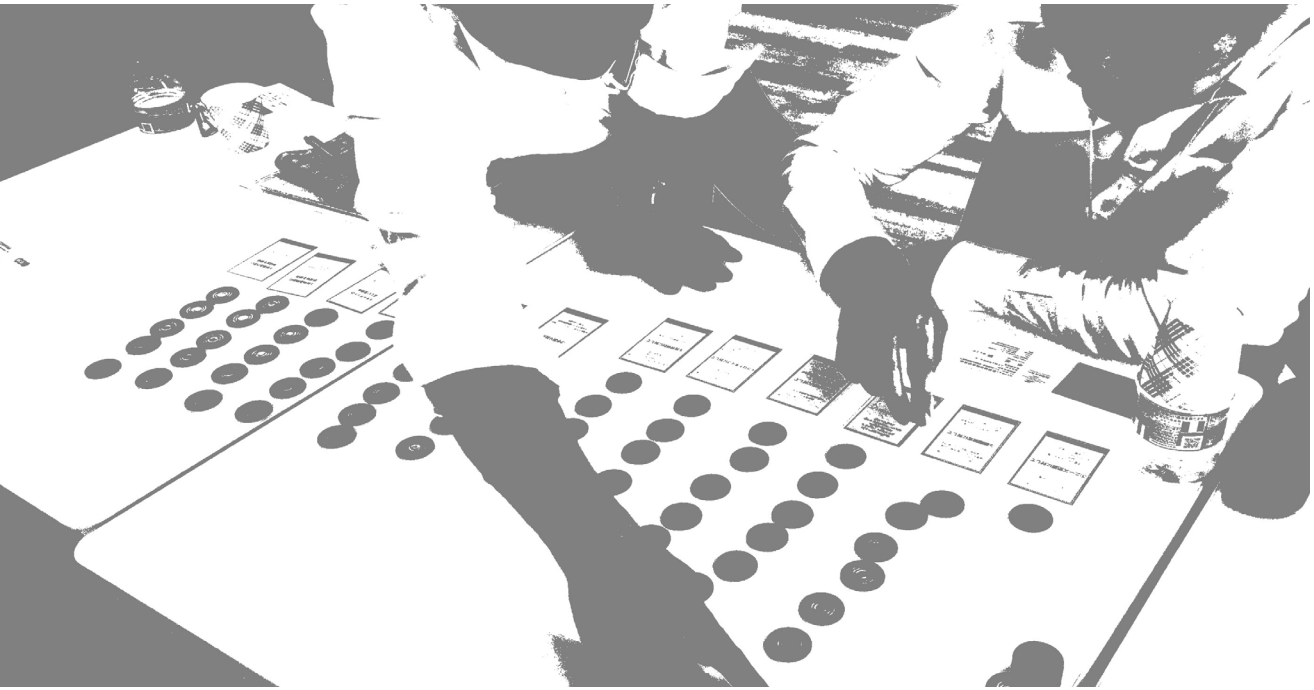
DMCT

Design Management for Cross-disciplinary Teams



Solution approach and effect measurement method in design and engineering

Action Toolset 2014 for experience-value capturing technical design

September 2015

Project representative: The National Institute of Advanced Industrial Science and Technology (AIST), National Research and Development Corporation
Collaborator: Seymourpowell, Ltd.

Participating Companies:

CASIO COMPUTER CO., LTD.

KOTOBUKI CORPORATION

COBO DESIGN CO., LTD.

Sphelar Power Corporation

DENSO Corporation

TOSHIBA CORPORATION/TOSHIBA LIFESTYLE PRODUCTS & SERVICES CORPORATION

TOCLAS CORPORATION

Nissha Printing Co., Ltd.

Hitachi, Ltd.

Fuji Xerox Co., Ltd.

FUJITSU LIMITED/FUJITSU DESIGN LIMITED

Brother Industries, Ltd.

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Kazuo Tanaka: Executive Director at JDP/the chairman of the board of directors In Japan Industrial Designers' Association & CEO of GK Industrial Design

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Martyn Evans	Director, Lancaster University
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(In random order without honorifics)

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1 Introduction

In the manufacturing sector, design-driven innovation and design thinking for marketing is a global movement that may make business more efficient. In Japan, there is much latent power in design, as well as in highly reliable quality control in mass production, since product planning and exploring new markets are essential for development in manufacturing.. However, there are serious global barriers to the direction mentioned above: 1) design is an intangible process, unlike manufacturing, which leads to difficulties in communication due to its ambiguous definition (i.e., poor definition framework) and in performance measurement against input resources (i.e., a lack of measurement method); 2) design involves practical engineering in industry with confidential information, leading companies to solve problems individually without sharing process management knowhow (i.e., no collaboration in design process management) and resulting in insufficient co-work between industrial activities and academic research (i.e., poor research validation in industry). We intend this paper to activate a discussion by sharing current problems and problem-solving approaches among industries as part of the national research project described above.

1-1 Summary

This report outlines the Digitization of Design/Engineering Effect. This initiative is part of the Design Management for Cross-disciplinary Teams (DMCT), led by the National Institute of Advanced industrial Science and Technology, which studies how to implement experience-value capturing technical design*1 processes and hammer out a best business management model for it with the support of the Council for Science, Technology and Innovation's (CSTI) Strategic Innovation Program (SIP) under the theme of "Innovative Design/Manufacturing Technologies." The purpose of the study is to map out how to digitize and factorize the Effect on Design/Engineering by analyzing the patterns of the relationships among design, engineering, and business teams in Japanese companies.

In our research project, relational design is a key term. Here, design variables are not items but relationships among items, including humans. This involves a human-centric design, in the relationships between items and humans via craft design and its later incarnation as industrial design, and a system design, in the relationships among items, which is an updated version of product design. Managing relational design properly requires developing a management method and tools along with the appropriate environments for creating the missing links among uncoupled teams such as market and manufacturing, user-focused design and technical design, and the service section and design section, the main objective of this project.

This paper intends to provide a basis for discussion by describing both the definition and the domain of design, proposing a measurement method for design effectiveness, and sharing current problems and future goals from a synchronic viewpoint, as well as furthering the research and development of design management for effective relational design in a diachronic sense. We set up highly challenging tasks in this paper, not based on a best-practice analysis, but by capturing the gap between the reality and the ideal by examining the real problems faced by designers. This sharing of current problems and future goals should foster the development of design.

Return on investment (ROI), much discussed in the EU and the US, is one of the most typical measurements of cost-effectiveness. However, though it might work for outsourcing-based design activities in the EU and the US, it might not be suitable for in-house design. Though ROI provides overall investment numbers, it gives no hints for improvements. Thus, we propose a new type of effective validation method by introducing the crossing of terms between customers' responses and resource management in product development following several discussions with researchers in the EU. This empirical formula has not yet been validated by companies or academics. We share this empirical formula to encourage discussion

1. about design effectiveness measurement in Japan, including the feasibility of this formula, and
2. about the elements used in this formula (i.e., about customers' interest items in a new product for current as well as future market bases) and contributions from various teams (led by the teams working at the front end).

As mentioned, the main purpose of this paper is not to offer a goal but to trigger a discussion on issues concerning design, such as its definition, effective measurement, current problems, and future goals. This is why this paper is called a "Action toolset."

The 14 manufacturing companies we examine constitute a sufficient sample because the firms were selected to represent a wide distribution of patterns in the formation, positioning, and size of their design teams, allowing several common tendencies to be observed even within this limited number of cases.

*1 Experience-value capturing technical design is not a detailed design process performed after the design specifications are set during back-end activities but the early stage of design before the design specifications are validated that explores customers' values, decides the target and concept of the product or service, defines the required functions, and verifies manufacturability, which the paper discusses below.

1-2 State of the Art

The paper's proposed methods are summarized by the comparison between them and conventional ones.

A cost-effectiveness survey (*1) conducted by the British Design Council increased company awareness of the importance of good design practices and encouraged them to implement them. For example, they state that "we can expect a £20 return from every £1 invested in design." The data show the result of a cost-effectiveness measurement that observed changes before and after a company's engagement with good design practices.

Maximizing the success of a cost-effectiveness analysis in Japan requires a method of assessing the impact of good design practices on a project-by-project basis in comparison with more holistic measures that quantify the success of a whole company or industry.

A related survey (*2) conducted by €Design was also extremely useful. It employed a quantitative method to systematically record the contribution of design to overall company activity. For this study, we decided to conduct interviews to collate qualitative data within the limited time available, enabling us to measure the detailed contributions of both design and conceptual engineering (*3) from a real-world perspective.

In Japan, few initiatives have been taken to quantify design cost-effectiveness. Our intention was to create a document that would help companies implement a better new product development (NPD) process.

Previous Method:	A cost-effectiveness measurement of the overall business benefit from the introduction of strategic design practices.
Proposed Method:	A cost-effectiveness measurement of the contribution of both design and conceptual engineering teams on an individual project basis.

Previous Method:	A quantitative survey method that measures the value of design.
Proposed Method:	A qualitative conversational survey method that captures the real experiences of and attitudes to current and ideal design practices.

*1 Designing Demand National evaluation 2007–2012, Eden Partners (2012)
*2 Measuring Design Value, €Design | Measuring Design Value (2014)
*3 Conceptual engineering refers to "activities prior to decisions on specification" conducted by the Engineering Department.

1-3 Research Outline: Proposed Methodologies

Effectiveness measurement model

Description	• Effectiveness measuring methods (using data within a company). • Combine data from both manufacturing and customer sides. • Measure the contribution of each team by subjective opinions (not only by time or cost). • Measure effectiveness of individual projects. • Activate discussion on design's effectiveness measuring
Potential Benefits	• Individual project effectiveness measurement (which has not been attempted). • Compare each project's effectiveness and allocate accordingly. • Collect multiple sets of measurement data and create data patterns, such as product categories. • Foster a discussion about how many design resources should be allocated to each project.

A Field-based Distribution Survey

Description	• Visualize the balance between resource allocation and the contribution of each team. • Visualize the gap between the current and ideal balance and also between different divisions. • Use interviews to effectively understand the obstructions causing misalignments. • Determine the patterns of different projects or divisions.
Potential Benefits	• Foster discussion by clarifying the different opinions among the teams. • Support better project planning within the time and cost constraints. • Create a clear understanding between managers and practitioners. • Together with the proposed measurement method, create a tangible approach towards a better design process.

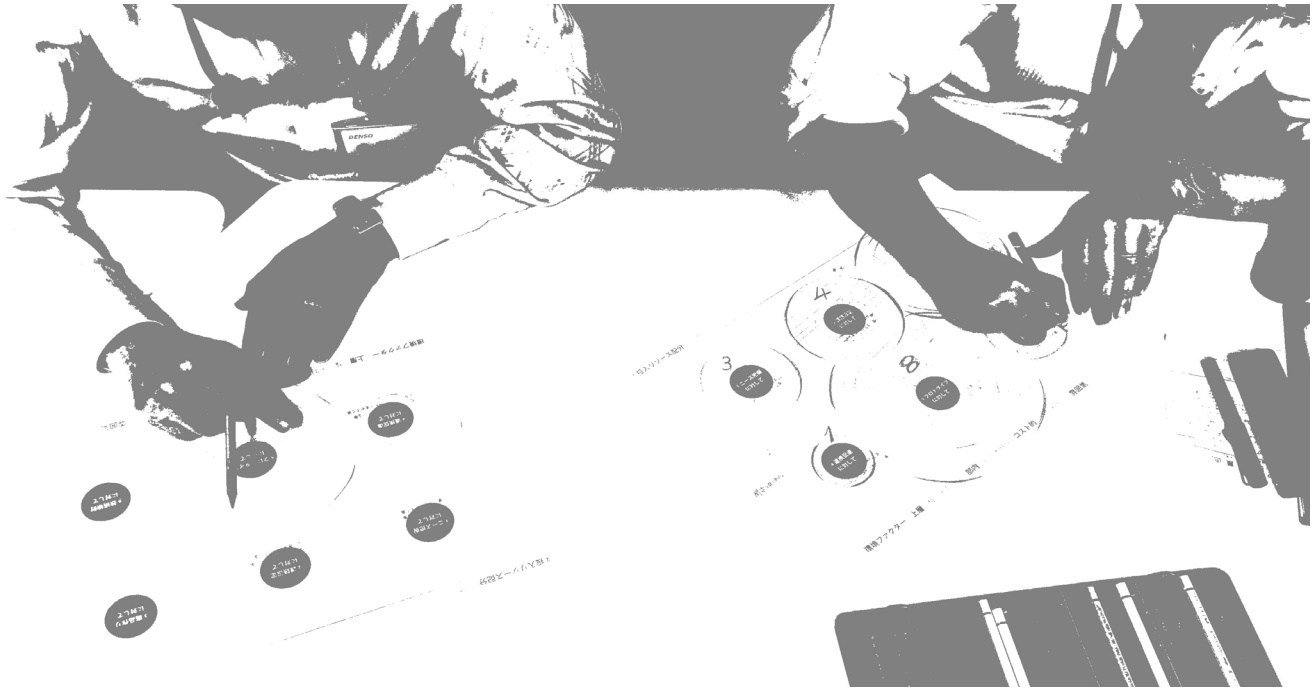
1-4 Configuration of the Material

Mission of this paper

This paper tries to describe the implicit knowledge or feeling in the design process by explicit visualization so that both design and engineering teams in front-end activities may begin dialogic communication for better design performance.

Configuration matrix with user guide

	Design and concept engineering: please refer to p. 7	Measurement model of design effectiveness: please refer to p. 9	A field-based distribution survey: please refer to p. 13
Explicit definition	• Coverage • Role	• Customer response • Process contribution • Before-and-after differences	• Distribution of input resources • Distribution of ripple effect • Gap between the current and the ideal
Sharing targeted section	• The section with a limited idea of the effectiveness of design elements, such as color and form • The section interested in concept engineering	• Management executives • Business unit • Development departments	• Design department • Concept engineering department
Subject for intensive discussion	• Proper use of design • Proper use of concept engineering	• Direction of product development • Customers' interests and their ratios • Section-in-charge's contribution • Expectation, result, cause	• More sensitive to input resource • More sensitive to ripple effect • Recognition of obstructions to the ideal • Discussion on improving circumstantial factors



2 Design & Concept Engineering

The target of this paper is NPD, including service and maintenance, and the targeted process is the front-end, before the design specifications are set. We focus on the design and technical design teams among the many divisions involved in NPD, such as product planning teams, sales teams, and marketing teams.

This paper's design and engineering target is relational design; this includes items-to-humans design (or "human-centered" design, which flowed historically from first craft and then industrial design) and items-to-items design (or "system" design, which grew out of product design). Design goes beyond color and form factors to encompass insight gathering and problem solving. We clarify the exact roles of the two teams in the following pages.

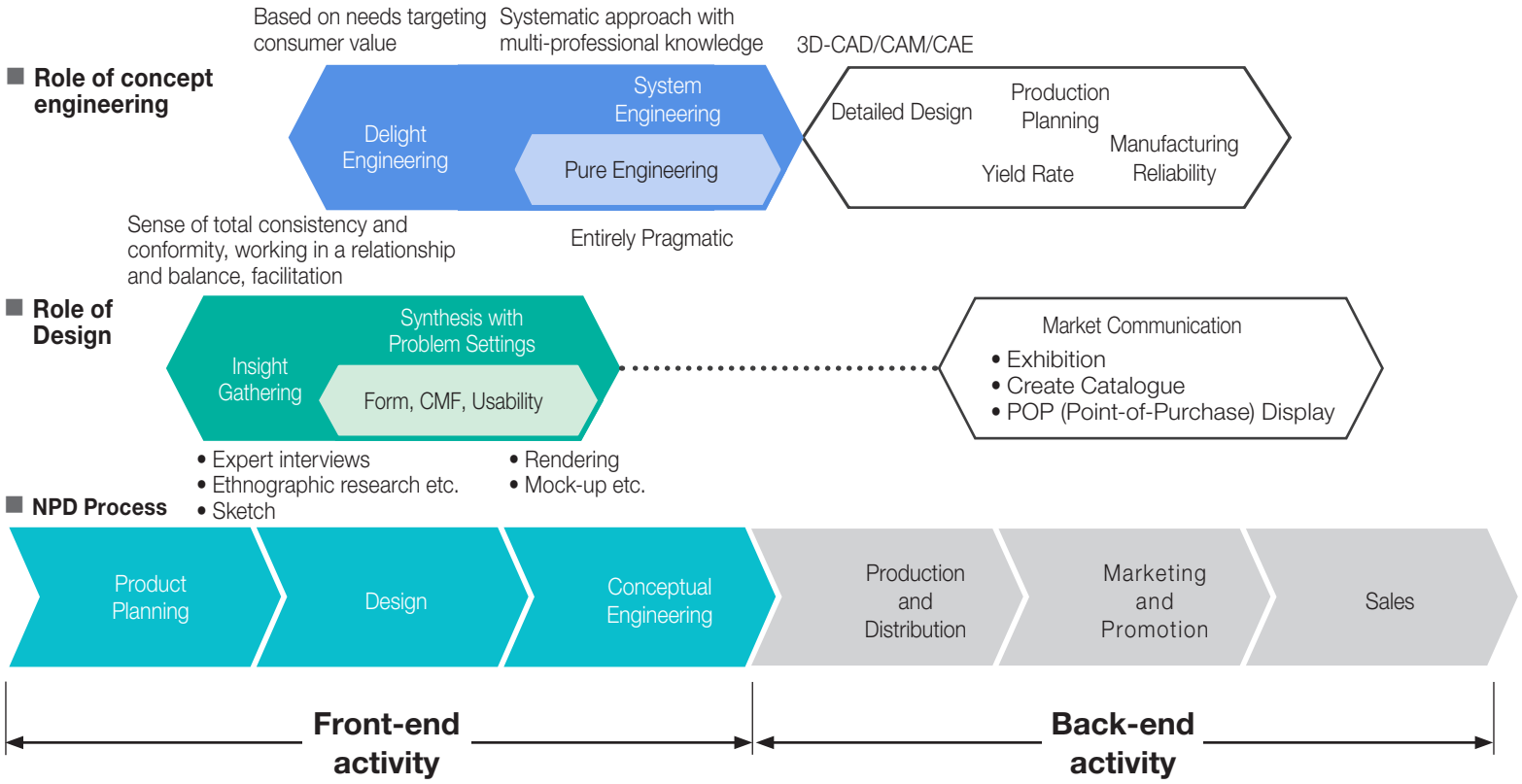
2-1 Design & Concept Engineering: An Overview

We outlined our view of design and technical design roles using published references and a pre-interview survey.

Design has expanded its role from involving just color and form to include insight gathering and problem solving. Technical design has expanded from “pure engineering” to system engineering and delight engineering. The fact that the two teams now have wider roles means that they are liberated from their closed specialties, enabling increasingly effective cross-disciplinary activity.

Although this study targets front-end activity, front- and back-end activities are related: back-end activities such as manufacturability, yield rates, manufacturing reliability, and market communication are all considered in advance during the front-end activities of advertising design. This framework for design and engineering should be used in discussions among sections, while considering the company’s structure and position.

Our focus in this study



2-2 Design and Concept Engineering - Their Relation

This conceptual diagram expresses the hypothesis formed in preparation for the interviews with companies and experts.

In the West, the word “design” often includes both the Japanese meanings of “design” and “engineering.” In Japan, the two disciplines exist separately. This can cause a beneficial effect, such as “challenging the threshold value of technology,” created when the designer directly questions the engineer. However, negative effects also occur, such as a gap between the understanding of a market and that of the producers.

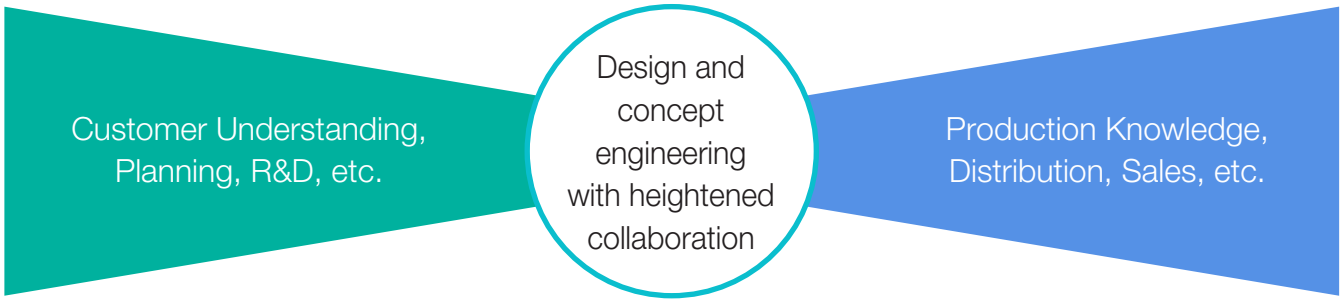
There is an old analogy in which the design department draws a “pie in the sky,” and the engineering department creates an “unappetizing pie.”*1 However, many Japanese companies have recently facilitated cooperation between these two departments. Company-specific resource allocation and the contributions of both the design and engineering departments were primary points of discussion in the interviews carried out for this study.

Previous Relationship between Design and Conceptual Engineering

Design was leaning too much towards “pie in the sky” by focusing on style with no interest in technology, while conceptual engineering made “unappetizing pie” by showing no interest in customer surveys.

Current Relationship between Design and Conceptual Engineering

Conceptual engineering can obtain better customer understanding at an early stage by collaborating with design teams. The same can be said for design: better communication with conceptual engineers allows a greater understanding of manufacturability and cost at an early stage.



*1 Comment made in an interview

3 Effectiveness Measurement Formula

The most difficult aspect of creating an effective measurement formula for new production development is anticipating future customer expectations in a static market system for decision-making concerning resource allocation for design and engineering because new products introduced to a market change market behavior and customers' lives, as in any dynamic system. Using customer questionnaires systematically may help companies model customer expectations.

Traditional ROI covers only the return against the investment in terms of an overall number, ignoring the role of customers and the effectiveness of designers' efforts. This provides analytical data but offers no guidance on capturing consumer needs. Our proposed approach offers ideas on how to identify customer needs and market requirements by considering both the customer's "investment" in the purchased product/service and the section-in-charge's contribution to making it.

3-1 Characteristics of Proposed Formula

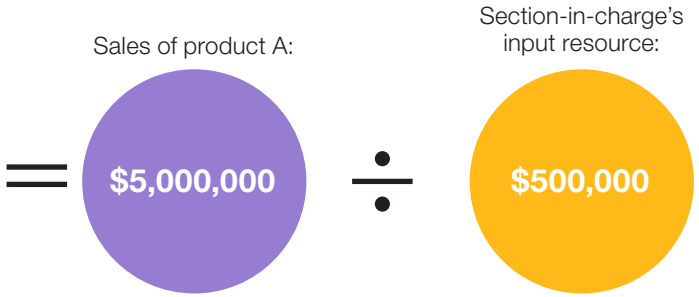
As with European cases, the economic value of design can be measured. Many types of values are considered, such as sales, gross profit, and net profit. We use overall sales as the output for convenience of explanation in our measurement formula. The inputs used vary depending on the product, category, and duration of the project. Relevant criteria must be clearly defined in order to identify an appropriate measurement technique.

"Cost performance of the section-in-charge's input resource against sales of the product A" is the ratio between sales amount and the section-in-charge's devoted resources. This has shortcomings, as described below, which the proposed model formula has overcome.

The advantage of the proposed formula is that the customers' interest-oriented term*1 is explicitly introduced. There is little awareness of how much design contributes to the sales of a product; this model brings this question to the forefront of discussion. The proposed approach multiplies the decomposed contribution rates of the customers' interest items from each team and the customers' interest item rates together with the NPD's resource input and product sales.

Conventional ROI formula

Cost performance of the section-in-charge's input resource against sales of product A

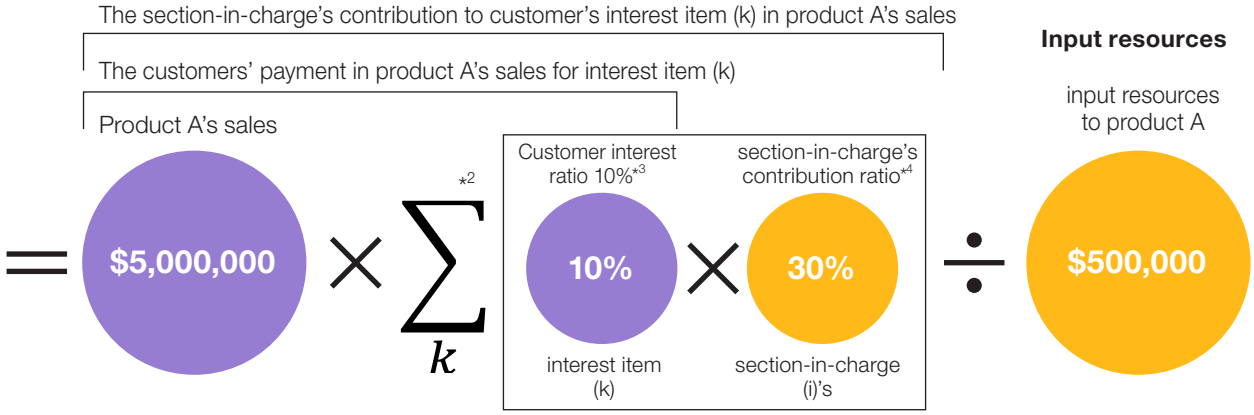


Shortcomings

- Dependent on other sections' input resources
- Insufficient index for future investment
- Nothing to do with KPI (key performance indicator)

Proposed scheme

Effectiveness measurement of section-in-charge's contribution against product A's sales



*1 Customer here means product purchased user or consumer.
*2 Summation of interest ratio × concerning ratio: For example, brand 5% × concerning ratio 10% + Styling 15% × concerning ratio 20% + usability 30% × concerning ratio 20% + Performance 15% × concerning ratio 20% + reliablity 15% × concerning ratio 10% + price 20% × concerning ratio 20%
*3 Customer payment rate for the interest item (k)
*4 The section-in-charge's contribution ratio to customer's interest item (k)

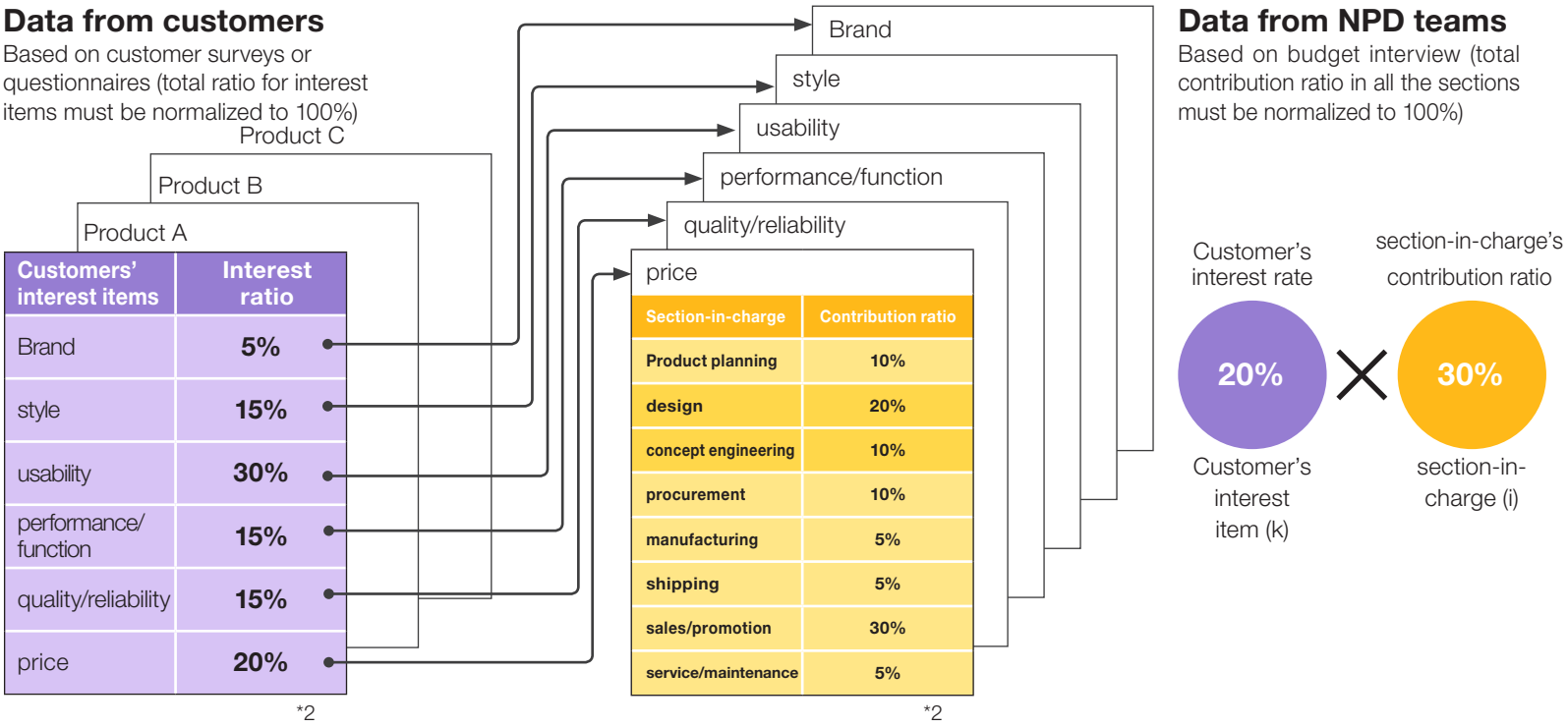
3-2 Measurement model

There are three key elements that the company must understand, as shown in the diagrams below. First, the customer's interest ratio describes the extent to which the customer is interested in the characteristic items of the product/service in terms of purchase decision. Firms must also understand the underlying issues that drive customer purchasing habits (i.e., customer interest). A carefully considered questionnaire or interview should be used to gain a clear understanding of what customers are most interested in. These customer interviews could be integrated within the existing marketing and customer research activities of a large manufacturer. The summation of the ratios must be 100% for normalization.

The second element pertains to how much each section-in-charge contributes to each term in the customer's interest item. The contribution ratio is a function of resources (i.e., budget, time, manpower, and creative credit for product development). The total amount of the contribution rates summed up to all sections must be normalized to 100% in interviews and discussions, where a calibration fit to each employee's sense or feeling is important.

Third, not only a measurement after the product is introduced into the market but also a market prediction is conducted for the two terms. For a proper prediction of the customer's interest items and interest item ratios, cooperation among the sales, market, product planning, and design sections is needed, while the sections' adjustments are required for the contribution rates of the section-in-charge.*1

The merit of this model is that it encourages communication among various disparate sections for normalization and calibration. Applying this formula in a company requires authorization from all the sections (e.g., design, engineering, manufacturing); however, local operation is also possible.



*1 Please refer to section 6-1 for the PRV method for NPD process flow (p. 35)

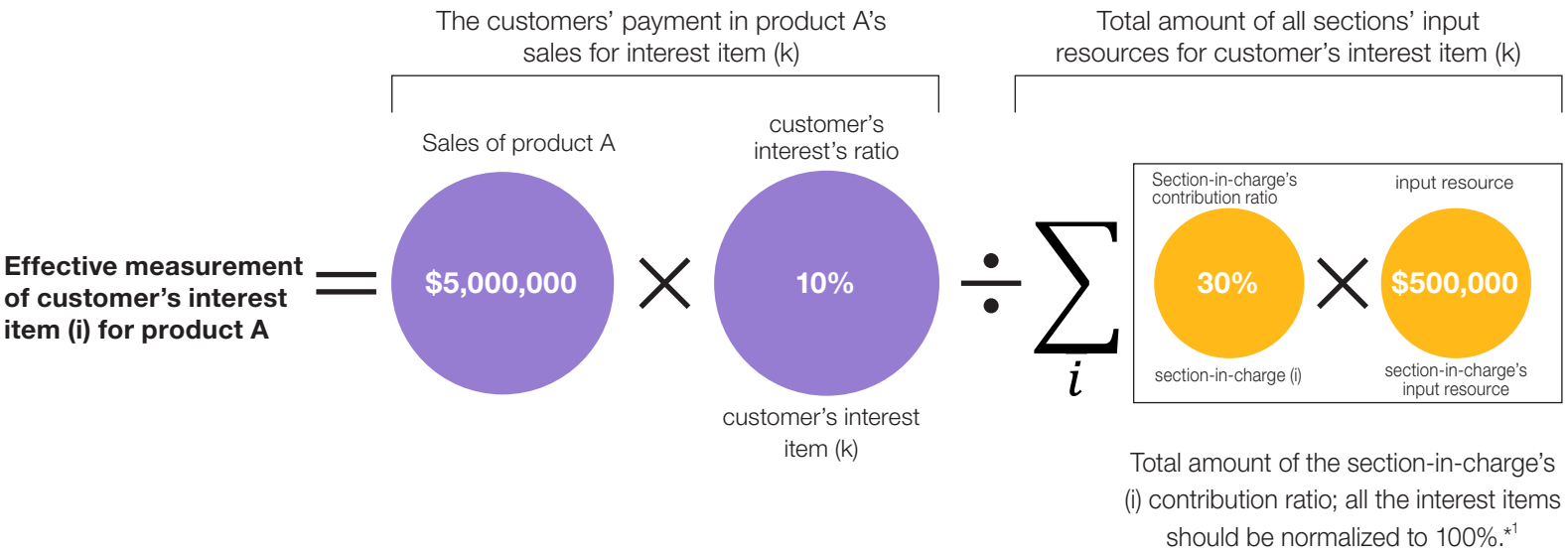
*2 Numbers in the figures are provided only as examples for convenience of explanation

3-3 Application Example

You can modify the formula for the effective measurement for customer's interest item (i). For example, suppose you take the ratio between the sales and the total amount of input resources summed up in all the sections with customer's interest item "brand" (this summation method is different from that described previously). If you compare the set of this measurement for several interest items (i), you can determine which interest item (i) is most effective. You must not be too sensitive to temporary numbers but carefully average the observations of the measurements over several years to avoid market and customer response noise.

The purpose of this formula is not to obtain exactly accurate values but to promote section-to-section discussions and sharing of customer responses. The discussions and idea exchanges should ideally be activated by applying this formula to bridge current market response-based sales and sections to design and concept engineering intended for future market exploration.

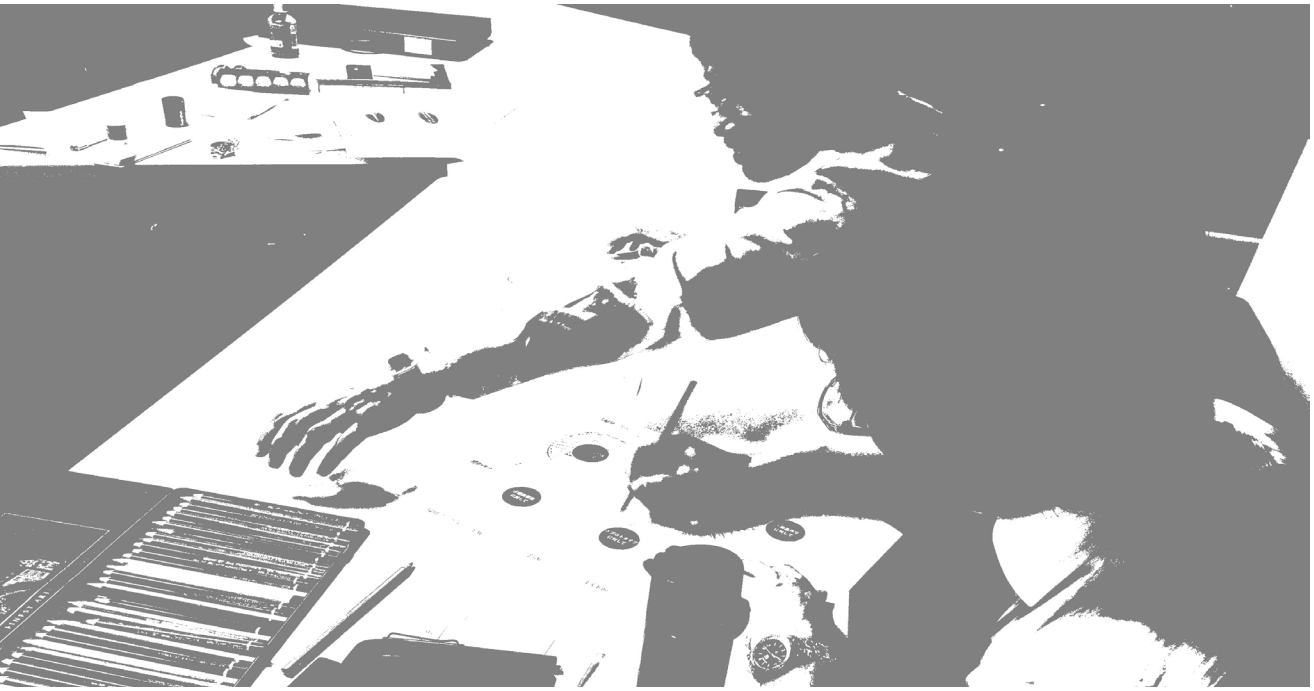
Also, this formula could be extended to foreign markets, to activate communication between main and branch offices, for example.



*1 Product A: section-in-charge's contribution ratio to interest item * input resource:

- Brand (product planning section (contribution ratio 30% * resource $100,000) + design section (contribution ratio 20% * resource $200,000) + concept engineering section (contribution ratio 10% * resource $200,000) + procurement section (contribution ratio 10% * resource $300,000) + manufacturing (contribution ratio 5% * resource $500,000) + shipping section (contribution ratio 5% * resource $100,000) + sales & promotion section (contribution ratio 40% * resource $100,000) + service & maintenance section (contribution ratio 10% * resource $200,000)
- Style (product planning section (contribution ratio 20% * resource $100,000) + ...)
- Usability (product planning section (contribution ratio 10% * resource $100,000) + ...)
- Performance & function (product planning section (contribution ratio 20% * resource $100,000) + ...)
- Quality & reliability (product planning section (contribution ratio 10% * resource $100,000) + ...)
- Price (product planning section (contribution ratio 10% * resource $100,000) + ...)

Total amount of product planning section's contribution ratio; all the interest's items (summation must be 100%) = brand 30% + style 20% + usability 10% + performance & function 20% + quality & reliability 10% + cost 10%



4 Field-based Distribution Survey: Outline

The success of design activity depends on the mutual interaction between the uncertainty of the market and customers (i.e., the effectiveness of market research) and the design's optimal resource allocation (i.e., validation ability). The former requires ethnographic research or customer-reaction feedback via prototyping; the latter requires pre-evaluation via methods such as multi-domain CAE (computer-aided engineering).

The output from an effective measurement formula can be used to evaluate the relative success of a process; however, it will not, alone, improve performance. Thus, an interview methodology was designed to gain a better understanding of how best to allocate resources and which objectives to focus on.

4-1 Targets and Method of Interviews

The employees of 14 Japanese manufacturing companies were interviewed. Representatives from three divisions (Design, Conceptual Engineering, and Business) were invited to participate. Due to their busy schedules, some respondents replied on behalf of their absent colleagues.

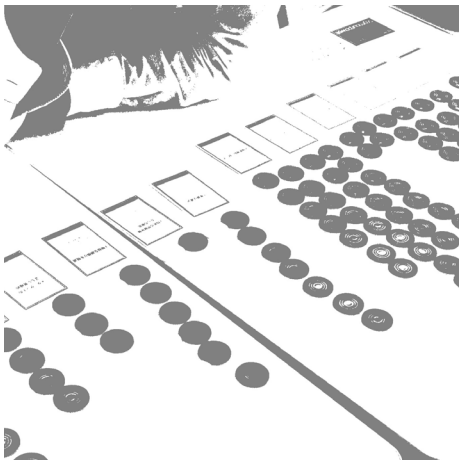
The objectives of these interviews were to highlight the variance between the current and ideal situations and to identify differences of opinion among the teams.

Respondents were asked to base their responses on one project that involves NPD and innovative solutions (involving either product concepts or how they sold the product) and that featured more involvement from either the design team or the conceptual engineering team. An interactive approach was adopted to engage the respondents and gain as much information as possible. Playing cards were prepared with inputs and outputs printed on them. Thirty coins were used to represent a limited amount of resources. Participants were then asked to allocate coins to the cards in a way that reflected their current NPD situation and then their ideal NPD situation.

The purpose of the interviews was not to highlight the differences between the participating companies but rather to identify the differences between their current and ideal situations. This interview technique was well-accepted by some participants, who expressed a willingness to use it to plan their next project's resources.

Combinations of the respondent types contributing to each interview

1 x Design, 1 x Conceptual Engineering, 1 x Business team	5 cases
1 x Design, 1 x Business team (Business served as a proxy for functional engineers)	2 cases
1 x Business team (Business served as a proxy for other departments)	1 case
2 x Design (Design served as a proxy for other departments)	2 cases
1 x Design (Design served as a proxy for other departments)	2 cases



*1 A snapshot of our interview using playing cards and coins

4-2 Field-based Distribution Survey: Resource Allocation and Objectives

The objectives of these interviews were to highlight the variance between the current and ideal situations and to identify differences of opinion among the teams.

Referring to the answered distribution map in each subject on input resources and output objectives in the real and the ideal, interviews are conducted to clarify the background cause for distribution differences (gaps) between the real and the ideal.

Six areas of Resource Allocation for NPD

Potential obstacles: Authority, Expectation, Ability, Experience, Time, Budget, Culture, etc.

1	2	3	4	5	6
Identify Needs	**Set Objective**	**Concept Creation**	**Improve Com-munication**	**Prototyping**	**Apply Suitable Technologies**
Qualitative and Quantitative Research	Set clear criteria for achieving goals	Create and visualize the idea	Improve internal collaboration	Confirming feasibility and gathering feedback	Feasibility and relevance of technology

Six areas of Ripple Effects Distributions for NPD

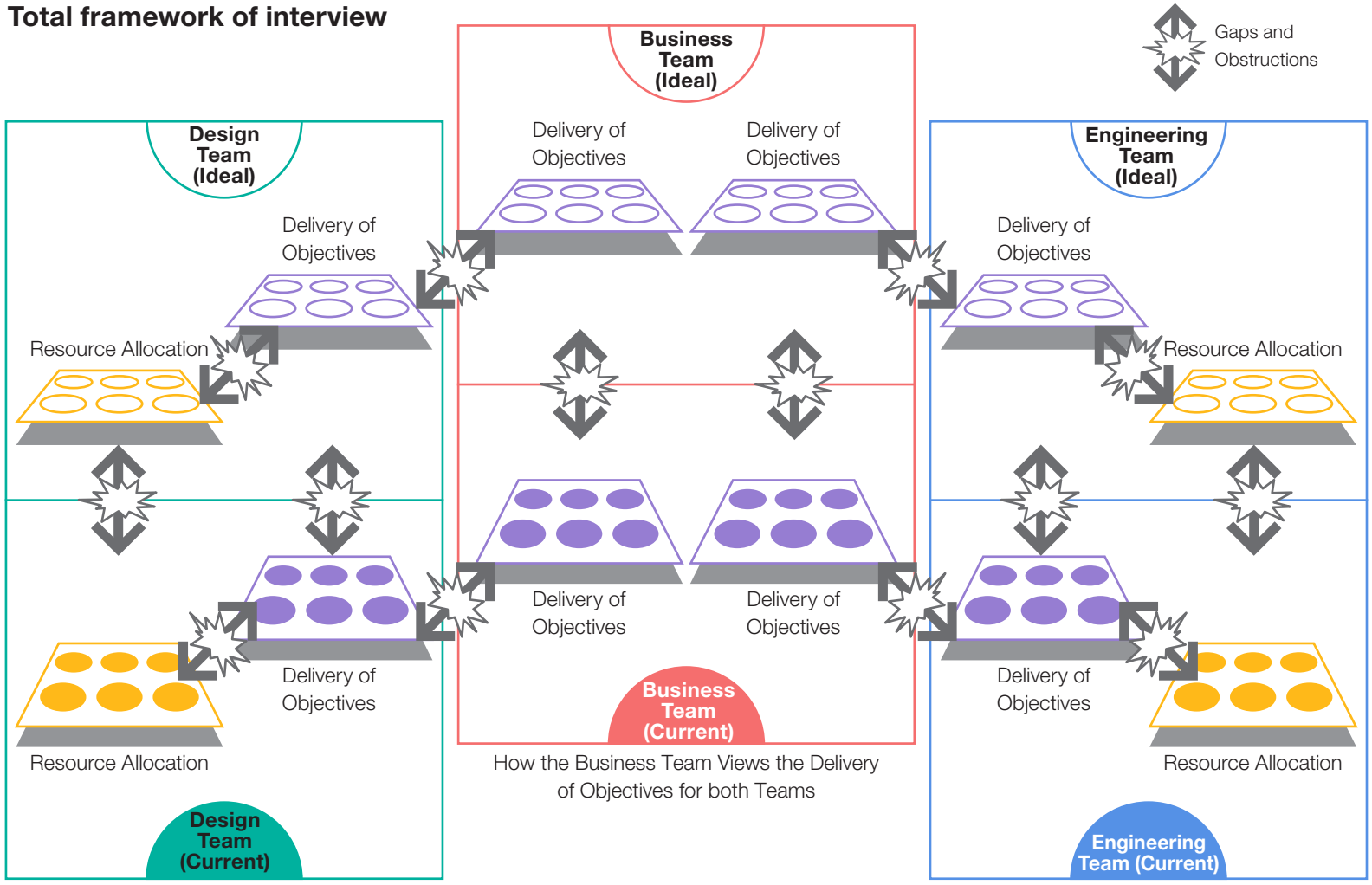
Potential obstacles: Culture, Size, Time, Stakeholder, Market, Customer, etc.

1	2	3	4	5	6
Minimize "Reworking"	**Technological Awareness**	**Avoid Unnecessary Effort**	**Identify the Target**	**Create Innovative Solutions**	**Attention to Detail**
"Get it right the first time"	Utilizing technology internally and externally	Best allocation of resources	Target user and relevant business model	New solution of technology and/or design	Deliver trustworthy high-quality solutions

The figure below shows the multi-scanning of the interview into three sections—design, concept engineering, and business—for the current and ideal situations.

We can identify common characteristics despite the limited number of cases.

Total framework of interview



How the Business Team Views the Delivery of Objectives for both Teams

How the Design Team Views the Balance of Resource Allocation Delivery for Objectives

How the Engineering Team Views the Balance of Resource Allocation Delivery for Objectives

4-3 Qualitative Analysis through Interview Comment Clustering (1):

For quantitative analysis, interview comments on similar themes are displayed as clusters.

Messages from Design

The Importance of Customer Needs and Target Customers.

- The target customer is important for design.
- The designer is the one best able to ascertain the target customer.
- We spend time thinking about questions like “What should we make?” and “What should we do, and who should we target it at?”
- I want to do more work on customer needs, but reducing other areas could be difficult.
- In the future, the linkages with customer needs will be important.
- Design is an active process that seeks out needs that the user doesn’t yet know they have.
- Just clarifying the customer needs would increase our freshness, I’m sure.
  Don’t just leave it to a research company. The designer must go and see it on the ground.
- Designers must spend adequate time when clarifying customer needs and defining problems.
- We could make customer-needs clarification more effective, but we have so much to do already that we can’t reduce anything else.

Invisible Contribution, Bad at Presenting Value

- We are not trying hard enough to present or value the management level
- No other profession involves contact with as many different perspectives as design.
- Design is not able to convey its worth in terms of freshness, superior functionality, or social benefit.
- For example, their contribution can’t be seen even if the designers themselves make the product-proposal documentation.

Use Us Well!

- Operations divisions that think there is value in investing in design will do so.
- If design simply focuses on appearances, then it won’t be able to make a contribution.
- People who still have an old-fashioned view of design still request things like high levels of perfection and products that will be hot sellers.
- Some people view designers as magicians who can produce novelty and freshness from even the most ordinary technology.
- Focusing on preserving perfection will mean that the designer will go to waste.
- Design can contribute Concept, Communication, and Coordination.
- The ability to express how the whole will change if something is altered...that kind of birds-eye level proposal skill. The ability to make coherent proposals.

Worries about Working on Multiple Projects at Once

- I’m working on two projects at the same time, so I just can’t keep my head in order. I give one product priority and then the one after that gets neglected.
- I am working on multiple projects simultaneously, and there is just not enough time.

We Want Trust and Decision-making Power!

The designers in the operational division who have high numerical and technical skills have fought hard against a prevailing atmosphere of "What are designers good for?" for 10 years to carve out their position.

Designers can't see things from an operational or business perspective. People just say "Ah, design is just design." In the past, comments in meetings have not carried weight.

I want them to give their input when things are brought up like, "The cost is this; the configuration is like this… so?"

Weakness when it comes to debating profitability.

The perception of the designer as an outsider has not disappeared. They still refer to us as "those design guys."

The funding for the design department comes from the operations division. In this context, it is difficult for us to have our voices heard.

Designers have no decision-making power. They are not trusted. It doesn't matter because the stuff won't sell anyway.

Change!

I want to understand what can happen when using the technology.

I want to develop designers who view usability as their calling.

I want to be able to proactively propose ideas, without thinking that it's the job of management or other departments.

An attitude of being eager to learn a wide range of things.

I want to develop better numerical and technical skills so that I can have a stronger presence in the operational division meetings.

Cooperation with Engineering

I want engineering to share an understanding of the issues with us.

If there were more input from engineering regarding the user image, then I could adjust things more precisely. If it were this way, I would consider coming up with ideas for technology.

I would like technology to have more input from the early stages. I would like them to understand that differentiation will be impossible without some kinds of technologies.

Cooperation is a new way of working, which makes all kinds of things possible.

If there were more interaction between design and engineering, we'd be able to produce results faster.

4-3 Qualitative Analysis through Interview Comment Clustering (2):

Messages from Engineering

I'm too busy! No time to spare!

As our time is limited, we have a habit of doing the technical investigation and gaining security for the prototype before losing our way.

It's getting to be a competition based on perfection, but, in reality, I want them to put more effort into an investigation of the target consumer and product concept.

I feel overworked, so I don't really access new information. A relaxed 10 minutes is very different to a rushed 10 minutes. I hate the fact that everyone is so constrained by time.

There is no time to find out what is happening outside. Absolutely no time. We are at breaking point just trying to keep things going, Demand is up, and quality should be number one.

It's a culture or attitude of having to get everything done first. Every possibility has to be tried out. I get so tired.

Time and money. It will get even worse in the future.

The definition of the target consumer is weak, so it just becomes a case of "Ah, OK. First of all, we need to make everything."

Prototyping

Even without large-scale tests, if we have a set direction, then prototyping can be reduced.

Working on prototypes is essential when making new things.

There is a tendency for too much time to be taken up after prototyping. It would be good to be able to foresee expected technical issues and costs at the initial stage of problem definition.

If more prototypes were made, then time spent on technical assessment would decrease.

Cooperation with Design

There is little upstream interaction and a lot of cooperation at the results end.

Ten years ago, the designers just said, "You guys take care of it!" I want more cooperation, and I want them to do more problem-definition themselves. We won't be able to create new things if we can't cooperate.

As the design was slow to emerge, cooperation took a lot of our time, but things have become a little easier now that we have a place to share directions beforehand.

Change!

There is a lack of training where we need to think. I want us to become creative together.

Japanese engineers are too quick to set things out in numerical targets.

They lack the will to do problem-definition themselves.

Engineers with a design perspective are the most powerful.

Change from an order-taking to a proposal-based or exploratory model.

4-3 Qualitative Analysis through Interview Comment Clustering (3):

Timing of Product Introduction

Time and the timing of release is all-important. You won't learn anything unless you release it. Learning from the experience is a good thing, but there are times where the product is killed off in the debate leading up to release.

Even if you make something good, there is no guarantee that it will sell. The timing of the release is important.

We need a system where pirated products can't circulate.

We've had the experience of working hard to develop something but then not making any money from it. If we are too early, then we will create the market, but others will benefit from it.

Preservation and Challenge

There is a feeling that, if business is going well, then that is precisely the reason why we should dare to take on some new challenges.

I want all operations that are making money to continue for as long as possible. If we can't keep those resources going, there won't be any money to spend on new projects.

Development of routines takes priority. We need to secure the operations that are the foundations of market and customer development.

Medium-term and Short-term Planning

Making changes every time the partner or goal changes makes things very difficult. If we had medium-term stock, then the current process would become easier. If we had medium-term quantitative data, then more time could be spent on actually designing. If we recognize a relative priority—for example, something taking a long time but of little importance—we can spend time on the things we should be spending time on.

A step-change enlargement in the size of our market is a possibility. We need to think hard about how we are going to survive in the long term.

Needs Identification, Problem-setting, Product Concept Creation

Through IT implementation cooperation, efficiency will be raised, so I would like to spend time on this area.

Producing defective products is a problem, so even more time needs to be spent on this.

Suppose we can propose an acceptable concept of a home appliance in the early stage, then we won't need to spend time on the later stages. Projects go well when we make a concept catalog, propose it to the operational division, and share it with related parties, etc. We are working on this stage.

The first three areas are weak in the first half, which uses up resources in the second half, and we run out of time.

I want engineering to share an understanding of the issues with us.

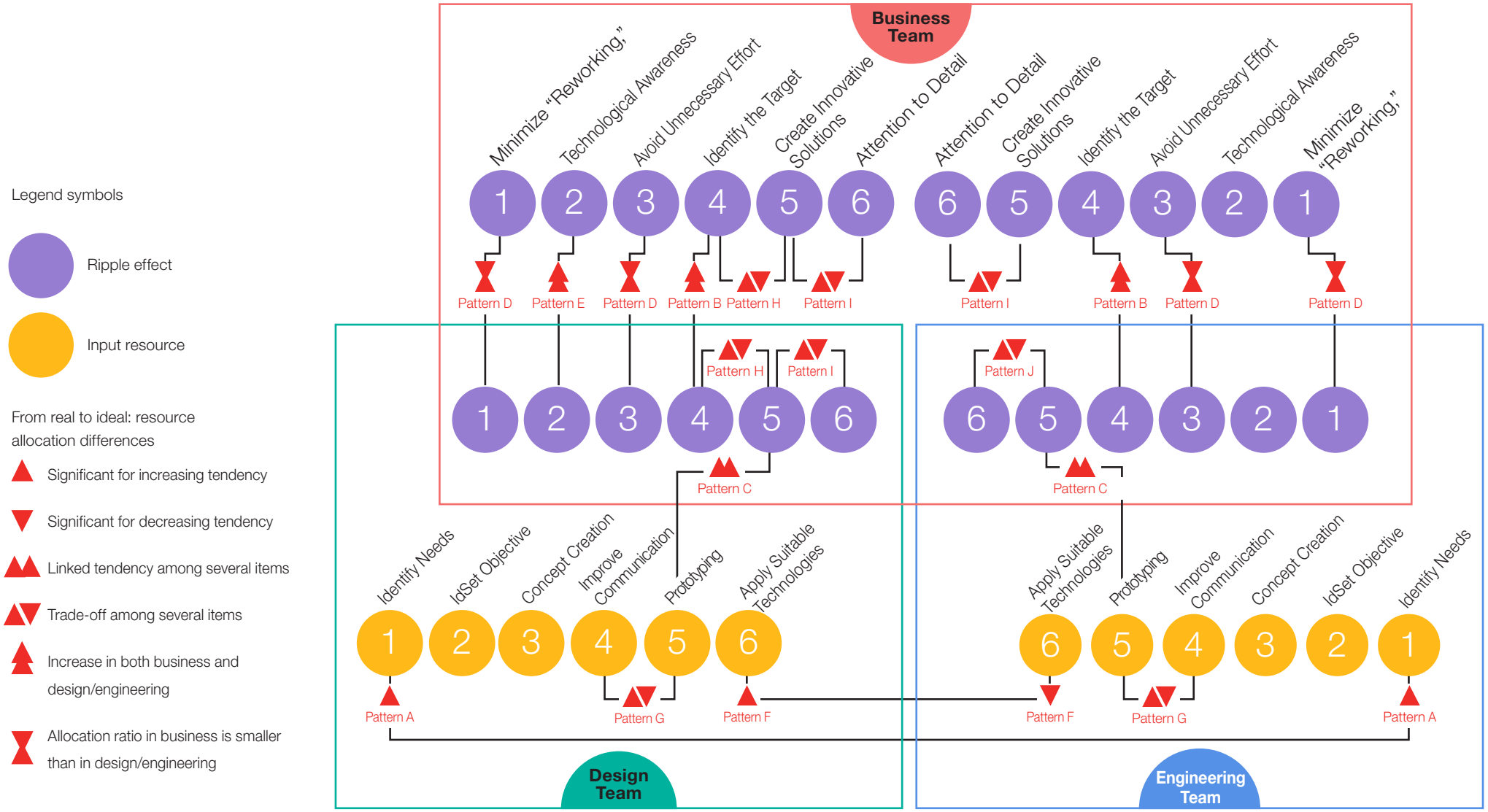
I would like them to understand that differentiation can't be achieved without this technology.

In order to establish the target, customer needs and challenges need to be understood.

If there were more input from engineering regarding the user image, then I could adjust things more precisely. If it were this way, I would consider coming up with more ideas for technology.

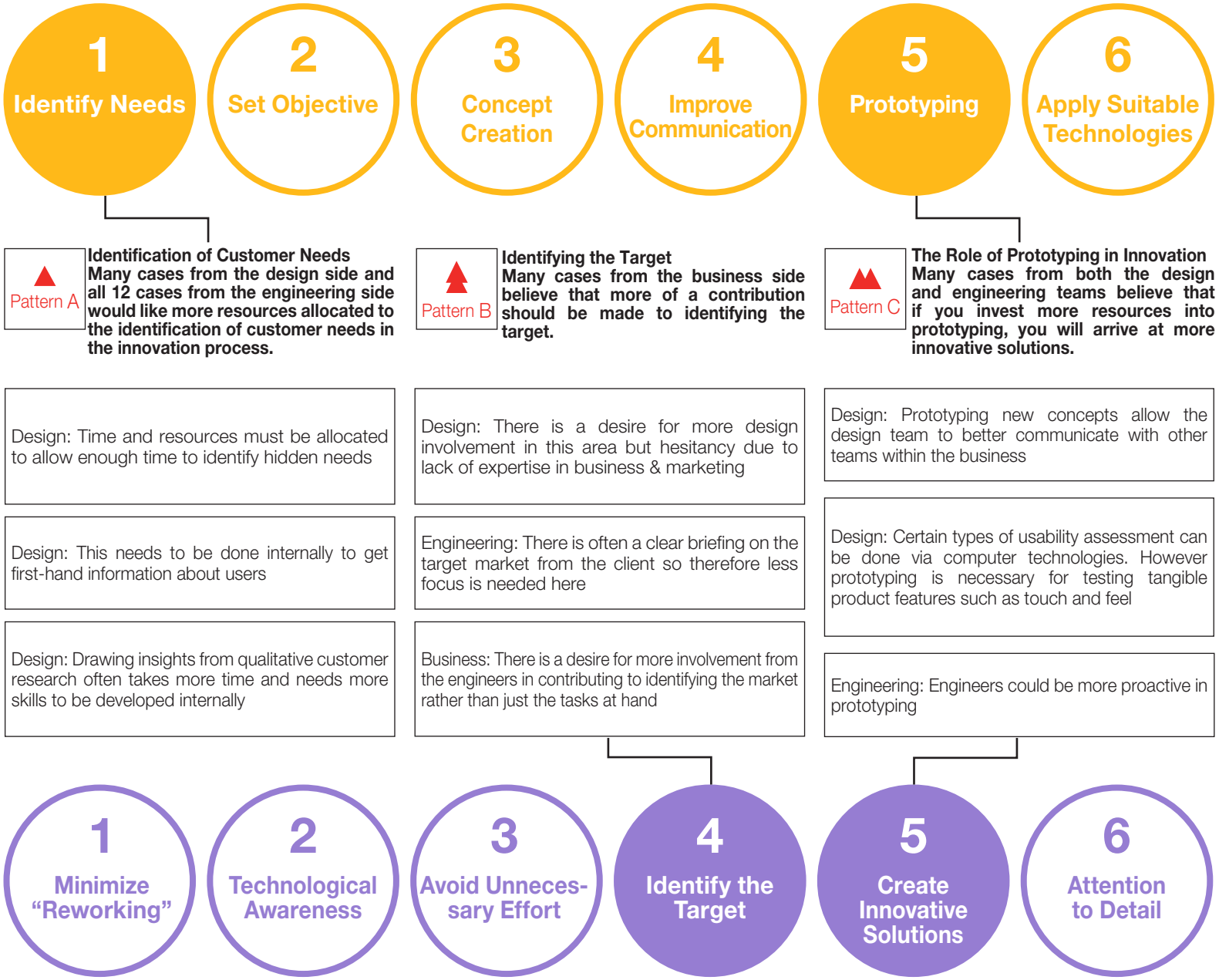
4-4 Overview of analysis

Here, we classify the differences in behavior and tendency between the real and the ideal into three categories:—global issues, unexpected tendencies, and locally unsolvable problems—to visualize the quantitative analysis.



4-5 Quantitative analysis on resource allocation differences between real and ideal (1)

Global issues



4-5 Quantitative analysis on resource allocation differences between real and ideal (2)

Unexpected tendencies

Pattern D

Work Efficiency
Many cases from the business side believe that the design and engineering contribution is less than what the engineering side believes it is contributing to reduce other teams' wasted work.

- Design: Business unit consider reducing rework or no-policy trial & errors by design is not special contribution. It's a matter of course
- Business: Design related prototyping is not a big issue in a whole company's level
- Design: Design's skill or contribution is not sufficiently represented to other units, which provides gaps on expectation or role of design. Stylish design is not a design's core

Pattern E

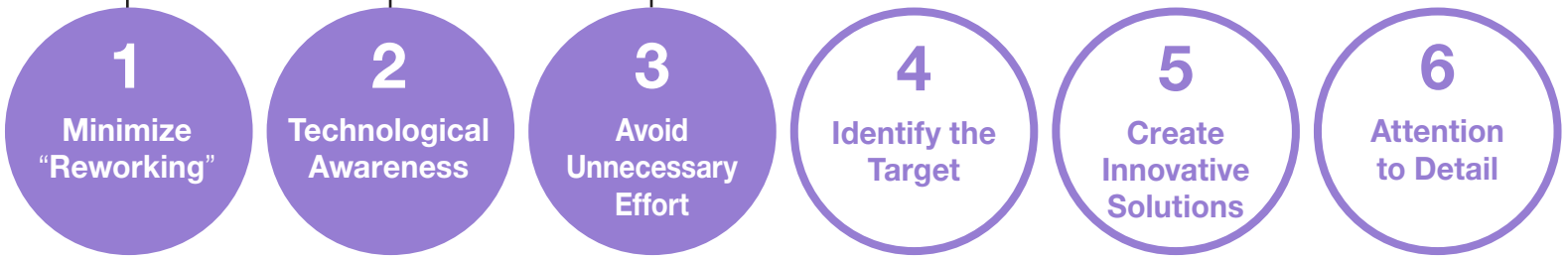
Internal & External Technology Capabilities
Many cases believe that more design team resources should be allocated to working on internal and external technology capabilities.

- Design: More collaboration with engineers during the technical assessment phases is key. Increased sharing of ideas and information between engineering and design teams results in novel ways of applying new technologies
- Design: Designer has a potential to find some excellent technology and to link it with its use, which is a real designer's important work
- Engineering: Engineers could be more proactive in prototyping. Developing technologies internally requires more time and cost investment and would therefore need partnering with another company

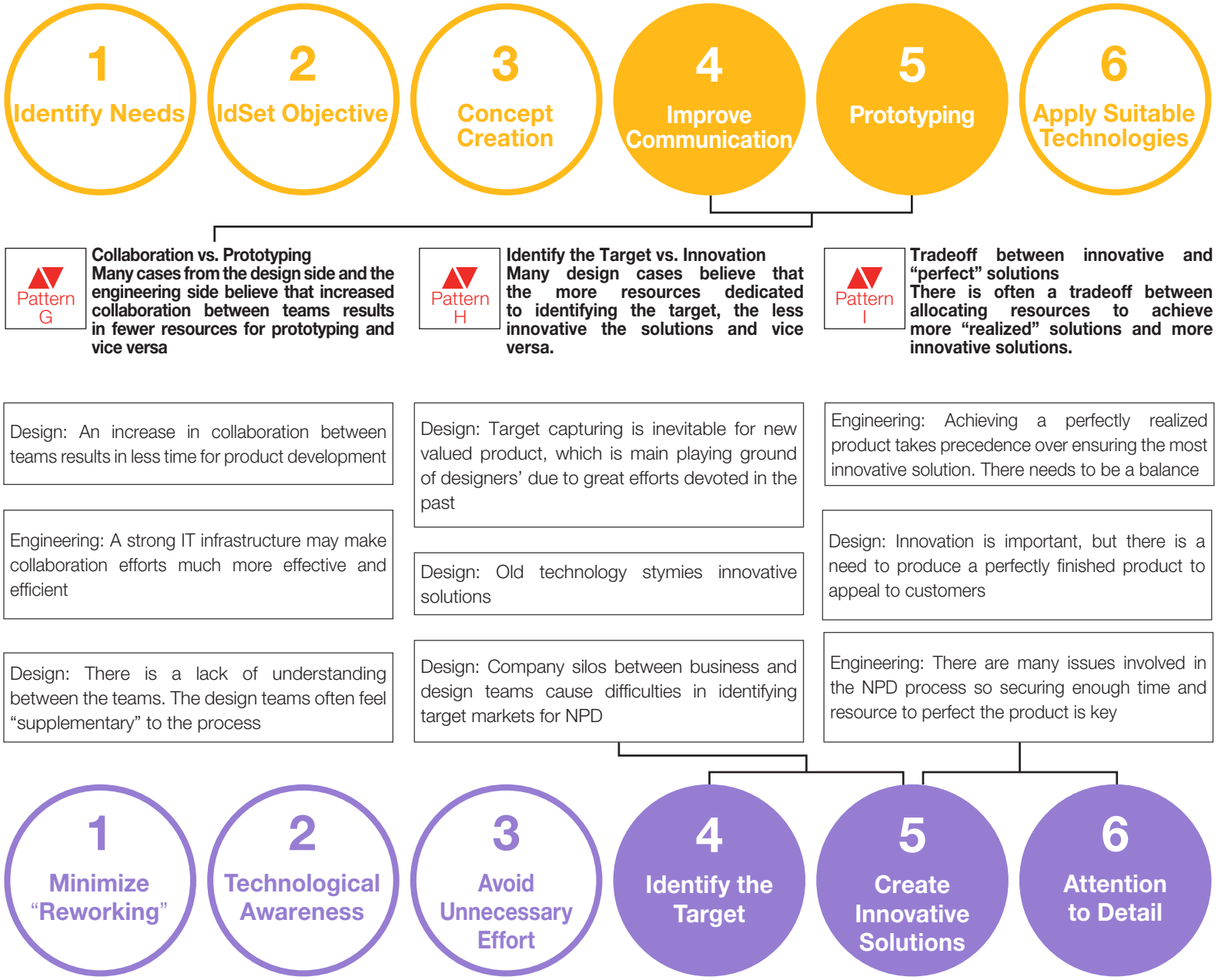
Pattern F

Technical Assessments
Many cases from the design side believe that designers should allocate more resources to technical assessments. Many cases from the engineering side believe that engineers should allocate fewer resources to technical assessments.

- Design: Designers with expertise in numbers succeeded in establishing today's design team
- Design: Designers could be more proactive in applying smart design solutions but time constraints are often an issue
- Design: Design teams need to be more proactive about contributing to engineering and therefore being more at the heart of Japanese manufacturing



4-5 Quantitative analysis on resource allocation differences between real and ideal (3)



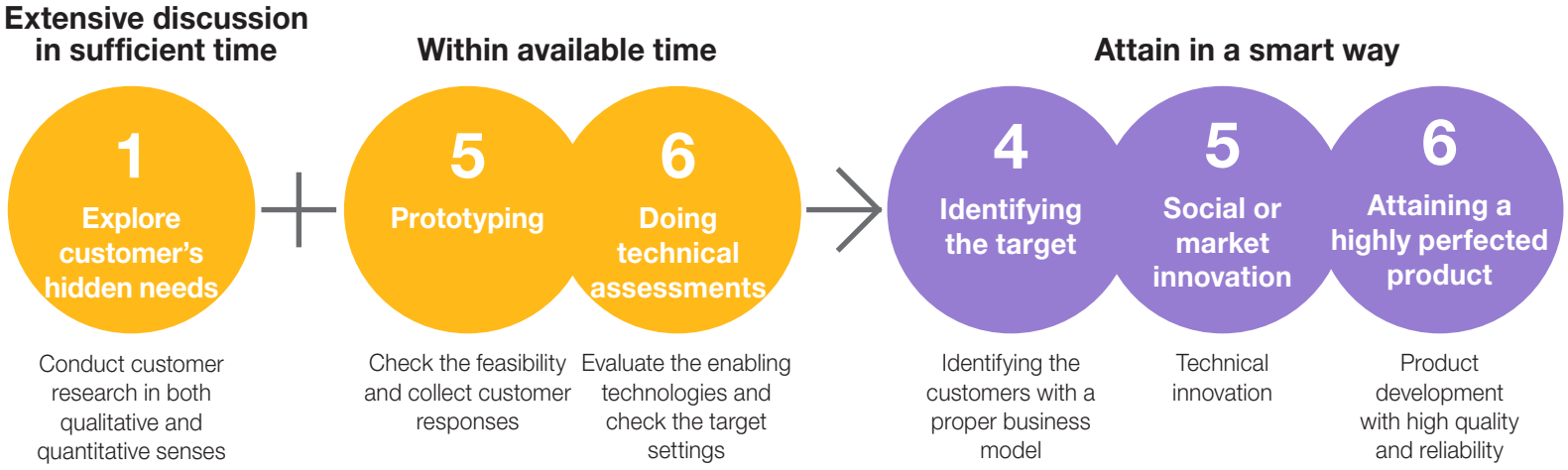
4-6 Field-based Distribution Survey: Common Goals and Issues

Analysis of the research has identified a number of common goals and challenges. The ultimate goal is being able to conduct consumer research, prototype, and perform technical assessments while creating a highly perfected product in the time available. The following diagram illustrates the challenges common among different teams (the arrows indicate the direction of the comments). The individual challenges will be detailed later.

The distribution of several issues to be solved on behalf of the final goal in a global sense is described with directional arrows representing message-passing sections on p. 27. The individual issues within each section are explained starting on p. 28.

These hints and approaches are drawn from interview comments that provide directions for solutions.

The ultimate goal over three sections



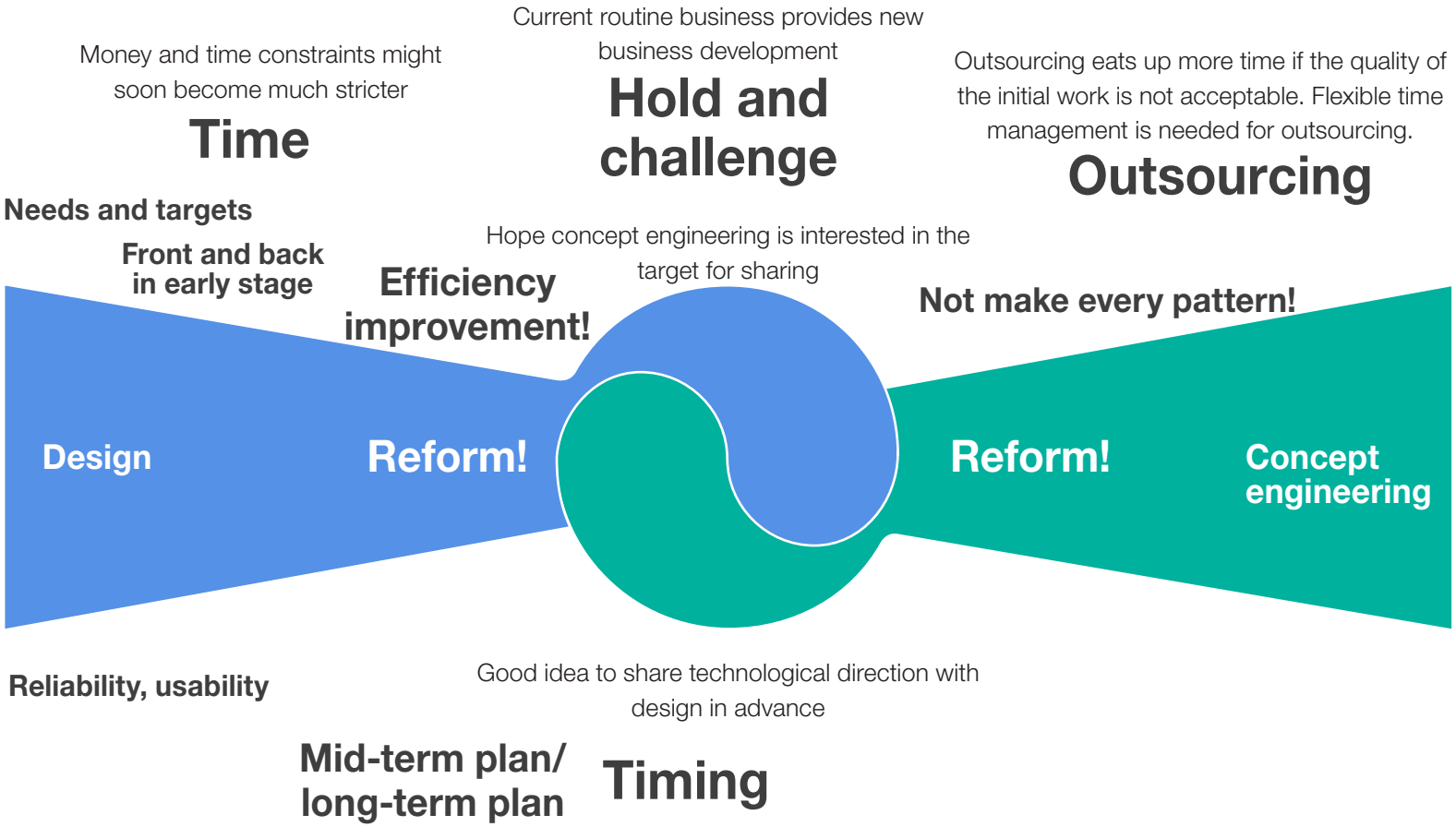
Uncontrollable constraints recognized in interviews

Time and money constraints getting much stricter
No challenges without current business support
Outsourcing is unstable factor in time management if quality is inadequate

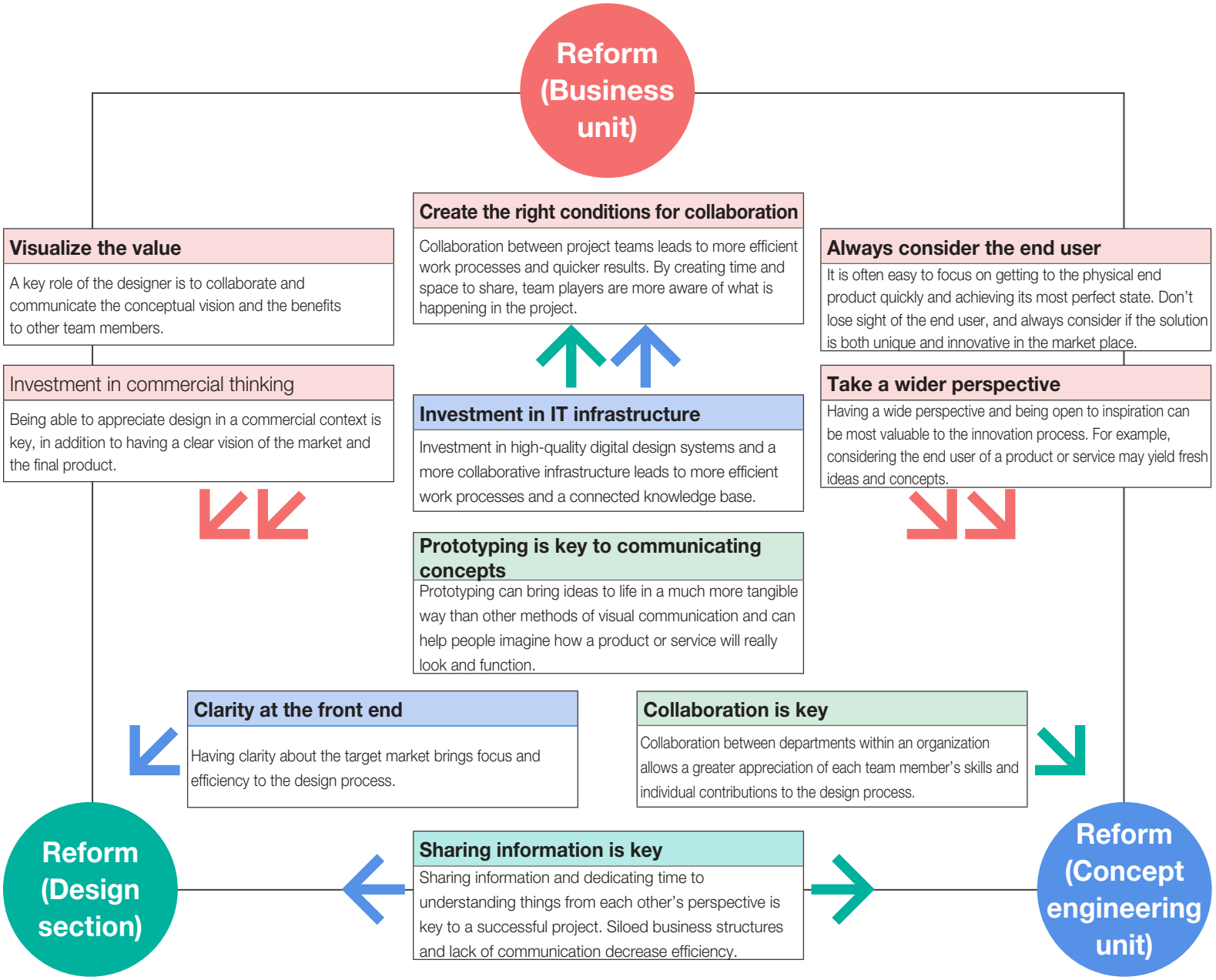
4-7 A path to a solution extracted from quantitative analysis

The local optima shown on p. 24 cannot lead to a global optimum. Achieving sufficient consumer research, prototyping, and technical assessments while attaining a high-quality product in the time available under current time and money constraints requires a structured solution and a tight relationship among design, concept engineering, and business.

For example, possible solutions might be; “Sharing target set with engineering earlier provides better performance on technical assessment, prototyping and create innovative solutions” for design team, “Technical testing based on focused target by sharing the direction with design earlier makes extra time for other work” for engineering team, and “Setting the framework or mechanism for sharing motivation, direction and targets leads to flexible development” for business unit.



4-8 Issues in achieving global goal



4-9 Reform in the section and goals (1)

Business unit

Current Issues

■ **Understanding what sells and why:**

We always struggle to define the responsibilities of design and business.

If you are trying to perfect everything about NPD, then you will never launch a product.

A good product doesn't guarantee good sales.

■ **The business team is always searching for a new approach:**

There appears to be no clear solution to the current issues.

Although the importance of collaborative teams is understood, how we do it is a different topic

There is no one answer to all the issues, unfortunately.

Goals

■ **Need to shift from being technology driven:**

Consider both technology and consumer insights in the appropriate measures when driving forwards with NPD

Instill a pioneering attitude to innovation within teams, and do not let the easy solution compromise the best solution

■ **Need a proactive and aggressive challenge with the main product too:**

The company is very conservative, especially with core product types.

Even when the engineering team is keen on a new idea, the marketing team is always cautious about consumer reaction.

Recognize the need for change within companies, but do not compromise the stability of the business.

Approach

■ **Commitment to action:**

Focus on tangible solutions as opposed to spending too much time thinking.

Constantly assess the products' functionality and success by looking at the market reaction.

■ **Better understanding of design:**

Create an environment of understanding between design and business teams. Encourage collaboration and communication wherever possible.

The design team still stands by itself. We have been doing seminars, but this hasn't been enough.

If someone doesn't understand design, they might say, "Just create something new."

■ **Everyone can be creative:**

Encourage increased creativity in multiple teams.

Invest more time and resources into education within teams to develop skillsets.

We can't just change our people even if the company requires different skillset.

■ **External input:**

We will need consulting from external companies to achieve better results.

Develop partnerships with external consultants to reduce the load on internal resources and to create higher-quality solutions.

We need careful planning to work with external partners.

■ **Underground project:**

Work in compact teams to reduce protocols and therefore deliver more satisfying products.

By doing it that way, we actually delivered a product that satisfies our team.

Develop a strategy that uses time and budget allocation efficiently for projects.

4-9 Reform in the section and goals (2)

Design section

Current Issues

■ **Lack of authority and responsibility:**

Manufacturing departments and engineers drive most of the decisions. Design teams have less decision-making power There is much migration of engineering personnel to design and product planning teams.

■ **An understanding of design:**

There is a mismatch in the expectations of what the designer can deliver within the limitations of the technology at hand The pressure to keep coming up with new and innovative solutions is frustrating given our limitations

■ **The contribution of the design team could be more overt:**

Ensure that the design team's contribution is recognized and communicated when new concepts are launched Because the design team isn't assessed properly in some areas, it ends up spending more time on something they are assessed on, which is technical assessment. Ensure that the design team is closely aligned with the other teams

Goals

■ **A desire to contribute to the bigger picture:**

The project outcome could have been much better if we had done some materials research.

Expecting too focused a role from designers limits their potential to deliver.

In-house designers need approval from their boss even just to go out to do some research.

■ **Appointing designers to the Business Unit:**

Some ex-designers now in the business team helped established the current design team.

In the past, ex-designers now working in the business team used to support the design team, but now they are gone.

The ex-designers in the business team are the ones pushing our ideas forwards.

Approach

■ **Utilization of not only hard marketing data but also future data:**

Consider market and trend data in the design process while maintaining an open and opportunity-driven mindset.

There is a huge difference between utilizing the power of data for the present context and for the future.

■ **Create a special project:**

For example, a product for the foreign market will require different things; therefore, we can set up a new framework more easily.

Create small and young design teams to work on special projects to pilot new, innovative project frameworks.

Create a good, positive tension in small teams with very specific tasks.

■ **Relevant resource allocation:**

The time will always be limited, so what we can work on is resource allocation.

Use tools to make resource allocation more efficient in the time available for a project.

Ensure that time and resources are fairly distributed across the teams when planning projects.

■ **Expect more from designers:**

Invest in education and training to enhance designers' capabilities in engineering and manufacturing.

There is still much of the "painter" in a designer.

The creation of systematic engineering solutions is weak.

■ **Create a process that is not dependent on a specific resource:**

Use a process that is not dependent on overly specific resources.

Invest in infrastructure and processes that increase efficiency

By upgrading the infrastructure with new tools and processes, we can train people more systematically and avoid dependency on tutors.

■ **Long-term strategy:**

A mid-term solution would be to allocate more time to each project.

We must have a clear and common viewpoint to create a long-term vision.

Last-minute negotiations between teams always lead to compromises.

4-9 Reform in the section and goals (3)

Concept engineering section

Current Issues

■ **Focus on perfection:**

Perfection is almost a prerequisite, so there is little recognition, but mistakes never go unnoticed. It is not nice having to settle for less knowing that a project could have been perfect given more time.

■ **Too hectic, not enough time to think:**

Deadlines are frequent, and we are always pushed to the limit to meet them. Multiple projects are always running concurrently, which can be confusing at times. We are responsible for quality control, so we're always working late to achieve it.

■ **A desire to learn more about new technologies:**

We are asked to attend conferences and trade shows on our personal time. The last project was successful because there was one engineer with a great knowledge of technologies. Although we are exposed to a lot of information, we are just so busy that very little is actually absorbed.

Goals

■ **As a professional engineer, I want to be able to propose more ideas:**

Engineers could do more prototyping, like the designers do.

There is never the time or inclination to use new technology.

If we had more information about our end user, we could create a much more relevant solution.

■ **We are expected to understand the wider business:**

It is said that an engineer with the mind of a designer is very valuable.

We need to shift from a conservative, craftsman-like attitude to a modern user experience-focused mindset.

We already have many engineers and designers who can talk about business.

Approach

■ **More proactive engagement with the front-end process:**

We would like a clearer understanding of our target audience.

Pay more attention to the intangible things that are currently excluded from conversations because of a lack of understanding or acknowledgement of their importance. Focus more on the relevant market and consumers.

■ **Change the situation:**

Remove the boundaries within the engineering team to allow more effective information flow. Since several remote offices were combined, we have seen performance levels increase because we see each other every day, Some of the engineers who are used to being in the factory should move to headquarters.

■ **Appropriate resource allocation:**

Better resource allocation is key to improving performance within the time constraints.

The "coin" method introduced during the interview seems useful.

Time reduction for one team usually causes more work for another team.

■ **Support from the board:**

The "hands-on" teams are constantly overworked; the board is in a position to think of better ways of working.

Build a legal team to support the engineers and save their time currently spent on such matters.

Host a seminar or study group on new technology.

■ **Expectations to deliver innovative solutions:**

Blending relevant technologies successfully requires very creative thinking.

Awareness of new technologies and being able to apply them is very important.

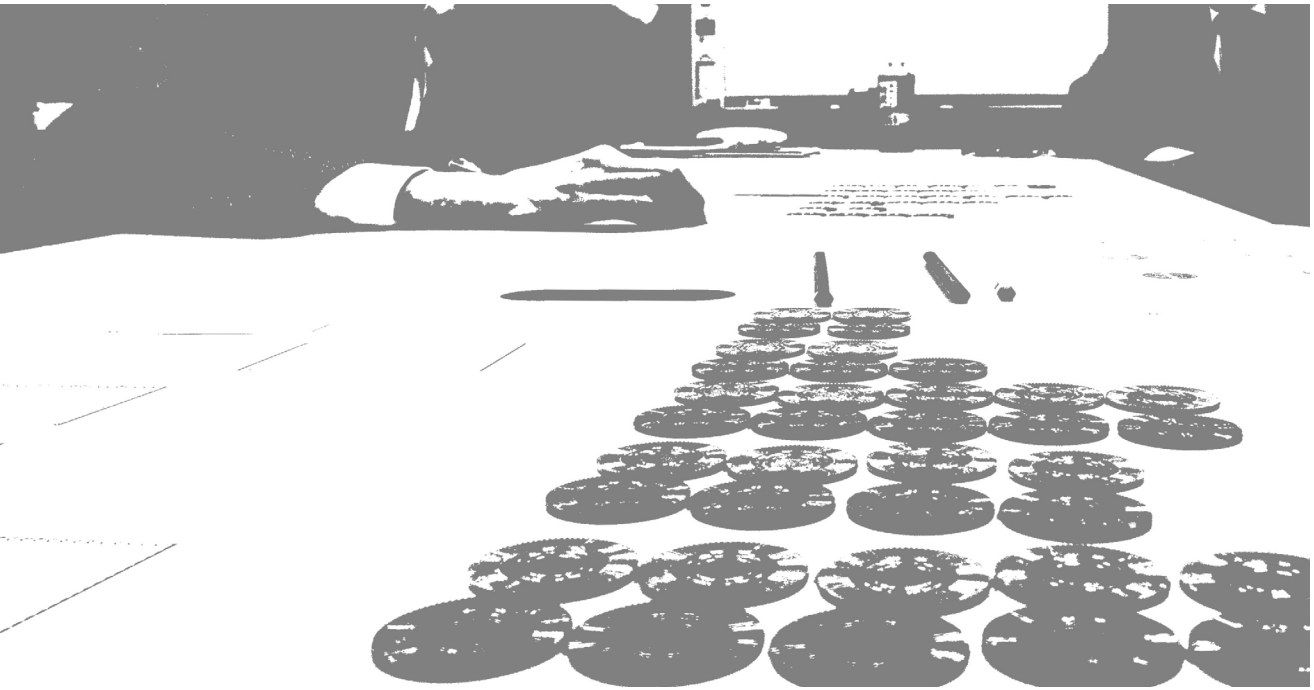
We are a technology-driven company; technological innovation is key for us.

■ **Long-term strategy:**

A mid-term solution would be to allocate more time for each project.

We must have a clear and common viewpoint to create a long-term vision.

Last-minute negotiations between teams always lead to compromises and the lack of a long-term strategy.



5 Field-based Distribution Survey: Summary of Expert Interviews

Interviews were carried out with five European experts to gather information and advice. They also shared their knowledge about the typical issues in and solutions developed by European companies that had undertaken this type of activity. Although these comments are very valuable, further interpretation will be required. Clearly, solutions that are applicable to Europe don't necessarily have the same relevance to Japanese companies.

5-1 Expert inputs to this project

■ Creating an ROI Formula

- Both rational and emotional values need to be measured
- To understand the ROI of design, its overall benefit to a company needs to be broken down into sections

■ Creating a valuable output report

- Multiple incremental changes are often more relevant than a single big change.
- The ideal situation is small improvements occurring regularly.
- What is meaningful to a company is not just cosmetic beauty but something tangible that offers real improvement.

■ Creating an interview structure

- Companies are always involved in many activities. Understanding the balance of these activities is very important.
- It is essential to be clear about the subject matter at hand.
- A clear definition of terminology is required.
- Creativity is not just restricted to designers. It is useful to speak to those in non-designer roles to understand their perspective on creativity.
- It helps to imagine and share ideal scenarios to aid the flow of discussion.

■ Areas for improvement

- The principle of amalgamating manufacturer and consumer data is interesting. Also, investigating existing marketing survey methods and discussions with relevant experts will certainly improve the ROI formula.

5-2 Issues and solutions developed by European companies

■ Prototyping

- This activity must be recognized as a communication tool to fuel constructive discussion. Different types of prototyping by each team will help raise awareness of its importance.
- We should record what we seek before, and what we've obtained after, prototyping.

■ Risk Management

- Awareness of a worst-case scenario can help assuage fears.
- Create a culture that encourages inquisitive and challenging behavior.
- Envision a scenario where expectations are not met.

■ Decision Making

- Voting can be appropriate within suitable frameworks.
- Remove existing protocols via a special project environment.
- Encourage input from external parties.

■ Constructive Discussion

- Relevant internal marketing activities enable stakeholders to become more involved.
- Hold meetings in a place that encourages creativity.
- Remove the focus on hierarchy.
- Clarifying the objectives and purpose of a meeting in advance facilitates constructive discussion.

■ Collaboration between teams

- Establish a common language across different divisions.
- Modernizing working environments can improve collaboration.
- Invite external parties or people from different divisions to review your work.

■ Leadership

- Encourage leadership that challenges the norm and breaks protocol.
- Invite external parties to lead; some things can't be done or said internally.

■ Bring clarity

- Sharing stakeholder expectations always benefits the team.
- Certain things cause anxiety until they are clarified.

■ Expectations of design

- The ratio of designers to engineers has changed; there are now more designers than engineers.
- Designers have raised awareness of the importance of branding and consistent design language. A commitment at the board level is fundamental to a design team's proper functioning.

■ Implement New Methods

- Double Diamond (Design Council)
- Pair Discussion (Partner a designer and an engineer for discussion)

6 Future Issues and Road Mapping

This is a first step towards developing what would ultimately be optimized solutions for collating, analyzing, and putting data to good use.

This chapter addresses the ways that this ongoing study might be improved over the course of its five-year duration.

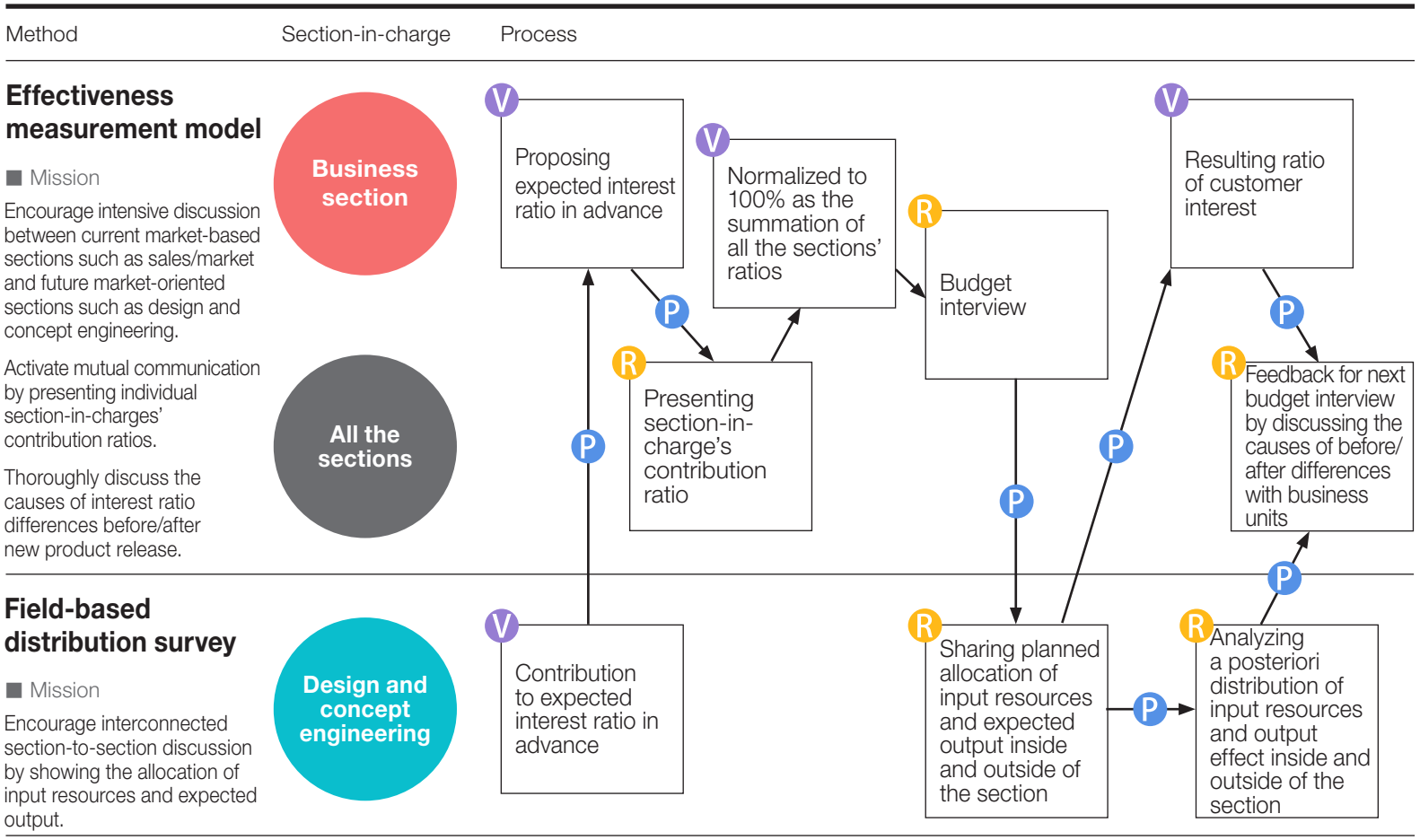
6-1 RPV method for design and concept engineering

The RPV method for design and concept engineering sections is visualized below. It is proposed following the application of the concept in Christensen's RPV theory. This is just an example of the application of an effectiveness measurement formula. Please use it to discuss how to apply the formula to the company's processes.

R (Resource): section-in-charge contribution ratio, input resource

P (Process): Process visualized

V (Value): Customer's interest items



*1 Clayton M. Christensen, Erik A. Roth, Scott D. Anthony, Seeing What's Next, Harvard Business Review Press, pp. 279-280, (2004)

6-2 Future Improvement

Future Development of the Effectiveness Measurement Model

■ Authorization of this effectiveness measurement formula:

This empirical formula has not yet been authorized by companies or academics. It is intended to be tested and improved by participating companies. To achieve the best results, authorization is required from teams involved in front-end activity, as well as those working mainly at the back end (such as manufacturing teams and supply teams).

We are sharing this empirical formula to encourage discussion of

1. the ROI of design in Japan, including the feasibility of this formula
2. the elements used in this formula: consumer interest (led by the marketing team) and the contribution of the different teams (led by teams working at the front end).

■ Measuring the contribution from each team:

In the future, more time can be allocated to these conversations, as they are managed internally within a company. This is a subjective approach, so participation is needed from all related divisions.

■ Measuring Consumer Interest:

For the purpose of this study, a questionnaire was used as a prototype to test and validate the principle of the new measurement formula. The most appropriate way to gather consumer interest data might be to integrate them into existing consumer questionnaires or focus group interviews. These are typically carried out by the Marketing or Design teams.

■ Intended beneficiaries of this measurement formula:

This formula is intended for internal use within a company rather than by external researchers because consumer interest and the contributions of each team can be collated and analyzed more effectively within a company.

Future Development of Field-based Distribution Survey

■ Resource Allocation and Objectives:

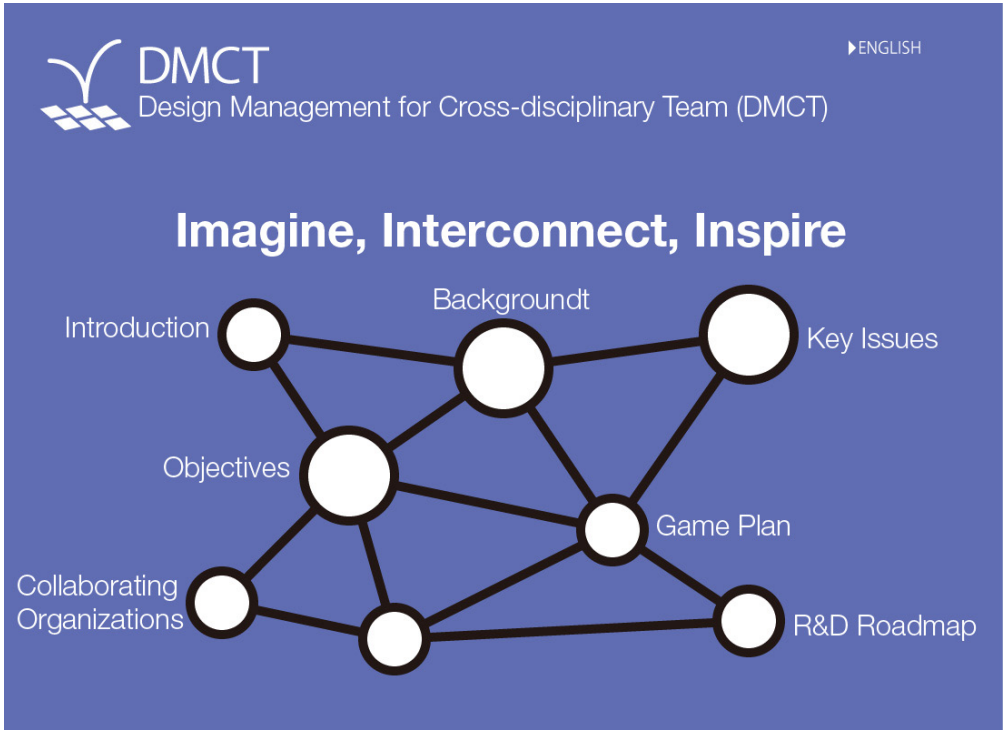
The 12 areas identified for resource allocation and objectives were created based on an understanding gathered from initial pilot interviews and existing research. For the purpose of this survey, it was important to use a consistent set of considerations, which allowed comparisons of like-for-like responses to validate the overall principle. It is essential that future iterations of the study consider the specific products, services, and experiences that a company provides. Careful internal discussion will allow participants to tailor the 12 areas to suit their particular needs and circumstances. Feedback from companies will improve the method.

■ Quality of information:

Twelve respondents from 13 companies were studied during this project. Although this is a relatively small number, some interesting patterns were identified. Future studies, using 100 companies for example, could produce a larger data set and offer more reliable insights.

6-3 Introduction of our project homepages

The goal of our project is to assist manufacturing industries to draw upon their technological strengths to gain a commanding lead in the global market. We will research effective management strategies for promoting cross-industry, cross-disciplinary collaborations towards highly innovative products.

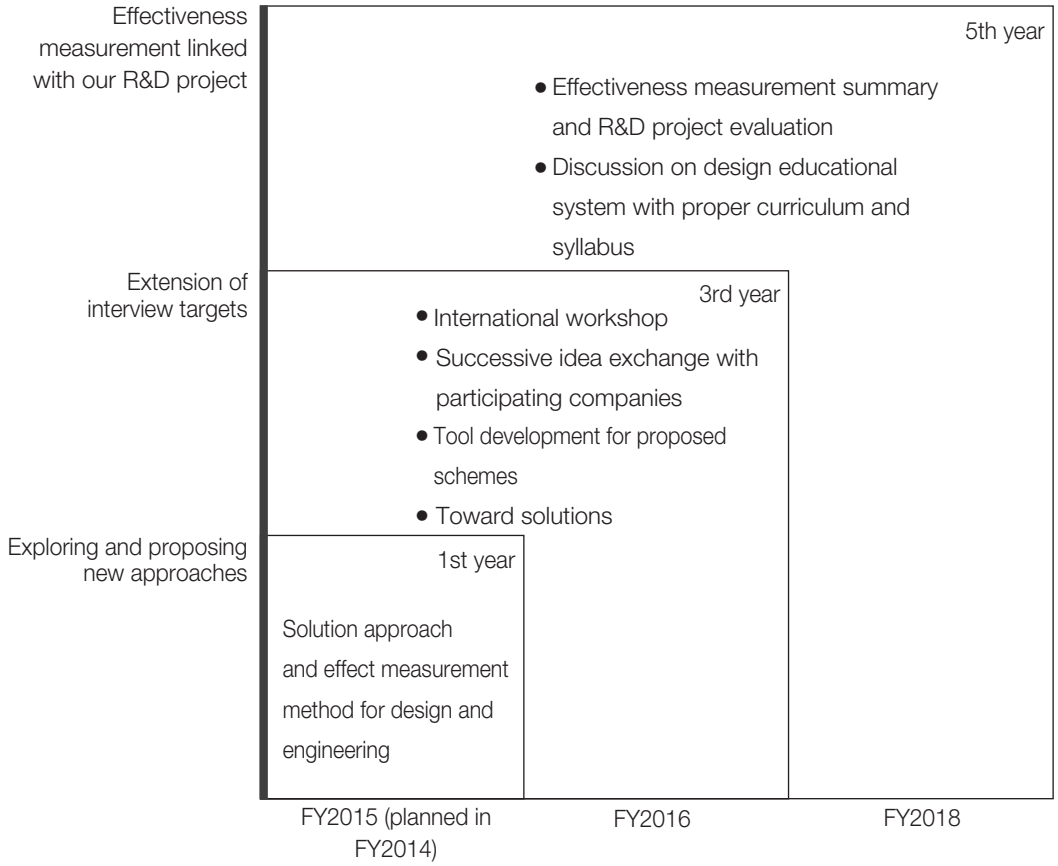


Design Management for Cross-disciplinary Team (DMCT)

http://monozukuri.org/dmct/index_en.html

6-4 Road mapping

The methodology used in this project will continue to be developed through continuous input and advice from those with real-world experience working in NPD situations. Ongoing discussions with the British Design Council and Cambridge University are essential for improving the methodology.



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Mr. Take Ikeda at Seymourpowell Ltd. worked hard on the designer interviews and documentation, fulfilling challenging requests many times, and is responsible for the final shape of this AIST paper. Mr. Katsumi Yonetsu, visiting researcher, was fully in charge of the high-quality editorial design of this paper, helped by the advice of Mr. Masayuki Baba in Public Relations and Ms. Tokuko Maki, AIST guest researcher.

Some have argued that using dezain for user-focused design and sekkei for technical-oriented design is a problem. However, we believe that the explicit role description in these two words helps us to consider more effective ways to foster collaboration between design and engineering, which will guide us towards a more advanced stage of global-leading design. However, poorly interconnected communication due to vertically scattered organizations is an obstacle. Please use this discussion paper as a communication trigger, and try the proposed formula, then give us feedback that we can use to take the next steps. We thank you in advance for your contribution to our project.

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National Institute of Advanced Industrial Science and Technology (AIST), National Research and Development Corporation
Project leader
Akira Tezuka

Issued: September 2015

Project representative: National Institute of Advanced Industrial Science and Technology (AIST), National Research and Development Corporation
Survey corporation: Seymourpowell Ltd.

Research project

Design Management for Cross-disciplinary Teams (DMCT), supported by the Council for Science, Technology and Innovation's (CSTI) Strategic Innovation Program (SIP) under the theme of "Innovative Design/Manufacturing Technologies"