Title	Highest life by high-V : Smart physical feedback city
Sub Title	
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Group 5

Group 5's Theme Proposed by Toshiba Corporation with Shimizu Corporation

Theme 12:

ALPS "safety and security" theme title: **Smart Physical Feedback City**

Proposer Organization's Name: **Toshiba Corporation with Shimizu Corporation**

Supporter Name and contact info: Naoshi Uchihira (naoshi.uchihira@toshiba.co.jp)

Abstract of your project theme :

How do Mono-zukuri companies survive competing against Google? Physical feedback is the key issue!

Recently, cyber-physical systems are becoming very important which gather information with the sensor network, process them, and then give useful information (**virtual feedback**). However, few systems give useful physical services with actuators (**physical feedback**). In this project, future vision, concept, and application of smart physical feedback city are requested to make cities safer and smarter with physical feedback. Moreover, service business strategy for Mono-zukuri companies to compete against Google in the future virtual and physical feedback world is very interesting. **This project supported by a physical device company (Toshiba) with a construction company (Shimizu).**

Examples:

• Smart energy-saving facilities in which controls air conditioners, lighting, window shades, etc. using environment sensor data (e.g. weather information) and human behavior modeling.

•Transportation scheduling system in which control commuter vehicles, elevators, robots, movable space, etc. utilizing real-time traffic flow information.

•Smart operation, maintenance and patrol of city facilities utilizing haptic devices and robots.

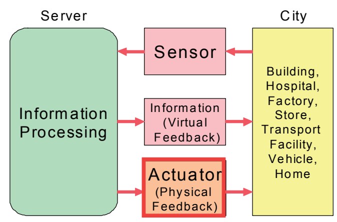

Fig. 1: Virtual and Physical Feedback

http://www.toshiba.co.jp/tech/review/2010/03/65_03pdf/01.pdf

Fig. 2: Example: Physical Feedback Home (Smart Energy-saving Home)

ALPS Final Report 2010

Group 5

PROJECT TITLE:
"Highest Life by High-V"

Theme:
"Smart Physical Feedback City"

Proposer Organization: Toshiba Corporation with Shimizu Corporation

Proposer Organization's Supporter: Naoshi Uchihira

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Toshiba Mentor: Prof. Takashi Maeno

November 29 , 2010
Graduate Scholl of System Design and Management, Keio University

Table of Contents

1. Summary

This report aims to propose a solution to address problems in everyday life by providing physical feedback using actuator, instead of providing information-based service.

The development of information technology has made it possible to provide virtual extended spaces. Yet the virtual space is not able to address the problem.

As a final solution, we propose a product named HIGHEST LIFE that consists of a double-deck desk and a lift chair. By moving up and down the chair, uses are able to sit in front of the upper and lower desk. The product realizes "physical" extension of working space.

Main potential users were clarified though tools such as brainstorming, mind map, KJ-method, Pugh selection, Scenario Graph, use case analysis, interview and morph analysis: 1. people who like to have study room as private space. 2. people who have little children.

VoC through the interview showed two key concerns, security and price. We leveraged the Voc regarding security in failure analysis. As a result, several safety measures were implemented in our product. Regarding price, we searched and estimated a likely price by competitive analysis.

While we refined the product through tools like QFD, cost-worth analysis, FMEA and prototyping, we provided insights into business by CVCA , NPV, and competitive analysis.

Firstly, CVCA illustrated two key stakeholders. One is potential sales channels between the product provider and end-users. The other is advertising agents. CVCA additionally gave us insight that the channels were essential to maintenance in addition to expanding sales. In case critical failure of the product occurs, the channels are likely to play important role on calling-out operation. In terms of contingency plan, we recommend to take into account this point. Regarding advertising agents, they improve the awareness of the product and appeal the value of the physical extended working spaces. Since advertising media are various, research and analysis of the media is required, which is suggested as a future work.

Secondly, competitive analysis led the likely price of our product. Although no complete competitors were found, we regarded two existing products as competitors, a sound-proof small room [1] and a lift chair [2]. Yet we have not made, we suggest price sensitive measure (PSM) to calculate more accurate competitive price.

Thirdly, NPV showed expected sales volume and pretax income. Although the first year is in the red, the second year goes the red into the black. Estimated target volume

of annual sales is 100 in the first year and 350,000 by 10 years later. To meet the number in the period, collaboration with big building constructors such as Shimizu Corporation is recommended.

2. Problem Statement

2.1. Original Theme / Project Requirement

Our theme is shown in Figure 2.1-1. In short, the client, TOSHIBA and SHIMIZU CORPORATION, wanted us to create big business with physical feedback interaction technologies to beat GOOGLE, the largest company in information technology.

2.2. Challenges

This project is *very* challenging because of the following reasons:

a. The topic is simply large; the only given system requirement / keyword is “physical feedback”.

b. Hundreds of companies and researchers all over the World, such as robotists and managers with MBA, thought about it, and it seems that nobody has a good answer. (So, there is no dominant company like GOOGLE in actuation and feedback industry!)

2.3. Assumptions / Project Constraints

In the process of the project described in Chapter 5, we found we should solve a social problem by the developing product in order to obtain a large number of users. So, in addition to the “physical feedback” requirement, we added another constraint: *helping nurturing especially in a double-career household*.

When we say helping nurturing by technology, we tend to think the system, where a grandmother can watch kids remotely, or, another system, where a robotic arm plays with kids. However, one VOC said, *“We don’t need a robot to take care of my kids. Rather, the system should help me out to get my extra time for everything!”*

This comment gave us a great insight. We should create a system, where anyone (especially busy people) can get private time and space. This way, the number of potential users is much larger than the number of people lacking time for nurturing.

2.4. Problem Statement of HIGHEST LIFE

To help people obtaining extra time, HIGHEST LIFE provides the user having her/his private space, using a double-decker desk and safely operated lift-chair.

2.5. Existing Similar Products

Although we regarded two existing products as competitors, a sound-proof small room [1] and a lift chair [2], our concept is quite original.

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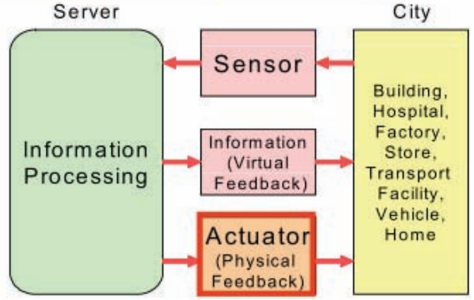
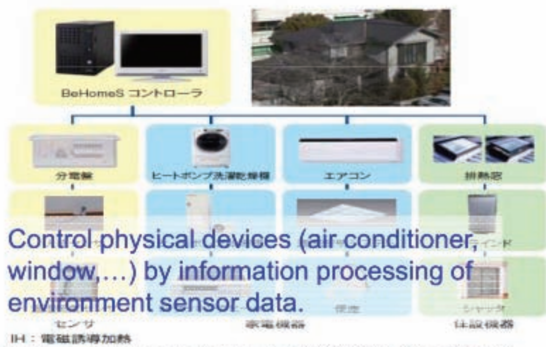


Fig. 1: Virtual and Physical Feedback



http://www.toshiba.co.jp/tech/review/2010/03/65_03pdf/01.pdf

Fig. 2: Example: Physical Feedback Home (Smart Energy-saving Home)

Figure 1 **ALPS theme**

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3. System / Design Recommendation

This section describes detailed description of HIGHEST LIFE that we recommend as a design.

3.1. Motivation

We came up with HIGEST LIFE because it has three major advantages: low cost, making use of dead space under the ceiling, and adapting to the compact city.

a. Low Cost

When we put a loft in house or apartment, it costs at least 50,000 dollars (1 dollar = 100 yen). HIGHEST LIFE costs 6,000 dollars.

b. Making Use Of Dead Space Under The Ceiling

Currently, the space under the ceiling is used for lighting, roof space, and loft. But it can be much better.

c. Adapting To Compact City

A Compact city will reduce the size of the rooms per household and progress of high-rise of per household. We will live in a small room than it is today. HIGHEST LIFE does not require a large space.

To sum up, HIGHEST LIFE makes life comfortable. HIGHEST LIFE will solve the problem of narrowing the area of the room due to increased population density.

3.2. Deployment Scenarios

HIGHEST LIFE deployment scenarios are described.

Case-1) Male, 30-40's, Family, Salaried Worker

He lives in an apartment with his family. While he must keep the size of current floor, he wants his own study room, where his child will not disturb his work, reading and hobby. Also, he wants to spend as little money as possible for it.

Case-2) Female, 20-30's, Bachelorship, Artist

She wants to live in a designer's apartment. There are many designer's apartments in urban areas and the area of the room is not big enough. To work in the room, she wants a lot of desks.

Case-3) Male, 50-60's, Family, Salaried Worker

He wants to buy a new apartment.

He wants a large room with his children and he wants to make effective use of small room. Previously, if HIGHEST LIFE is evaluated good, he wants to purchase an apartment that HIGHEST LIFE is attached.

3.3. Use Case

Use cases are listed.

a. The user sits down the chair.

b. The user goes to the upper desk, where children and other adults cannot reach.

c. The user relaxes at the chair in front of the upper desk.

d. The user relaxes at the chair in front of the lower desk.

e. The user exits in an emergency even when the user and chair is at the upper position.

f. The user locks the chair at the lower position when it is necessary.

3.4. System/Product Specification

3.4.1. Diagrams

Given system specifications described previously, those are diagrams for the system.

a. Front View

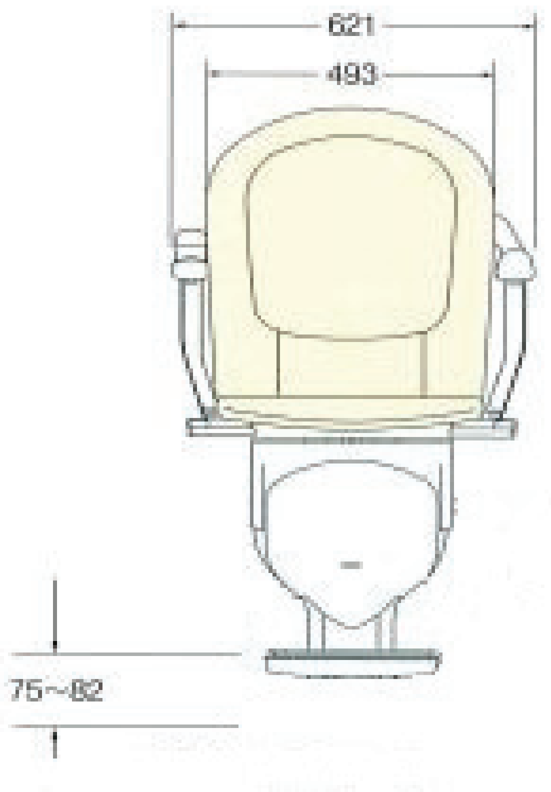

Figure 2 **Front View of chair**

b. Upper View

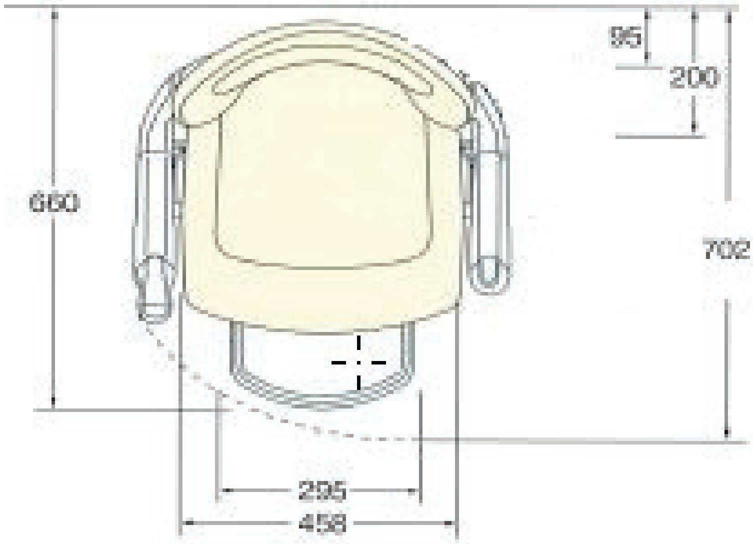

Figure 3 Upper View of Chair

c. Side View

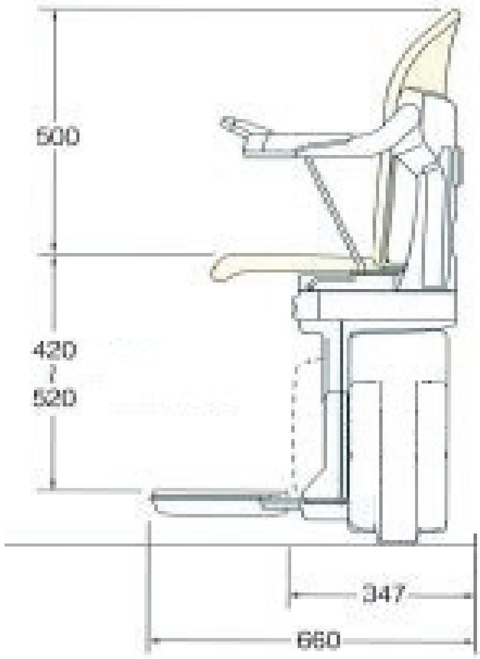

Figure 4 Side View of Chair

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d. Prototype_1

Figure 5 Prototype1

e. Prototype_2

Figure 6 Prototype2

3.4.2. Specification overview

Specifications	
Product Name	HIGHEST LIFE
Intended Purpose	Interior / Wall
Enrollment Limit	One Person
Rating Carrying Capacity	90kg
Work load	180kg (safety margin of 2.0 from the rating)
Running Speed	10cm/second
Power Supply	Home Use 100V
Electric Motor Drive	DC24V
Rail	Aluminum Product
Manipulation Method	Button Press Action
Regulation Equipment	Hand Turning Chair / Sensors For Detecting Obstacles

Table 1 **Specifications of HIGHEST LIFE**

3.4.3 Functional Specification

HIGHEST LIFE can lift and safety less or equal 90kg. Considering a safety margin of 2, the lift has a work load of 180kg. HIGHEST LIFE has the “up” and “down” switch. HIGHEST LIFE can detect obstacles, and stop automatically. HIGHEST LIFE can be fold into a half size. In a case of the emergency, the user can get off from the chair safely.

3.4.4. Subsystem Specification

HIGHEST LIFE realizes that the user obtains an own free space in the living room. To achieve that, HIGHEST LIFE has the following major components: a) a double-decker desk, b) chair, and c) electric-powered lift, d) controller, and e) emergency ladder.

a. Double-decker desk

The upper desk is fixed to the wall, and the lower desk can be attached and removed. The height of the upper table becomes critical. Typically, in Japan, the height of the working desk (floor to the surface of the table) is 70cm. In this sense, the minimum height of the upper desk would be 140cm. However, the tall users may feel uncomfortable when the upper layer is at such low height. Thus, the height of the upper desk depends on the user’s order after all: more specifically, it depends on height of the ceiling and the height of the users.

b. Chair

The chair is fixed to the lift. The user controls it by the controller, and the lift goes up and down. This way, the user can use both lower and upper desks in range of one desk; especially, when user is at the desk under the ceiling, it is her/his private space. It also has a footrest, which can be adjustable by a lever arm located side back of the chair. It functions just like the one seen in a conventional car. There is another lever arm back of the chair to deploy the emergency ladder.

c. Electric-powered lift

The chair is fixed to the lift. The user controls it by the controller. The chair/lift position - distance between surface of the desk and chair - would be about 32 cm and it is adjustable because the lift can move up and down.

d. Controller

There are three buttons on the controller: “Move”, “Stop”, and “Lock” as shown below. The button shapes a circle for “MOVE”, cross for “STOP, and triangle for “LOCK” so that the actions are recognizable by tough. The size of the panel is 150 by 80 mm. It is on the armrest of the chair.

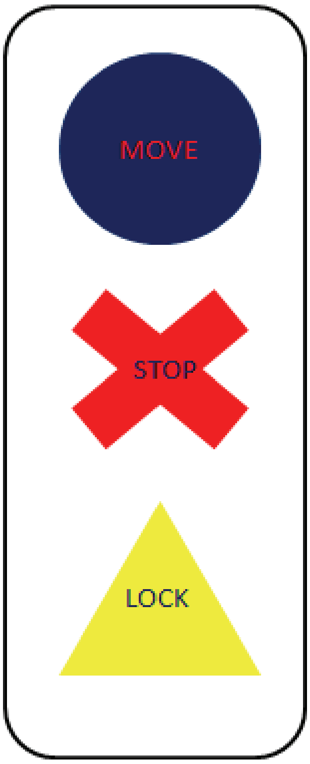


Figure 7 Controller of Lift

e. Emergency Ladder

It is used when electrical power is down at the upper layer. It is deployed by a lever arm located on the back of the chair.

3.5. Process Specification and Time

A state diagram of HIGHEST LIFE is shown below. The state starts at “Lower Nominal”, and goes to “Upper Nominal” via “Moving” triggered by the “Move” button. It can stop at the middle when the user presses the “Stop” or detects an obstacle. Even in the case of an emergency, the user can get off the lift safely. Also, the chair can be locked at the lower position if the user wants it. Let us explain process specification focusing on process steps.

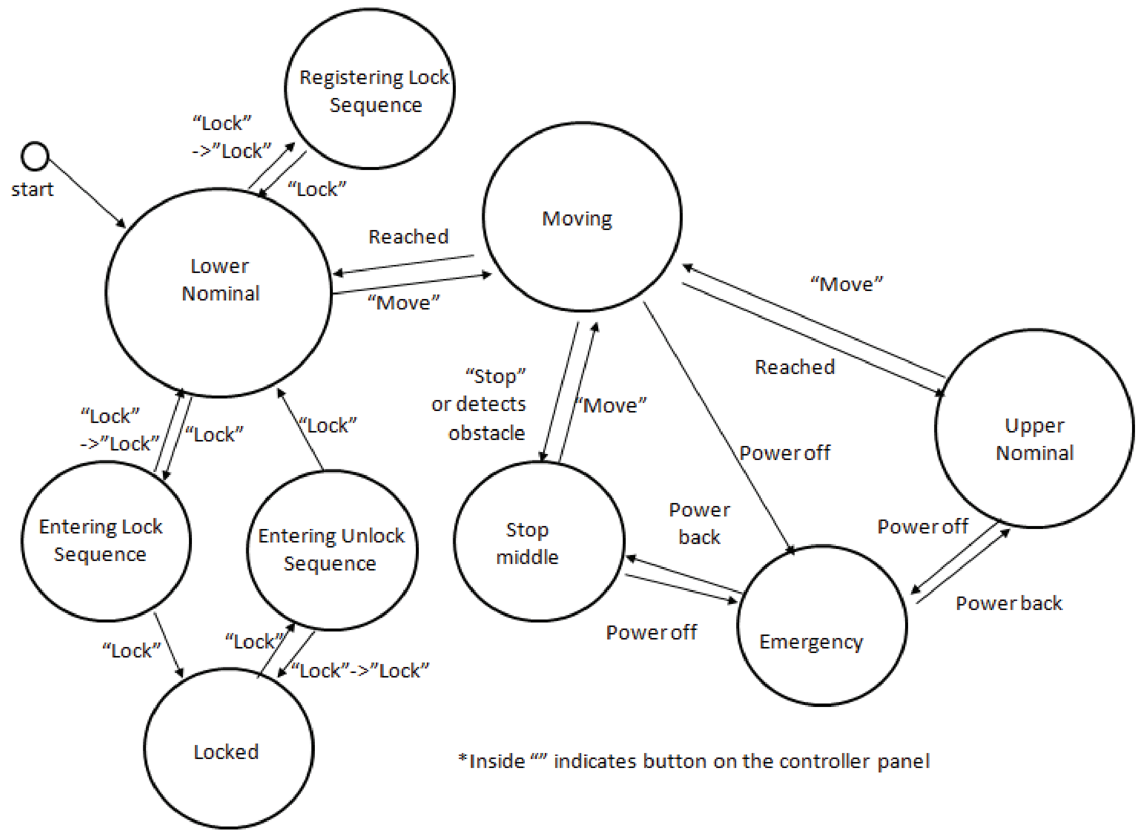


Figure 8 State Diagram

Case-1 The user going up to the upper desk

Initial conditions:

- The HIGHEST LIFE is in the "Lower Nominal" state.
- The user (owner of HIGHEST LIFE) is on the floor.
- The lower desk can be used for normal use, such as putting a television or eating
- The lift is down, and unlocked.

a. The user sits down on the chair.
b. The user press the "move" button on the controller located on the armrest. (->It goes to the "Moving" state. The lift moves up at 10cm/second, and reaches in front of the upper desk in 7 seconds. It goes to the "Upper Nominal" state.)
c. The user starts working on the upper desk.

Case-2 The user going down

Initial conditions:

- The HIGHEST LIFE is in the "Upper nominal" state.
- (After finishing her/his work in Case-1)

a. The user press the “move” button on the controller located on the armrest. (->The lift moves down in 10cm/second - the “Moving” state - and reaches in front of the lower desk in 7 seconds - the “Lower Nominal” state.)
b. The user gets off the chair.

Case-3 The user locking the lift
Initial conditions:
- The HIGHEST LIFE is in the “Lower nominal” state.
- The user is on the floor, and he does not want the lift to move up (probably because the user does not want her/his child to play with the lift, or the user does not want the other to see what she/he is doing.)
- The lift is down, and unlocked

Note: the lift cannot be locked when the lift is up or while it is moving.
a. The user sits down on the chair.
b. The user presses the “lock” button on the controller once. (-> Entering the “Entering Lock Sequence” state.)
c. The user presses the combination of “move” and “stop” button sequence.
d. The user presses the “lock” button on the controller once. (-> The lift is locked, the “Locked” state.)

Case-4 The user unlocking the lift
Initial conditions:
- The HIGHEST LIFE is in the “Locked” state.
- The lift is down, and locked

a. The user sits down on the chair.
b. The user presses the “lock” button on the controller once. (-> Entering the “Entering Unlock Sequence” state.)
c. The user presses the combination of “move” and “stop” button sequence.
d. The user presses the “lock” button on the controller once.
e. The user waits for 5 seconds (-> The lift is unlocked, the “Lower Nominal” state)

Case-5 The user registers the sequence for the lift lock
Initial conditions:
- The HIGHEST LIFE is in the “Lower nominal” state.
- The lift is down

a. The user sits down on the chair.

b. The user presses the “lock” button on the controller twice. (->the “Registering Lock Sequence” state)
c. The user presses the combination of “move” and “stop” button sequence with maximum of 16 presses.
d. The user presses the “lock” button on the controller once. (-> The lift-lock sequence has been changed, “Lower Nominal” state.)

Case-6 The user cancels the lift lock entering
Initial conditions:
- The HIGHEST LIFE is in the “Entering Lock Sequence” state.
- (Case-3 c. in progress)
a. The user presses the “lock” button on the controller with the wrong lock sequence (-> The lift goes back to the “Lower Nominal” state, where it can accept the up and down command)

Case-7 The user cancels the lift unlock entering
Initial conditions:
- The HIGHEST LIFE is in the “Entering Unlock Sequence” state.
- (Case-4 c. in progress)
b. The user presses the “lock” button on the controller with the wrong lock sequence (-> The lift goes back to the “Lock” state)

Case-8 The user cancels registration of the lift lock sequence
Initial conditions:
- The HIGHEST LIFE is in the “Registering Lock Sequence” state.
- (Case-5 c. in progress)
a. The user presses the “lock” button on the controller twice; the first press and second one has to be within 5 seconds. (-> The lift goes back to the “Lower Normal” state, where it can accept the up and down command)

Case-9 Stop
Initial conditions:
- The HIGHEST LIFE is in the “Moving” state.
- (The lift is moving up/down. Case-1 b or Case-2 a.)
a. The user presses the “stop” button probably because there is an obstacle. (-> The lift stops, the “Stop Middle” state)

b. The user presses the “move” button to resume the movement. (-> Entering the “Moving” state)

Case-10 An emergency

- Initial conditions: (The electricity power of the motor is down probably because of black-out, and the user needs to go down while she/he is up.)

c. The user manually slides the emergency knob located underneath the chair. (-> The emergency-ladder comes down.)
d. The user goes to floor by the ladder.

Other functions #1 - Footrest

HIGHEST LIFE has a footrest. While pulling the mechanical lever located at lower back down, footrest pulls and lifts.

Other functions #2 - Storage

HIGEST LIFE has lock on. While pressing pulling mechanical lever at the bottom of the seat down, HIGHEST LIFE is folded.

3.6. Life-Cycle Plan

3.6.1. Verification Test

Since the product has a moving part and moves at a relatively high position, the safety issue is critical. After the new development, the product is tested for verification.
a. Load test. The lift chair carries a 200kg man (dummy weight), and stays at the upper position rest for 24 hours.
b. Repeat test. The chair moves up and down for 100 times with a 180-kg weight on the chair.
c. Obstacle test. When the foot is about to be pinched by the lower desk, the lift detects it and stops. When the lift goes up/down and an obstacle exists on its way, the lift detects it and stops. It is tested three times each.

3.6.2. Service

For installation, it takes 3 hours for construction. We estimate personnel costs 5000 yen per hour, so it will cost ¥15,000 for the worker. When parts, such as footrest, are lost, or, when the chair is worn out, the replacement may be purchased. The repair cost the price of parts and labor costs.

3.6.3. Recycling

Removal of the system is done for free of charge. HIGHEST LIFE will be reused the removed parts into other products.

3.7. Service Process

HIGHEST LIFE is done by mail order and telephone sales only. TOSHIBA has created a dedicated website and brochures.20 percent of call centers to learn support of HIGHEST LIFE. Since HIGHEST LIFE operation is not as complex as others home electronics, the customer service operators can be shared among other TOSHIBA's product.

3.8. Implementation Plan

3.8.1. Service Delivery

HIGHEST LIFE is implemented in a minimum of two days. Testing prior to implementation is one day. Construction is one day.

3.8.2. Partnerships

The partners are advertising company, apartment building designer, remodeling contractor, apartment developer.

3.8.3. Part Fabrication and Assembly

TOSHIBA produces the chair and lift. As a prototype, TOSHIBA integrates the system together. After TOSHIBA sells this technology to interior / house construction companies, they take a role as an assembler, since their designers will determine how it looks.

3.8.4. Training

Workers through training of 40 hours set for HIGHEST LIFE in TOSHIBA. TOSHIBA can use their prototype as a training facility.

4. Business / Competitive Analysis

This section describes how HIGHEST LIFE can be financed from development to operation.

4.1. Overview of business model and value proposition

Business model is made of 3 elements. At first, 'Customer' is all people who needs relaxation. Secondly, 'Values' is The Relaxation at home in the dead space. Finally, 'Managerial resources' are excellent Partner as a manufacturer & provider (TOSHIBA).

4.2. Revenue sources, Cost structure

Our revenue sources is sales of HIGHEST LIFE packages. Cost structure is of product design, material and labor, including shipping and assembly.

4.3. Assumptions of forecast (for demand, cost, etc.)

a. Early phase(1-3years)

Demand is between 100 and 800.

Cost/unit is about between $8268 and $5,287.

Pretax Income is about between ▲$271,752 and $210,585.

b. Middle phase(3-6years)

Demand is between 10,000 and 50,000.

Cost/unit is about between $5,180 and $5,074.

Pretax Income is about between $3,703,686 and $23,794,779.

c. Late phase (6-10years)

Demand is between 250,000 and 350,000.

Cost/unit is about between $4,963 and $4,955.

Pretax Income is about between $146,813,946 and $208,207,746.

4.4. Net Present Value Calculation

NPV is $1,401,754,409.

A precondition is the growth rate of volume after 2018 is assumed to be 5%, WACC is 10％, and TAX is 40%.

4.5. Development Time/Risk

Development Time is about a year because safety issues should be considered enough. Safety is a risk of the entire process – once it fails and someone injured, the reputation of the product goes down, and may not be able to recover.

Another risk is that cost target cannot be achieved. The system does not require special technology, so competitor may imitate the concept of HIGHEST LIFE. As a result, the actual cost may go much lower than the estimate. Because of that, TOSHIBA should protect the product by patent carefully. (See the next section.)

4.6. Protections strategy against competition (Intellectual property, branding, exclusive partnerships, etc.)

We apply for a patent and Intellectual property. The differentiates of similar services is clarified by branding.

We establish a company in addition to Manufacturer & provider (TOSHIBA), as a joint management apartment developer (SHIMIZU CORPORATION), advertising company, furniture manufacturer, and remodeling contractor.

5. ALPS Roadmap and Reflections #1 (Pre-HIGHEST LIFE)

Although this paper focuses on the final product, HIGHEST LIFE, it has a long way to reach the final concept given the challenging problem described in the sections in Problem Statement. Therefore, we split the chapter for the roadmap in two: pre-HIGHEST LIFE (this chapter) and HIGHGEST LIFE (the next).

Given the problem statement, we came up with four different system concepts. The roadmap before the fourth idea (that is HIGHEST LIFE) is shown in the next page. Let us list them and discuss how ideas are evolved and critiqued

5.1. “FIVE SENSES”

<Period>

ALPS #1 - #2

<Summary of the system>

To realize more realistic physical interaction, FIVE SENSES provides five senses in front of the computer instead of / other than a 2D imaging screen and not-so great speaker, using technologies that realize physical input and feedback, such as a 3D display, smell dispenser, haptic device, ultrasonic wave.

<Input>

Described in Project Requirement.

<Output - How we came up with the new idea>

We used a scenario graph to generate situations to use physical feedbacks in our lives. After we generate over 50 scenarios, we roughly scored to pick up 5 finalists. Then we employed the Pugh selection to choose our idea. After that, we confirmed the idea was cool by conducting interviews.

5.2. “Sharing a space, sharing hearts, and THIS IS IT” (Short name: “THIS IS IT”)

<Period>

ALPS#2 - #3

<Summary of the system>

To share “Ba,” properly during business conferences, THIS IS IT provides an advanced tele-conference space, where subtle things can be done, such as pointing “this” and communicate, or sharing whiteboard or document files.

<Input - Problems with the previous idea>

-We could not imagine what the system/devise look like.

-What makes our system different from other methods (cell phone, Skipe, or other similar products.)

-We all knew the complete FIVE SENSES system would be great, but we were not sure what we wanted to do with the system. (bottom-up ideas only, no top-down requirement)

- We could not find the FIVE SENSES system pays off. Technologies were too immature, and it may not be possible to achieve something demanded. (E.g., The tele-handshake system with a cold, metallic haptics device seems to be useless.)

<Output - How we came up with the new idea >

- We carefully identified what to achieve with the FIVE SENSES system: “the concept of Ba (場),” ‘A shared spaces for emerging relationships’ – space that can be physical, virtual, mental, or any combination.(Nonaka,I et al.,1998)

- We specified a scenario to remote business meeting

- Creating Roadmap, Project Charter and Milestone Chart, we recognized total image of our project.

5.3. “ARMS IN LIFE”

<Period>

ALPS#3 - #4

<Summary of the system>

To help busy people save time, ARMS IN LIFE provides the user a hand to clean rooms using a big robot arm installed in the middle of the room. The arm can reach the entire room. The arm can pick up mess (such as dishes and toys), use clothing, and use a vacuum by changing the tip of the arm.

<Input - Problems with the previous idea>

- We had paid attention to technology aspects too much and yet we were not sure how we overcome some technology challenges. We could not come up with an idea that is better than the existing tele-conference system.

- The concept was therefore too technology-orientated.

- The concept may make good money, but market is limited. This may be because it does not solve a social problem.

<Output - How we came up the new idea>

Getting back to the early stage, we started from brainstorming about urgent social issues of Japan/worldwide. We listed several issues, such as low birthrate, women's social advancement and hiring slump, and picked up a baby/child care support system to tackle with low birthrate and women's social advancement problem.

Then, we made interviews to survey what kind of supports people who have babies/children need most. One interviewer (working mother) said, "We don't need a robot to take care of my kids. Rather, the system should help me out to get my extra time for everything!" It means she expected some laborsaving system regarding housekeeping rather than baby/child care system. We decided to focus on a "housekeeping laborsaving system".

After that, we developed our new system, as well as our previous system, through the Pugh Selection, use case analysis, QFD and cost-worth analysis, prototype testing to name a few.

The roadmap showed us the iteration of the process of idea expansion, convergence and refinement for our new system using tools such as Mind Map, scenario graph, interview, Pugh Selection, QFD and cost-worth analysis. Since it was second round, it took shorter time than the first round.

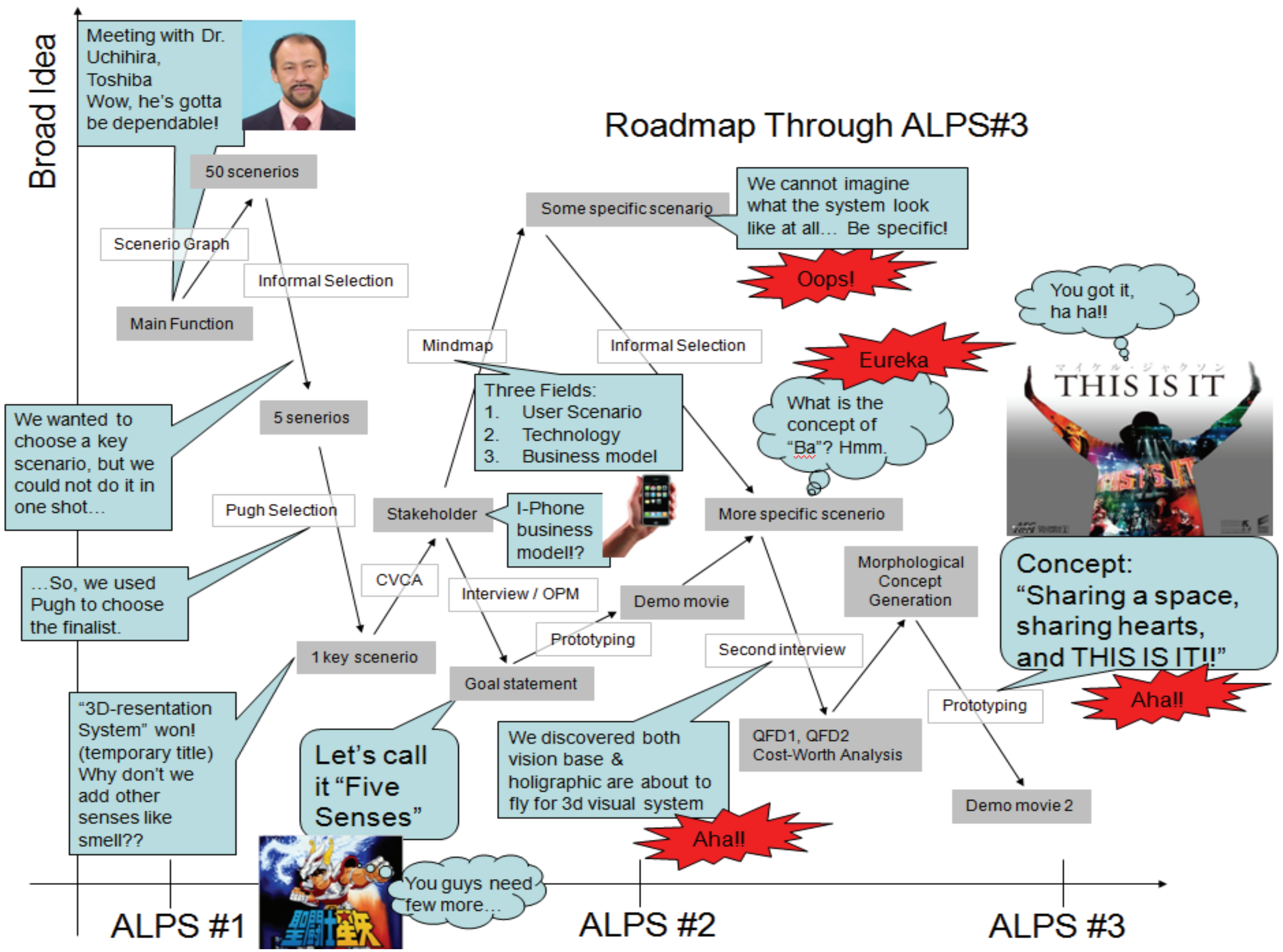


Figure 9 Roadmap ALPS #1 - 3

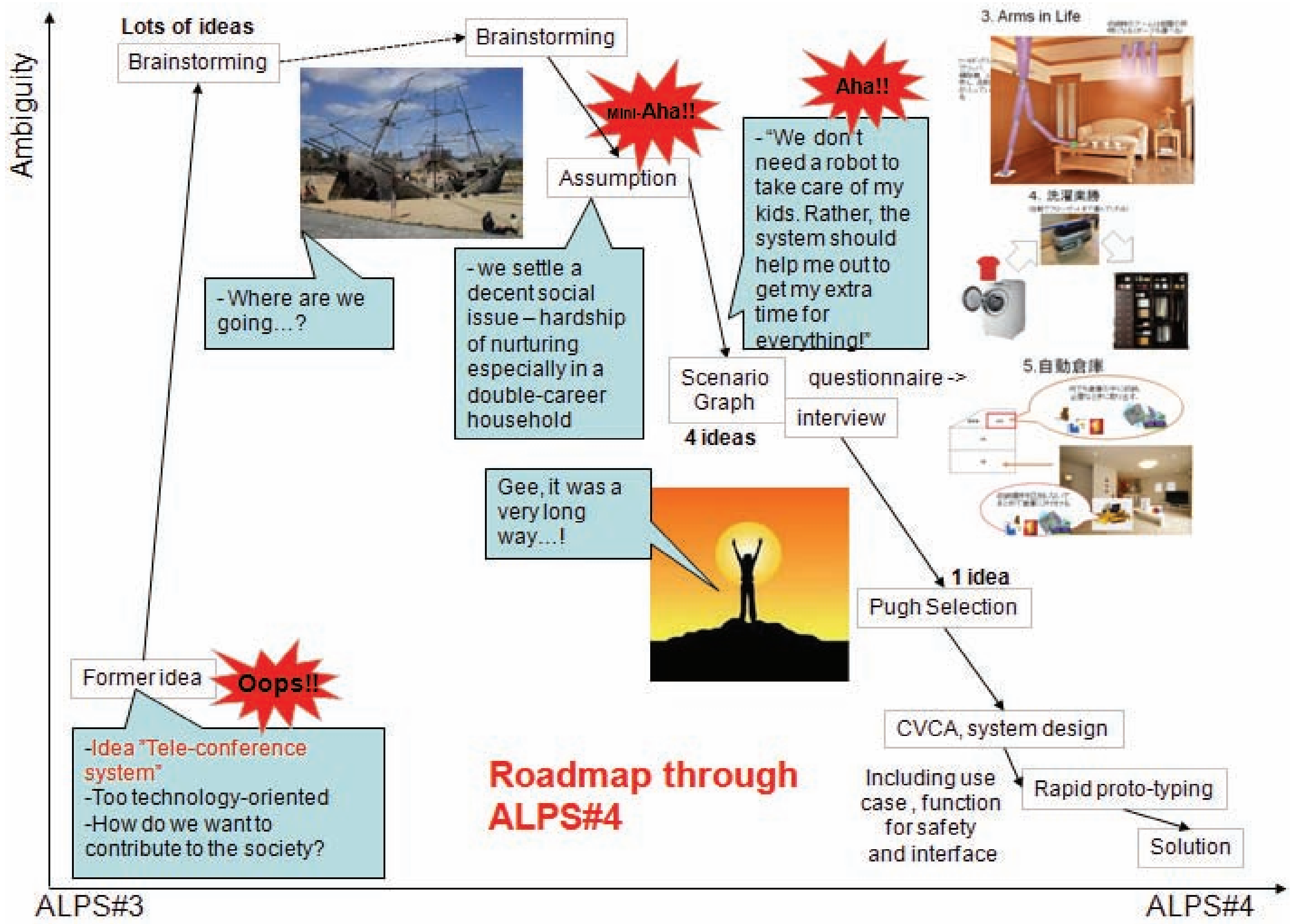


Figure 10 **Roadmap ALPS #3 - 4**

Figure10. Roadmap ALPS #3～#4

6. ALPS Roadmap and Reflections #2 (HIGHEST LIFE)

In ALPS#4 we introduced ARMS IN LIFE, a remote house cleaning system using robot-arm. However, we found two issues difficult to address. Firstly, the system was costly. Secondly, the system was not much popular among women who were key potential users. We finally decided to step back to the sponsor's requirement development.

6-1. Roadmap description

More details are described as follows: what methods we used, why we used , what is input/output for it, when we got Aha/Oops/Eureka.

- Interview: get feedback about ARMS IN LIFE,
  - Output – negative feedback
  - Oops!!
- Brainstorming and KJ-method: diverge and converge ideas of "physical feedback city"
  - Output & Input - Narrowed down ideas
- Scenario Graph, Pugh selection: select a key scenario
  - Output & Input -A key scenario
  - Eureka!!
- CVCA : outline the system boundary
  - Output - System boundary
  - Input - key scenario
- Morph analysis with component as key: illustrate components of the system
  - Output & Input - Components of the system
  - Aha!!
- User Case analysis: figure out more detail of the system
  - Output & Input - more detail of the system
- Interview: to potential users: get feedback
  - Output & Input - main concerns about safety and cost
  - Input – concerns about safety
- FMEA: analyze failures
  - Output & input – recommended actions as countermeasure
- Prototyping rapidly: check user's feeling and estimate size of system
  - Output & input – detail information of the system
- Prototype: show the functionality of the system

- ✧ Output – 1/8 scaled model
- ✧ Input – detail information of the system

- ➢ CVCA : make clear stakeholders' function and positive/negative benefit
  - ✧ Output & Input - Business Plan outline
  - ✧ Aha!!
- ➢ Competitive analysis: refine business plan
  - ✧ Output - Business Plan outline
- ➢ NPV: analyze financial feasibility
  - ✧ Output – financial analysis result

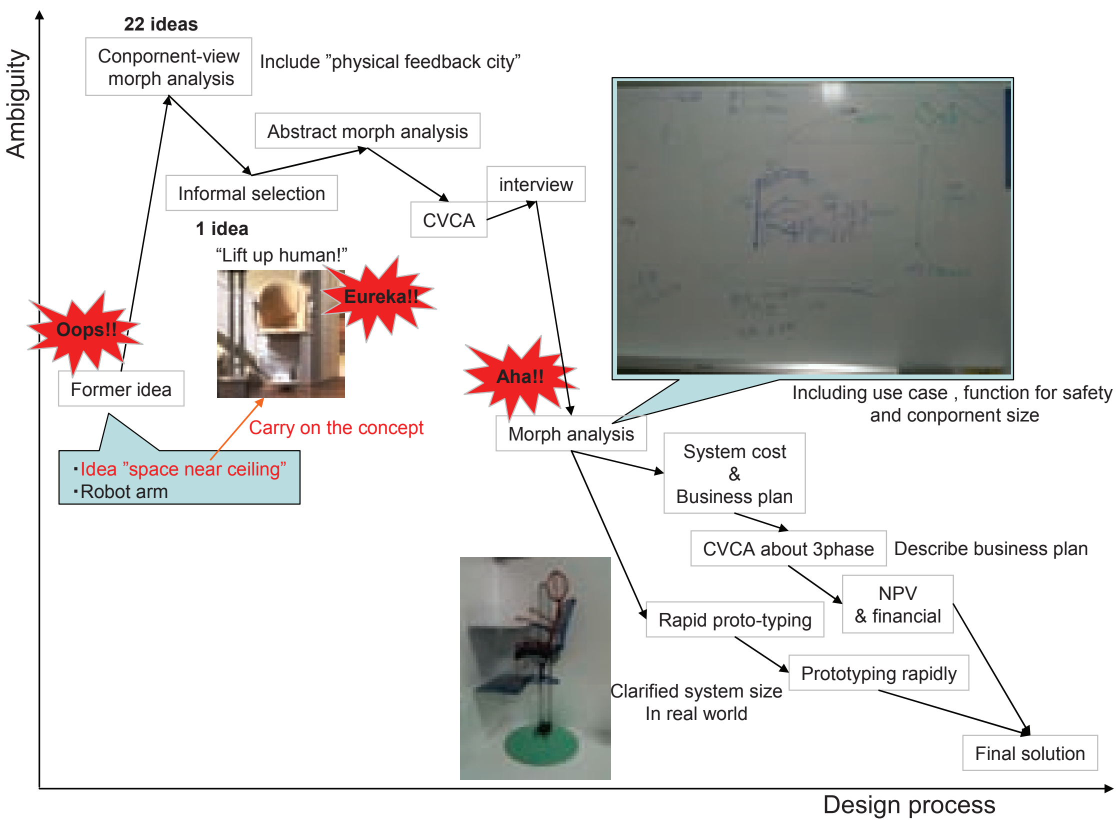


Figure 11 **Roadmap ALPS #4 - 5**

6-2. Expected roadmap

As for an overall trend of roadmap, we would like to draw a downward trend according to time axis, iterating up and down in the process of system refinement. In reality, we stepped back to the beginning of design process twice. That is, three peak points of ambiguous appeared

In addition, we would like to utilize more analysis methods at each cycle of the system refinement. Actually, we spent more time on idea creation and selection than analysis of our system.

6-3. Other feedback/comments for teaching staff

- Various methods were introduced during ALPS sessions. We wish we already understood the methods before dealing with the project given by sponsors, so that we could make a proposal of higher-quality, which would be also beneficial to sponsors.

We wish we could stay focus on ALPS. Because target students (SDM M1/M1.5) generally took many courses besides ALPS, the students could not focus on ALPS so much. That could lead to the students' feedback saying "too many assignments".

7. Analysis and Discussion of ALPS Methods #1 (Pre-HIGHEST LIFE)

As described previously, we have changed the products three times. We have investigated researches for tools when it is needed, while we have used the necessary tools for the final product, HIGHEST LIFE. Let us discuss about the research for the tools in Chapter 7, and the application for HIGHEST LIFE in Chapter 8.

7.1 Overview

The ALPS Methods is a framework of light-weight systems engineering which consist of various tools related with each other. The methods can enrich creativity, analyze problem and design solution easily and quickly. Our Solution is based on those methods therefore their artifacts and understanding to this method can present justifications of the solution.

The methods are composed of five major groups: creativity tools, analyzing tools, design and solving tools, evaluation tools and project management tools. Each tool is categorized to some groups by its usage. The creativity tools, our usage, are: Mind Map, Scenario Graph and Value graph. The analyzing tools are Scenario Graph, CVCA (Customer Value Chain Analysis), Interview & Observation, Scenario Prototyping Rapidly, Value graph, Function-Structure map, QFD I, QFD II and OPM(Object-Process Methodology). The design and solving tools are CVCA, Scenario Prototyping Rapidly, QFD(Quality Function Deployment) I, QFD II, Complexity/Cost-Worth Analysis, FMEA(Failure Mode and Effect Analysis), OPM, Design of Experiment, Quality Scorecarding, Environmental Complexity/Recyclability and Design for Variety. The evaluation tools are Complexity/ Cost-Worth Analysis, FMEA, NPV (Net Present Value), Quality Scorecarding, Environmental Complexity/Recyclability, Design for Variety, Serviceability. The project management tools are DSM (Design Structure Matrix).

We didn't use some tools because of unmatched situation, such as Project Priority Matrix and DoE(Design of Experiment). Detail of the reasons will be explained in its section.

As a process, we considered of what is necessary at first. Then we discussed interface of next tool. As occasion demands, the tools were combined and not separate. Sometime there is the necessity to go back and forth to refine the idea and solution.

This chapter intend to introduce ALPS Framework, thus, each tools which be explained to the below sections, are not always coincide with our final solution.

7.2. Mind Map

<Summary>

We used Mindmap when the idea must be organized. So the time may be any time. In addition, those situation is not fixed therefore interface should be dynamic. The following parts are sample interfaces when we considered first solution.

<Interface for other tools>

After we created our main scenario and CVCA analysis, we built a mindmap. The team wanted to share the idea of the system, whether we use existing technologies or not for the sensing system.

In our mindmap, we made 42 unprivileged branches in previous meeting. From this result, we obtained the insight of prospective users of the system, and our business plan. From the prospective users we found, we think we will have to investigate for new technologies. Also, from the business plan, we discussed about the similar existing devices. We concluded that the iPhone's business model, where Apple provides the device for applications developers and users, can be suitable for our system.

Next step, we need to try how to realize our system. We did not consider cost, schedule and technical feasibility. In addition, we should verify each branch. Finally, we should create more branches to specify the system, as mind map has an infinite of possibility.

<Thoughts/Insights>

Our team enjoyed using the mindmap tool. For example, when we used mindmap, we made important elements of our system freely. Also, we found that we finished the meeting quickly as we employed the mindmap method. On the other hand, we thought that it is difficult to articulate a critical point, as the mindmap tend to expand without orders.

7.3. Scenario Graph, Function-Structure map, Value graph

<Summary>

We constructed a scenario graph and selected one key scenario from the scenario graph. As variations from this, we created function-structure map and value graph. Using function structure map, we selected main function. Those tools were useful for clarification of our solution value.

<Interface for other tools>

For input, we used VOC which result of brainstorming, use case analysis and interviews. As a result, the key scenario is:

Where – at home
What – utilize dead space
Who – busy salaried worker
When – want to more space

(If you want to details, see chapter 3 or appendix.)

The result of those tools ware connected to QFD.

<Thoughts/Insights>

Since our theme is broad, we took three steps to pick up a single key scenario. Firstly, we constructed a scenario graph with the main function "Physical Feedback" to get rough idea for the theme. Secondly, we individually created 10 scenarios and it resulted in 50 scenarios. Some of the scenarios were chosen from the scenario graph and the others were created newly. Because it was difficult to select only one key scenario from the broad selections, we narrowed down them into 5 scenarios. Thirdly, we selected a main scenario by using Pugh selection. For the Pugh selection we used several criteria such as safety & security, novelty and contribution to society.

It was easy to diverge items for the scenario graph and it is not easy to select single key scenario from the various scenario graph. This time we used the Pugh selection to specify the key scenario. During the Pugh selection we noticed some criteria of the Pugh selection have higher priorities, and we took it into account. As a result, the key scenario above was selected.

The partner team said our scenario graph was broad. The partner team conceived of the "smart-traffic" as core competency and they listed items for where/what/who/when regarding the core competency.

7.4. CVCA (Customer value chain analysis)

<Summary>

We used CVCA as Stakeholder analysis and Business model analysis. In other words, visualizing as-is model and to-be model. This is example of analysis of stakeholders.

<Interface for other tools>

The main scenario was decided before this activity. Information about the main scenario is the input for creating a CVCA.

We created a CVCA. It includes stakeholders and flow of information, money, service, and product. The identified key-stakeholder was "Device R&D," which includes research universities and companies.

Also, the concept of "device" and "applications" was introduced. The "device" is the hardware and software platform that realizes the Five Senses "applications". For example, for a 3D-drama application, "application" is the 30-minute program, where actors and actress are acting something, while the "device" projects the drama. Also, for Hawaiian aroma application, "application" is recipe of smell, while the "device" arranges and dispenses the smell.

Also, we will have to analyze who are prospective users of the system. For the next iteration, we clarify this diagram around "Device R&D", "device" and "applications." We will return to this after we finish constructing a mindmap and OPM.

<Thoughts/Insights>

Our main scenario only shows a technical aspect of the system. On the other hand, our CVCA depicts a business model as well as technologies. As explained in "Results/Output", application developers will take an important role. However, we decided that the key stakeholder is the platform R&D because we need to pick up interesting, attractive technologies to achieve the Five Sense system. After all, we, the Devise Integrator, may be the most important to design an attractive platform like Apple did in iPhone.

Our system may be useful for people with disabilities in the sense they can experience traveling and many other activities without visiting, so that the Project theme (safe and security) is satisfied. However, they are only a part of users so they are not the major stakeholder. We hope it is good for the class activity.

7.5. Interview, Observation

<Summary>

To get feedback from customer, we did interview and observation again and again. Those cycles could help us to find problems and enhance quality of our solution. Pick up some cycles for example as follows.

<Interface for other tools>

-At First Cycle

Based on the scenario graph and CVCA we created, we selected three types of stakeholders, platform developers, contents developer and users. As developers we picked up several experts and professionals, such as Professors at Keio SDM and our advisory Uchihira-san. As for users we picked up several Keio SDM students and our friends.

We summarize interviews as follows.

1. Interviewee: Uchihira-san, Toshiba. CVCA Category: a Device Integrator. He points out each maker do R&D in 3D monitors. The device should cost no more than ¥40,000 if the business form is B2C. Quote: "it is already researched to apply 3D presernation on online shoppings. Instead, how about Twitter-approach"
2. Interviewee: Prof. Maeno, Keio Univ. (an expert of haptic sensor). CVCA Category: a Device R&D. He feels it would be interesting to achieve interactive haptic system in the Five Senses system. The device may cost ¥100mil for medical application. The most realistic haptic device is the phantom and ultrasound display in Maeno's lab. Haptics systems can be as realistic as current TV in twenty years.
3. Interviewee: Prof. Ogi, Keio Univ (an export of 3D visualization). CVCA Category: a Device R&D. He thinks vestibular sensation can be added to the 3D display. Binocular disparity and convergence near point are used for a 3D liquid crystal display. Also, there are some other research approaches going on.
4. Interviewee: Mr. Aoki, Yukai Engineering Inc. (a robotics venture company). CVCA Category: an Application Developer. He developed some iPhone applications because iPhone is cool and collected attentions. Also, iPhone platform with an accelerometer, which is used in his game application. In addition, He had a feeling that the platform for the system would be interesting especially if extended to home electronics.
5. Interviewee: SDM students and our friends. CVCA Category: User. He said he would buy the system if "it costs no more than existing devices like a mobile phone." Regarding usage (i.e. what kind of use do you imagine?), their replies are online shopping, simulated experience on travels, online chatting, games, monitoring of nuclear reactor.

Price of the product/service, and accordingly the development cost, depends on business, B2B or B2C. Research and development for five senses, (sight, smell, hearing, taste and haptic,) seems to be proceeded individually. So there could be a value to provide common platform.

How to use the “five-senses system”: We imagined applying the system on online shopping at first. However, it is already researched and we have to think of other scenarios.

We reflect those insights to our OPM diagrams and mindmap.

-At Second Cycle

So we analyzed VOX for refining our concept and validating our contents by “More Observation/Interview, VOX Insights”. As the input about these tools, we invested all of former results.

The objective and strategy is as follows:

- Bridge the gap between ideas and technologies by researching the new technologies.
- Find out other solutions to make sure that current solution is much better.

To act those objective, we interviewed young couple in long-distance and professors who familiar with five senses technologies. Also we were going to a manufacturing museum and researched technologies in the internet. After those activities, we analyzed our solution from several aspects such as customers and technologies.

About new technologies, we found innovative ones which realize our concept enough. Some laboratories showed interesting demonstration such as 4K-3D Display, K-CAVE, and haptic devices. Especially, it was productive finding to recognize feasibility of 3D holographic display, which achieves a realistic 3D screen without 3D-glasses.

As making other scenarios which categorized as five senses scenario only, we brainstormed again and created specific scenarios based on VOXs. Then we selected key scenarios using Pugh’s selection. We compared selected scenario with original scenario but new scenario could not reverse. Our scenario remained as “distance communication”; and it is for business meeting usage. The original scenario was enhanced.

We make sure that VOCs was verified. Those results will be used in the next processes such as QFD, Use Case Analysis. Concurrently, CVCA and OPM will be refined.

<Thoughts/Insights>

It was not our intent to begin a role-playing or real-playing as distance communication, but we could realize what is important in distance meeting actually. Sometimes communication was stopped by intermittent disconnection. Special or specific function is interesting but that is not necessarily needs for communication. We closely felt Kano model and Maslow's hierarchy of needs. It may be useful to become a mummy through finding mummy.

7.6. Scenario Prototyping Rapidly

<Summary>

Scenario Prototyping rapidly is quick demonstration of the concept. This tool can confirm feasibility as feeling. What is important is that what assumption to confirm is. The way of demonstration can take various forms such as video, paper model, skit, etc.… Follows are example of assumption and result at our first solution.

<Interface for other tools>

We could share two ideas with others:

A. The concepts of "Ba (場)"

B. Technological solutions

After we created the first "prototyping rapidly" video in the previous ALPS session, we redesigned use cases and customer requirements carefully. This is because our system was ambiguous so we could not even produce QFDs. During use case development, we discussed what of the five-sense system differentiate existing communication systems such as Skype and mobile phones. From our discussions, we got the idea that "sharing spaces for emerging relationships" could be a key differentiator. Our second prototyping rapidly" presentation shows the concept.

Also, we have better understanding in technologies that were unclear back then as well. We know we could use technologies such as 3D display, holography, dynamic microphone, condenser microphone and so on. In our second prototyping rapidly presentation, we hope to show these technologies are already feasible.

We used creating a video clip. Because it would be easy to share the messages correctly.

As described above, we generated the concept of "Ba." In the movie clip we eliminated showing complete hardware because it does not exist yet!

We believe that our new concepts were shared.

As we will receive critiques and feedbacks, we will continue our development.

<Thoughts/Insights>

In our first Prototyping Rapidly presentation, we simply showed what the Five Senses system will do. This time, we show the concept of "Ba". That was difficult.

It is also useful to share the idea within the group, as it is such a subtle concept.

7.7. QFD I, QFD II, Complexity /Cost Worth Analysis

<Summary>

Generally, QFD is a tool for quality management, deployed from customer requirement to product. In this deploying process, complexity is reduced. We used this tool to design the detail as specific. When the specification was determined, we calculated those costs and evaluated the value of solution.

<Interface for other tools>

As a result of more interviews, our latest model case, a remote business meeting system, was used for our analysis. The input of QFD I is the result of costumer requirement analysis for the application. QFD I, QFD II, Cost-Worth Analysis are done sequentially.

QFD I, QFD II, and Cost-Worth Analysis output engineering metrics, solution elements, development priority, respectively.

When we know those analyses are accurate, we would be ready to write a proposal for developments. First, we probably want to increase cost accuracy in our cost-worth analysis. Since many solution elements are not mass-produced yet, it would take more searches.

<Thoughts/Insights>

We failed analyzing QFD several times in finding engineering characteristics in QFD Phase1 and part characteristics in QFD Phase 2. Back then, we knew our system would enhance five senses during remote communication. However, we could not imagine what the system look like. We concluded that our CRs were too ambiguous. After that happened, we specified the application to business meetings. Then, we could go through the first iteration of the analyses.

The original client's (Toshiba) requirement is to produce interesting business to beat Google. Since it is such a big request, we need to produce more complete a Five Senses system, where the system is a development platform and could add more features like iPhone does. We really want to come back to the complete system after finishing the first iteration of the system analysis that is in the business meeting situation.

7.8. OPM (Object-Process Methodology)

<Summary>

We used OPM as design tool to visualize system boundary and functions of system. Follows are example of result at our first solution.

<Interface for other tools>

First of all, given stakeholders and the other objects found in CVCA and scenario-graph, we used OPM for defining our system's boundary and analyzing it. We discussed those relationships including the functions and the processes for mapping to the OPM.

The next step, we focused on analyzing which "Process" is more important for the stakeholders. That is, what values will be provided by this system.

We created the OPM with two aspects as outputs. The first one is a business-model of the system. The other part is how the user interacts with our Five Senses system.

We must continue to discuss about definitions of each object, and their relationships. The OPM diagram must completely show the business model we are imagining.

At the same time, we will flow down the system level (OPM Level-1,…) as soon as it is necessary.

<Thoughts/Insights>

It was difficult to express business model in our OPM because we felt the other aspect (how the users interact with our system) has higher priority for the tool, OPM. However, we could focus on developmental regime, which is strongly related to our business model, just like iPhone has the same situation.

7.9. Prototype

<Summary>

Prototype is tool to evaluate assumption such as usability and functionality same as prototyping rapidly. What is important is that how to work actually. Follows are example of assumption and result at our second solution.

<Interface for other tools>

We modified our main function to "housekeeping laborsaving system". Now our system supports people to clean their house from distance using robot arms that is set in their house.

Test points we are planning are as follows.

- User Interface of the system is simple and easy to use
- The system is possible to access from distance
- The system helps people cleaning rooms in accordance with their order

Dates, list of names for testing, Use Norman's principles for interface.

Since we did not test yet, no dates are written.

- User Interface test: It is supposed to show if the input device (operation panel, voice recognition) is easy to use and intuitive enough.
- Remote access test: It is supposed to ensure the system is possible to access through the internet.
- Appearance test: It is supposed to clarify what appearance/look and size are appropriate.
- Safety test: It is supposed to verify the system works safely in rooms and clarify

any potential dangers.

<Thoughts/Insights>

Through the interviews/VoCs we have made, appearance of the system seems to be one of important factor for consumers. We need to take it account into system.

In addition, it is important to confirm what functionalities are necessary for room cleaning through remote operation.

7.10. FMEA(Failure Mode and Effect Analysis)

<Summary>

We used FMEA as design tools mainly to get safety. Follows are example of our second solution. We made two types of FMEA, a VOC-based FMEA and a Function based FMEA.

<Interface for other tools>

In the VOC-based FMEA we used Scenario Graph, Use Case and Brainstorming for input. In the Function based FMEA we used Use Case, OPM and Brainstorming for input.

In the VOC-based FMEA, we found some unconventional failure modes, such as few operation patterns and bad aesthetic design. The example of our FMEA is as follows.

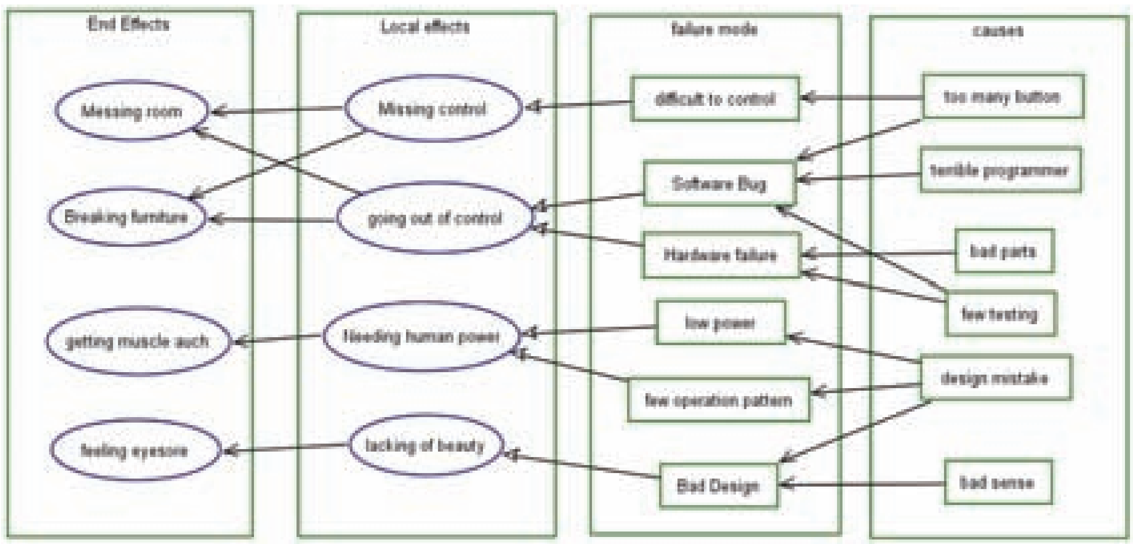


Figure 12 FMEA example

Regarding the Function based FMEA we found some specific failure modes.

We will check those failures and test them with our prototype as far as possible. When we find the failures, we will fix it and ensure robustness to design our system.

<Thoughts/Insights>

In retrospect, we once made another type of FMEA, which is project type, as a result.

7.11. NPV, Environmental Complexity/Recyclability, Serviceability

This section will be explained in chapter 8, see next chapter.

7.12. Quality Scorecarding, DfV(Design for Variety)

<Summary>

Quality Scorecarding is tool for analyzing of system elements to improve robustness. Based on control factor in this tool, we made DfV as architectural variation. Follows are example of our second solution.

<Interface for other tools>

For input to this tool, we used QFD and OPM. QFD has some objectives as VOC related with those measures. OPM describes the relationships between variations like transfer functions. Variations in our system are shown in the table below:

Variations type	Variations(*selected)
Project Objective(Biggest Y)	minimize burden of housework(Y)
Objective Measures(Y's and y's)	operation time(y1), learning time(y2)
Control Factor (Vital X)	size of arm(X1), number of buttons(X2)
Noise Factors(V's)	volume of housework(V1), size of room(V2), intelligence of user(V3)
Transfer Functions	learning time(y2) = X2 * V3 * coefficient

Table 2 Scorecarding

We will address the control factor to eliminate effect of noise factor.

Dimensions of button are shown in the table below:

number of buttons	Architectural Variation
0	Voice recognition, Motion recognition(gesture)
1	Circle button, jog dial
5	Arrow type buttons, joy stick
10	Multi functions

Table 3 dimension of button

We want to make our system easy to use. For the purpose, functionality of voice recognition or motion recognition is desirable.

We will verify the variation of our system that is shown by this tool in the prototyping.

<Thoughts/Insights>

We need more analyses in the sub system level.

7.13. Design Structure Matrix

<Summary>

DSM is tool for analyzing to concurrency. We used this tool as Project Management tools.

<Interface for other tools>

Context/Input:

Right after ALPS#3 sessions, we decided to review and reconsider our project from the early stage (i.e. main function and scenario graph of our system). Therefore, we created a DSM for recovery of our project.

Input for DSM is a series of tasks to reconsider of our product/system.

Results/Output: Here is a task-based DSM we created.

		1	2	3	4	5	6	7	8	9
1	Assess the concept used before ALPS #2	1								
2	Create mindmap about "sharing Ba"	x	2							
3	Brainstorming about urgent social issue of Japan/World			3						
4	Connecting mindmap sharing Ba and urgent social issue		x	x	4					x
5	Think about good usage of "sharing ba" concept (direct method)	x				5				x
6	Organizing scenario candidates				x	x	6			
7	Pugh selection						x	7		
8	Determine a new goal statement							x	8	
9	Assess the new concept and scenario								x	9

Table 4 DSM example

Step1&2 vs. step3 can be in parallel, while step1-3 vs. step4-9 must be in sequential.

Next Steps: Based on the DSM, we work on revising our system or proposing a new product/system.

<Thoughts/Insights>

Since we did not much time to rework our project, we needed to make sure what activities influence next activities and what activities can be done in parallel. The DSM was helpful for it.

In addition, the DSM could be replaced with CPM regarding the input we used.

7.14. Project Priority Matrix, Design of Experiment

We didn't use these tools. In case of PPM(Project Priority Matrix), we didn't need this tool. At beginning of project requirement was very ambiguous otherwise very clear.

Also, as case of DoE, We didn't need their result because of usage of COTS.

8. Application of ALPS Methods (HIGHEST LIFE)

In this chapter, ALPS tools described in the previous sections are applied to HIGHEST LIFE.

8.1. Component-view Morph Analysis

<Context/Input>

Input: Problem statement

<Results/Output>

Output: 22 ideas

<Thoughts/Insights>

No	component1	component2	component3	'=	solution
1	Baby	inspection equipment	car, house, baby car	'=	meet the changing needs of baby's physical condition
2	kids with special needs	Camera	GPS	'=	if kids go to dangerous area, system take a movie and parents can watch it
3	flooring sensor	house, caring home	Physical feedback	'=	if kids or old go to dangerous area, system take a movie and parents can watch it
4	healthcare	house	memory & Physical feedback	'=	>It takes record of steps. >It fixes user's walking pose. >It makes stair steep when the user is lack of exercise.
5	refrigerator	roof	movement	'=	Refrigerator that moves the ceilings
6	Sensor	Internet	Arm	'=	Autonomous cleaning arm
7	Sensor detects laughter	Glasses	Electric current generator	'=	It forces the user laugh
8	vehicle (car, ship, airplane)	Brain	helmet	'=	Helmet prevents motion sickness by electric current

9	Current position information	AR tag	Cell phone	'=	It displays the directional arrows when cell phone reads the AR tags in environment
10	Small arm	desk	book	'=	The arm holds and flips the book's page.
11	desk	makeup	automatic	'=	It helps hair−drier and cosmetics
12	designer house	under floor	all change	'=	Remodel furniture automatically
13	description	by way of compensatio n	sensing feeling	'=	The sensor tells the user's feelings like Bowlingual.
14	elementary school	operation	cleaning	'=	Moves desks and chairs automatically in cleanup time in elementary school
15	safety & security	house	sensing	'=	When a person without permission comes to the building, the doors and windows shuts down automatically.
16	Sensor detects laughers	belt	Electric current generator	'=	It makes the user laugh
17	Wall paper	Dirt sensor (?)	motor	'=	When wall paper gets dirty, it changes the wallpaper automatically.
18	chair	lift	High position at a room	'=	The chair moves up and down, so the user can use a large room
19	Ceiling space	arm/lift/bed/f ridge	Autonomous sensor	'=	Expensive house
20	Ceiling space	Arm	lift	'=	Cleaning, (semi-autonomous)
21	Paper	Scan	arm	'=	Cleaning up
22	Toys	Suction arm	Arm	'=	Cleaning up

Table 5 Component-view Morph Analysis

8.2. Abstract Morph Analysis

<Context/Input>

Input: The idea "HIGHEST LIFE"

<Results/Output>

Output: Component of the system

<Thoughts/Insights>

Room	Loving loom	kitchen	toilet	bedroom	garden	Reading room
Position at the room	corner	center	Besides wall			
Lift shape	H-shaped	L-shaped	One-side held from one side	Holding from the bottom	hanging	Arm from the front
Actuation	Electrical motor	pedal	Hydraulic pressure	Counter-weight		
Shape of chair	Flat	sofa	bed	hammock		
Usage of desk/table (any of them are OK)	Reading	Working office	workshop	dining	Watching TV	Closet
	Fridge	sleeping	cosmetics	interior		
Building	New	old				

Table 6 Abstract Morph Analysis

8.3 Interview

<Cntext/Input>

Input: Component of the system

< Results/Output>

Output: User requirement (Potential customer worry about safety.)

<Thoughts/Insights>

Sex	male	male	male	male	female	male	male	Male
occupation	Salary man	student	student	student	House-wife	Salary man	researcher	Salary man
Age	50s	20s	20s	20s	50s	50s	40s	30s
Satisfied with current room size?	No	No	No	No	Yes	Yes	No	Yes
If you could get	child	study	music	work	bedroom	Not	For	Not

a new room, what kind?						needed	research	needed
Want two tables?	Yes	Yes	Yes	Yes	No	No	No	No
Want study room?	yes	yes	yes	yes	No	No	Yes	No
Want a private fridge?	no	Yes (small one)	yes	yes	no	no	no	No
How much do you pay for this system?	¥500k	¥600k	¥200k	¥300k	¥150k	¥100k	¥500k	¥300k
How do you feel when something on the ceilings?	No accepted for bedroom。	Ok if study room	OK	Feel crowded	Not okay	OK	Not okay	Not okay
How many hours on desk at home in a day?	5 hours in weekends	1-2 hours	3 hours	2-3 hours	1-2hours	0 – 1 hour	7 hours	1-2hours
Concern about this system?	Safety when earthquake	Drop of a cell phone	safety	safety	safety	Not really	failure	Safety

Table 7 Interview

8.4. Morph Analysis

<Context/Input>

Input: Component of the system and user requirement

<Results/Output>

Output: details of components

<Thoughts/Insights>

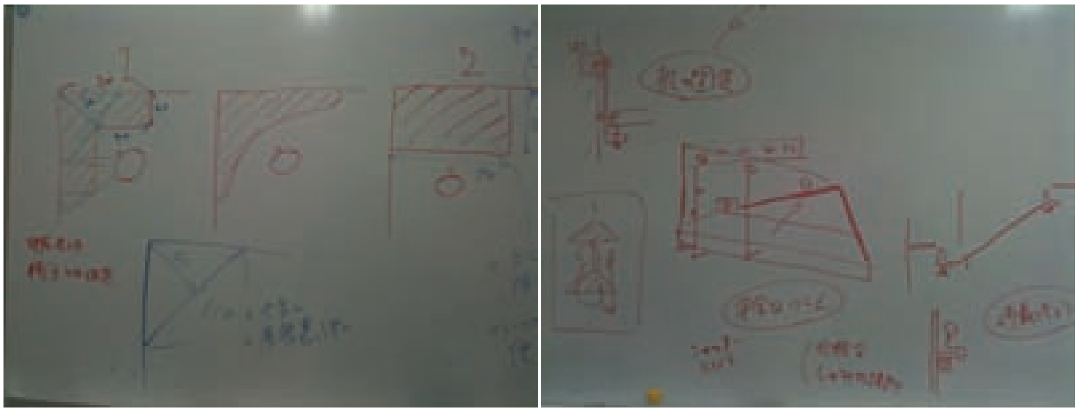


Figure 13 Morphing shape of desk

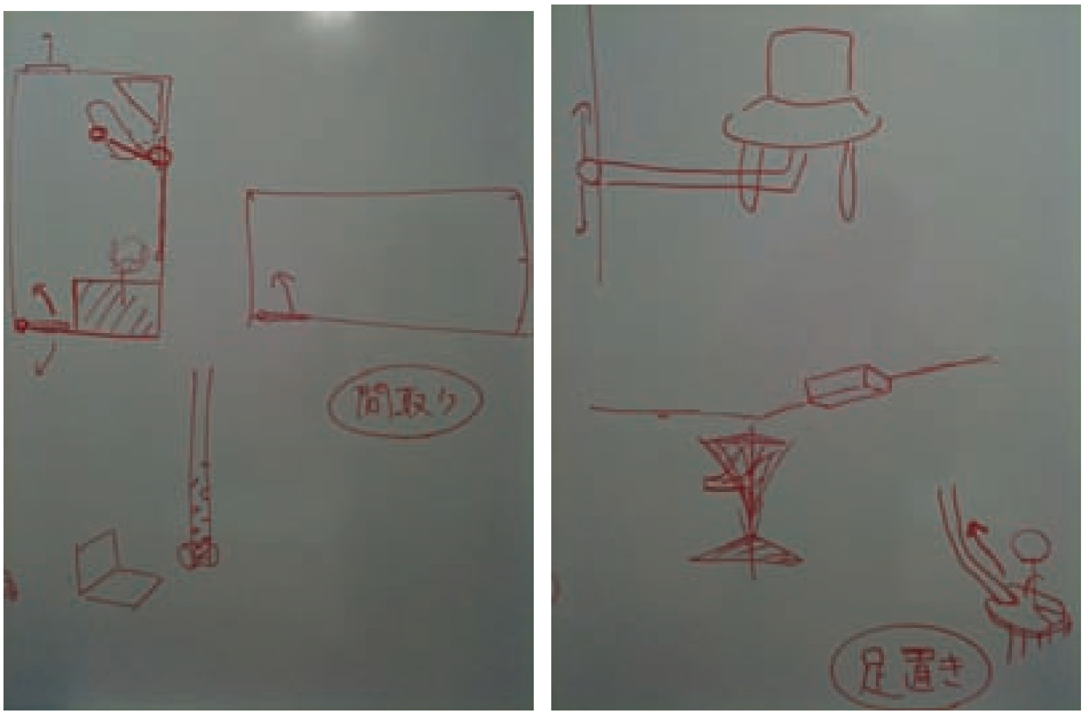


Figure 14 Morphing room and location of component

8.6. System cost & business plan (pre-NPV)

<Context/Input>

Input: Catalogs of components

<Results/Output>

Output: Business plan outline

<Thoughts/Insights>

System cost	Chair	21000	http://www.verysoho.com/verysoho/item/category/0000004_0000011_01.html
	Double-decker desk	10000	http://www.verysoho.com/verysoho/item/detail/0000026.html
	Lift – max of 2 meters	350000	http://www.eshop-plus.com/do-chan/product.aspx?id=242924
	Structural supporting parts	5000	
	Benefits	114000	
	System cost	500000	
Construction	Per one system	20000	
Advertisement	Per one system	20000	http://www.777money.com/torivia/torivia2.htm
Labor (person x month)	In average, 4.06mil/year ÷12(months / year)	338000	
salesperson (person x month)	1/10 of labor	33800	

Sales plan	Period	# of sales	Reasons
Initial	Yr 1-3	800	Designer's mansion 800 x20rooms=16000; 5%
Expansion	Yr 4-5	50,000	1% of 5million houses
Spread period	Ye 6-10	250,000	5% of5million houses
Employer plan	period	# of employers	
Initial	Yr 1-3	10	Around Tokyo
Expansion	Yr 4-5	30	Entire Japan
spread period	Yr 6-10	50	All over the World

Table 8 System cost & business plan (pre-NPV)

8.7. FMEA

<Context/Input>

Input: Requirement for safety

<Results/Output>

Output: Safety lock mechanism

<Thoughts/Insights>

Failure Modes & Effects Analysis

System Name: HIGHEST LIFE
Major Function:
Prepared By: HIGH-V

FMEA Number:
Page:
Date:

Function or Requirement	Potential Failure Modes	Potential Causes of Failure	Occurrence	Local Effects	End Effects on Product, User, Other Systems	Severity	Detection Method/ Current Controls	Detection	RPN	Actions Recommended to Reduce RPN
Obstacle detection	Pinching a person (child)	Failure of detecting person	3	N/A	User	6	Motor control tracking	2	36	Decreasing pinching parts
Falling down	Injury of person (child)	Careless of user	3	N/A	User	6	N/A	9	162	Design chair not to fall down
Motor stopping	lose of function	Aging	2	Motor	User	2	Periodical maintainance	4	16	Periodical maintainance

Table 9 FMEA

8.8. Rapid Prototyping

<Context/Input>

Input: System's component alternatives

<Results/Output>

Output: Shape of desk and location of the system

<Thoughts/Insights>

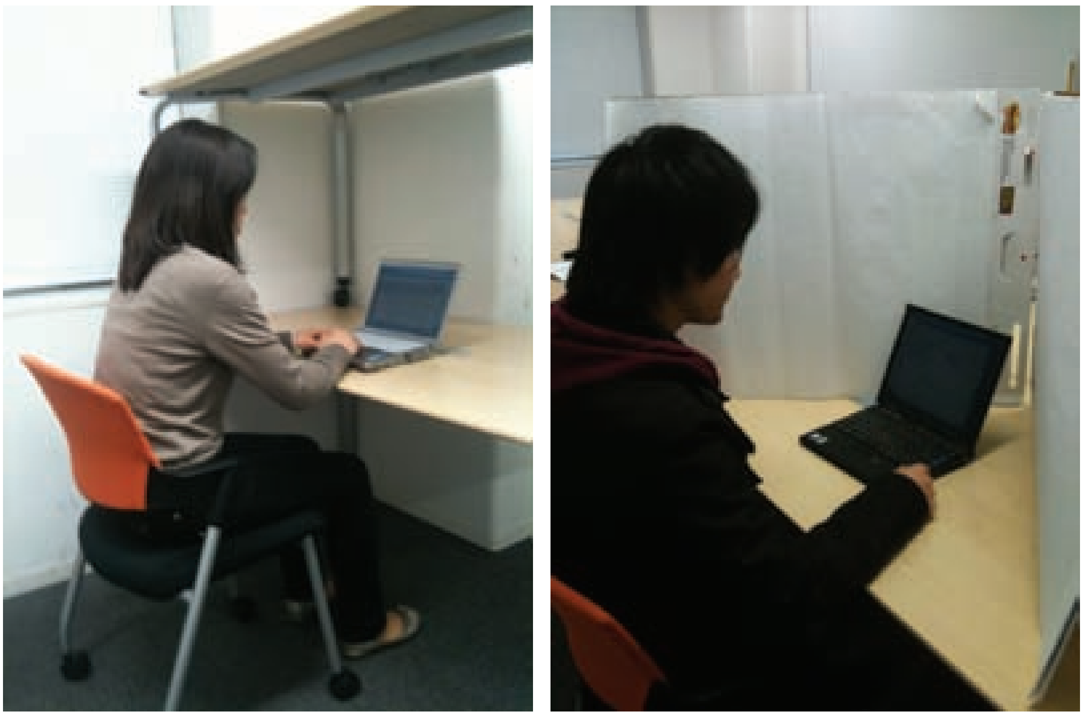


Figure 15 Desk scale check

8.9. Prototyping Rapidly

<Context/Input>

Input: Shape of desk and location of the system

<Results/Output>

Output: View of user on the floor

<Thoughts/Insights>

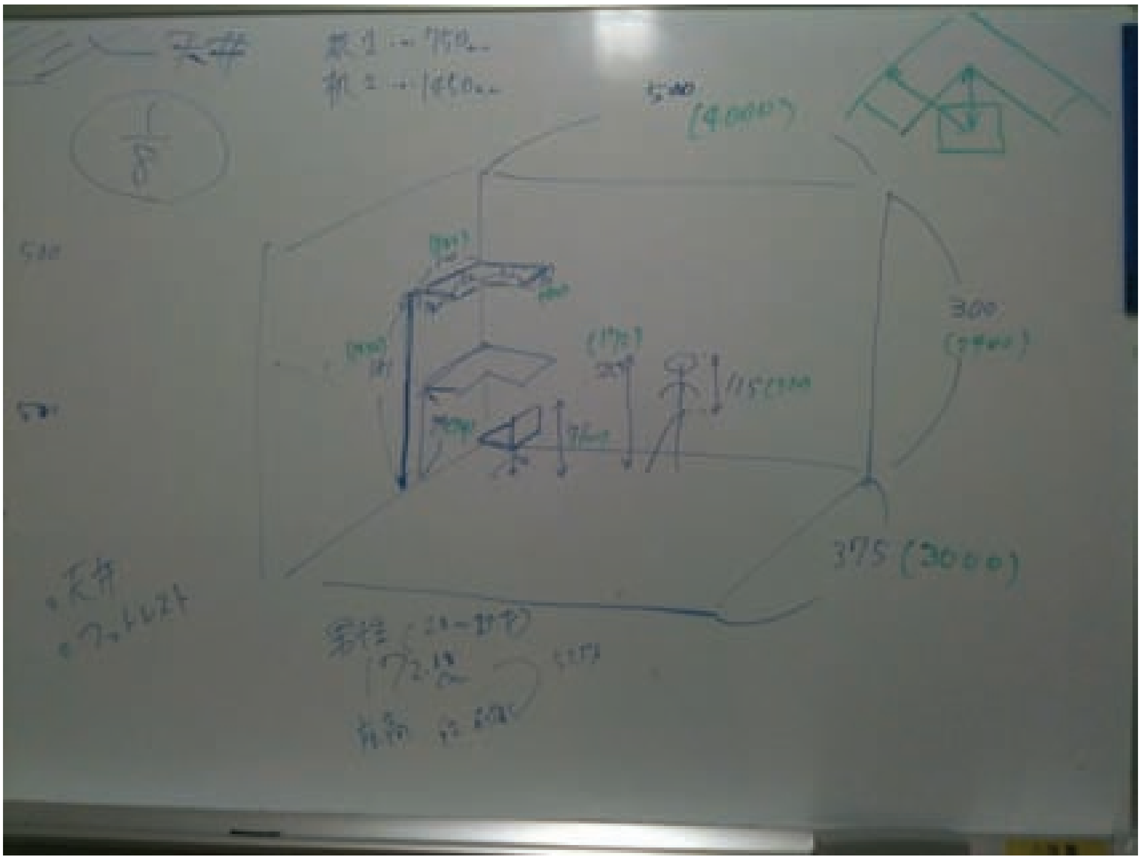


Figure 16 Spec. of the prototyping

Figure 17 Prototype

8.10. CVCA about 3 business phase

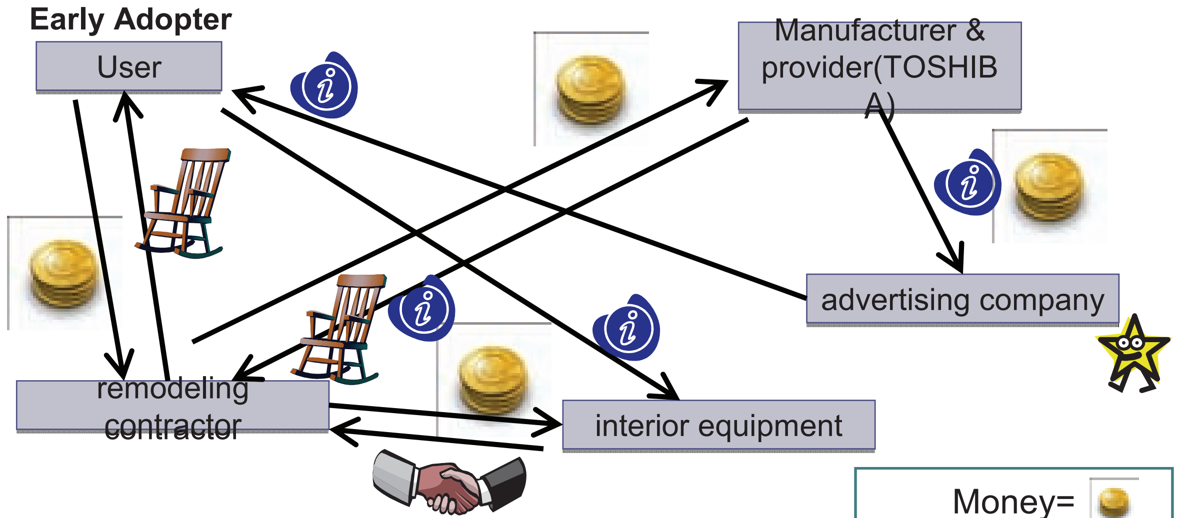
<Context/Input>

Input: CVCA and system cost business plan outline

<Results/Output>

Output: Object that visualize morphing stakeholders

<Thoughts/Insights>



Calendar Year	2010	2011
Expected Volumes	100	800
Pretax Income	$ ▲271,752	$ 210,585

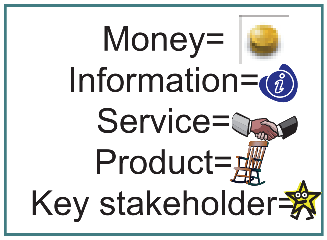
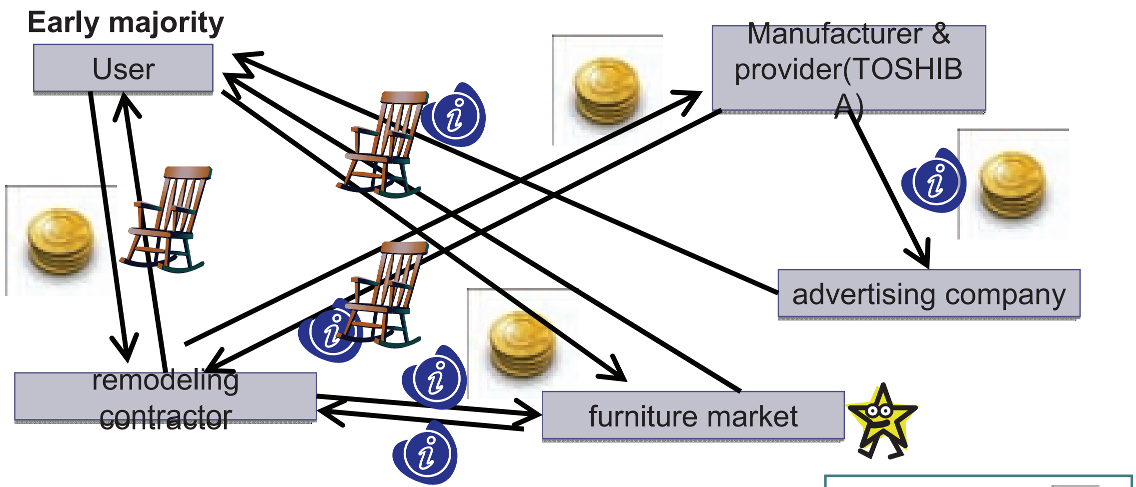


Figure 18 CVCA in early phase



Calendar Year	2012	2013	2014
Expected Volumes	10,000	30,000	50,000
Pretax Income	$3,703,686	$11,616,502	$23,794,779

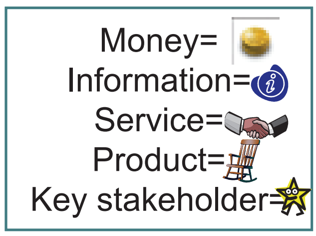
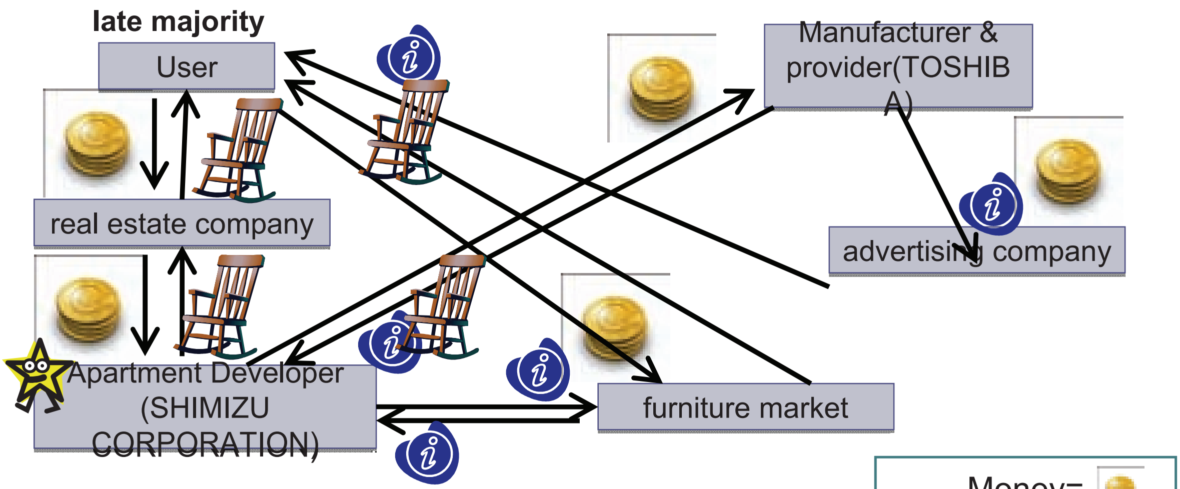


Figure 19 CVCA in middle phase



Calendar Year	2015	2016	2017
Expected Volumes	250,000	300,000	350,000
Pretax Income	$ 146,813,946	$ 177,520,846	$ 208,207,746

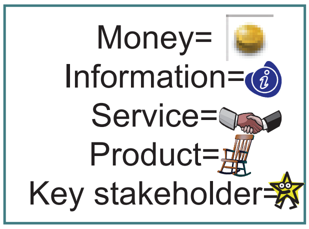


Figure 20 CVCA in late phase

8.11. NPV

<Context/Input>

Input: System cost and business plan outline

<Results/Output>

Output: Business plan

<Thoughts/Insights>

Note: For all input numbers, show a separate sheet describing how you determined these numbers.

Calendar Year	2010	2011	2012	2013	2014	2015	2016	TOTAL
Expected Volumes	800	800	10,000	30,000	50,000	80,000	250,000	421,600
Expected Savings per Unit (describe savings on separate page)	$ 5,550	$ 5,550	$ 5,550	$ 5,550	$ 5,550	$ 5,550	$ 5,550	
ADDITIONAL FIXED COSTS (describe costs on	0	1	2	3	4	5	6	TOTAL
- Product Design	$ 50,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 110,000
- Machines & Equipment	$ 10,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,000
- Mfg Start-up		$ -	$ -	$ -	$ -	$ -	$ -	$ -
- Tools/Molds (inj. molding, casting, etc.)			$ -	$ -	$ -	$ -	$ -	$ -
- Misc 1 (describe here)	$ 177,777	$ 177,777	$ 2,222,222	$ 6,666,666	$ 6,666,666	$ 6,666,666	$ 6,666,666	$ 29,244,440
- Misc 2 (describe here)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
- Misc 3 (describe here)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
PRODUCT'S Additional FIXED COSTS	$ 237,777	$ 187,777	$ 2,232,222	$ 6,676,666	$ 6,676,666	$ 6,676,666	$ 6,676,666	$ 29,364,440

ANALYSIS	2010	2011	2012	2013	2014	2015	2016
Savings (Savings/unit * Volume)	$ 4,440,000	$ 4,440,000	$ 55,500,000	$ 166,500,000	$ 277,500,000	$ 444,000,000	$ 1,387,500,000
Fixed Costs	$ 237,777	$ 187,777	$ 2,232,222	$ 6,676,666	$ 6,676,666	$ 6,676,666	$ 6,676,666
Pretax Savings (Loss)=Savings - Fixed	$ 4,202,223	$ 4,252,223	$ 53,267,778	$ 159,823,334	$ 270,823,334	$ 437,323,334	$ 1,380,823,334

NET PRESENT VALUE ANALYSIS (PROFITABILITY CALCULATION)

(assumes accurate Volume & Savings forecasts)

Rate of Return Required	Net Present Value
10%	$ 1,280,115,000
15%	$ 976,090,000
20%	$ 755,015,000

Current Setting	
VolumeError	0%
SavingsError	0%

SENSITIVITY ANALYSIS (update this section by clicking the "Run Sensitivity Analysis" button to the right)

(calculates NPV based on potential error in volume or savings forecasts)

	Best Case			Worst Case
VolumeError Settings:	0%	20%	0%	20%
SavingsError Settings:	0%	0%	10%	10%
RoR	NPV-Best	NPV-Vol	NPV-Sav	NPV-VolSav
10%	$ 1,280,115,000	$1,020,502,000	$1,150,309,000	$ 916,657,000
15%	$ 976,090,000	$ 778,002,000	$ 877,046,000	$ 698,767,000
20%	$ 755,015,000	$ 601,688,000	$ 678,352,000	$ 540,357,000

Potential Error in:	
Volume	20%
Savings	10%

Graph Settings	
VolumeError	20%
SavingsError	10%

Figure 21 NPV

9. Conclusions and Future Work

Our product’s conclusions are as follows,

１ : Physical　Viewpoint merit:
Additional space without physical extension

２ : Mental Viewpoint merit:
User can relax in own space

３ : Technical Viewpoint merit:
Use COTS. No new technology

４ : Social Viewpoint merit:
Adapt to Compact city

５ : Innovative Viewpoint merit:
Effective utilization of dead space

- What problems do you need to overcome in order to complete your project?

In order to complete our project, it is necessary to bring in sales to solve the deficit. For that, we appeal convenience of our product, and make it known by word of mouth.

- Plan of future work for the organization that will take over your project results.

We must make the prototype of 1/1 scales, and the test is done enough, because neither safety nor durability are considered enough. After testing there is no problem, we commercialized our product.

- Specify goals, dates and needed resource to complete future work.

After Commercializing it, we must raising to the business that turns out profit. We need the capital of about 100 million yen as a running cost for that. Moreover, we need one year of more to develop the product for full-scale sales.

- Make Contingency plan/guidance--how will the organization proceed if some of the problems are not resolved or if unexpected problems arise?

When we turned out safety and durability of our products, we should maintain the structure that can be immediately collected them. It falls into the crisis of the company continuing when the problems are not resolved.

10. Acknowledgments

We would like to give heartfelt thanks to Dr. Uchihira, TOSHIBA, who provided helpful comments and suggestions. When Dr. Uchihira showed up to our meeting and we heard his large voice, we knew we have to think hard and tight. Also, we would like to thank Prof. Maeno, SDM/KEIO University, and Dr. Hirabayashi, SHIMIZU CORPORATION, whose meticulous comments were an enormous help to us.

Finally, we would like to thank SDM and Keio University for a grant that made it possible to complete this study.

Appendix A. Reference

[1] “MYROOM II” Yamaha Corporation
http://www.yamaha.co.jp/product/avitecs/product/myroom2/index.html (access Nov 16, 2010)
[2] “Step Lift” CHUO ELEVATOR INDUSTRY CO;LTD
http://www.steplift.jp/about/index.html (access Nov 16, 2010)

Group 5's Final Presentation Slides

Team5: Final Presentation

1

HIGH-V:
Hayato Yamaguchi
Youichi Watanabe
Akira Oka
Akiko Ishikawa
Motoshi Matsunaga
"Yu" Hiroki Kato

Supporter: Dr. Naoshi Uchihira
Toshiba Mentor: Prof. Takashi Maeno

Fri.11, 19, 2010
Graduate School of System Design and Management, Keio University

Contents

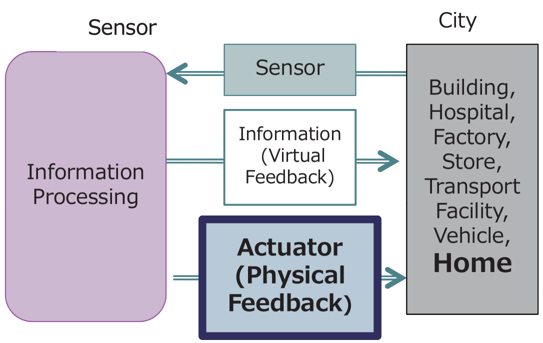
2

- Theme
- Problem Statement
- Final Solution
- Business Case

Theme

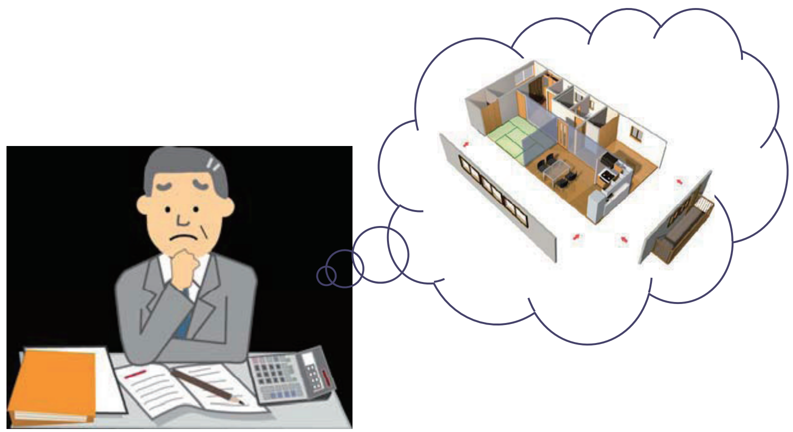
3

"Smart Physical Feedback City"
by Toshiba Corp. with Shimizu Corp.



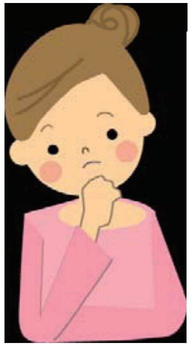
Problem Statement

4



Problem Statement

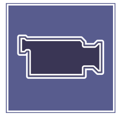
5



Final Solution

6

- Then, they saw a CM ….



Final Solution

7

- Highest Life
  - Moving up/down chair along to rail put on the side wall
  - Upper and lower desks
  - Side board set at the edge of desk
  - Slanted desk

existing product

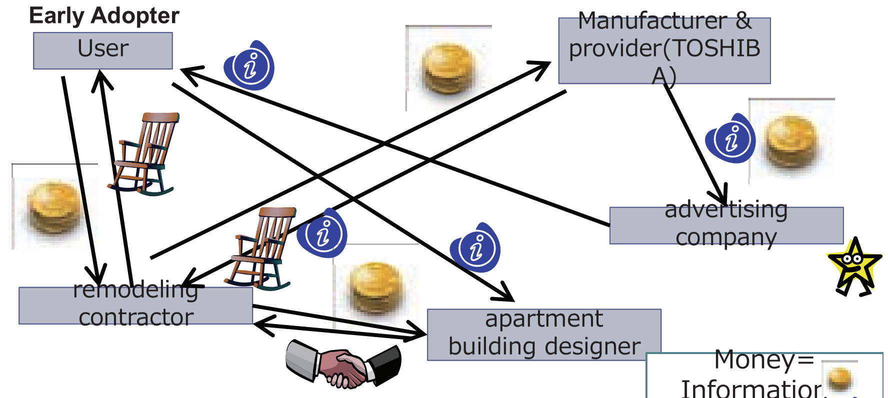
8

- Sophia(CHUO ELEVATOR INDUSTRY CO;LTD)
  - Climb the stairs carrying elderly in house
  - Price 600,000yen

Business Case

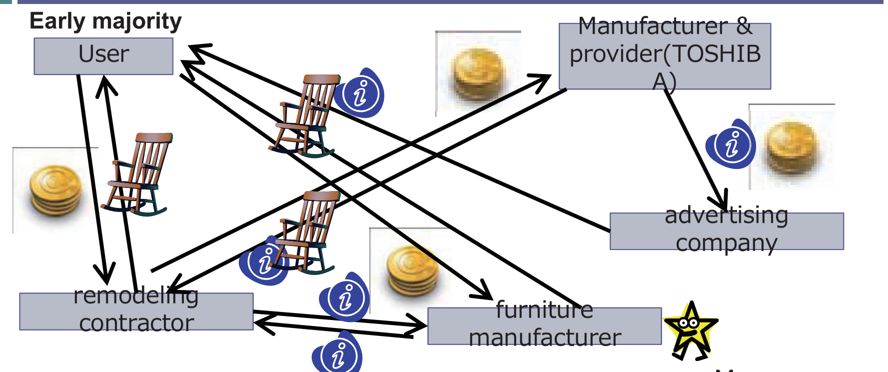
- CVCA
  - Early phase(1-3years)
  - Middle phase(3-6years)
  - Late phase (6-10years)
  - NPV

CVCA-early phase(-3years)



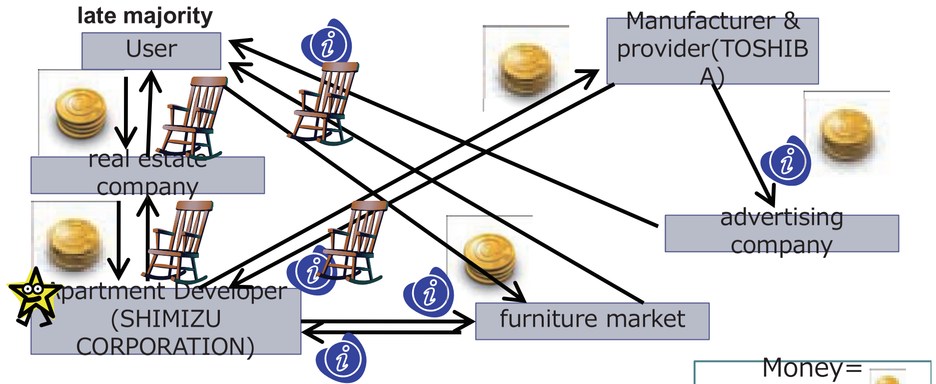
Calendar Year	2010	2011
Expected Volumes	100	800
Pretax Income	$ ▲271,752	$ 210,585

CVCA- meddle phase(3-6years)



Calendar Year	2012	2013	2014
Expected Volumes	10,000	30,000	50,000
Pretax Income	$3,703,686	$11,616,502	$23,794,779

CVCA- late phase(6-10years)



Calendar Year	2015	2016	2017
Expected Volumes	250,000	300,000	350,000
Pretax Income	$ 146,813,946	$ 177,520,846	$ 208,207,746

Conclusion

13

Summary of Benefit.

- **1:Physical Viewpoint:**
  Additional space without physical extension.
- **2:Mental Viewpoint:**
  User can relax in own space.
- **3:Technical Viewpoint:**
  Use COTS. No new technology.
- **4:Social Viewpoint:**
  Adapt to Compact city.
- **5:Innovative Viewpoint:**
  Effective utilization of dead space.

14

Thank you for kind attention.

Solution Expansion

15

- Expand to lateral direction
- New study room, extended working space on limited floor area

Appendix

16

- Final Solution
  - address the safety(1)
  - address the safety(2)
- Solution Expansion
- Safety and security
- NPV

17

Final Solution: address the safety(1)

Worries from interview :

- Something on the desk falls and gets broken
- People gets injured from something falling from the desk
- The chair does not lower
- People does not want to be on the higher chair when an earthquake occur

18

Final Solution: address the safety (2)

Potential Failure	Potential cause of failure	Actions
Object falling from desk	objects rolling down	slanted desk
	objects put at edge of desk	side board
Objects broken	objects falling down from desk	cushion floor
People falling from chair	falling down from the side	side board
	losing a balance	foot rest
Chair not lower	electric power outage	ladder
		Jump down
	earthquake	Automatic lowering system

19

Safety and security

- Social problem - High rate of suicide
- Solution – our system provide
  - securing personal space
  - releasing from stress
  - enriching one's life
  - if people become free from feeling depressed and committing suicide, their family will feel safe…

20

NPV (Fix Costs & Variable Costs)

Calendar Year	2010	2011	2012	2013	2014	2015	2016
Expected Volumes	100	800	10,000	30,000	50,000	80,000	250,000
Company Actual Sales Price	$5,550	$5,550	$5,550	$5,550	$5,550	$5,550	$5,550

FIXED COSTS							
– Product Design	$50,000	$10,000	$10,000	$20,000	$50,000	$10,000	$10,000
– Machines & Equipment	$10,000						
– Mfg Start–up							
– Tools/Molds							
– Advertising	$177,777	$177,777	$2,222,222	$6,666,666	$6,666,666	$6,666,666	$6,666,666
– Operational Cost	$9,389	$9,388	$23,472	$23,472	$37,555	$46,944	$93,888
PRODUCT'S FIXED COSTS	$247,166	$197,165	$2,255,694	$6,710,138	$6,754,221	$6,723,610	$6,770,554

VARIABLE COSTS / unit							
- Material	$4,288.88	$ 4,288.88	$4,288.88	$ 4,288.88	$4,288.80	$4,288.88	$4,288.88
- Labor	$751.00	$ 94.00	$19.00	$ 6.00	$ 6.00	$ 5.00	$ 3.00
VARIABLE COSTS / unit	$ 5,039.88	$4,382.88	$ 4,307.88	$ 4,294.88	$ 4,294.80	$ 4,293.88	$ 4,291.88

NPV(Analysis)

21

ANALYSIS	2010	2011	2012	2013	2014	2015	2016
Unit Contribution Margin	−$245.86	$509.69	$595.94	$610.89	$610.98	$612.04	$614.34
Gross Profit Margin	−4%	10%	12%	12%	12%	12%	12%
Revenues (Price * Volume)	$555,000	$4,440,000	$55,500,000	$166,500,000	$277,500,000	$444,000,000	$1,387,500,000
Total Variable Costs	$579,586	$4,032,250	$49,540,620	$148,173,360	$246,951,000	$395,036,960	$1,233,915,500
Gross Profit (Rev − Tot Var Costs)	$−24,586	$407,750	$5,959,380	$18,326,640	$30,549,000	$48,963,040	$153,584,500
Fixed Costs	$247,166	$197,165	$2,255,694	$6,710,138	$ 6,754,221	$6,723,610	$6,770,554
Pretax Income (Loss)	$−271,752	$210,585	$3,703,686	$11,616,502	$23,794,779	$42,239,430	$146,813,946