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A Joint Method of Design Thinking and Systems Thinking

Framework for Problem Definition

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www.incose.org/symp2017

Japan. Cool Japan.

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Government ministry campaign to internationally promote Japan' creative industries.

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Japan's Game Industry Battle

Video Game Consoles

SONY

NINTENDO

Units sold

1995 — 5th

2000 — 6th

2006 — 7th

PlayStation

102.5 million

33 million

Nintendo 64

PlayStation 2

155 million

22 million

Game Cube

PlayStation 3

86 million

102 million

Wii

Japan's Game Industry Battle

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2006 — 7th

PlayStation 3

86 million

102 million

Wii

Problem definition determines the solution

Japan's Game Industry around 2005

Issue	problem definition	Solution
Address your Issue	Define your	sign your Solution

SONY

NINTENDO

The game market growth is levelling off…

"How might we make our customers more pleased with our product?"

Providing customers with realistic experience

High-resolution PlayStation Series

"How might we make our products more sim…

Providing opportunities for communi-cation

Family Use Wii

Problem definition determines the solution

Japan's Game Industry around 2005

Issue — Address your Issue

problem definition — Define your

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High-resolution PlayStation Series

Family Use Wii

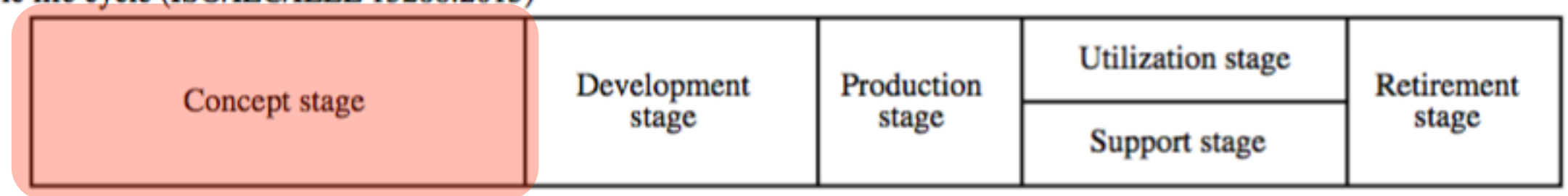
http://butsuyoku-senmu.doorblog.jp/archives/50291890.html

Problem Definition Process

Problem Definition process: - important but difficult -

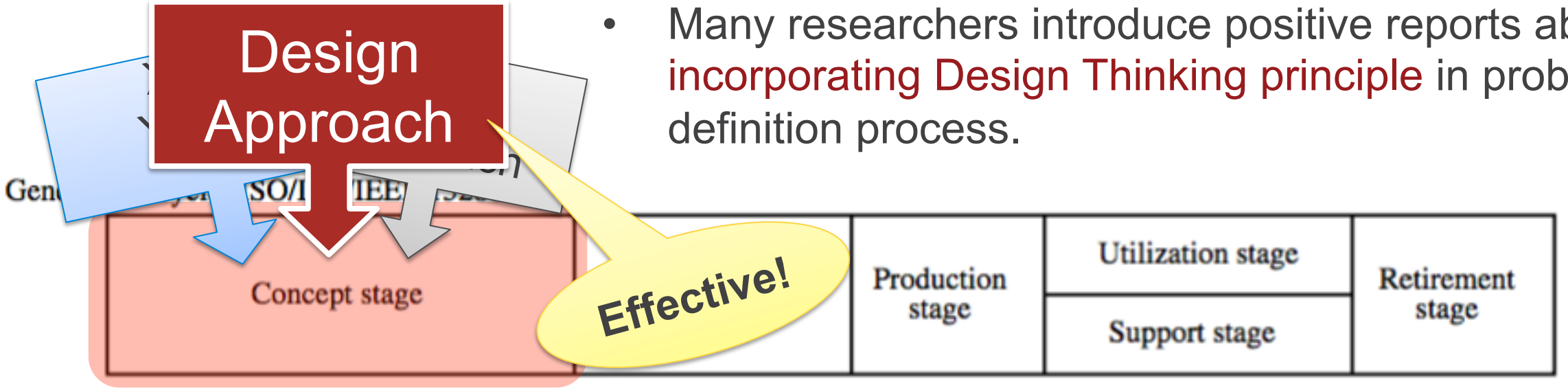
- Defining problems is a quite important process for generating innovative solutions.
- More and more focus on the early phase of the system development.
- Concept stage
  - Exploratory research for opportunity space, problem space and solution space.
  - More and more focused, but more and more difficult as the problems becomes larger-scale and ill-structured.

Generic life cycle (ISO/IEC/IEEE 15288:2015)



Design Thinking for Problem Definition Process

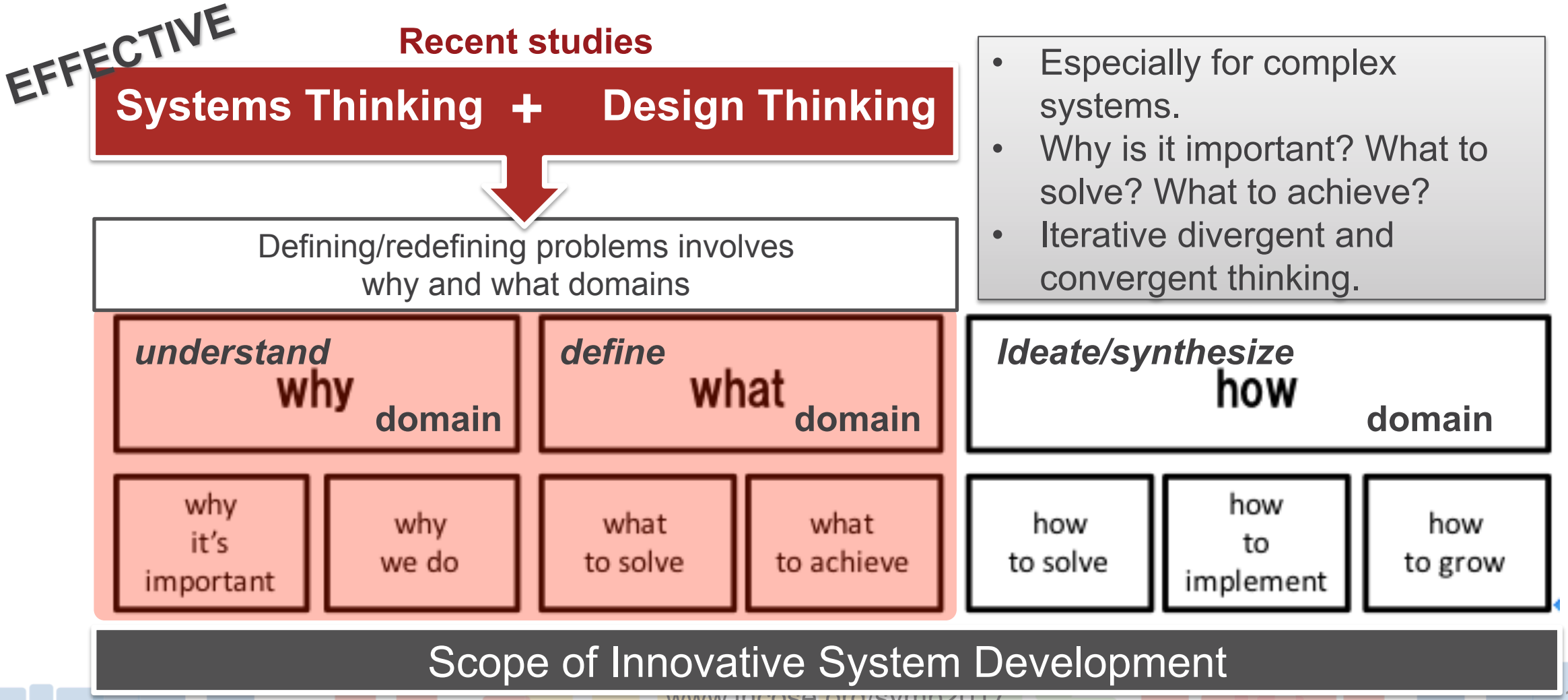
- One of attempts to tackle complex problems: Design approach
- Aspect of design is drawing attention and design-related activities introduced in systems engineering practice.
- Many researchers introduce positive reports about incorporating Design Thinking principle in problem definition process.



- Many researchers introduce positive reports about incorporating Design Thinking principle in problem definition process.

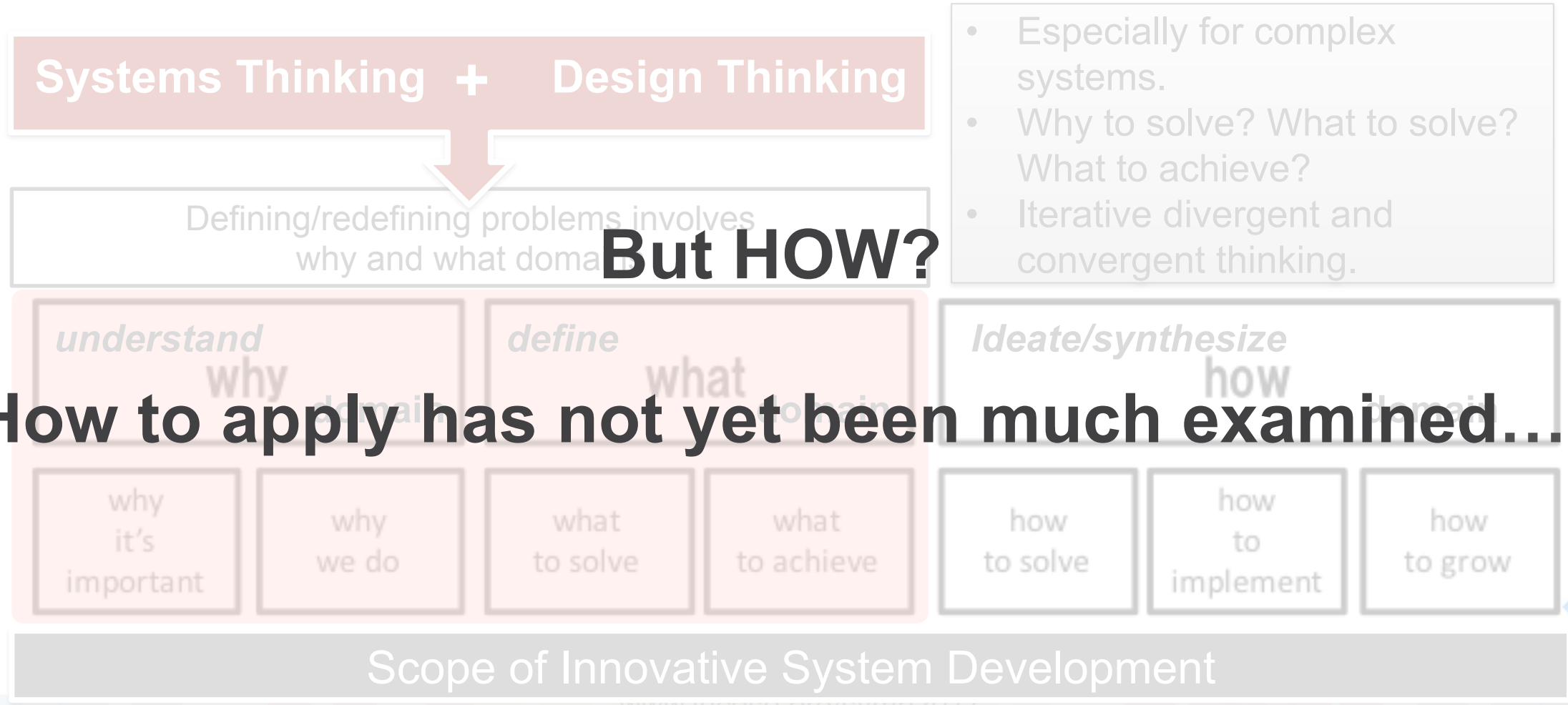
(Shafaat 2015, Zhao 2015)

Design Thinking and Systems Thinking in Problem Definition Process



- Especially for complex systems.
- Why is it important? What to solve? What to achieve?
- Iterative divergent and convergent thinking.

Design Thinking and Systems Thinking in Problem Definition Process



But HOW?

How to apply has not yet been much examined…

Design Project Program at
KEIO University Graduate School of System Design Management

Introducing a Framework for Problem Definition Process

Five approaches for defining problems

Framework designed for redefining and reframing a problem jointly utilizing design thinking and systems thinking.

Knowing what are in the box and getting out of it.

Exploring the problem space and solution space by identifying conventional “in-the-box” and extending thoughts towards outside the “box”.

Analytical approach.

General approach using existing analytical frameworks including lifecycle, 3C, 4P, SWOT and many other framework.

Solving the problem halfway.

When a issue is too big and uncontrollable, finding some hidden important and actionable factors would be quite important.

Achieving a higher purpose.

Reframing an issue/ a problem by seeking its upper purposes.

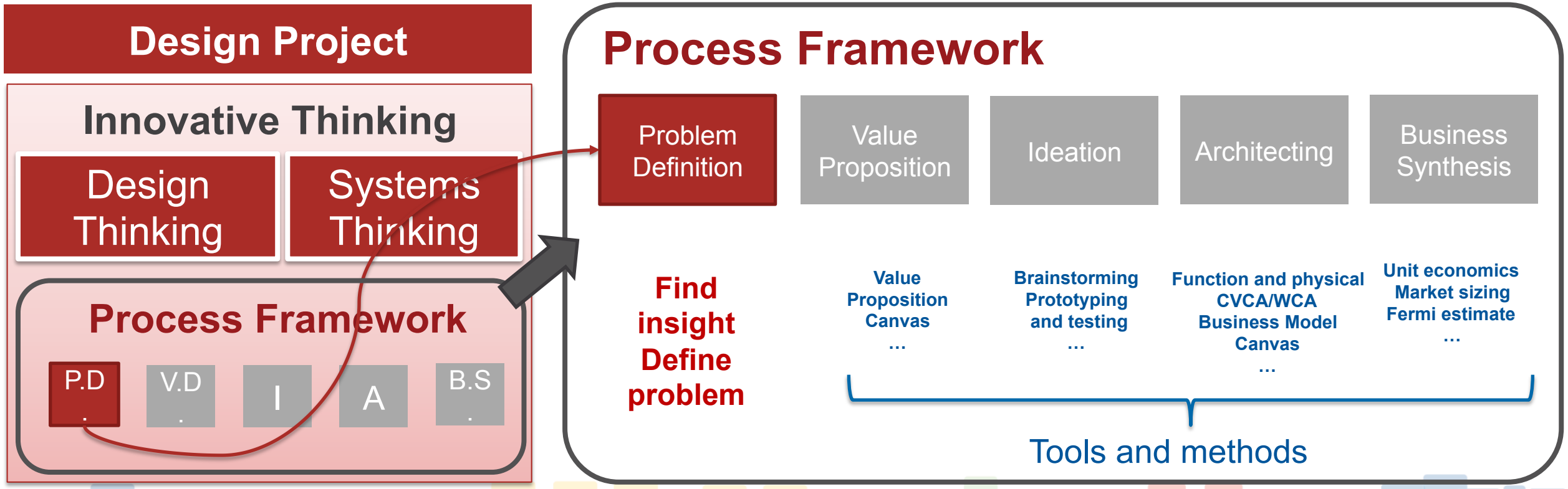
Getting rid of something regarded necessary.

Exploring the problem space by doubting things that are considered necessary to exist or to be equipped with as a matter of course and trying to remove them.

“Design Project” Program @ Keio SDM

Core subject for the 1st grade master students. Five-month PBL program. Lectures and group-work sessions. Solving real business issues posed by companies.

Keio SDM PBL program



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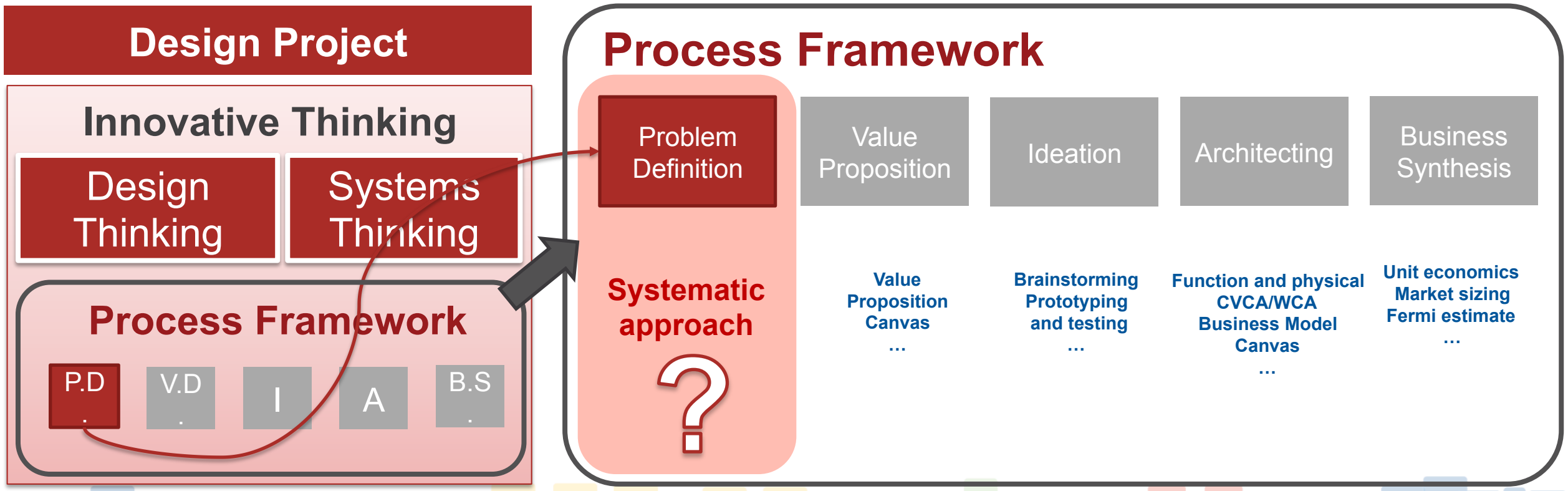

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Keio SDM PBL program

Design Project

Innovative Thinking

Design Thinking

Systems Thinking

Process Framework

P.D.

V.D.

I

A

B.S.

Process Framework

Problem Definition

Five approaches
For defining problems

Value Proposition

Value Proposition Canvas
…

Ideation

Brainstorming
Prototyping and testing
…

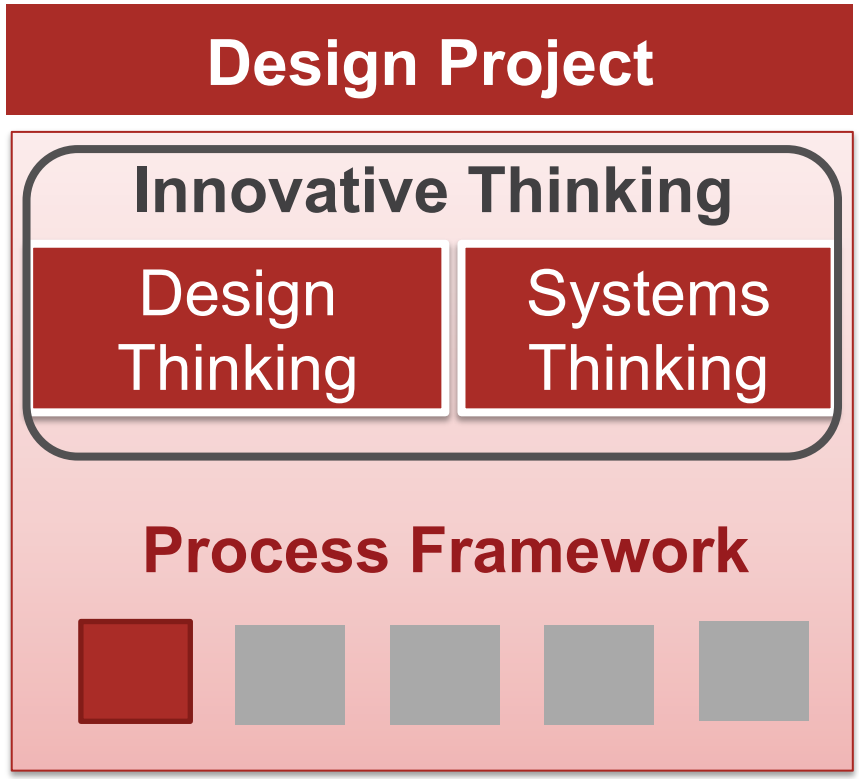
Architecting

Function and physical
CVCA/WCA
Business Model Canvas
…

Business Synthesis

Unit economics
Market sizing
Fermi estimate
…

Joint method of Systems Thinking and Design Thinking

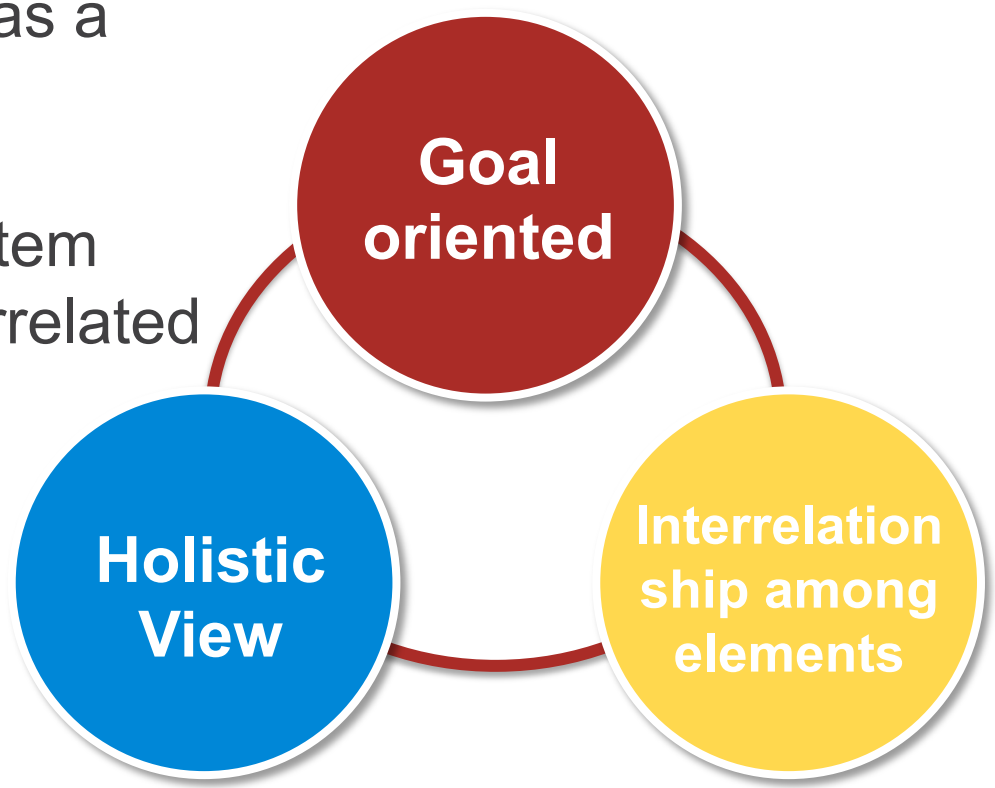


"Innovative thinking" is an integration of Design Thinking and Systems Thinking.

Both principles of toolsets of design thinking and Systems Thinking are jointly utilized in each process in the program.

Systems Thinking in Design Project

- Looking at things as a system
- Multiple elements consisting the system
- Elements are interrelated



- Perceiving in a holistic view
- Knowing how elements are interrelated.
- Structurize the system with multiple viewpoints
- Visualize the structures

Multiple Viewpoints

Structurization

Visualization

Design Thinking in Design Project

"Design Thinking is a mindset."
by IDEO

Design Thinking for Educators Toolkit, IDEO, 2011

It's Human-Centered.

It's Collaborative.

It's Optimistic.

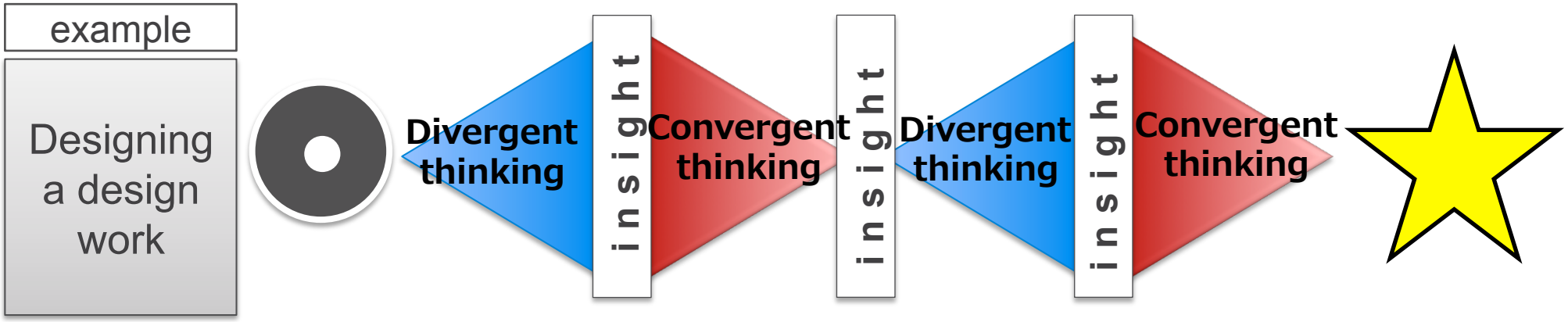
It's Experimental.

Integrating Systems & Design mindsets

How does design thinking work together with systems thinking?

Systems thinking makes design thinking goal-oriented.

The ultimate goal for the system development is to deliver new value to the society. When practicing systems engineering, “goal-oriented” is always an essential factor. Even when exerting design thinking, it requires to be progressed towards certain goals. By incorporating systems thinking, design thinking processes could be progressed systemically and systematically.



Keio SDM's methodology

Process Framework	Analysis				
	Problem Definition	Value Proposition	Ideation	Architecting	Business Synthesis
	Research				
	課題を定義する	価値仮説を創出する	アイディアを創出する	実現方法を組立る	事業をデザインする
Tools & Methods		**Value Proposition Canvas …**	**Brainstorming Prototyping and testing …**	**Function and physical CVCA/WCA Business Model Canvas …**	**Unit economics Market sizing Fermi estimate …**
Output	Reframed/redefined problem Innovative problem	Innovative value proposition	Ideas to realize value proposition	Architecture Feasibility	Rough estimation on Market size and Business planning

Keio SDM's methodology

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	Research				
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Problem Definition Process Framework

Five Approaches

Five approaches for defining problems

Knowing what are in the box and getting out of it.

Exploring the problem space and solution space by identifying conventional “in-the-box” and extending thoughts towards outside the “box”.

Analytical approach.

General approach using existing analytical frameworks including lifecycle, 3C, 4P, SWOT and many other framework.

Solving the problem halfway.

When a issue is too big and uncontrollable, finding some hidden important and actionable factors would be quite important.

Achieving a higher purpose.

Reframing an issue/problem by seeking its upper purposes.

Getting rid of something regarded necessary.

Exploring the problem space by doubting things that are considered necessary to exist or to be equipped with as a matter of course and trying to remove them.

Approach 1.
Knowing what's in the box and get out of it

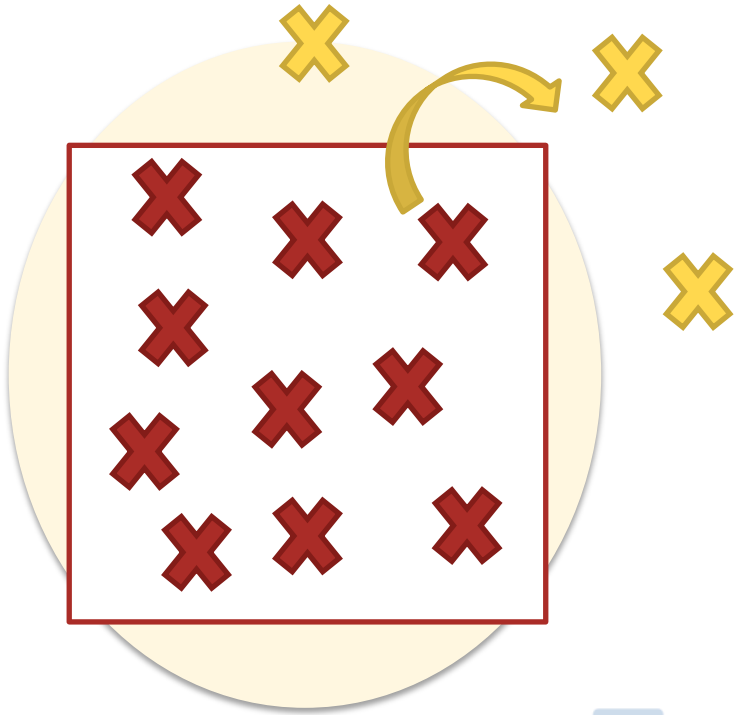
This approach aims at exploring the problem space and solution space by identifying rather conventional "box" of recognition of a certain issue and extending thoughts towards outside the "box."

Steps

Step 1. First, list up what are already there in the box.

Step 2. Put them in some structure.

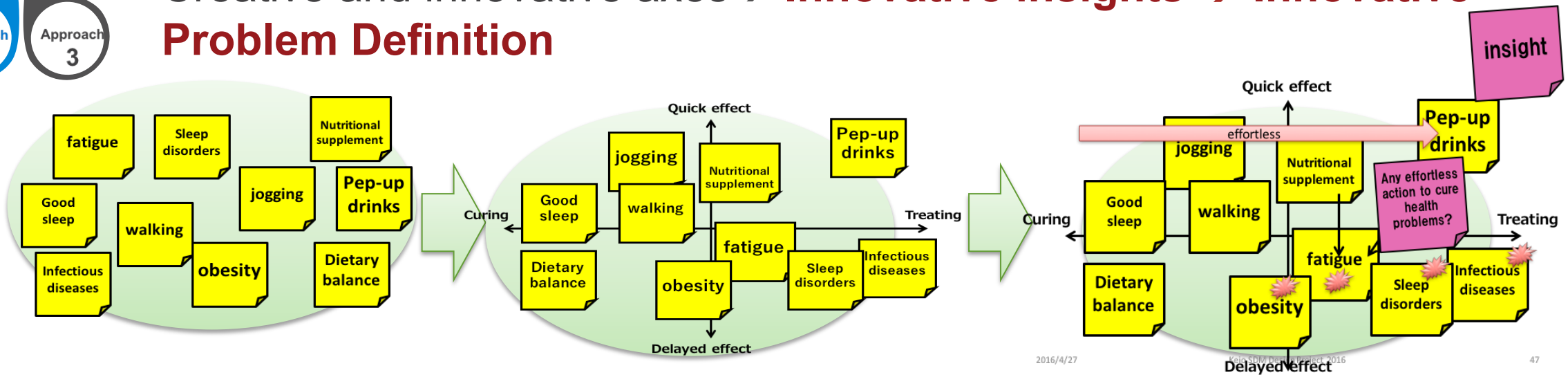
Step 3. Find insights from the structure and define a problem.



Approach 1.
Knowing what's in the box and get out of it

Structure Example: 2 axes

Create 2 axes, name the axes creatively and plot the listed items.
Creative and innovative axes→ **Innovative insights → Innovative Problem Definition**



Design thinking
Collaboration with diverse participants
Optimistic and experimental mindset

Systems thinking
Exerted to find structures and intentionally and logically lead you to find innovative problem space

Approach 2.
Solving the problem halfway (Type 1)

Solutions that do not completely solve the problem.
Finding actionable problem space. Applied when a problem cause is too big or uncontrollable.

Type 1: Breaking the link between cause and effect

When there is a cause-effect relation, break the link between "cause" and "effect" instead of trying to get rid of "problem cause"

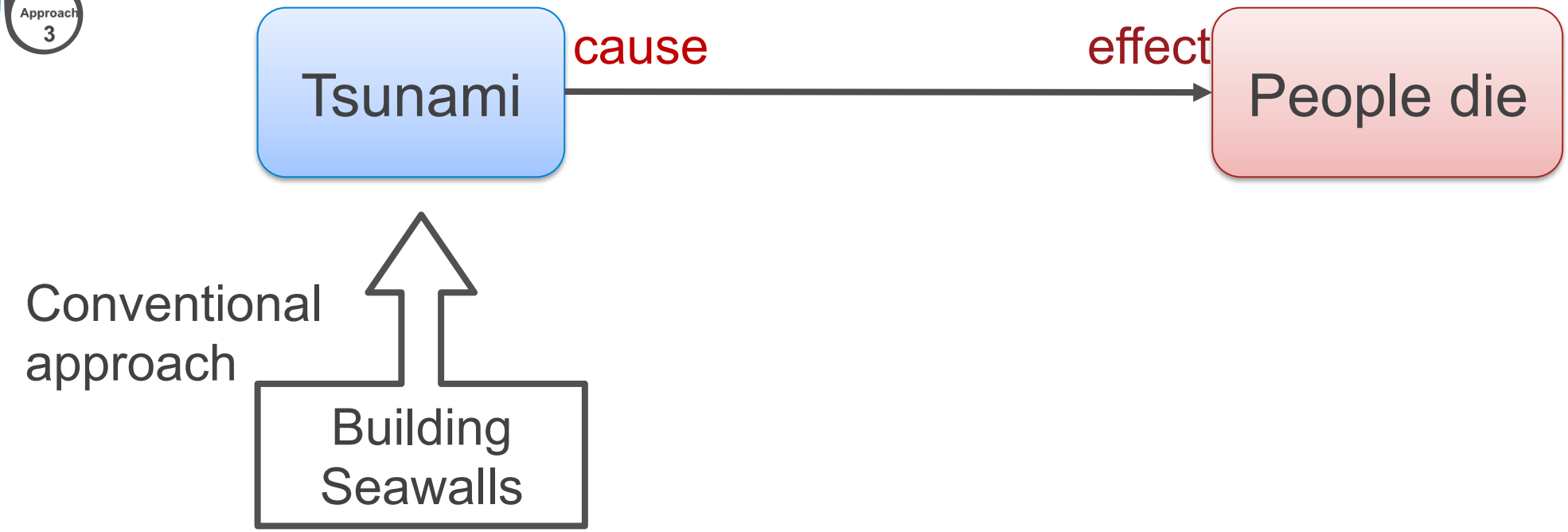
Step 1. Find a cause-effect relation.

Step 2. Break the direct link between them and find cause-effect relations inbetween.

Step 3. Find actionable cause and define a problem.

Approach 2.
Solving the problem halfway (Type 1 example)

Example) Problem: Tsunami kills many people.



Approach 2.
Solving the problem halfway (Type 1 example)

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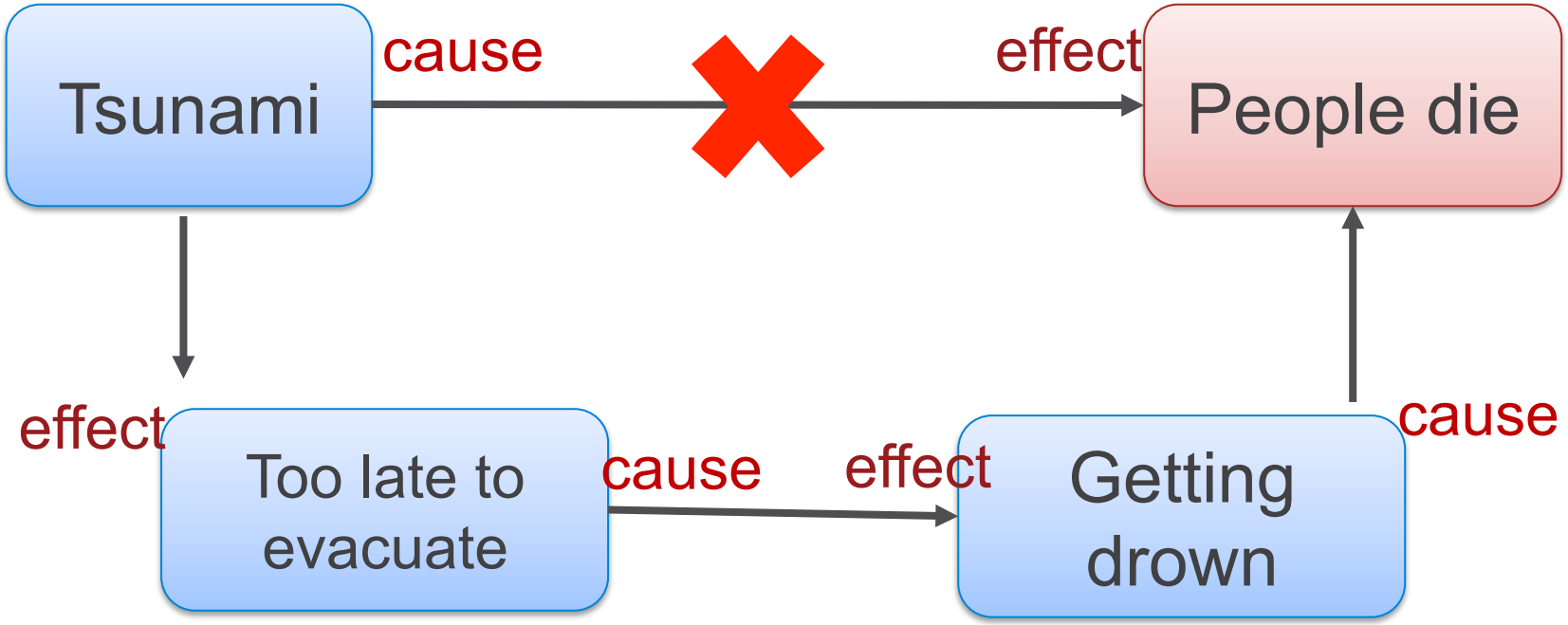
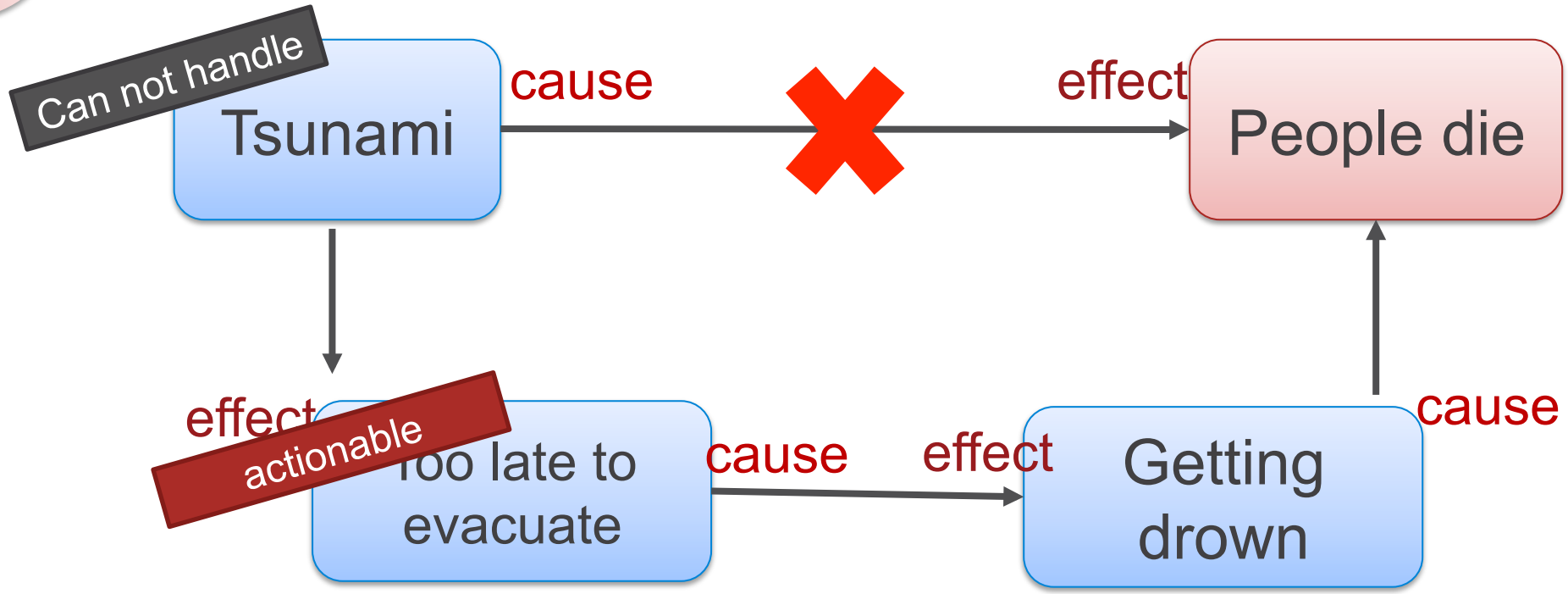


Approach 2.
Solving the problem halfway (Type 1 example)

Example) Problem: Tsunami kills many people.



Reframed problem

How could we gain some time for evacuation?

Approach 2.
Solving the problem halfway (Type 2)

Solutions that do not completely solve the problem.
Finding actionable problem space. Applied when a problem cause is too big or uncontrollable.

Type 2: Step-by-step approach. Solving the problem to some extent.
When the given issue is too big or takes too much time to solve, find a actionable and achievable problem space by detuning the goal.
Step 1. Break down the big final goal into step-by-step
Step 2. Examine goals of each layers and find achievable and actionable problem

Approach 2.
Solving the problem halfway (Type 2 example)

Problem: Having not clean water. (Kathmandu, Nepal)

Conventional approach:

- ✓ How could we provide them clean water?
- ✓ How might we live without water?

***Step-by-step approach**:*

Starting from small things.

Reframed problem

How could we provide them just one bottle of clean water everyday?

d3kw9b2lsnxnex.cloudfront.net

Letting babies drink milk with clean water

Approach 2.
Solving the problem halfway

Design thinking

This approach involves design thinking in an effort to come up with a number of ideas for cause-effect links and how to break them in Type 1, and to break down the given problem into creative and unique layers that no one had ever found.

Systems thinking

This approach involves systems thinking in an effort to find cause-effect relationships in type 1, and step-by-step layers in type 2 systematically and systemically.

Approach 3.
Getting rid of something regarded necessary

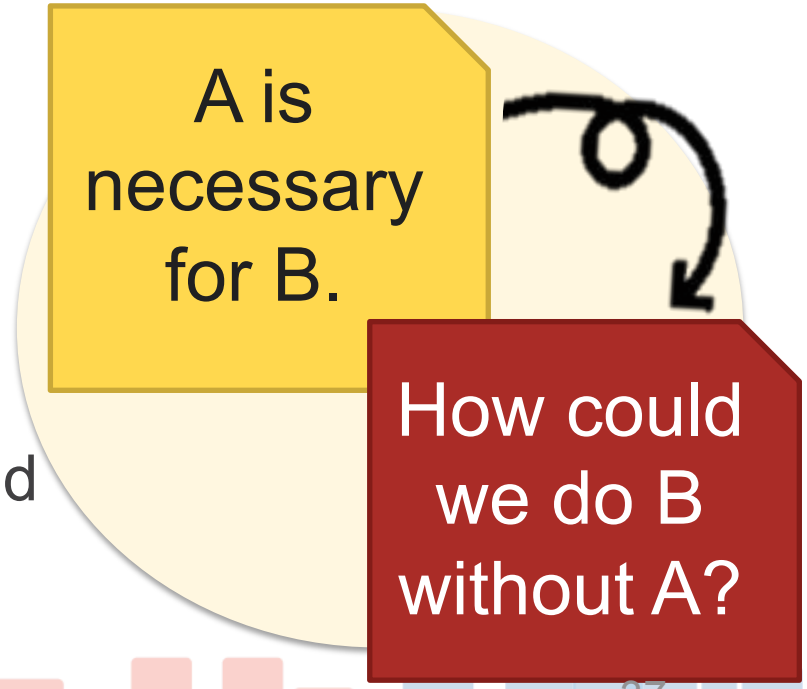
Exploring the problem space by doubting things that are considered necessary to exist as a matter of course. Asking "What if it is removed?" Applying this approach is one of challenges to go out of the conventional box.

Steps

Step 1. List up anything perceived conventional, essential or relating to an issue.

Step 2. Ask questions with each listed items, "How could we xxx without xxx?"

Step 3. Draw out insight from those questions and redefine the problem.



Approach 3.
Getting rid of something regarded necessary

Example: Healthcare

What are regarded necessary:

→ doctors, medicines, health checkups, hospitals….

Questions:

→ "How could we get diagnosed without doctors?"

→ "How could we know health conditions without checkups?"

Reframed problem

How might we make people always health conscious without checkups?

Design thinking

Collaborative, optimistic and experimental mindsets are quite important to force you to get out of the conventional box.

Systems thinking

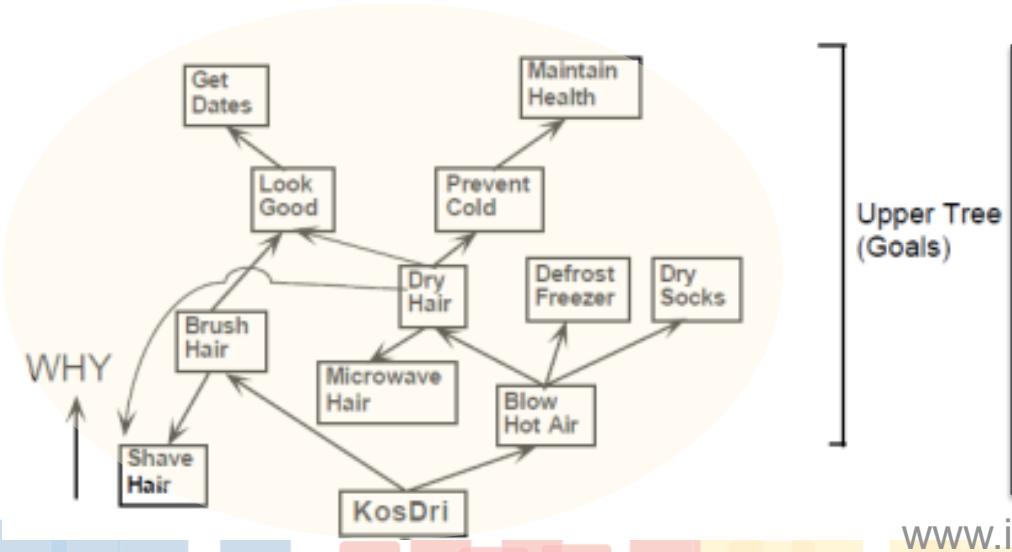
Activities are designed goal-oriented and conducted systematically and systemically.

Approach 4. Achieving a higher purpose

Expanding thoughts for exploring a problem space. Reframing an issue or a problem by seeking its upper purposes.

Steps

Step 1. Find higher purposes of an issue or a problem.
Step 2. Find alternatives to satisfy the identified higher purposes.
Step 3. Draw out insights from the output and redefine the problem.

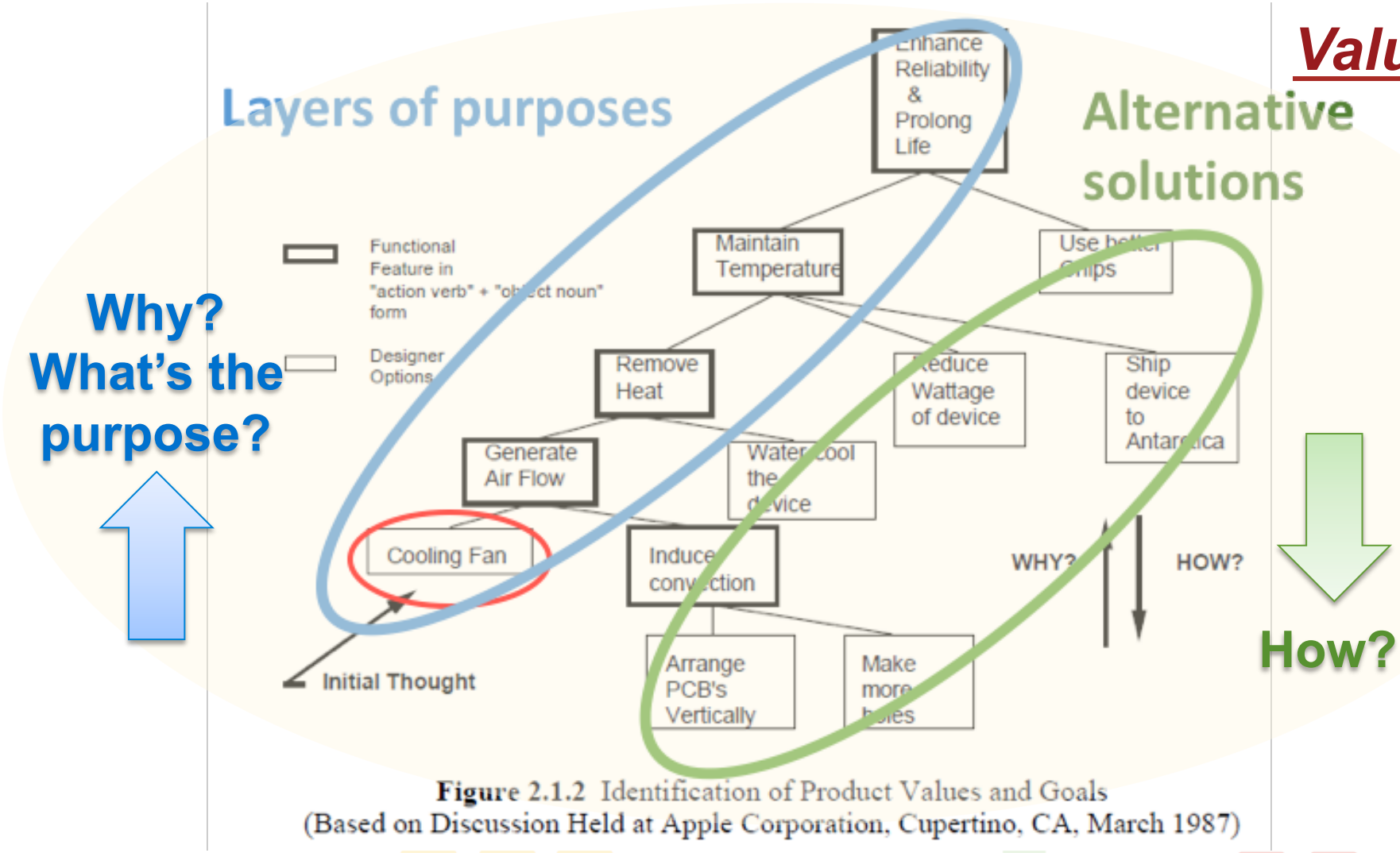


Using a method called **"Value Ladder"**
A part of a method called "Value Graph" developed by Professor Kosuke Ishii at Stanford university. Placing a core concept at the bottom, go up a ladder with upper purposes step by step and generate ideas satisfying the purposes as "alternative HOWs".

Approach 4. Achieving a higher purpose

Value Ladder

Why? What's the purpose?



How?

Figure 2.1.2 Identification of Product Values and Goals
(Based on Discussion Held at Apple Corporation, Cupertino, CA, March 1987)

Approach 4. Achieving a higher purpose

Example: Deodorant

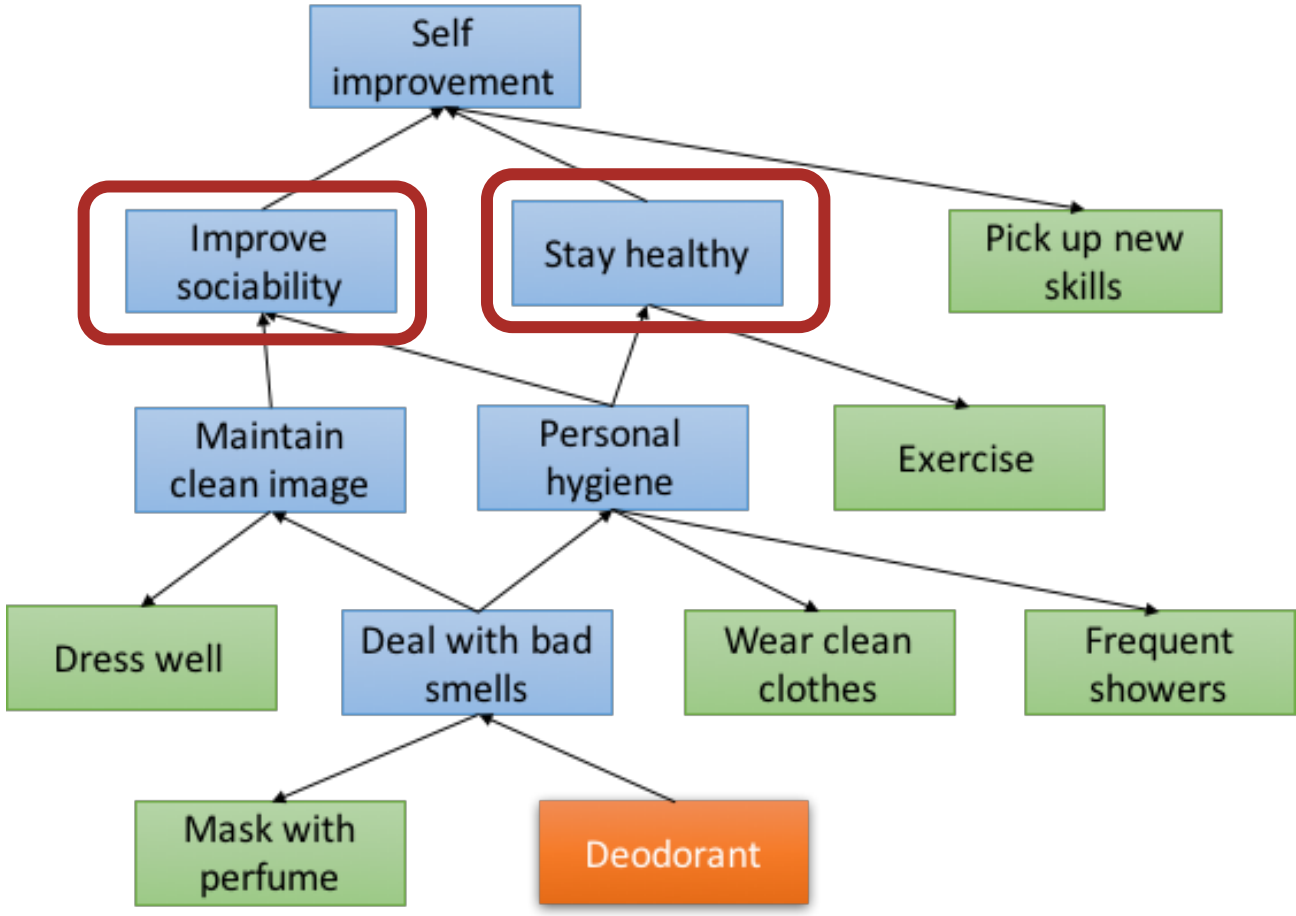
Higher purposes:

To improve sociability

To stay healthy

Reframed problem

How could we make people sociable and healthy at the same time with deodorant?



20170502 Class Assignment by Ronny Ho Yung Hui

Approach 4. Achieving a higher purpose

Design thinking

This approach involves design thinking in an effort to come up with a number of ideas for alternatives to satisfy different layers of purposes. Collaboration and human centered approach is required to define higher purposes in different viewpoints.

Systems thinking

This approach involves systems thinking in an effort to find step-by-step layers of purposes. Systematical aspect is required in making sure the lower purposes enable upper purposes and upper utilizes the lower.

Approach 5. Analytical approach

Redefining/reframing problems using conventional analytical frameworks. (CVCA, 3C analysis, 4P analysis, SWOT analysis and more)

EXAMPLE) Lifecycle Analysis

Steps

Step 1. Jot down LIFECYCLE of some aspect of the given issue/problem.

Step 2. Discuss, find insights

– e.g. any stage/phase missed out?

Step 3. Define problems based on the insights.

Approach 5. Analytical approach

Example: Healthcare

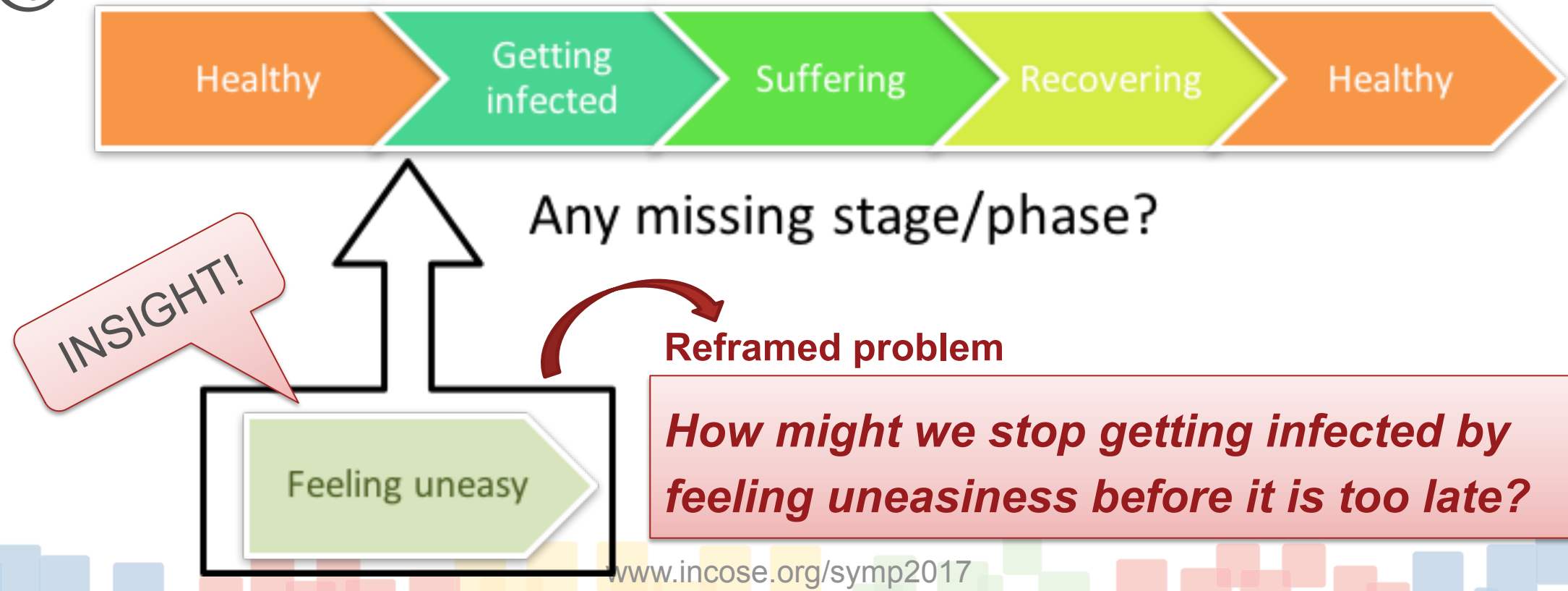
Lifecycle of people infected to some disease and recover from it.
From Healthy stage and to the stage where he becomes healthy again.

Any missing stage/phase?

Approach 5. Analytical approach

Example: Healthcare

Lifecycle of people infected to some disease and recover from it.
From Healthy stage and to the stage where he becomes healthy again.



Reframed problem

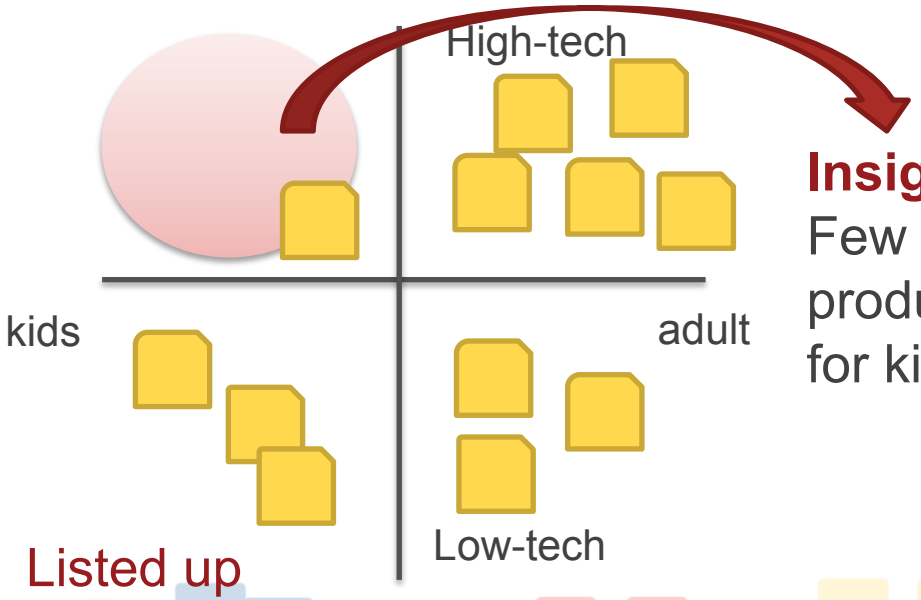
How might we stop getting infected by feeling uneasiness before it is too late?

Examples from classroom

Application of the Framework

Application Example 1: ”Smart Shoelace” solution

Approach 1
Knowing what are in the box and getting out of it
@ Keio SDM 2016 Design Project class group work
Problem proposer: Geospatial information service company
Proposed issue: A new innovative way to use the geographic information



Listed up
items related to geographic information

Insight
Few GPS-related products designed for kids.

Market Research
Used for monitoring kids’ location

Reframed problem
How could we bring GPS useful functions to kids’ ordinary life?

Solution idea
“**Smart shoelace for kids**” incorporating some kid team game like hide and seek into GPS function.

Application Example 1: ”Smart Shoelace” solution

Approach 1
Knowing what are in the box and getting out of it
@ Keio SDM 2016 Design Project class group work
Problem proposer: Geospatial information service company
Proposed issue: A new innovative way to use the geographic information

The team listed up services, products, items and other elements that came up to their mind related to geographic information and plot them on a two axis chart. They labeled the axes as **“high-tech** and **low-tech**” and “**kids** and **adults.**” The output of this work derived an **insight** that there are few GPS-related products that are designed for kids. They then conducted a research such services and products and found that most of them on the market are used for monitoring kids’ location. So, they reframed the problem definition as **“How could we bring GPS useful functions to kid’s ordinary life?”** Based on this problem definition, the team came up with a solution idea **“Smart shoelace for kids”** incorporating some kid team game like hide and seek into GPS function.

Application Example 2: ”Optimizing inappropriate drug remedy”

Approach 5 : Analytical Approach (Lifecycle analysis)
@ Keio SDM 2016 Design Project class group work
Problem proposer: Pharmaceutical manufacturing company
Proposed issue: Redefining the term ‘medication’ and creating a new medication service

Analyzed “medication” lifecycle. Broke down in stages from the viewpoint of pharmaceutical manufacturer.

Last stage: “prescription”

Patients take medicines

Insight
lifecycle terminates before the phase where patients actually take medicines.

New Question
any opportunity for the company to support the “taking medicine stage” by patients.

interviews and fieldwork
Major problems for patients: “many kinds of medicine prescribed and fear of inappropriateness in their combination.”

Reframed problem
“How might we optimize inappropriate drug remedy?”

Application Example 2: ”Optimizing inappropriate drug remedy”

Approach 5 : Analytical Approach (Lifecycle analysis)
@ Keio SDM 2016 Design Project class group work
Problem proposer: Pharmaceutical manufacturing company
Proposed issue: Redefining the term ‘medication’ and creating a new medication service

The team tried to analyze **“medication”** using **lifecycle** framework. They broke down the lifecycle of medication into stages from the viewpoint of a pharmaceutical manufacturer. The last stage was “prescription.” Here, they found that the lifecycle terminates before the phase where patients actually take medicines. This insight had lead the team to think through any opportunity for the company to support the “taking medicine stage” by patients. They then conducted interviews and fieldwork and found that one of major problems for patients is “many kinds of medicine prescribed and fear of inappropriateness in their combination.” Then they reframed their problem definition as **“How might we optimize inappropriate drug remedy?”**

Application Example 3: ”Stopping global warming”

Approach 2 : Solving the problem halfway (Step-by-step approach)
@ Takagi Girls High School 2014 PBL class group work
Issue: Global warming

Actionable/Achievable problem definition

Stopping Global Warming

Ultimate goal

detuned

“How could we make people quickly feel that they are contributing to stop global warming?”

High school girls team

Fieldwork & interview

We do mind this issue.
We do things that should contribute to stop this problem.

We don’t know whether those actions are actually making contributions or not!

Application Example 3: ”Stopping global warming”

Approach 2 : Solving the problem halfway (Step-by-step approach)
@ Takagi Girls High School 2014 PBL class group work
Issue: Global warming

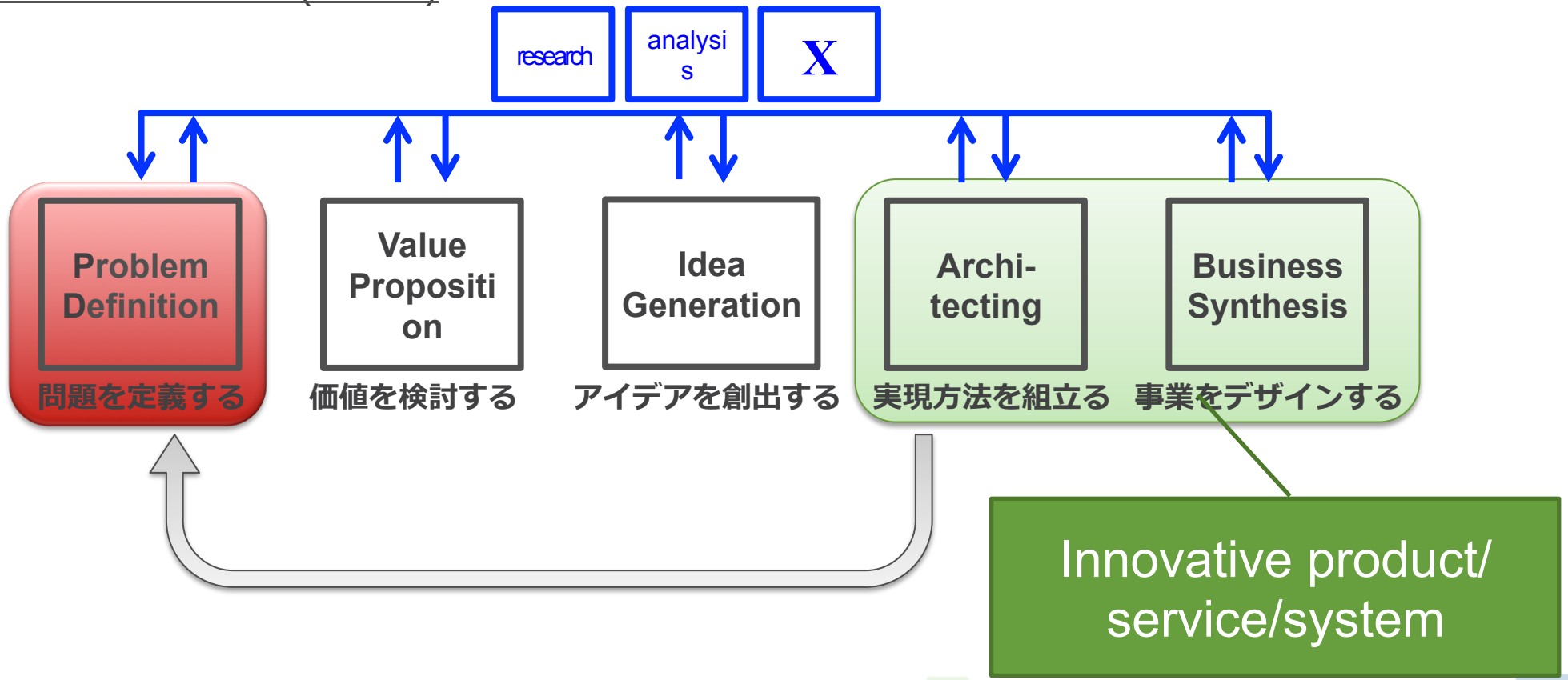
One team picked up an issue, **“Stopping global warming.”** A rather big and uncontrollable issue for high school students. They went out for a fieldwork activity, collecting people’s voices about the global warming issue. Many of them said they mind global warming and do something that should contribute to stop this problem. But they also said they don’t know whether those actions are actually making contributions or not. After the fieldwork, the team detuned their goal on the layer where it is achievable and actionable with their point of view. They reframed their problem as **“How could we make people quickly feel that they are contributing to stop global warming?”**

Assuming the problem definition from innovative products/services

Reverse assumption

Assuming the Problem Definition

Process Framework (modes)



Assumption 1:
Harinacs (KOKUYO, stationary company)

Approach 3

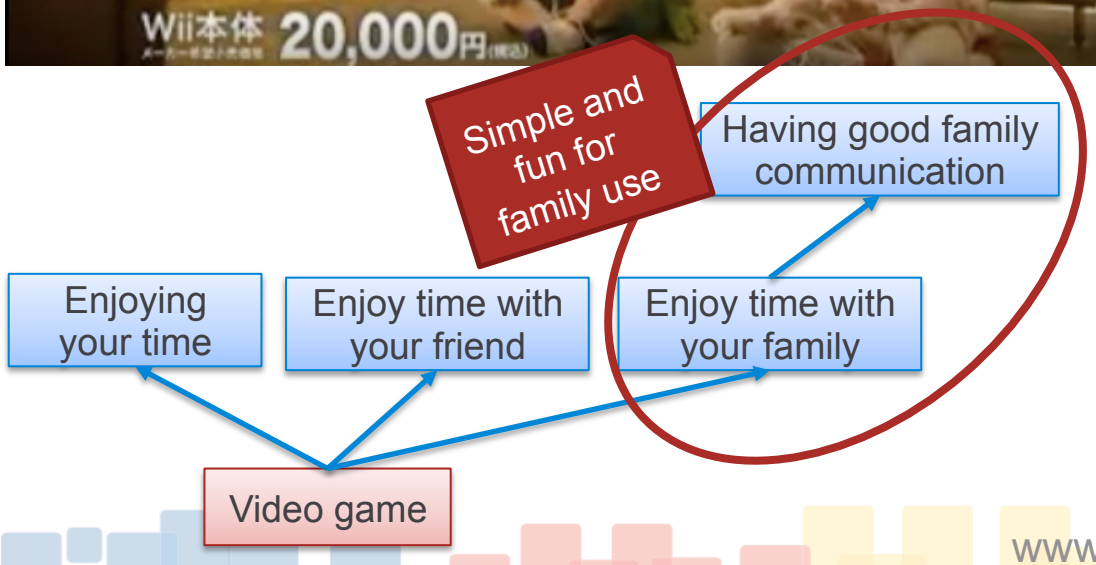
Getting rid of something regarded necessary

“How might we staple sheets of paper without using staples?”

Solution:

Staple-free stapler, Harinacs

Assumption 2:
NINTENDO Wii Video Game Console



Approach 4

Achieving a higher purpose

"How might we make our product more simple and fun?"

Solution:

NINTENDO Wii

Video Game Console Focused on "family communication" as a higher purpose for video game

Conclusion & Future work

Conclusion

- Discussed the importance of integration of systems thinking and design thinking especially in the problem definition process for innovative system development.
- Introduced our methodology implemented in our PBL program.
- Introduced the Framework for problem definition process.
  - Five approaches with step by step activities, examples and how design and system mindset is utilized in each approach.
- Shared application examples for problem definition framework.
- Challenged reverse assumption of problem definition for existing innovative products.

Future work

- Problem statements derived from each approach could be widely collected from several different educational entities and further research could be proceeded.
- Thus, effective approach depending on types of issues would be revealed and that would further contribute to innovative system development.

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Thank you !

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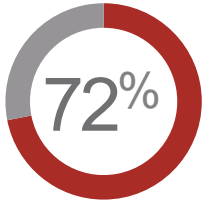

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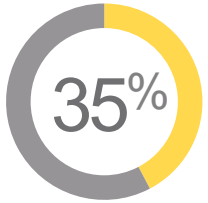

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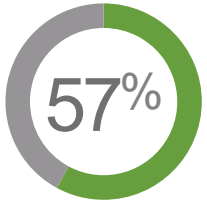

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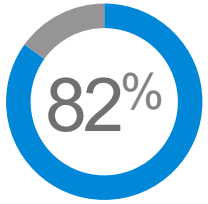

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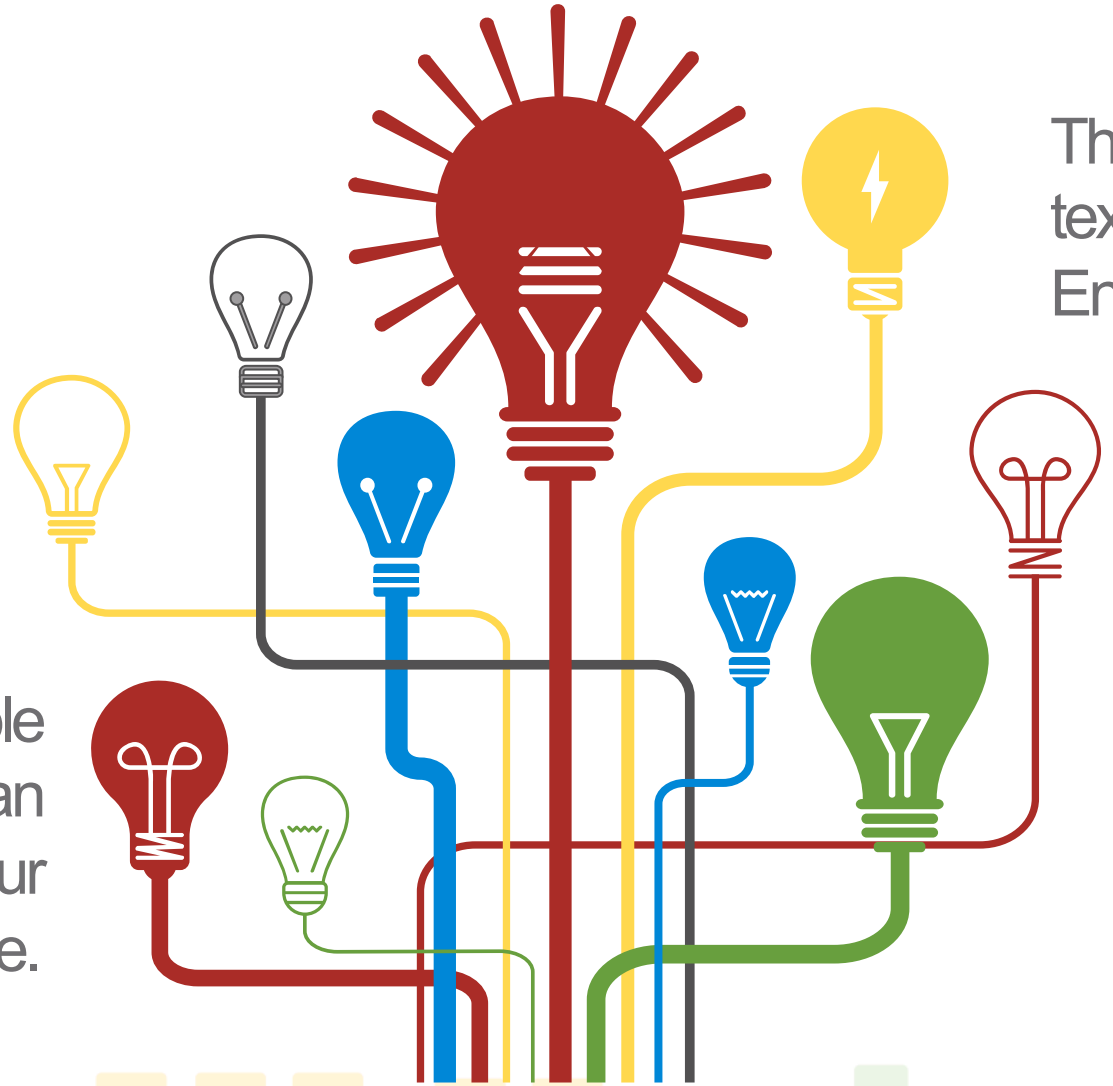

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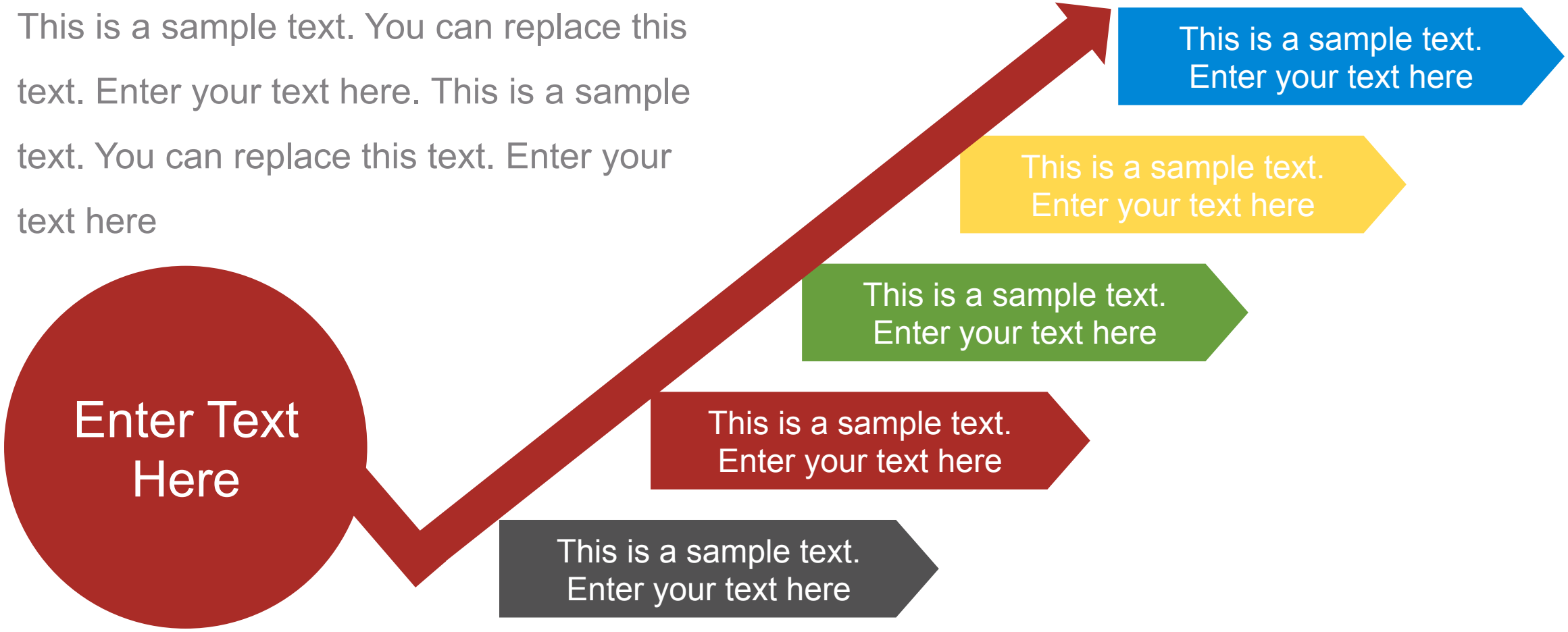

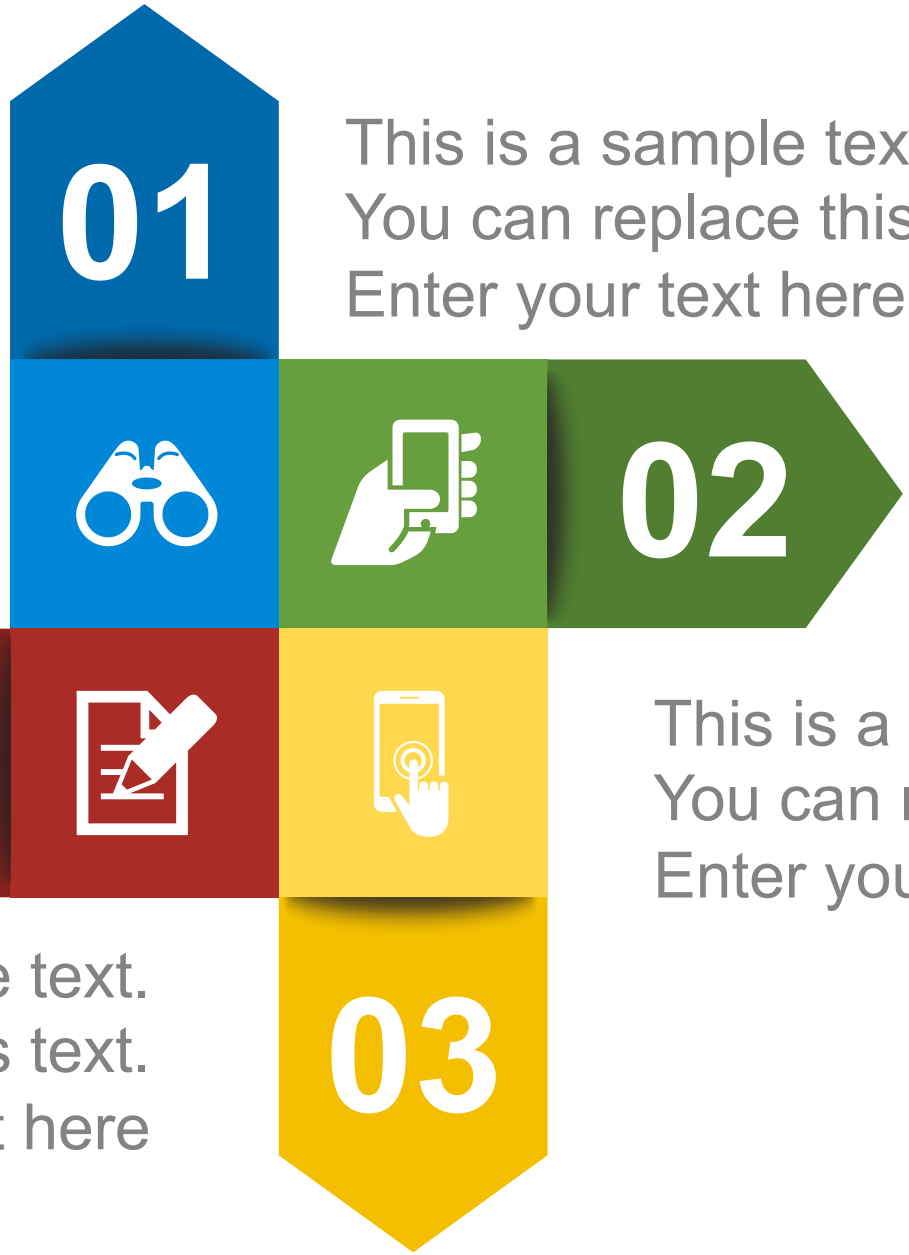

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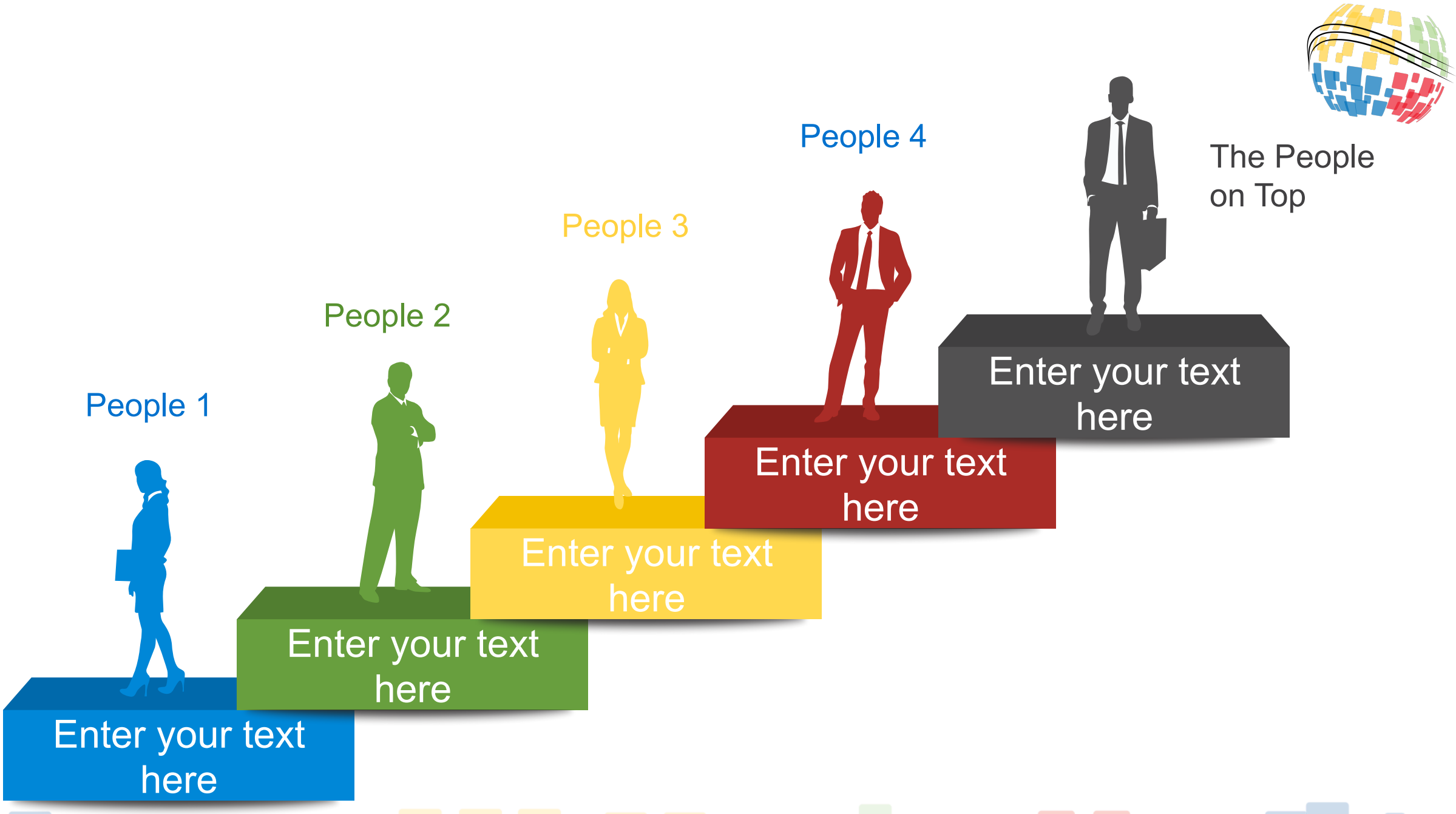
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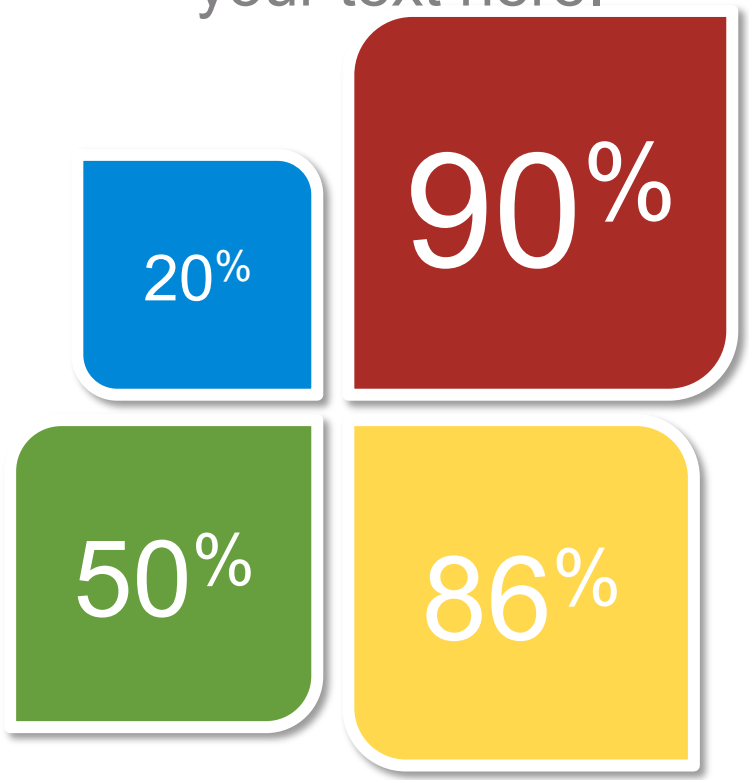

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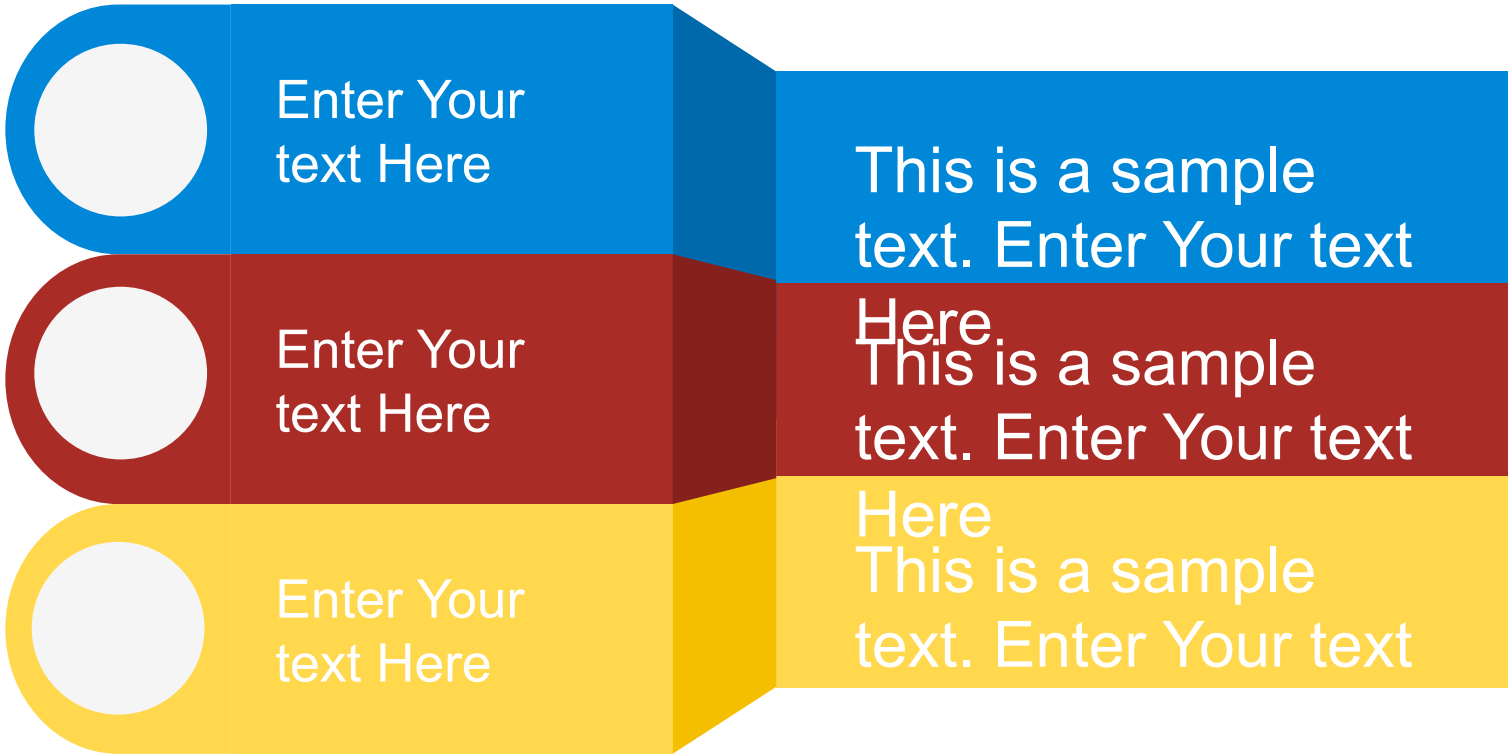

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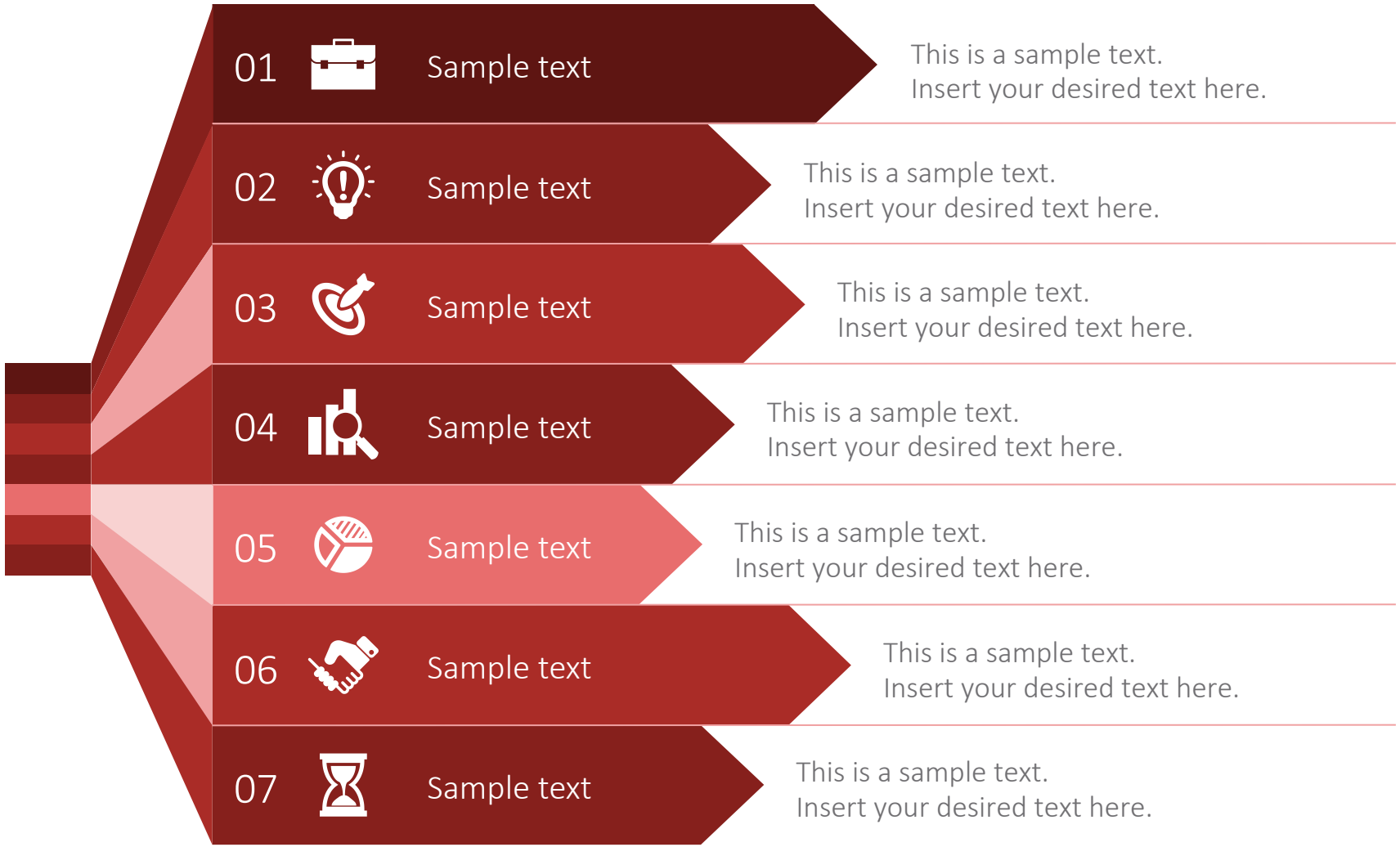

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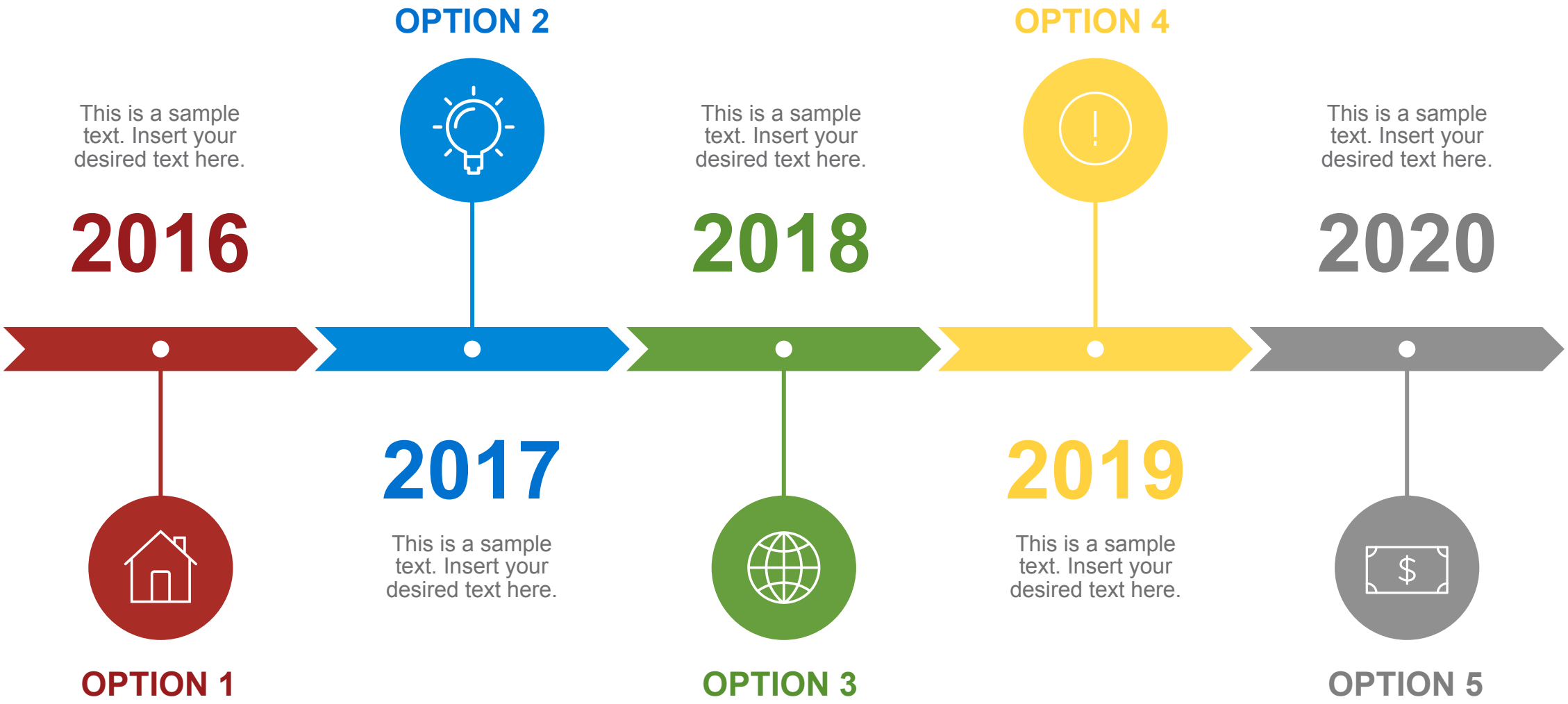
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