bamboo"

- To be held function
- Food sticking function

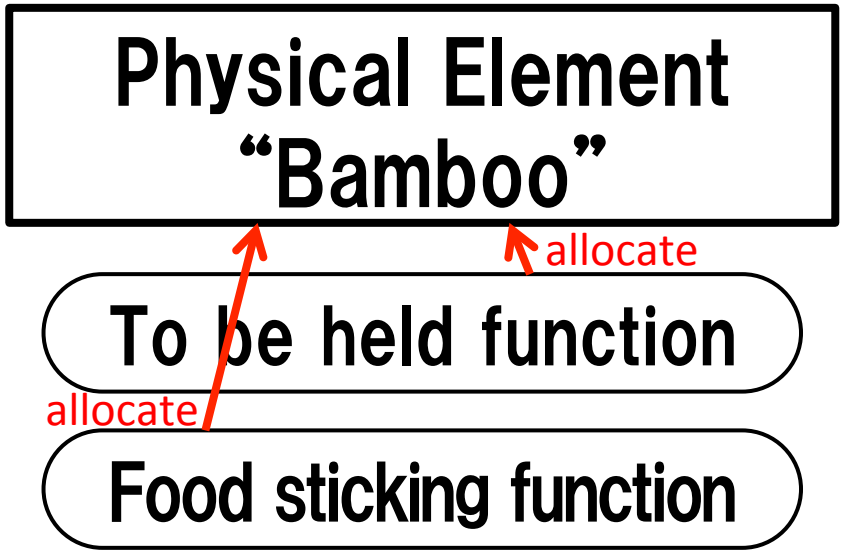
System architecture description of bamboo skewer

Definition of **Architecting**

- Allocating functions to elements and clarify the relation (interface) between elements
  （Maeno 2010）

Design Purpose:

I want to fasten pieces of meat together when I roast them



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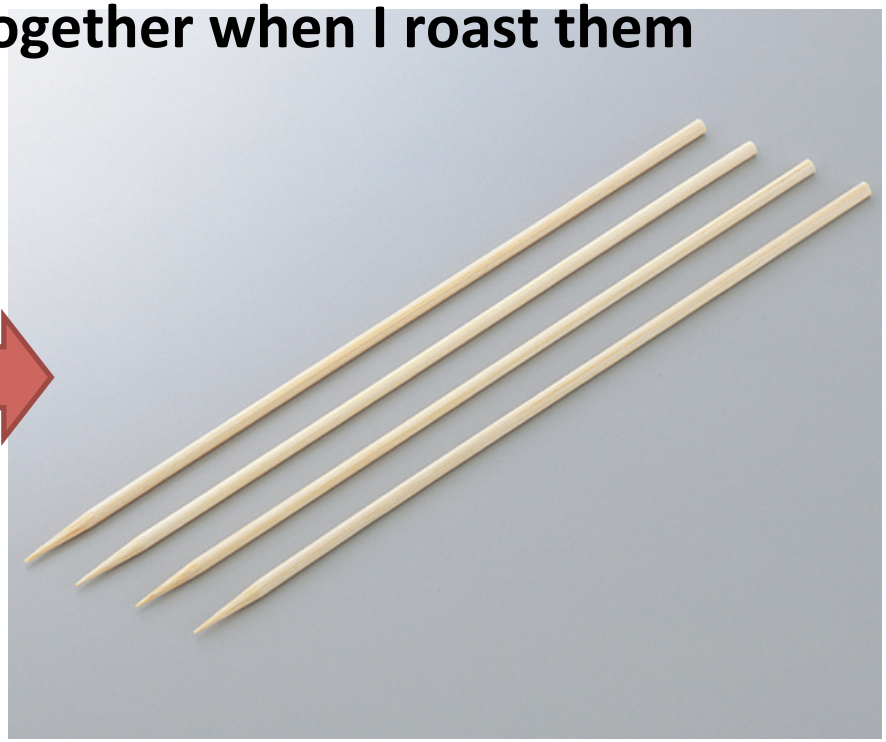


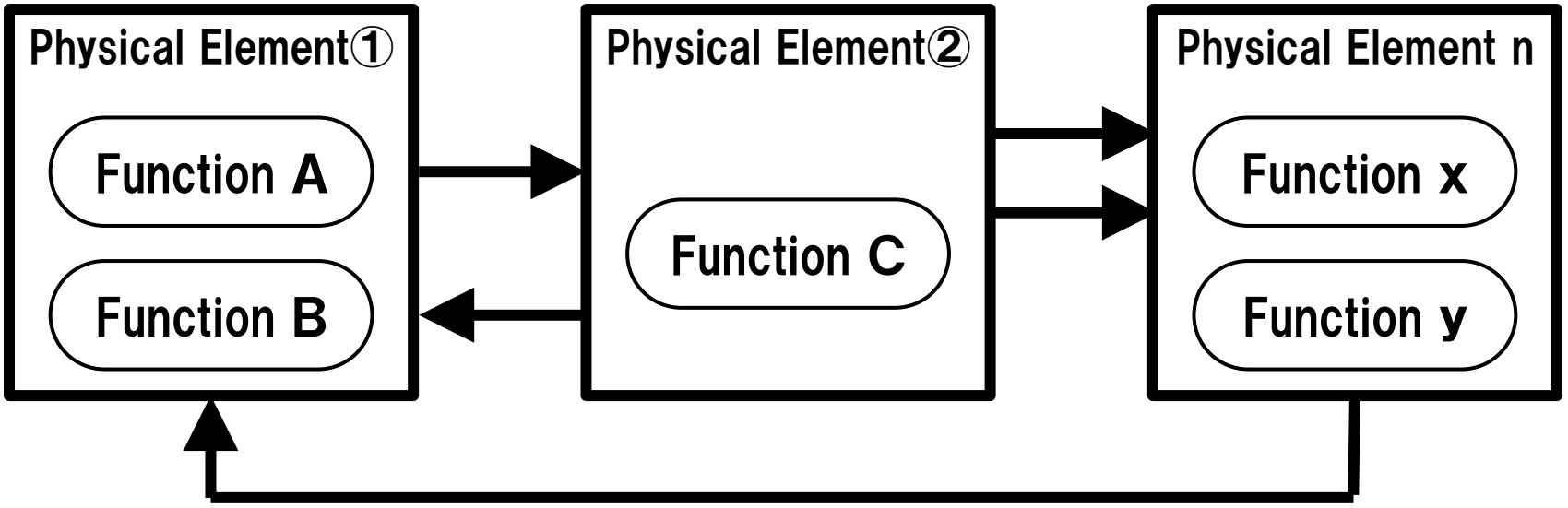
Architecting result

= System architecture description

Mechanically designed result

Definition of **System Architecture**

- Relationship between **system and its context** and **elements** which constitute a system and **the relation between elements**.
（Shirasaka, 2011）



【exam

System Design ≒ Architecting

Your Turn!

Basic steps of Architecting

Define functions needed to achieve the set goal

Design the logical order of functions

Define physical elements which realize the functions

Design hierarchy of physical elements
Allocate functions to physical elements

(IEEE 1220 Standard for Application and Management of the Systems Engineering Process, 2005)

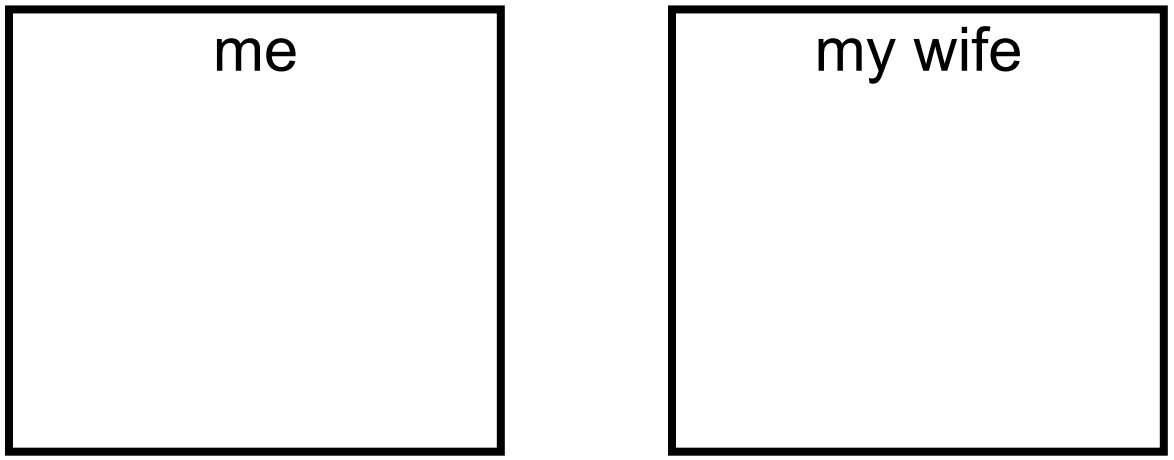
Example of Architecting①

Design Purpose: **Executing household duties**

Functions

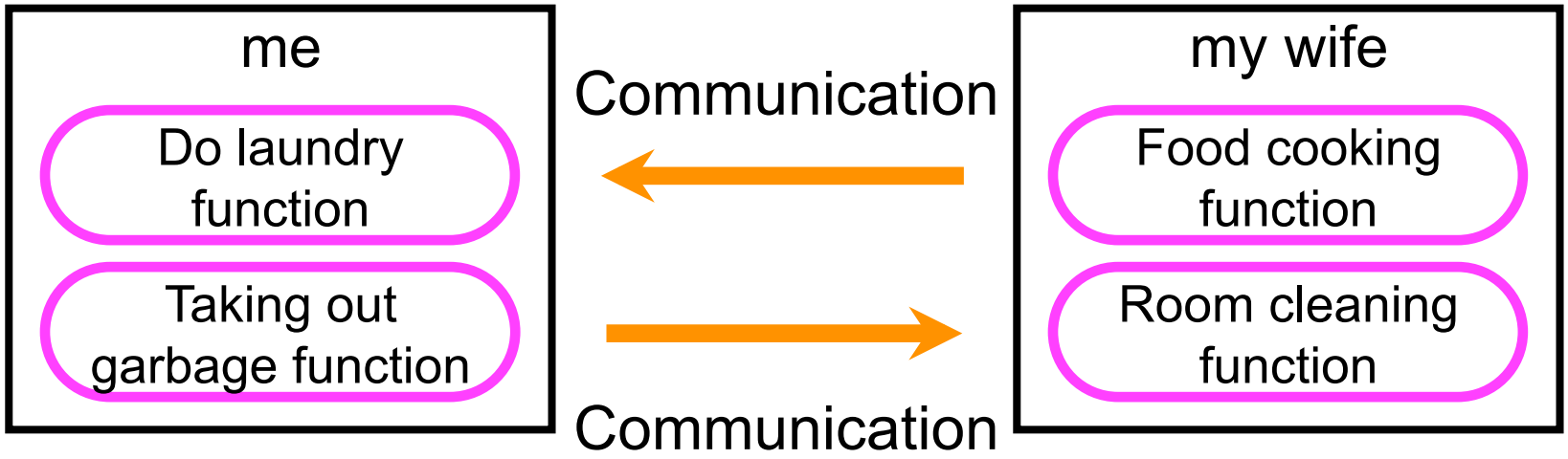
- Food cooking function
- Do laundry function
- Room cleaning function
- Taking out garbage function

Physical Elements



Example of Architecting①

Design Purpose: **Executing household duties**

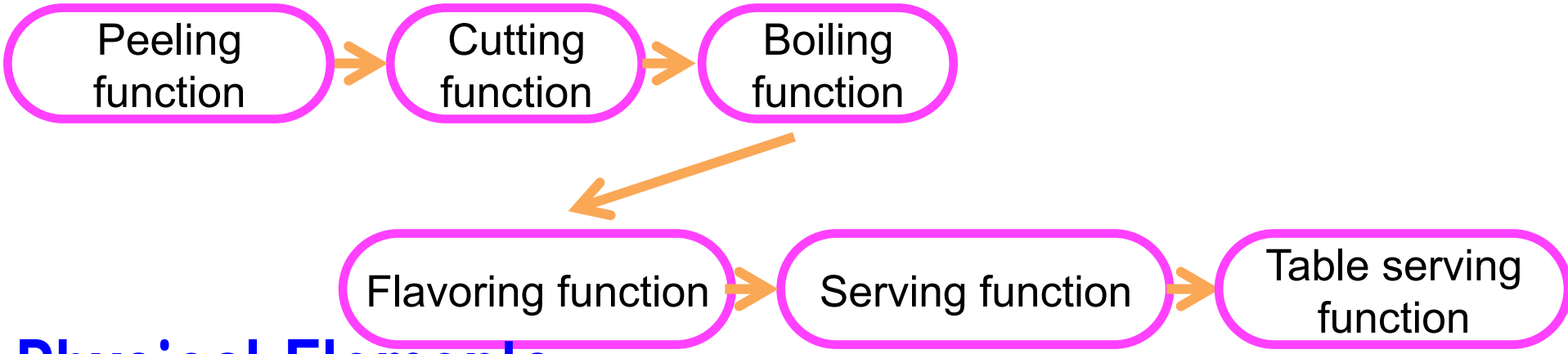


Example of Architecting②

Design Purpose:

Cooking a dish at well-established restaurant

Functions

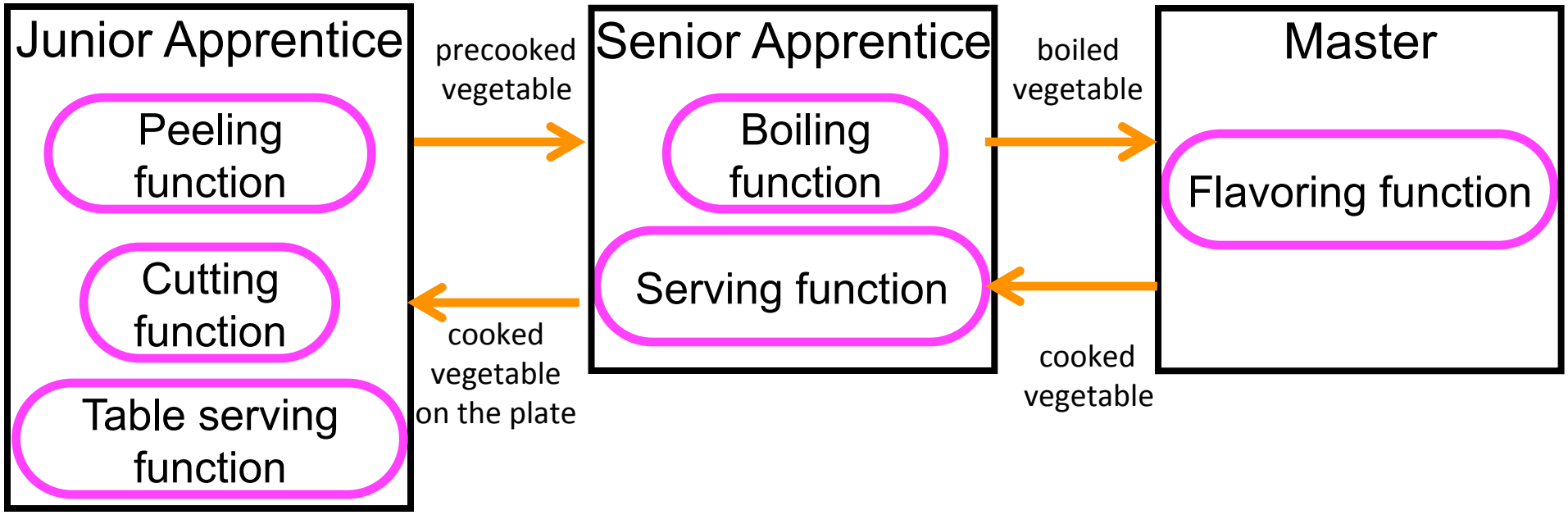


Physical Elements

Example of Architecting②

Design Purpose:

Cooking a dish at well-established restaurant



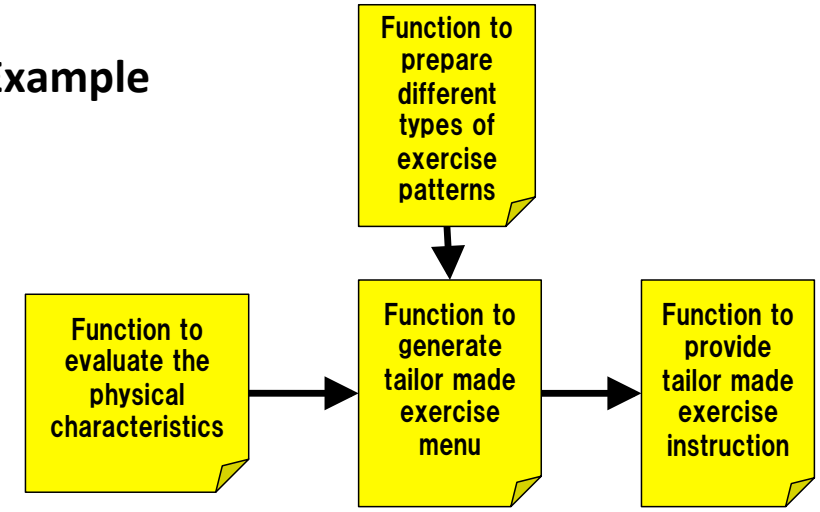
Exercise

Architecting① : Define functions

- Define high abstraction level functions and their logical flow for your idea.
  - **Focus on the most important functions**
  - **KEEP it at high abstraction level**

Discuss what functions you need to realize your idea.

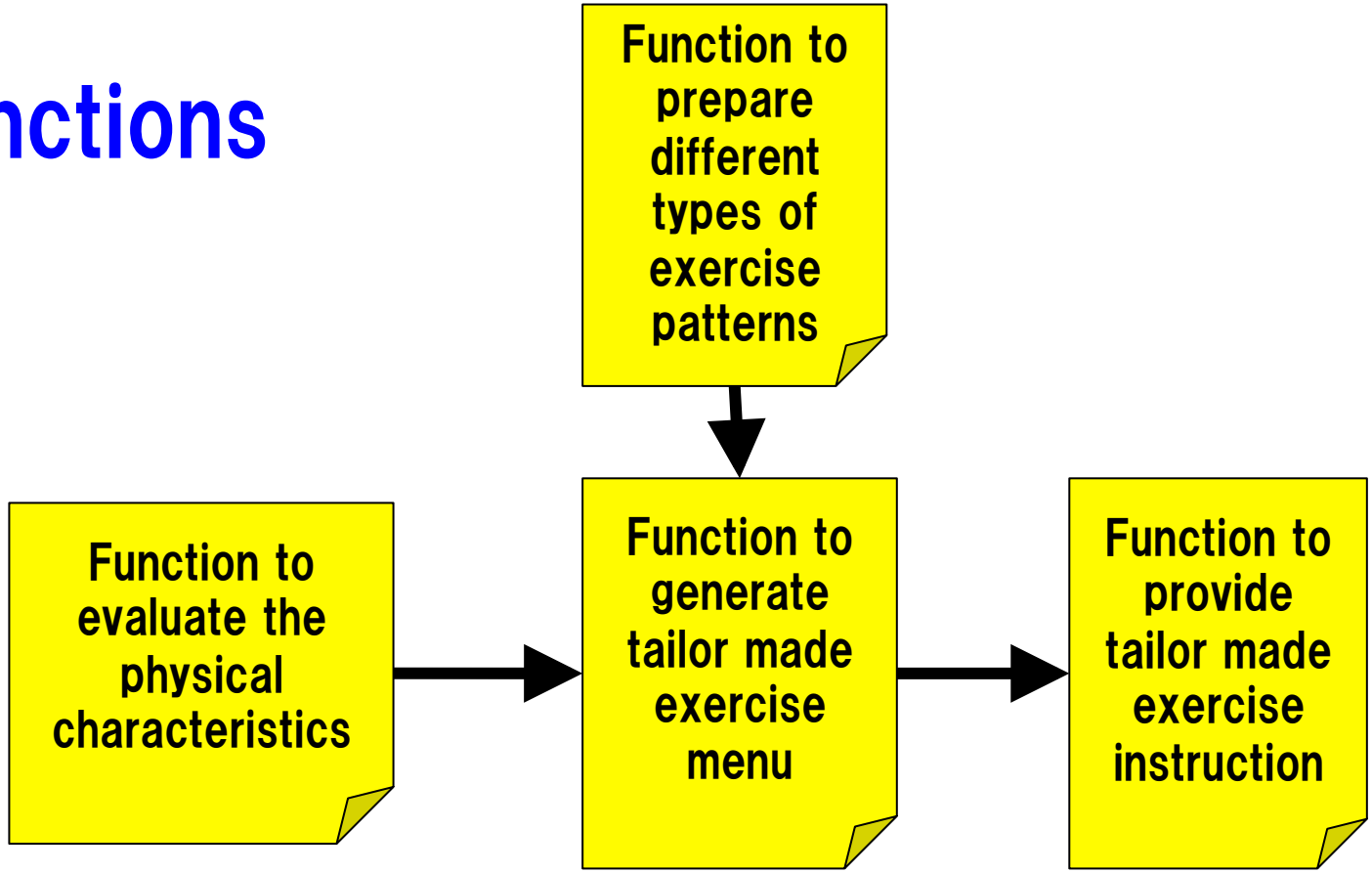
Example



Example of architecting① : Define functions

Design purpose: **Tailor made exercise menu providing**

Functions



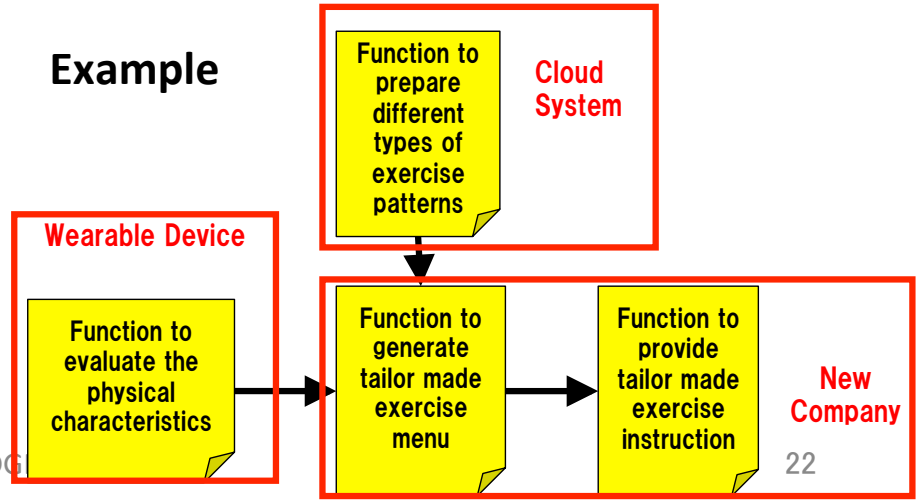
Think what kind of functions you need to realize your idea

Exercise

Architecting②：Define Physical Elements

- Define physical elements which realize your functions.
  - Physical elements can be *human*, *organization*, *device*, *system, service* and many other things.
- Carefully allocate all of your functions to physical elements.
- ➢ **One physical element can have more than one functions**.

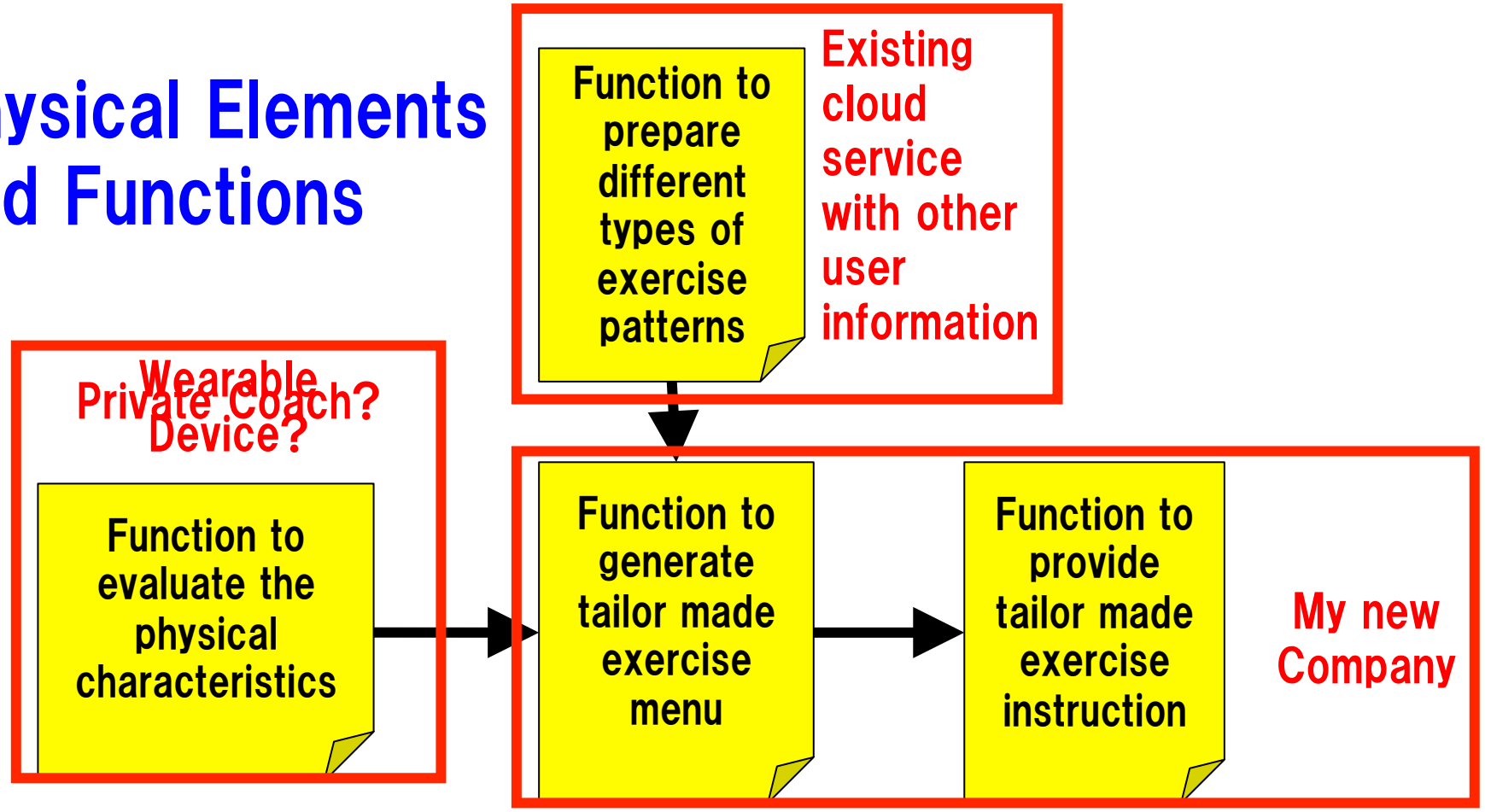
Discuss what physical elements can realize the functions and how functions may be allocated.



Example of Architecting② : Think Physical Elements

Design purpose: **Tailor made exercise menu providing**

Physical Elements and Functions



Think what kind of physical elements can realize the functions