A proposal of a holistic and human-centric system design approach for a beauty industry stimulation

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Abstract

This paper seeks to provide a novel approach to identify systemic leverage points on individual, business and demographic views and to develop a social solution to promote individual beauty in Japan. Our approach is leveraging a systems-approach to analyze three themes: (i) factors and bottlenecks restraining beauty industry's further development and causes of current saturation, (ii) a hypothesis of social system solution based on user needs, and (iii) dynamics on increased number of beauty-sensed people and possible social economic benefit.

The main findings are that normal individuals should have two hurdles to start behavior actions for his or her more beauty. One is an unclear criterion for start actions because beauty is subjective concept. The other is an issue on how to identify the effectiveness along with diverse personal requirements of beauty.

Our systems-approach is a combination of design thinking for analyzing individual mental model, system thinking for a value chain hypothesis and system dynamics for analyzing the effectiveness. It should provide a holistic verification of a proposed solution, "Beauty checkup". Our approach could serve as catalysts for a more unified study of design methodology for problem solutions on a complex system, containing mental, industrial and social viewpoints.

Key Words: *Systems Approach, Design Thinking, Beauty Home electric appliances Industry, Mental Model, System Dynamics*

1. Introduction

Background and Issues

Japan's market on beauty industry has been reaching a saturation point, and its total market, including aesthetic services, has also stagnated since 2006, when its size reaches a plateau of approximately US 40 million dollars (Yano Research Institute Ltd., 2012). Whilst a significant growth can be seen in the home beauty appliance industry, as shows in Figure 1 (Ministry of Economy, 2013), our survey result mentioned that only a few percent of answers showed the relationship between the beauty one wants and home beauty appliances.

According to our field research and literature reviews, there are a wide variety of understandings and viewpoints on human beauty, which should be fully subjective. In addition, the effectiveness of improvement of the beauty remains unclear. Socrates mentioned that beauty is defined as the pleasant feelings of watching and hearing. Ernest Hilgard defined beauty as the second high dimension of wants (Smith & Nolen-Hocksema, 2004).

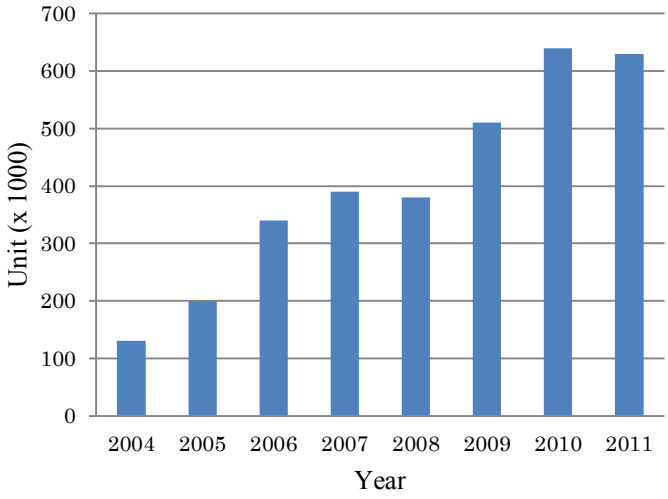

Figure 1: Quantity-sold of home electronic facial appliances in Japan

Figure 2 shows an issue tree on how to increase beauty-sensed people in Japan, consolidated via our Systems Approach in the Design Project, which was called "ALPS" (Active Learning Project Sequence) projects at the Graduate School of Systems Design and Management of Keio University. Unlike the healthcare industry, there should be a complex interrelationship amongst individual, industry and social perspective in Japan, where the market of home beauty appliances had a significant growth. The complexity should be related with subjective aspects of beauty and its sense, and thus we noted a mental model.

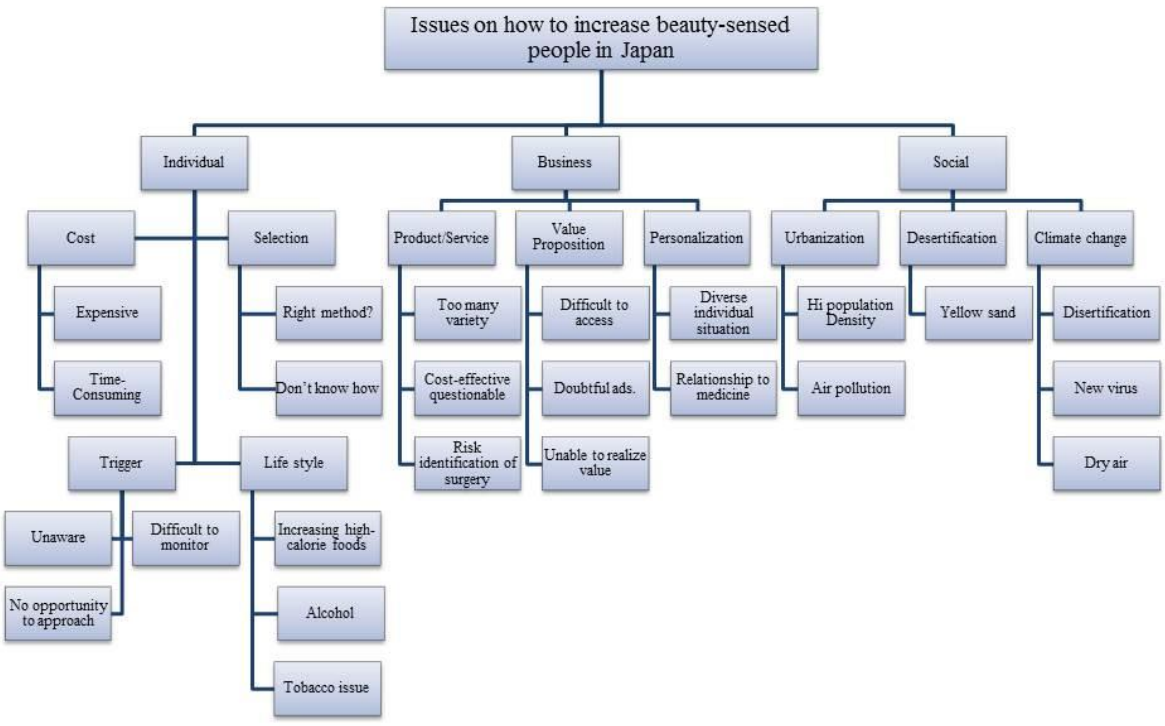

Figure 2: An issue tree on how to increase beauty-sensed people in Japan

In order to clarify the system boundary between beauty-sense mental model and home beauty appliance industry, this paper proposes a new approach leveraging system dynamics

simulations with design thinking and system thinking.

Existing Research

Some of existing researches have analyzed individual beauty-sense and solutions such as make-up activities. Takahashi stated in his paper (Takahashi, 2005) that Japanese beauty-sense is “chaotic”, because we may not able to even distinguish differences between beauty and ugliness. Based on impression evaluation experiment with Sematic Differential method and an illustration of a cluster structure of beauty concepts, “Ambiguity” is one of major concept by illustrating.

Graham found that make-up activities contribute to a positive influence on appearance, self-confidence, self-imagination and view of life, based on the experiments for ladies age between 60 and 90 (Graham, 1983). They stated that skin-care and makeup should be effective to mitigate and slow the progress of senile dementia and depression as well as to recover from post-traumatic stress disorder.

From the industorial perspective, Nomura Research Institute found that the market of beauty applicance industory has growed by 7% of CAGR (Compound Annual Growth Rate), whereas the astetic and beauty service industory has shrinked (Kawamoto, 2011). The survey result stated that the size of caniveralization from beauty applicances to its services is US 160 million dollars in 2013.

We identify that the above research had concluded that the beauty-sense is subjective matter, and cannot find a clear description of size of population portion of people with beauty-sense. The research methods are oveall qualitatative and conceptual investigations based on survey. Thereby, it may not be feasible to explain the dynamic causal and correlation of the relashonsips between mental model and industorial. Furthermore, we may not be able to propose the sytemic intervation more than intutive hypothesis.

From the methodology perspective, Forrester argued the relationship amongst system thinking, soft operation research and system dynamics (Forrester, 1994). The soft operations research, which may own potions like design thinking, is an analysis approach containing human subjective aspects. His article mentioned (Forrester, 1994), “systems thinking and soft operations research as they are related to system dynamics“, and “If systems thinking leads to a deeper understanding through system dynamics, then the result will be positive”, meaning that system dynamics is critical.

For researching beauty-sense and beauty industry, our paper deals with design thinking to describe mental model to stock-flow diagram. There seems no existing research of system thinking and dynamics on beauty service/products industry such as ones in Japan.

Objective of Our Research and Expected Benefits

This paper seeks for a new holistic approach from concept definition, ideation, solution design & evaluation and benefit clarification. The problem theme is human beauty researched in the Design Project in the Graduate School of Systems Design and Management of Keio University (SDM). Our approach is to leverage systems-approach to analyze three themes:

(i) Factors and bottleneck of why the beauty industry has been saturated,

(ii) A hypothesis of social system solution based on user needs

(iii) Dynamics on the number of beauty-sensed people and its causes and effects.

In the Design Project, design thinking and system thinking have been mainly used, whilst the

using the quantitative and dynamic simulations such as stock-flow diagrams are optional.

The originality of our research is to infuse dynamic (time-dependent) simulation with the existing Systems Approach of SDM and then to promote the decomposition of functional requirements of solution design. In the research on beauty, we investigated the interaction between mental, industry and demographic model in the society level. This approach enables us to make quantitative cycle of hypothesis and verification on the solutions design including issues in a society-level system and thereby to propose a firm plan with a time-dependent feasibility and benefit projection. Figure 3 shows how our new approach enlarge the understandings of design by As-Is approach using design thinking and system thinking.

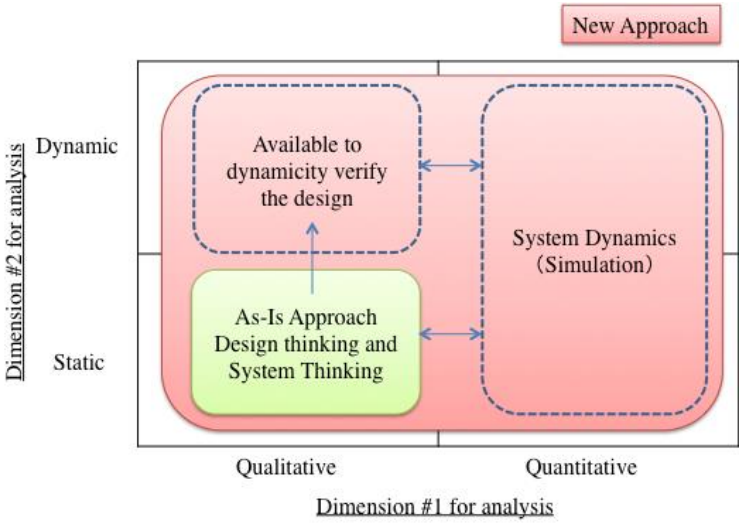

Figure 3: A 2 X 2 matrix illustration for positioning of the new approach

2. A Systems Approach: Keio-SDM Design Project

According to Jackson, the systems approach is a general term used for the organization and management of complex system and is the foundation for both analytic and holistic methods (Jackson, Hitchins, & Eisner, 2010). It contains mainly four instructions:

1. Identification of system elements, system boundary and the function of each element
2. Analysis of the interactions among elements and Identification of emergent characteristics of the system
3. Synthesis of the system
4. Verification and validation of the system

Design thinking is a designer-like approach for ideation to realization in terms three elements: human-centric, science and technology and business (Minato, 2013). Leveraging the divergence thinking and forced ideation, diverse members can create an idea outside a current thinking framework. It is in parallel with contacting direct contact with users via field interviews, participatory observation ethnography.

This section described a new systems approach to design the innovative solutions and systems, leveraging design thinking and system thinking as well as system dynamics, which has possible synergy.

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Process of Design Project at the SDM

A recent trend for transformational solution design is to leverage design thinking with innovation education and innovation workshops (Minato, 2013). Design Thinking is focusing at human centric approach and enables us for creative ideations with a breakthrough of As-Is framework or bias.

On the other hand, Nguyen stated in Iceberg Theory (Nguyen, Bosch, & Maani, 2011) that the solutions would fail when we are focusing only on superficial symptom and events instead of focusing on hidden root causes. Thus our approach combines the above design thinking with system thinking to visualize interactions amongst elements in multiple views of the system collaboratively, which makes it possible to understand and analyze a mental model below the Iceberg.

Along with the power of diverse members collaboration and ideas, we also uses systematic method and tools such as causal loop diagram and Bayesian Belief Network to analyze solution feasibility under the complex system. As Figure 4 depicted, a wide range of method was used for idea generation and analysis in a holistic system. The tools have been practiced Design Project in 2013. The underlying methodologies of systems-approach are systems engineering and design thinking for value co-creation (Yasui, 2011).

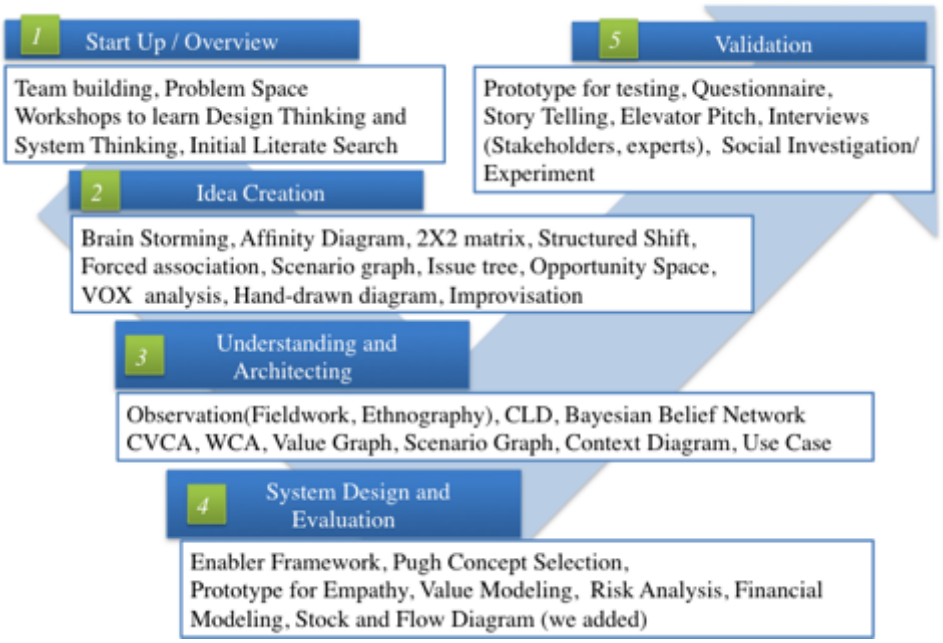

Figure 4: Tools for design thinking and system thinking in the Design Project

Originally SDM's systems approach, used in the Design Project, is targeting creation of innovation, by utilizing group-works and workshops with diverse members and V-Model in systems engineering. In design thinking, the process is mainly composed of observation, ideation and prototype for Empathy. Generally, the design thinking is human-centric and artistic, whilst the system thinking enables us to plan a feasible design and verifications.

In the Design Project, a wide range of tools is being leveraged to logically and systematically understand system-of-interest covering technology, society and human. Along with individual logical thinking, diverse members have participated in a group to collaboratively work on problem solving and innovative system design. This diversity will promote the divergence and convergence process of innovation ideation.

Synergy with System Dynamics

Usually, for decision making in a business organization, it is necessary for project managers to show quantitative benefits with well-analyzed system characteristics. Besides, project sponsors needs to know time-dependent return-on-investment (ROI), while the static financial modeling and Net Present Value (NPV) method may be not enough for complex system design investment.

Forrester stated the importance of system dynamics as "Using system dynamics models, decision makers can experiment with possible changes to variables to see what effect this has on overall system behavior." In this paper, we choose stock-flow diagram along with tools on Design and System thinking to simulate a time-dependent behaviors of solutions. The simulation results are included in an iterative process to improve the design.

The objective of our research is to clarify benefits and effectiveness of new approach via causal relationship analysis amongst the multiple viewpoints on beauty-sense and dynamic benefit simulations of propose solution. Figure 5 shows the viewpoints, derived from Design and system thinking, for increasing beauty-sensed people and promoting a beauty industry.

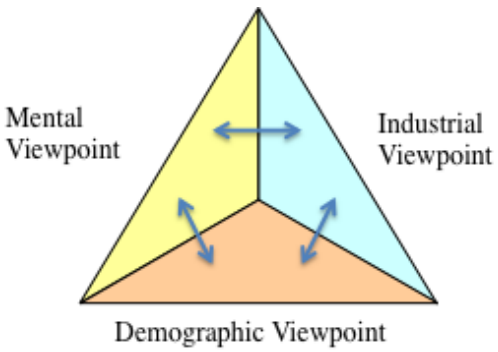

Figure 5: Viewpoints derided from architecting phase

3. Execution of Design Project

The Design Project at the SDM has been utilizing an iterative approach to make solution idea evolved. The cycle is composed of observation, ideation and prototype for sympathy. This section will describe the iterative process and relationship with system dynamics. The problem theme is to consider and design future relationships amongst beauty and health, people, enterprise, service providers and possible public sectors. This paper will focus on the beauty.

Co-create a Problem Space

The problem space in product development in businesses, practiced in Department Mechanical Engineering, Stanford University, usually contains company history, product history, competitions and potential markets (Kurt, 2013). The problem space should be co-created with stakeholders and experts via systems-approach tools such as brainstorming. Figure 6 shows the initial problem space map for members to build a common purpose and establish a sort of solidarity by sharing interests.

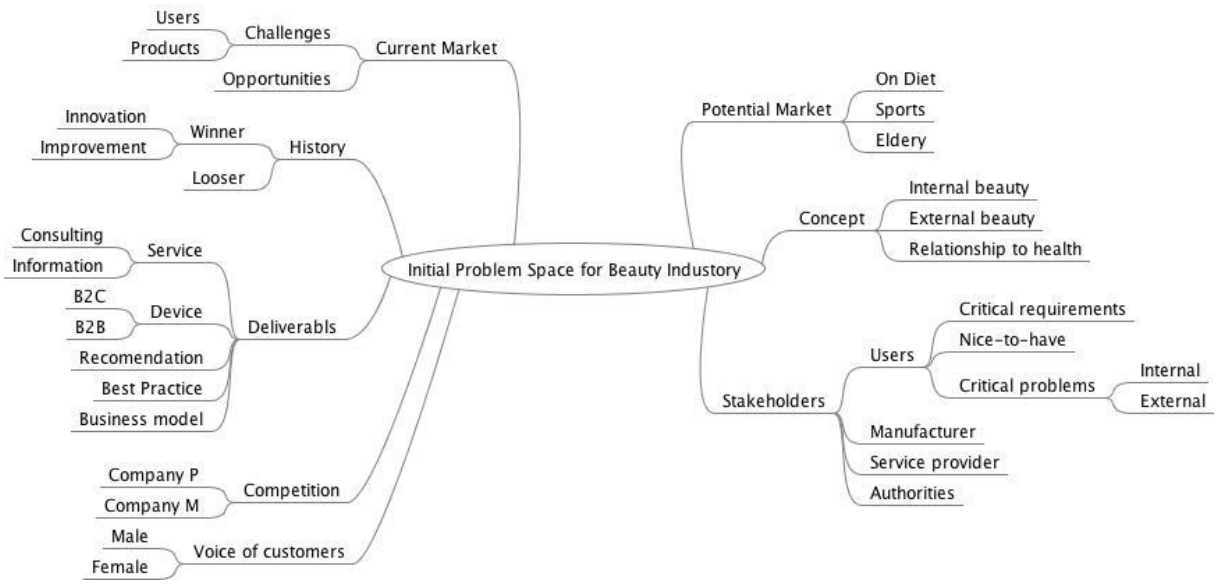

Figure 6: A problem space map to promote a whole beauty industry

Formulating the concept of beauty-sense for individual

The design thinking is majorly focused on using three factors, human centric, technology development and business to design and approach the ideas (Minato, 2013). By actively using diverging thinking technique (brainstorming or mind map), and forced association thinking techniques (Scenario Graph), we are able to think outside the frame.
Our Design Project first researched and understood beauty in various viewpoints. The group brainstorming helped a divergence of our thinking. Figure 7 demonstrates a diffusion thinking result by using the Value Graph (Ishii, 2003).

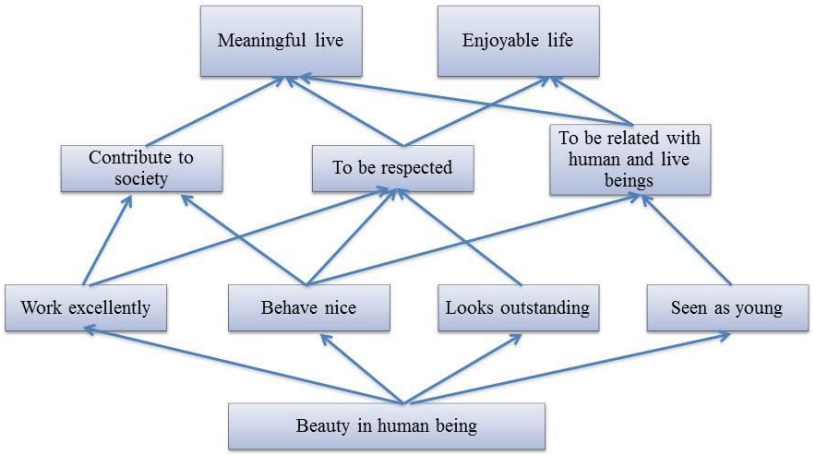

Figure 7: Upper side of a value graph of why the beauty is necessary.

The group members acquired an initial concept of "Beauty promotion in daily life" and commenced a field research and desk works on relationships and issues around human beauty and daily life. In parallel, as described in the problem space, the conceptual relationships were brainstormed with the Enabler Framework (Shirasaka, 2009), where we defined the relationships between beauty and health and between internal beauty and external beauty.

By iterating the cycle three times, with literature search, interviews and system thinking, the group members defined the beauty-sense as a wish to transform one individual into other stages. The stages are persons who one thinks ideal or wants to be or younger ones with a clear skin for example.

Tanaka conducted a cluster analysis of women's make-up activities and one cluster includes the transformation or metamorphosis (Tanaka, 2006). Based on our design thinking and system thinking, we enlarged the concept into a human beauty-sense.

Understanding individual beauty-sense as a system

Based on issue tree, ideation and interview results, we created two types of causal-loop-diagram (CLD) to analyze the number of beauty-sensed people. Figure 8 illustrates the CLD on industry viewpoint. One reinforcing loop is between beauty-sensed people and beauty service/products industry, whilst there are two types of balanced loop.

One of the balanced loops is due to the variety of products and services. One's wants to become more beautiful is fully subjective, and thereby it is not easy to select right services and products. This issue was derived from the field search of beauty service providers and interviews for professionals, which should require a higher level of beautifulness.

The other balanced-loop is due to a side effect of the strong wish to become beauty. If personal requirements are too strong, one may deprioritize the healthy life. It is also from interviewees mentioning an extreme weight-loss and frequent surgeries.

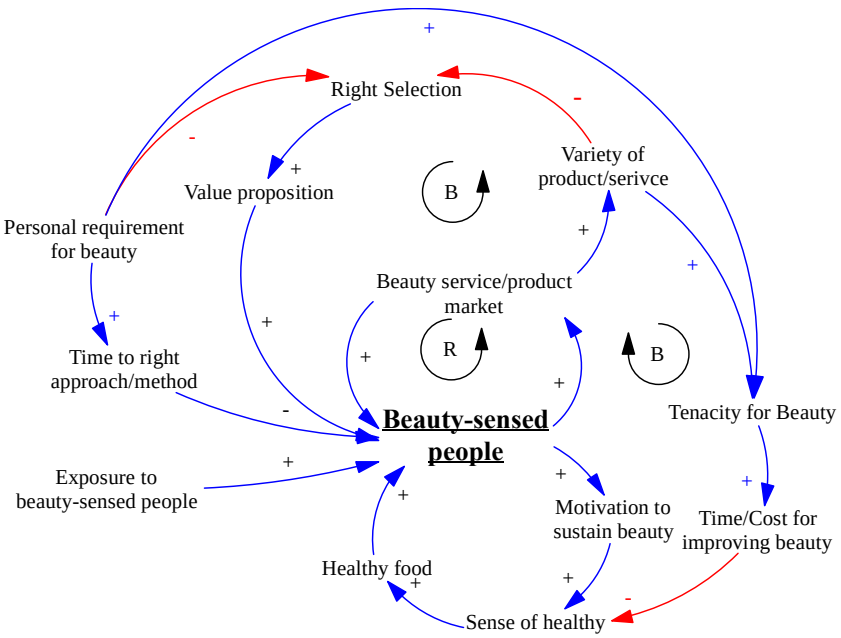

Figure 8: Causal relationships between beauty-sensed people and beauty industry

Extreme-user interviews and prototype

After consolidating the concept of beauty and issues on system, we conducted the interviews with professional beauty users: such as body builder and actress with a high exposure from public people. The purpose of the interviews is to identify issues of future from innovative user points and to seek for a clue to solve the problems.

Figure 9 shows the CLD of mental model of individual beauty-sense, derived from interview results and brainstorming. The possible key issues are awareness to promote one's beauty and effective recognitions to start and continue actions.

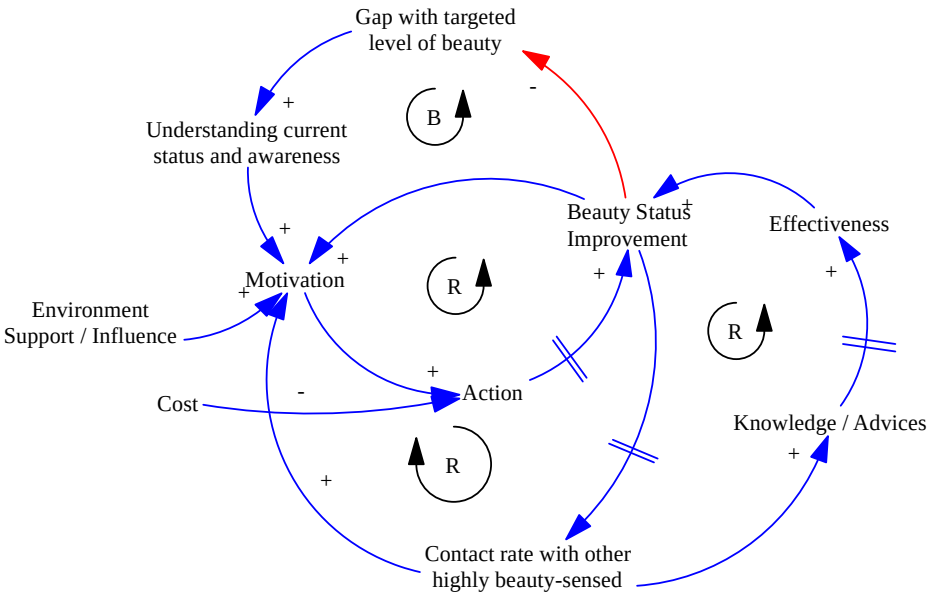

Figure 9: Causal relationships on individual beauty-sense

Stakeholder Validation of New Value Chain

We analyzed from Figure 9 actors and bottlenecks restraining beauty industry's further development and causes of current saturation. In conjunction with the field research and analysis on the Bayesian Belief Network diagram, awareness and motivation were specified as leverage points on mental model. The problem for awareness of beauty we identified is how to identify the goal of individual beauty and gap from the target.

Based on Figure 8, it should not be an essential solution to just establish new products and services because the complexity in front of customers will increase. Rather, according to the balanced feedback in Figure 9, a unique point of human individual beauty sense, the solution should be a mechanism for individual to continuously identify the gap between "As-Is" and "To-Be".

An electronics manufacturer in Japan also has identified a same sort of problem recognition on the relationship amongst users, enterprises and products/services on individual beauty. Whilst customers in Japan may terminate the use of new beauty appliances in less than one year, the competitors, such as Panasonic, already created a significant level of beauty markets by electronics technology. On the other hand, the company appears to not provide the customer wants of true values, and thereby they need real user requirements that are not superficial. The company mentioned the needs of new type of relationships with customers and industry model.

After the comprehensive interviews of "early adaptors" on individual beauty, several solutions are ideated. In parallel, we conducted prototyping, a design thinking process. As described in

Figure 2, human sense of individual own beauty is complex, so the solution design should be based not on completely new behavior of individual. After interviewing health and beauty professionals and extreme users and the Pugh Concept Selection (Pugh, 1991), we designed the Beauty Checkup system, an analogy of health checkup.

Our Beauty Checkup system has three contexts. One is beauty checkup service providers who check the level or standard of individual beauty. Normally, on the point of skin, criteria would be moisture, oiliness and elastic. The second context is manufactures that daily-use appliances and store the data. The third context is beauty advice service providers. Considering the analogy with health checkup, beauty checkup system should be national policy or rule because the shape and weight is related with health.

The stakeholders and its value propositions were analyzed via Customer Value Chain Analysis (CVCA), as shown in Figure 10 and Wants Chain Analysis (Maeno, Makino, Shirasaka, Makino, & Kim, 2011). Finally, our hypothetical solution and business model was qualitatively validated via stakeholder interviews.

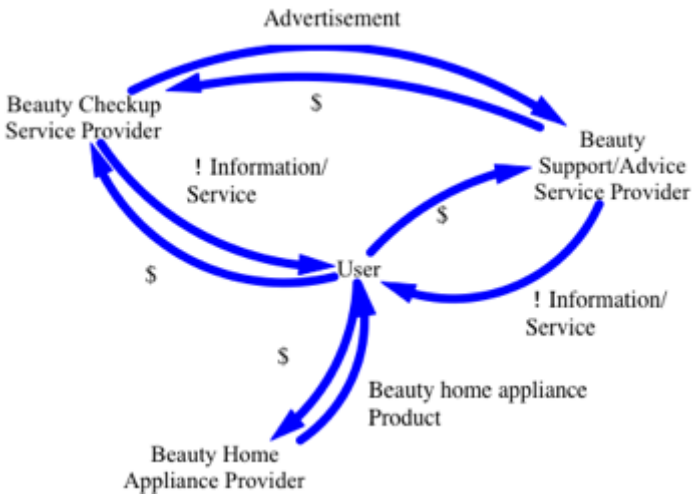

Figure 10: Customer value chain analysis (CVCA) on the proposal of Beauty Checkup system

5. Dynamic Simulation: Model and Testing

Leveraging system dynamics, this section intends to describe a verification method to verify the benefit of our solution idea with a time-dependent simulation. The problem articulation (Sterman, 2000) is how to promote a beauty-sense of public people especially in Japan. Key variables are the number of beauty-sensed people and users of beauty service and products. Time horizon is 15 years since 2002 when we got the public statistical data of the market size.

The reference mode for behavior production test is the number of a home beauty appliances sold with the population size of Japanese. We are noting the three viewpoints: mental, industry and demographics. This paper describes the overall simulation process and relationships with design thinking, while it will illustrate the simple stock flow diagram, aiming at explaining the effectiveness of our new approach.

Dynamic Hypothesis

A dynamic hypothesis is a working theory of how the problem arose (Sterman, 2000). The hypothesis in the Design Project was derived from iterative process with design thinking and

system thinking. Based on the causal-loop-diagrams and leverage points and interviews with professional beauty advisers, we assumed that a Beauty-Checkup system is one of the solutions to promote individual beauty sense. The novel system, we believe, will change the demographic profile of beauty sensed people, and thereby extend the market size of overall beauty industries. Here, we excluded the variables of cannibalization between aesthetic service and home beauty appliance industries.

Modeling

The simplified stock and flow diagram is shown in Figure 11. Here, the Replacement Purchases Model (Sterman, 2000) is used as our market sub system. The information delay model was selected to illustrate time-dependent impacts of our Beauty Checkup system. Besides, the population pipeline is included to the impact of the falling population in Japan. Here, the mental impact after introducing the beauty checkup are simply modeled and connect adoption rate because the impact will affects adoptions from advertisement and the word of mouse. The variables and equations are shown in the Appendix.

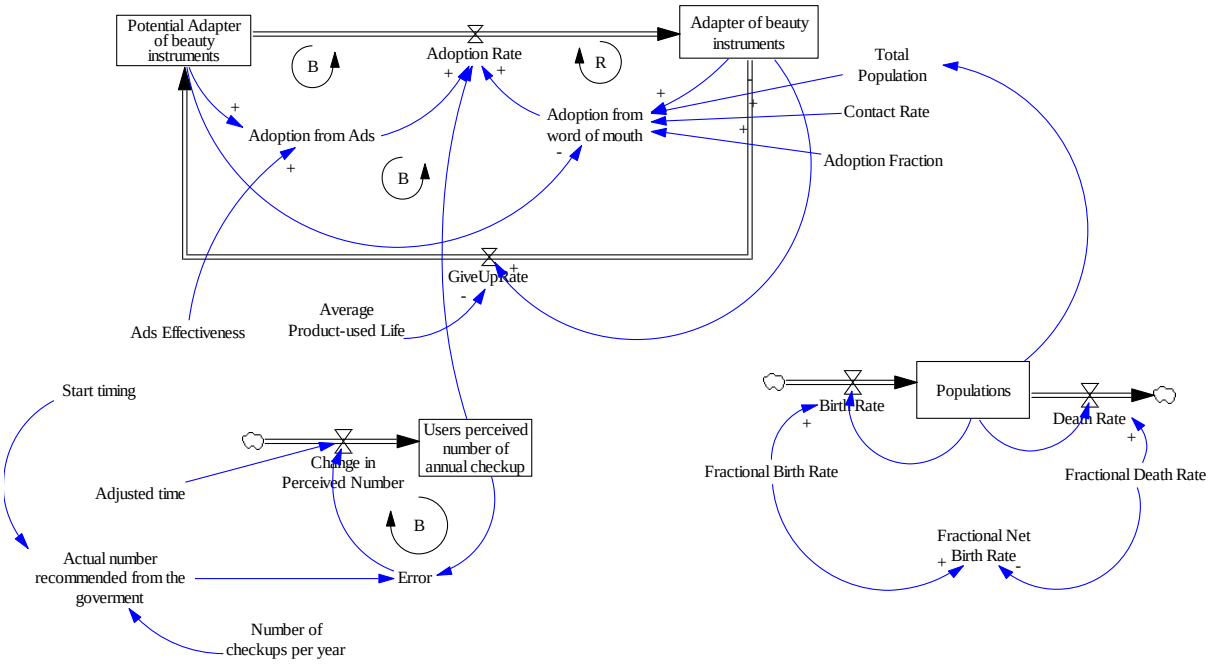

Figure 11: Stock Flow diagram of a number of adapters in beauty industry

Model testing

We had tested the model by comparing the simulated behavior of the model to the actual behavior of the system. This was achieved by using the public statistical data (Ministry of Economy, 2013) as our reference. The stimulation timing was set to be year 2012, so it was out of our simulation range. By doing this, we can see how close is our simulation data to the real data without the stimulation.

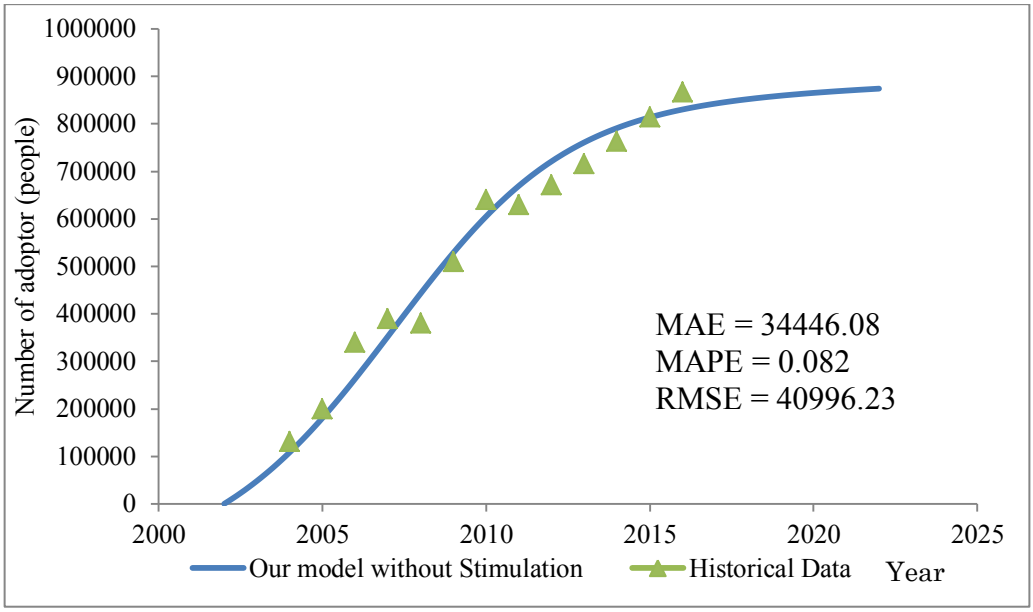

Figure 12: Test result of behavior test via Adapter of beauty instruments

The comparison shows the understanding the discrepancy between the simulated and actual series

Simulation

We run the simulation after introducing the Beauty Checkup stimulation in 2012 with information delay by two years. We could see a significant increase of potential adoptor can be raise with our proposal.

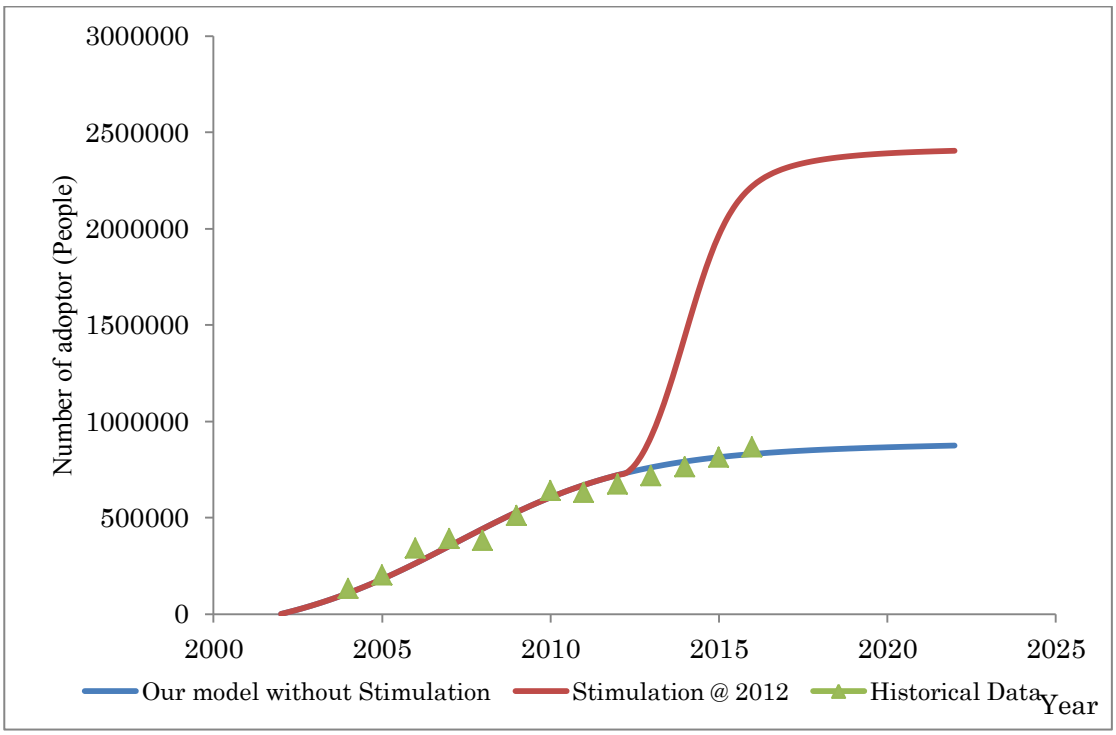

Figure 13: Simulation with stimulation

The red line is the model simulation with the stimulation of introducing the Beauty Checkup system at year 2012, and the blue line is the model simulation without the checkup. With the stimulation, it takes approximately one year for the system to recognise the change. And almost immediately, we can find an exponential growth. However, it soon reached a saturation point in year 2016.

The sensitivity analysis by the number of checkup per year shows the proportional growth of the saturation point. For example, if the number equals 3, the saturation point of the red line is approximately 3.2 million of people approximately. Intuitive speaking, it is more sensitive than our intuition, because the three times of check-up may be shorter than beauty products discard time or life cycle. Next step is to make the model more sophisticated in parallel with the detail design of new Beauty Checkup system.

6. Discussion and recommendations: what a new methodology can propose

The findings of our Design Project are described as below:

(i) Each understands the human beauty differently and personally, and thereby it should be not feasible to evaluate the effectiveness of actions for improving his or her beauty. Besides, the effectiveness arises with time delay. Besides, unlike health, we are not educated to promote beauty from childhood and trigger for promoting beauty should be unclear. These observations are mainly derived from tools: Brainstorming, Affinity Diagram, Value Graph, Enabler Framework, BBN, CLD, Interviews and Surveys.

(ii) One of the possible effective solutions is to regularize Beauty Checkup, analogy of health checkup. It will positively impact the leverage points on metal model: Awareness and Effectiveness. The novel solution is conceptualized using CLD, Extreme-user Interviews, Forced idea association, and CVCA.

(iii) Our Beauty-Checkup solution will create a significant upside of the current saturation points. However, further evaluation and improvements of our equation between the number of check-up per year and adoption rate. Currently we simply used the 1st order simple product.

Potential indirect benefits may include the reducing of healthcare cost by promoting health-consciousness and the increase of tourists. Actually, Venezuela in 1950 commenced a national policy to support beauty industry by supporting schools of models and promoting events such as “Ms. Venezuela”, expecting the increased of sightseeing/tourists internationals1. Japan’s cabinet has been aiming at the increase of international tourists up to more than over 30 million by 2013, expecting the economic benefits by 30 trillion yen.

The next step may be to simulate the indirect benefits above using system dynamics simulations, because the static human mental model and system behavior analysis become dynamic via our new approach with dynamic simulations with time-delay.

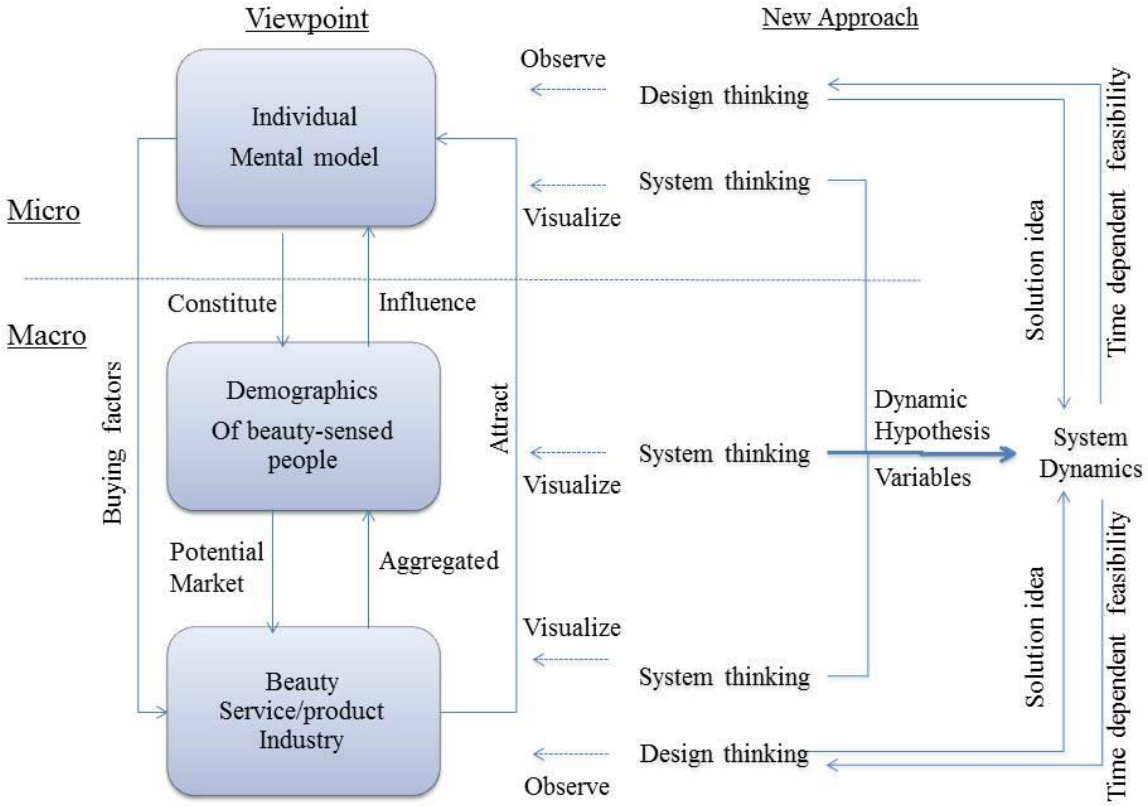

Figure 14: Context diagram containing viewpoints and our systems approach

Figure 14 shows a context diagram of the new approach with design thinking, system thinking and system dynamics. The former two are for innovation ideation and dynamic hypothesis building, to model a stock flow diagram of system dynamics. Our systems-approach is a combination of design thinking for analyzing individual mental model, system thinking for a value chain hypothesis and system dynamics for analyzing the effectiveness. It should provide a holistic verification of a proposed solution, "Beauty Checkup".

To simply verify the effectiveness of our approach, we conducted a survey for members of the Design Project in 2013 (n=15). Over 80% of members mentioned that the dynamic simulation is necessary to make solutions more effective, whilst 50% do not self-evaluate as satisfied with the level of the validation result. Over 68% of members mentioned that should include a mental model to confirm the benefits of a new system by leveraging a dynamic simulations.

6. Conclusions

This paper describes an effectiveness of joining human centric design thinking, system design and system dynamics, using a topic on human beauty-sense in the Design Project at the Graduate School of Systems Design and Management of Keio University. The new approach enables us to dynamically simulate the solution idea from design thinking in a system.

Our proposed method contains multiple viewpoints from mental, industry and demographics. We confirmed a validation as a subjective evaluation of a system designer at the University.

However, the current model of system dynamics on the beauty industry has a simple portion, and besides next step is to compare this result with other methods such as agent simulation and discrete method (Minato, 2013).

For designing an innovative solution in a complex social system, especially, it may be necessary to visualize more systematically multiple viewpoints such individual, business and society. In order to smoothly interfaced with system dynamics modeling and simulate time-dependent benefits of policy design, international standard diagrams in the System Modeling Language may be appropriate.

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Appendix

- Stocks
  - Adapter of beauty instruments:
    - Equation: Adoption Rate-GiveUpRate
    - Initial value: 0
  - Potential Adapter of beauty instruments
    - Equation: GiveUpRate-Adoption Rate
    - Initial value: Total BeautySensed-Adapter of beauty instruments
  - Users perceived number of annual checkup
    - Equation: Change in Perceived Number
    - Initial value: 0
  - Populations
    - Equation: Birth Rate-Death Rate
    - Initial value: 1e+008
- Rate
  - $\text{Adoption Rate} = \int (\text{Adoption from word of mouth} + \text{Adoption from Ads}) \times (1 + \text{Users perceived number of annual checkup})$
  - $\text{Change in Perceived Number} = \int \frac{\text{Error}}{\text{Adjusted time}}$
  - $\text{GiveUpRate} = \int \frac{\text{Adapter of beauty instruments}}{\text{Average Product}-\text{used Life}}$
  - $\text{Birth Rate} = \int \text{Fractional Birth Rate} \times \text{Populations}$
  - $\text{Death Rate} = \int \text{Fractional Death Rate} \times \text{Populations}$
- Equations
  - $\text{Actual number recommended from the goverment} = \text{DELAY FIXED}(\text{Number of checkups per year}, \text{Start timing}, 0)$
  - $\text{Adoption from Ads} = \text{Ads Effectiveness} \times \text{Potential Adapter of beauty instruments}$
  - $\text{Adoption from word of mouth} = \frac{\text{Potential Adapter of beauty instruments} \times \text{Adoption Fraction} \times \text{Adapter of beauty instruments} \times \text{Contact Rate}}{\text{Total BeautySensed}}$
  - $\text{Error} = \text{Actual number recommended from the goverment} - \text{Users perceived number of annual checkup}$
  - $\text{Total Population} = 0.04 \times \text{Populations}$
  - $\text{Fractional Net Birth Rate} = \text{Fractional Birth Rate} - \text{Fractional Death Rate}$
- Parameters

Parameter	Base	Stimulation	Unit	Notes
Adjust time	2	2	Year	Time taken to realised the value of Beauty Checkup
Adoption Fraction	0.015	0.015	%	Fraction of population who will adopt the product
Ads Effectiveness	0.011	0.011	%	Advertisement effectiveness
Average Product-use Life	0.8125	0.8125	Year	Average product use lifetime (how long will the user continuously use the product)
Contact Rate	100	100	Person/month	# of people who will got in contact with highly affective beauty sensed people
Number of checkups per year	1	1	Per year	Number of checkups per year
Start timing	100	10	Year	Stimulation starting year
Fractional Birth Rate	0.499	0.499	People per Person per year	Birth Rate
Fractional Death Rate	0.5	0.5	People per Person per year	Death rate