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Towards Designer-Centered Design Brief Formulations in Industrial Design: Relating Design Brief Perception to Design Expertise and Design Context

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This research aims to investigate the methods to formulate a design brief, in which three approaches have been taken into consideration from existing design theories: (1) the cognitive approach which originated from the rational problem-solving paradigm, which focuses on varying a design brief formulation that stimulates designers to produce innovative design concepts; (2) the expertise approach which refers to the reflection-in-action paradigm that emphasises how designers initiate and frame a design problem in the design brief; and (3) the contextual approach which investigates how prescribed guidelines formulate a design brief in the professional practice of commercial settings, which facilitates communication among multiple stakeholders in design projects. Utilising the findings from a card-sorting exercise, this study examines how a design brief is perceived and interpreted by designers with various levels of expertise in the educational and professional context of industrial design. The result suggests a tentative framework of formulating a design brief under a designer-centred approach, which illustrates how 'design context', 'design expertise' and 'design brief formulations' influence designers' initial perceptions of design briefs.

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TOWARDS DESIGNER-CENTERED DESIGN BRIEF FORMULATIONS IN INDUSTRIAL DESIGN: RELATING DESIGN BRIEF PERCEPTION TO DESIGN EXPERTISE AND DESIGN CONTEXT

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Ph.D
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Towards Designer-Centered Design Brief Formulations in Industrial Design: Relating Design Brief Perception to Design Expertise and Design Context

Wing C. Lau

A thesis submitted in partial fulfilment

of the requirements for the degree of

Doctor of Philosophy

October 2008

CERTIFICATE OF ORIGINALITY

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Summary of the thesis entitled

Towards Designer-Centered Design Brief Formulations in Industrial Design: Relating Design Brief Perception to Design Expertise and Design Context

submitted in partial fulfilment
of the requirements for the degree of
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How to formulate a design brief is the original research question for this study. Three (cognitive, expertise, and contextual) approaches can be summarized from the existing design theories. The cognitive approach originated from the rational problem-solving paradigm focuses on varying a design brief formulation (in terms of its content and presentation) in order to stimulate designers to produce more innovative design concepts. The expertise approach related to the reflection-in-action paradigm emphasizes the dependence on a designer's expertise to actively frame a problematic situation provided by a design brief. The contextual approach investigates professional practice in commercial settings by prescribing guidelines to formulate a design brief in order to facilitate communication among multiple stakeholders in a design project. Adopting a systemic perspective, these approaches can be integrated into a quasi-theory of design brief production. Nonetheless, there is no explicit feedback mechanism to progressively improve these predominately prescriptive approaches of formulating design briefs. In order to close the feedback loop explicitly, card-sorting exercises were used to explore how a design brief is perceived and interpreted by designers with various levels of expertise in the educational and professional context of industrial design. The analysis leads to a tentative framework of design brief reception summarizing

how design context, design expertise, and design brief formulations influence designers' initial perceptions of design briefs. The results suggest that the current theory seems to concern only with stimulating cognitive factors of the perceiving designers while the tentative framework of design brief reception suggests that designers' perceptions are very integrated that are affected not only by cognitive factors (individual domain knowledge, skills, and abilities), but also by affective (personal preferences, prior encounters with similar design tasks) and conative (self-confidence) factors as well as the given context. By neglecting the context and these non-cognitive factors, design brief writers are in a position that tends to underutilize many designers' potential. A designer-centered approach of formulating design briefs is proposed based on these findings. The study concludes by juxtaposing these two complementary frameworks as the first step for evolving a more balanced approach to design brief formulations.

PUBLISHED WORK

During the course of this study, the following related papers have been published:

Thomas Fischer and Wing Lau, Marble-Track Music Sequencers for Children. *In: Hyrskykari, Aulikki (ed.): Proceedings of the Fifth International Conference for Interaction and Children.* University of Tampere, Finland, 2006, pp.141-144.

Wing Lau, An instrument for assessing levels of abstraction in educational design brief formulations, *Proceedings of the 9th International Conference on Engineering and Product Design Education*, Newcastle, UK, September 2007.

Wing Lau, A study on professional designers' initial perceptions of design briefs: Some reflections on design problem formulations, *Proceedings of the IASDR07*, Hong Kong SAR, China, November 2007.

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OUTLINE OF THE THESIS

This chapter provides an overview of all the chapters in the thesis.

0. OUTLINE OF THE THESIS

Chapter 1 introduces the general research topic using a visual map delineating various attributes and relationships that are crucial to the discussion of a design brief and its formulations. Three existing approaches (the cognitive approach, the design expertise approach and the contextual approach) to design brief formulations are reviewed. Their strengths and weaknesses are analysed. A potential gap in existing theories seems to be related to the lack of relationships connecting these three approaches in current discussions making the integration of findings from different approaches impossible. The relationships among design brief formulations, design expertise and design context to designer's performance also seem to be missing. In addition, most of these approaches tend to be mainly prescriptive and lack an explicit feedback mechanism that can be used for iterative improvements. These concerns become the motivations of this study. Chapter 2 discusses the three parts of research design aiming to tackle the three research questions. Since the three approaches to design brief formulations have been identified with their respective paradigms. Each approach seems to employ its own unique research method. As a result, the three parts of the research design can be considered to be methodologically separated. The first part of the research design aims to extend existing knowledge of design brief formulations in the Hong Kong educational and professional context utilizing qualitative methods including semi-interviews and content analysis. The second part of research design aims to consolidate the cognitive approach to vary design briefs into a theoretical framework for design brief production that is validated in a pilot study with industrial design students. A quantitative method of a questionnaire survey and statistical analysis were used to examine the effects of various design brief formulations on designers' perceptions. The last part aims to empirically construct a tentative framework of design brief reception

using a mixed method. Card-sorting exercises with content analysis and semi-structured interviews were proposed to investigate how design briefs are perceived by designers with various levels of design expertise and in different contexts. Chapter 3 reports the collection and analysis of interview data obtained from design educators and design managers. The background of formulating design briefs in the Hong Kong educational and professional context is investigated. This part of the study aims at extending the understanding of the contextual approach to design brief formulations that is mainly developed in the western context. A content analysis is conducted on the interview data. The results suggest that design educators and design managers both seem to take on a systemic perspective considering many contextual factors before formulating design briefs and reveal the diverse purposes behind design brief formulations. Existing theories related to design brief production are consolidated and formalized resulting in an integrated abstraction framework (discussed in Chapter 4). The framework provides three theoretical bases to examine and generate different design brief formulations that are compared with previous studies. A pilot study is used to empirically validate the effect of various design brief formulations on designers' initial perceptions. Since existing approaches to design brief formulations remain prescriptive, the validated framework is an essential component acting as a reference point for the discussion related to design brief reception in the following chapter. The explicit framework is the first step to bridge the existing gap between design brief production and reception. Chapter 5 presents results of card-sorting exercises and semi-structured interviews from subjects with various expertise levels (Yr1 design students, Yr3 design students, design educators, professional designers and design managers). Comparisons of subjects' sorting results within and across different cases shed light on various factors affecting designers' perceptions and the growth

of design expertise on designers' perceptions. Findings are discussed in relation to the theoretical framework and simplified models of design brief perceptions are proposed to account for the perception differences of design briefs. Tentative designer-centered guidelines are formulated in order to assist future design brief formulations. Finally, chapter 6 is the overall conclusion and discussion for the PhD study.

CHAPTER 1

LITERATURE REVIEW

This chapter introduces the general research topic using a visual map delineating various attributes and relationships that are crucial to the discussion of a design brief and its formulations. Three existing approaches (the cognitive approach, the design expertise approach and the contextual approach) to design brief formulations are reviewed. Their strengths and weaknesses are analysed. A potential gap in existing theories seems to be related to the lack of relationships connecting these three approaches in current discussions making the integration of findings from different approaches impossible. The relationships among design brief formulations, design expertise and design context to designer's performance also seem to be missing. In addition, most of these approaches tend to be mainly prescriptive and lack an explicit feedback mechanism that can be used for iterative improvements. These concerns become the motivations of this study.

1.1. Introduction

My original research question aims to understand instances where novices seem to surpass experts based on certain performance criteria. The phenomenon seems to be more complex than the case reported originally by Adelson (1984) in software design. Adelson proposed that the performance difference is due to mismatched mental representations (abstract (i.e. functions/purposes) vs. concrete (i.e. implementations) representations) of experts and novices respectively. Intuitively, these performance differences seem to be related not only to design brief formulations (content and presentation of a design brief) and design expertise, but also to the related design context (e.g. design discipline, design practice, etc.). These factors may even interact with one another and must be investigated from a holistic perspective. The research study selected industrial design as the domain of investigation since few studies focus on the discipline. The Hong Kong context is explored primarily due to availability of subjects and sampling convenience. The nature of the contextual work is mostly explorative aiming to understand how contextual factors might interact with the expertise factor and the design brief formulation factor. By integrating the existing findings on design brief formulations, a unified conceptual framework is proposed to explicitly model the influences of these three (cognitive, expertise and contextual) factors on designers' performance. The study aims to construct two complementary frameworks of design brief production and design brief reception since the existing theories tend to focus on how design briefs are formulated but often neglect how design briefs are perceived. The tentative framework for design brief production originates from the existing theories in cognitive psychology while the tentative framework for design brief reception has to be derived inductively using card-sorting exercises. A mixed research methodology including interviews, statistical

analysis, card-sorting, content analysis and correlation analysis is adopted due to the integrating nature of the study. Five expertise levels were conceived originally based on Dreyfus (2005) classification of experts. However, the actual subjects seem to correspond roughly to three expertise levels including naive designers, novice designers, and competent designers in the educational and professional context while the expert designer level is replaced by design educators and design managers whom may operate in a different role than a professional designer. By analyzing how designers with different levels of expertise perceive design briefs in different contexts from the card-sorting exercises, I am able to derive simplified models of design brief reception to explicitly create a feedback loop in the design brief production-reception cycle and remodel the predominantly prescriptive nature of design brief formulations. Designers' personal interests and preferences are found to be crucial in influencing their perceptions besides the design context. Designer-centered guidelines for formulating design briefs are proposed and potential hypotheses are outlined for future studies. Consequently, design brief formulations can be iteratively improved based on the developed explicit design brief production-reception cycle in the future.

1.2. Background

How do you formulate a design brief for a given project? This is the most frequent interview question that I have asked many subjects including designers, design educators, design managers, and even myself during the course of this study. The responses that I received were all over the place. Many subjects said that they had a written document that contained product specifications requested by clients but they might call the document a project brief, a design task statement or a quotation. Some subjects said that there was no such thing as a design brief.

Other subjects said that we only used a verbal design brief at a briefing session. These diverse responses suggested that everyone's use of the term, design brief, is different depending on the subject's specific context and discipline. However, most subjects agreed that a design project usually begins with a certain amount of information prepared in a certain format, which is commonly referred to as a project design brief. It includes background, introduction and problem statements, objectives, qualities of expected outcomes and similar information. The design brief is typically prepared by an external client or a marketing department. It offers a systematic or even exhaustive approach to present a design project at one of its earliest stages in a professional setting. This written document will be read by designers and thereby serves as an initial stimulus for the design process. In the context of the thesis, these terms (design briefs, project briefs, design problem statements, and design task statements) are used interchangeably to refer to documents for communicating relevant information about a design issue to designers. Based on Philips' (2004) definition, a design brief is a written description of a project that requires some forms of design. Even though the working definition of a design brief is established, the above statement only informs the readers what a design brief is, design brief formulation seems to be another issue. Besides the how question above, more importantly, readers may also want to know why it is necessary to discuss design brief formulations or what theories can be used to formulate design briefs.

A visual map (figure 1.1) is introduced delineating various attributes and relationships that are crucial to the discussion of a design brief and its formulations. Various attributes of interest are derived based on physical characteristics of a design brief. These characteristics include presentation formats (i.e. verbal, textual, bullet-point statements, etc.), amount of content (i.e. project background,

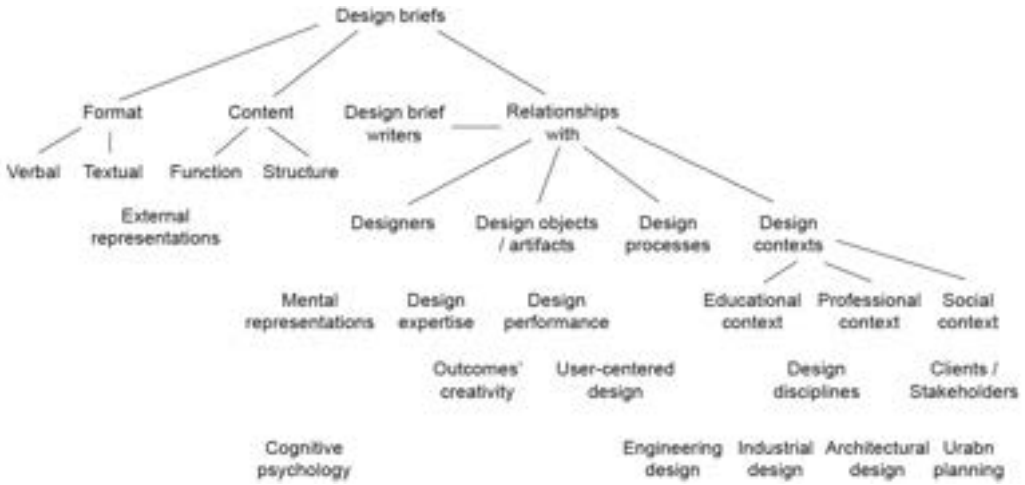


Figure 1.1.: A visual map highlighting topics that are essential to the discussions of design brief formulations

market research information, user research information, etc.) and levels of details/abstractions (project's objectives, product's functions, product's specifications, etc.). These systematic schemes are used to analyse all the possible physical structures of a design brief before investigating the impacts of different variations on design performance. This perspective mainly regards the design brief as an object with many physical attributes. Another perspective to study design brief formulations is through its relationships to other entities or areas of interest. Using the concept of relationships and a scheme suggested by Dorst (2008), design brief formulations can be studied in relation to designers, design processes, design contexts, and design objects/artefacts. Besides these major relationships, minor relationships or areas of interest can be further identified. For instance, sub-topics may include design expertise, design performance, professional practices, mental representations, etc. These attributes and relationships are used to assist the discussions and comparisons of existing discipline-specific approaches and results relating to design brief formulations.

According to existing design theories, the issue of design brief formulations can

be classified into three major approaches including the cognitive approach that is derived from the rational problem-solving paradigm, the design expertise approach based on the reflective practitioner paradigm and the contextual approach based on professional practice. Each approach seems to have a different purpose, model a different aspect of the phenomenon, be based on a different context, employ a different research method, and prescribe a different set of guidelines to formulate a design brief.

Under close examination, three issues are identified in these existing approaches. The first issue is related to findings from the contextual approach that seem to be derived mainly based on the western context. The model of design brief formulations associated with the contextual approach is highly contextualized and implicit. As a result, previous findings may not be applicable to other cultural and social contexts. The second issue is the exclusivity associated with the three approaches in current discussions. The relationships between different approaches seem to be missing and some findings based on a single approach may appear to be reductionist or even contradictory to findings from other approaches. For instance, the cognitive approach emphasizes the use of a design brief to promote creative design outcomes while the design expertise approach emphasizes individual expertise to superior design performance. It is not possible to integrate findings from different approaches without an explicit unified framework to address these three factors related to design brief formulations, design expertise and design context. The last issue is related to the predominately prescriptive nature of all approaches and the lack of direction to improve these existing approaches. These potential gaps in existing theories become the motivations and research questions of the study.

1.3. Design problem formulations - the cognitive approach

The first and relatively context-free approach is developed based on the rational problem-solving paradigm, which is commonly adopted by cognitive psychology and engineering design. I use design problems and design briefs interchangeably in the literature review chapter since historical development of problem formulations are included for its historical significance. Historically, Simon and Hayes (1976) have noticed that problem presentations affect problem-solving performance. They used a term, problem isomorphs, to describe presenting essentially the same problem using various formats (verbal, spatial, and graphical, etc.). The rationale behind this approach suggested how a problem is phrased affects the mental representation of problem-solvers and their subsequent performance that are often measured by success rate or efficiency. "Different formats make different information explicit and assessable (Marr, 1982, p. 8)." This particular perspective is often identified as problem formulations established in the rational problem-solving (RPS) paradigm. Problem formulations are believed to be an important factor affecting mental representations and thus performance (Dominowski, 1995). Problems are considered to be given and can always be clearly defined in the rational-problem solving paradigm. Problems contain initial conditions, under systematic manipulations and operations, final solutions can be identified and optimization is possible. Simon (1981) states that solving a problem simply means representing it so as to make the solution transparent. If a problem representation determines the kinds of possible operations, different representations will lead to different design strategies and solutions. Under this conceptualization, there is no need to formulate a problem besides varying its representation. Simon's taxonomy of representations includes natural language, mathematical models, diagrams of physical objects and processes, and three-dimensional models (Simon, 1981). This

particular view led researchers to the studies of problem isomorphism which seems to suggest there is an ideal representation for communicating information to a problem-solver.

Problem representations are considered either external or internal. An internal representation is often referred to as the mental representation of a problem-solver (Simon, 1978) whereas an external representation (ER) refers to information presented in the physical world. Previous studies (Hubal, 1996) have focused on presenting virtually the same amount of information in different forms which are called ”alternative representations” (Day, 1988) or ”isomorphic representations” (Ichikawa, 1989). The different forms can be expressed as verbal, numerals, and graphical using diagrams, graphs, lists, matrices, perceptual symbols, pictures, tree diagrams, words and etc. In general, visual-spatial/graphical representations assist performance relative to textual representations (Hubal, 1996). A good example is shown by presenting the Tower of Hanoi problem with or without a clarifying picture (Kotovsky, Hayes & Simon, 1985). Significantly faster solution times are resulted with the inclusion of a picture. Most of these previous studies aim to investigate the effect on performance with different external representations (forms) for problem-solving, decision-making, and other cognitive tasks.

Representations can vary not only in forms, but also in the amount of information. ”Stenning, Cox and Oberlander (1995) have proposed a theory of specificity of graphical information in which they argue that diagrammatic representations compel the representation of certain information whereas non-graphical representations (e.g. sentences of a natural or logical language) permit the expression of abstraction or indeterminacy as quoted in (Cox, 1996, p. 16).” This can be illustrated by comparing a triangle drawing to the word ”triangle” in which the drawing is a single graphical (hence concrete) representation of all the possible triangles.

Since abstraction is inevitably connected with a loss of detailed information (Bergmann & Wilke, 1996), the theory seems to also raise the question between concrete representations and abstract representations when presenting information in sentences. "A more abstract level is characterized through a reduced level of detail in the representation and abstract levels model the world in a less precise way, but still capture certain, important properties (Bergmann & Wilke, 1996, p. 2)." A recent study conducted by Fricke (1999) has investigated how the precision of a problem formulation/statement can affect the design process. The laboratory study presented two differently formulated (precise vs. imprecise), but in principle identical problems to mechanical engineers. The designers who received a precise problem formulation asked few questions, considered the information to be complete and spent less time on problem framing and goal analysis (on average 14 minutes). The other group of designers with an imprecise formulation, on the contrary, expressed the impression of incompleteness and uncertainty. The designers then proceeded to search for new information and took much longer time (on average 29 minutes) for problem framing and goal analysis. Fricke later identified successful design outcomes and concluded that successful designers focused to ask questions on the problem areas and then on technical characteristics of the product. The unsuccessful designers asked obviously unstructured questions and planned less often for their design approaches. The results seem to confirm that if a design brief's problem representation affects designer's problem understanding; it will then affect the design process and the design outcome. However, this study was conducted without knowing the designers' expertise. It is unclear whether the effects of representations may have any interactions with design expertise.

In addition, efforts are made to understand how ER can be integrated with internal representation to aid novices to perform better. Mayer (1976) concluded

that the more integrated (utilizing multiple ERs) the representations are, the better the learner's performance in problem solving tasks because the degree of structural integration is an important factor in mental representation (Jonassen, 2005). Cognitive tools (semantic networks, expert systems, and systems modelling tools, etc.) which aim to externalize learners' internal representations are also developed to represent problems and to support problem-solving (Jonassen, 2003). Some of these findings provide bases for recent design research in exploring the importance of design visualization (Dahl, Chattopadhyay & Gorn, 2001), visual reasoning (Oxman, 1997), and design sketches (Suwa, Gero & Purcell, 1998).

This line of reasoning also extends to cases for solving insight problems and design problems. Other studies (Goldschmidt, Ben Zeev & Levi, 1996; Restrepo & Christiaans, 2004; Fricke, 1996) also reported that varying a design problem formulation (in terms of format, content, and abstraction) influences various aspects of the design process, designers' information-seeking behaviours as well as the final design outcome. This approach of varying problem formulations is often discussed in parallel with other heuristic design methods for creative problem-solving in order to achieve more creative design outcomes. In these cases, designers are encouraged to interpret a usual problem in an unusual way or to alter their usual frame of reference which may lead to certain creative insights. Research conducted for systematic innovation techniques (TRIZ (Altshuller, 1996), Systematic Approach of Pahl and Beitz (SAPB) (1996), Synectics, etc.) falls under this pathway. These techniques formulate a problem in various ways in order to enhance creativity of design outcomes. "Since there is a close relationship between problem and solution, varied statements of the same problem [can] evolve different solutions (Fung, Lo & Rao, 2005, p. 36)." Eastman also argues that "most methodologies are in fact new representations that allow explicit comparison of

information not previously relatable (Eastman, 1970, p. 301)." The simplicity of this pathway is that it does not explicitly take designers or expertise into consideration when modelling the cause-and-effect relationship and the trial-and-adopted techniques, sometimes being exhaustive, can be universally applied across various disciplines. This moderating relationship has also been taken by other creativity techniques such as forced associations, synectics (Gordon, 1961), brainstorming, lateral thinking (De Bono, 1970) and morphological analysis which are often prescribed for the design process to promote creative solutions. The only drawback of this approach is that the results may vary significantly.

Varying design problem formulations has previously been examined in the form of a heuristics method to promote creativity in design outcome (Goldschmidt et al., 1996; Fung et al., 2005). Two formulations often used to categorize design briefs are "open-ended versus close-ended" and "precise versus imprecise". Goldschmidt (1996) reported that an open-ended formulation, which formulates the design problem by describing the functional requirements (a protective wear) leads design students to sketch more original solutions against a closed-ended formulation, which names the existing object (socks) in an empirical study. This problem formulation aims to avoid preconceptions of existing objects. Fricke (1996) showed that designers who are presented with a precisely formulated (and hence concrete) design brief asked fewer questions and accept the problem requirements without critical appraisal. "The designers subsequently did not discover several requirements that could have supported the design process (Fricke, 1996)." These formulations are shown to influence designers' performance in terms of creativity and perceived information completeness. In general, design outcomes are more creative and original when based on open-ended and imprecise formulations, which seem to encourage designers to seek additional information and further

define the design task. Nonetheless, these earlier efforts still rely mainly on individual design brief writer's experience of design brief variations that there is not a formal framework to systematically investigate design brief formulations.

Referring to figure 1.3, this approach is concerned mainly with the methodological level and regards a design brief as an object for manipulation. The role of design brief writers and the role of designers are also conceptually separated. A basic assumption is that problem formulations and design performance are modelled in a causal relationship and a design brief formulation is considered an independent factor moderating creative design performance. This approach combined with quantitative research methods is capable of producing generalisable rules in order to answer how a design brief should be formulated or varied to promote creativity in design outcomes.

The above discussions show that the first approach to design brief formulations is heavily influenced by the rational problem-solving paradigm. In contrast, the second approach is originated from the reflective practice paradigm. A fundamental difference between the two paradigms is their assumptions regarding the design process that is crucial to the understanding of the realization of design outcomes. A brief review regarding the design process is provided before introducing the second approach to design brief formulations.

1.3.1. Two descriptive models of the design process

Early studies of the creative process can be traced back to the 1920s when Graham Wallas described his model of creative thought (1926) which classified the process into 4 distinct stages: preparation, incubation, illumination, and verification. Over the years, the model was refined but basically remains the same. Gagné (1959), specialized in instructional theory, stated in the 1950s that problem-solving begins

with a stimulus situation consisting of certain explicit or implicit instructions which establish the sets and define the goal as quoted in (Eckersley, 1988). The series of phases are presented below:

- reception of the stimulus situation
- concept invention
- determination of the course, or courses of action
- decision-making when two or more courses are available, each appearing to provide adequate outcomes
- verification, where information of outcomes is fed back to the problem-solver for verification

This statement still echoes with the current understanding of the basic design cycle (analysis, synthesis, and evaluation) proposed by Roozenburg and Eekels (1995) and a more iterative and reflective design process described by Schön (1983). In the two descriptive models of a design process (figure 1.2), a stimulus situation can be interpreted as a designer's initial perception and understanding of a design problem initiated by a given design brief. Although the problem formulation stages of both models appear to be comparable, the underlying assumptions are quite different that they actually lead to different efforts needed to investigate problem formulations.

1.4. Reflection-in-action - the design expertise approach

The second approach is originated from the reflection-in-action or reflective practice paradigm. Due to the recognition of the co-evolution of a design problem and

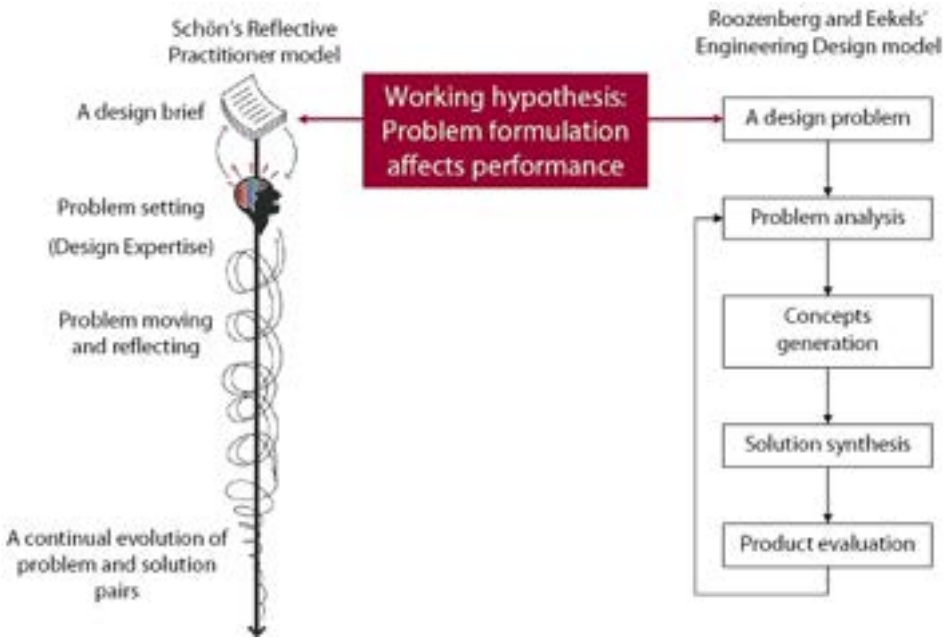


Figure 1.2.: Two descriptive models of the design process

its solution in a design process, this approach regards designers' problem-framing skills as parts of design cognition and design expertise. Even though a design brief may be formulated separately, a designer also acts as his or her own brief writer constantly framing the problematic situation in order to generate potential solutions. An expert designer also tends to solve a harder problem than the one originally presented (Cross, 2004). In this case, the role of design brief writers and designers are conceptually inseparable. A similar viewpoint is also suggested by developmental psychology studies (Arlin, 1975) stating that some individuals in adulthood may develop into a more mature problem-finding stage following the usual problem-solving stage. Since design problems are ill-defined, constraints and criteria are often un-defined (Cross, 2001), problem formulation is part of an internal problem-structuring process of a designer. A design problem becomes defined once the designer imposes a structure on the perceived information. Schön uses the terms problem framing and setting to describe designers' subjective

interpretations of the problematic design situation. "Problem setting is the process in which, interactively, we name the things to which we will attend and frame the context in which we will attend to them (Schön, 1983, p. 40)." "In order to frame a design problem to be solved, a designer needs to frame a problematic design situation: set its boundaries, select particular things and relations for attention, to impose on the situation a coherence that guides subsequent moves (Schön, 1988, p. 182)." Designers construct their own representations of the problem and try to tackle the perceived problems by making their own assumptions and constraints according to their experience. There is strong evidence to support this problem structuring stage to be crucial in affecting design performance. Lloyd and Scott (1995) reported that "in each protocol, there comes a time when the designer makes a statement that summaries how he or she sees the problem, or to be more specific, the structure of the situation that the problem presents as quoted in (Cross, 2001, p. 6)." They referred to this way of seeing the design situation as the designer's problem paradigm. However, "formulation of appropriate and relevant problem structures for ill-defined problems of a design brief is not easy. It requires sophisticated skills in gathering information and structuring information, and judging the moment to move on to solution generation (Cross, 2001, p. 4)." Processes of structuring and formulating the problem are frequently identified as key features of design expertise. Since problem structuring relies primarily on expertise, novice designers are likely to get stuck on the problem structuring stage or they simply take the given information for granted and solve a simple problem. Christiaans reported that industrial product students stuck in the information gathering process, some solve a simple problem without being aware of the potential criteria and difficulties (Christiaans & Dorst, 1992). Atman reported that novices (engineering students) spending a lot of time defining problems did

provide quality design while those attend to enough problem scoping did provide better results (Atman, Chimka, Bursic & Nachtmann, 1999). The second approach provides a plausible relationship between design brief perceptions and design performance since perceptions of design briefs are explicitly connected to design expertise partly through the design briefs presented to the designers and partly through the designers' internal problem structuring process. Schön emphasizes that frame analysis is important but it is also essential for practitioners to reflect on their own role in framing the problem and see other possible alternatives using other frames. "When a practitioner becomes aware of his frames, he also becomes aware of the possibility of alternative ways of framing the reality of his practice (Schön, 1983, p. 310)." There are certain elements that seem to foster or impede this kind of reflections. Practitioners, who operate mainly within a single discipline or paradigm, are likely to encounter what Schön called "automatic intercepts". Reflections are impeded by "intrusion of familiar, patterned responses. These automatic intercepts seem to serve the function of protecting the individual from exposure to failure, but they also assure his continued performance according to familiar routines (Schön, 1983, p. 320)." Automatic intercepts can be regarded as certain kinds of fixation effects in design studies. Seeing a familiar situation may promote practitioners to produce a fixed, stereo-typical, automated response. There are some evidence suggesting that experts are affected by their own routines since experts have been exposed to a large number of examples of the problems and solutions that occur in their domain. Experts can recognize underlining principles and are more efficient in abstracting and analogizing to exemplar cases (Cross, 2004). Prior findings suggest that design fixation can be induced by visual clues of existing solutions presented in a design brief (Jansson & Smith, 1991). Fixation is affected by existing solutions, reuse of existing features and may hinder

conceptual design (Jansson & Smith, 1991). Design fixation states that designers often attach to early solutions and concepts. It may be difficult for them to start from scratch again and they always hang on the same conceptual principle (Rowe, 1987). Purcell also suggested that fixation effects are pretty severe for engineering domains while the effect is limited for industrial designers. It may be due to the educational program and training for the two disciplines (Purcell, Williams, Gero & Colbron, 1993; Purcell & Gero, 1996; Purcell & Gero, 1991). There are more examples of fixation in mechanical engineering (Ullman, Dietterich & Stauffer, 1988) and electronics engineering (Ball, Evans & Dennis, 1994). However, few studies have explicitly studied the effect of design fixation in a verbal-textual form which can be presented in a problem statement of a design brief. Schön cautions that the process of reflection-in-action may not be cognitive alone. Researchers should take the interweaving of cognitive, affective, group dynamics effects into consideration.

When studying design expertise and the development of expert schemata, Lawson stated (2004, p. 457) that "we should explore perception of design situations and in particular how they are recognized and classified. It seems likely that traditional and superficial classifications are misleading here. For example, building typologies such as hospitals, schools or offices may turn out to be superficial, whereas the kinds of situations implied by Pattern Language studies and the idea of Behavioural Settings may offer the deep structures that enable experts to exploit ideas from apparently superficially different contexts. Such research is probably best pursued not so much by studies of actions designers take but more from the way in which they classify and conceptualize the bank of precedent based on episodic memories upon which they rely. Such research almost certainly requires us not just to look at drawings but to listen to design conversations and

explore long term episodic memories." Perception is not a photographic capture of an event (Eastman, 2001). Designers' perceptions determine how they will attend to the design situations and encode the information presented in the design brief. Designers interact with the design situations using their mental representations which are structured by their experience and knowledge in the design domains. Perceptually, people see or hear a pattern, match it with an identifiable structure, then fill in the details in succeeding moments based on the assumed structure (Kosslyn, 1996). In design studies, the pattern-matching behaviours can be viewed as some kinds of reflex responses to look for familiar patterns or differentiable cues in a design brief within a repertoire of precedents in expert designers.

The second approach regards design brief formulations as a trait of a creative individual or an ability of an expert designer. In addition, a prescriptive method is adopted to assist designers in formulating their design briefs. In a textbook on engineering design methods, Cross (2008) stated in the summary that a design brief is an end result after a systematic procedure and information-gathering process from potential users.

"...a procedure and examples for investigating potential product user wants and needs, including the development of user 'profiles', 'personas' and 'scenarios', and culminating in a clear statement (a design brief) that identifies an opportunity for developing a new product concept."

Dorst and Cross (2001, p. 1) also provided a functional view on a design brief suggesting that "the written design brief outlined the problem, introduced the stakeholders and defined the designer's position." Under this approach, designers can follow user-centered design principles investigating and translating potential user needs and wants. Designers are also encouraged to use narratives to uncover latent knowledge about end-users (Cross, 2008). In combination, the second

approach probably is an ideal situation where expert designers not only have been given a lot of design freedom, but also can afford the time and resources to investigate user needs and use scenarios thoroughly before generating an idealized design brief for a design project.

1.5. Design briefs in contexts - the contextual approach

The third approach is originated from professional practices in architecture, urban planning, design management, design consultancy, and in some cases industrial design and engineering design. This approach emphasizes the social context and actual uses of a design brief drawn from experiential and practical knowledge. It is more practice-focused compared to the theoretical concern of problem isomorphism in cognitive psychology. For instance, a design brief for mechanical engineering design may contain many specification-like statements while a design brief for product design may include a user scenario. Besides, design briefs are used extensively as legal documents and contracts that govern architectural design projects from the planning stage to the implementation stage. Different treatments on the subject seem to be the result of discipline-specific priorities. In the professional context, design projects are assumed to start with a market need or client need. Ulrich and Eppinger (1995) observes that client needs are generally expressed in the language of the client which is characterized by subjective phrases. Design brief writers are required to utilize their subjective interpretations to formulate design briefs. Designers typically do not have control over the formulation of a design brief because it also depends on the amount of information provided by the client. Clients may not have any clues of what they want, or they have a semi-developed solution with specific features, or they may have a full specification of a product ready for refinement (Darlington &

Culley, 2004).

The procedure of formulating a design brief is essentially prescriptive and depends on the nature of the design project. This approach can be very comprehensive and covers all the necessary bases in a design project. There is one book (to the best of the author's knowledge) exclusively focusing on design brief formulations in the professional context published by Design Management Institute and written by a business and management professional, Peter L. Philips (2004), who regards a design brief as a strategic business tool to gain an advantage in design management. In his book entitled "Creating the Perfect Design Brief: How to Manage Design for Strategic Advantage," Philips (2004, p. 1) defined a design brief as a written description of a project that requires some forms of design even though it may be known by many other names including an innovation brief, a project brief or a marketing brief. Drawn from his professional experience, Philips provided a prescriptive account to formulate a business-oriented design brief focusing on essential elements. A brief may systematically covers areas including business objectives, design strategy, project scope, project objective, market research, product features, target audience, budget, schedule and deliverables (Philips, 2004).

In an effort to review how the keyword, design brief, is utilized by design researchers from various disciplines, the keyword was entered into several academic databases and search results were filtered by their relevance to the discussions of either the effects of using different formulations of design briefs or how design practitioners regard the function of a design brief. Overlapped search results are eliminated and a summary of relevant search results is presented below.

Relevant results organized by journal name (no. of articles):

Design studies (3) (Luck & McDonnell, 2006; Ryd, 2004; Darlington & Culley,

2004)

Facilities (1) (Consoli, 2005)

Interactions (1) (Russell, 2000)

Journal of Engineering Design (1) (Cartmell, 1995)

Journal of Urban Design (1) (Fairweather & Larkham, 2000)

Mechanical Engineering (1) (Puttre, 1993)

Planning Practice and Research (1) (Turner, 1994)

Technology Teacher (2) (Sigmon, 1997; Tufte Jr, 2005)

Relevant results organized by discipline (no. of articles):

Architecture and urban planning (5) (Consoli, 2005; Ryd, 2004; Turner, 1994; Fairweather & Larkham, 2000; Luck & McDonnell, 2006)

Industrial design (1) (Darlington & Culley, 2004)

Mechanical engineering (2) (Puttre, 1993; Cartmell, 1995)

User interaction design (1) (Russell, 2000)

Technology education (2) (Sigmon, 1997; Tufte Jr, 2005)

If the keyword, design brief, is substituted by design problem formulation, the search results would increase exponentially (e.g. 3421 documents from ABI/INFORM(1971+)), which is partly due to the more liberal use and interpretation of the term in the rational problem-solving literature. Detailed discussions of search results from each database are presented.

Using the Academic Search Premier database which covers many peer-reviewed journals including Design Studies and Journal of Engineering Design, 52 articles are reported using the same keyword: design brief. Only 7 of those articles are relevant to the discussion of a design brief in various contexts and disciplines.

One article written by Turner (1994) discussed how to improve the content

and utility of design briefs used for local planning in Britain which are often inconsistent in structure and content; even design briefs prepared by an individual local authority can exhibit considerable diversity. There is no explicit guidance or advice offered by neither the Royal Town Planning Institute nor the Department of the Environment. Turner took a systematic approach, as does Philips (2004), suggesting a practical template that contains a Statement of Purpose, Policy Background, Survey and Analysis and Design Guidance in order to improve the content and utility of design briefs. Another article by Fairweather and Larkham (2000) in the same discipline discusses the importance of design briefs for urban design and considered the assessment of the role of design briefs to be incomplete without an examination of the policy context. However, they agreed that design briefing has rarely been discussed in the planning literature. Their results of a questionnaire survey identified that design brief preparation is rather ad hoc in some local planning authorities and there is also a disparity between brief preparation and brief usage. A change in attitude of staff and additional training of design briefing would be required to utilize the design brief as a powerful and proactive planning tool to bridge the gap between policy formulation and implementation. Luck and McDonnell (2006) were interested in the interaction between architects and building users in early design conversations, which can be considered to be a preliminary stage of design requirements exploration with users in a building project. They reported that most users were familiar with functional attributes of the space and often situated their discussions in functional and structural elements of design. They also noticed that the format of the event (i.e. presence of authoritative figures, usage of a wish-list to empower users) influenced architect-user interactions. Their suggestions on improving the exchange of information in architect-user interactions include establishing

a common understanding of purposes between architects and users as well as facilitating user discussions to be both problem-seeking and problem-solving. The results agreed with Cross's (2008) notion of preparatory work that is required to formulate a written design brief. Design brief formulation seems to be the result of an information-gathering process and procedure from potential users.

Ryd (2004) conducted an extensive study on the design brief (the product) and briefing (the process) of the Swedish building industry. She discussed how to promote integration and collaboration in a building project, however, not so much by varying the structure and content of the brief, but instead emphasizing creating a positive and stimulating collaboration environment for social interaction leading to a positive perception of the final result of the project. Several problems were identified such as certain brief requirements could be interpreted in different ways which led to disharmony and the brief manager was sometimes difficult to remain objective to reconsider other proposed solutions. She also commented on design brief requirements that are open to many interpretations, stating that the ambiguity and flexibility can lead to innovation and the efficient use of resources. Incomplete brief requirements were difficult to be criticized and questioned, leaving the situation open for new directions, impressions and changes. However, implementers were often reluctant to think in new ways and were restricted by previous experiences of practical solutions. She summarized that concentrating on the expectations of the parties and the briefing process to encourage innovation and change are crucial to satisfy client intentions.

In an article on how to elaborate conceptual design briefs, Cartmell (1995) suggested using a computerized support tool to optimally expand engineering design briefs (with briefs of differing length and completeness) into full requirement specifications based on the procedure of Pahl and Beitz (1996). The tool used in

conceptual design briefs for a range of mechanical engineering design problems was shown to produce specifications that are more efficient and have a higher impact on the outcome of the final design than the manual "paper and pencil" type of elaboration. There are two articles from the journal, *Technology Teacher*. One article (Sigmon, 1997) focuses on using design briefs to introduce design technology instructions to children in order to engage children in various kinds of problem-solving activities. Another article (Tufte Jr, 2005) focuses on using design briefs to bring out all kinds of "out of the box" thinking from children to solve a given problem.

Another search of the keyword: design brief in the ABI/INFORM(1971+) database via ProQuest returned 28 results in the scholarly journals section.

16 of the results come from a specific column called Design Brief in the magazine, Interactions, which feature interviews of designers from various corporations and design consultancies (Apple, Adobe, IDEO, Xerox PARC, etc.) discussing their design culture and philosophy. A discussion of the design brief is offered by Daniel M. Russell (Xerox PARC, user experience research (UER) group) who considered that design brief formulation is the second stage of the design cycle after the initial stage of understanding the problem. Russell (2000) stated that "the brief specifies what problem is being solved, what approaches we are considering, what resources we will need, what competition there is, what advantage/good ideas we think we have, and what the final delivery will be." There are 2 more articles that contain relevant discussions of a design brief. One article written by Puttre (1993), appears in the journal *Mechanical Engineering*, describes that new product development at Colgate-Palmolive involves gathering directors from business, marketing, design, engineering, and manufacturing to collaboratively formulate a design brief for the product. Puttre stated that design briefs are important because they often

contain raw, often divergent, ideas and let conceptual designers generate better new products with fewer false starts. Another article by Consoli (2005) discusses the effects of prescriptive versus non-prescriptive design briefs for constructing Australian private prison. A majority of the interviewed architects considered non-prescriptive briefs to be inadequate for prison construction due to the beliefs that it allowed for manipulation by contractors. A minority believed that non-prescriptive briefs to be adequate and may facilitate innovations. The rest of the articles shown up in the search results primarily are due to the presence of terms, design or brief, in the abstract.

Another search using the same keyword: design brief in the Design and Applied Arts Index (DAAI, 1973+) through CSA illumine online database (which also includes non-English publications) returned 57 results. In this database, many of the resulting articles' target audience are professionals and practitioners. Many articles (3 are published in Danish) offer professional and prescriptive advice on how to formulate an effective design brief to facilitate a successful design outcome and contain case studies of successfully designed services and products. An earlier article by Barlow (1983) might reveal a long-held belief regarding design briefs from a top management perspective. By quoting Sir Kenneth Corfield in his report "Product design," Barlow stated that requirements needed to be considered by designers can be grouped under three main headings: time, performance, and cost. He also suggested that no vague phrases should be inserted into a design brief because they leave too many loose ends for implementations.

In this context, design briefs are often collaborative work by people from different professions and the written documents are used for communications among various stakeholders including clients, designers, engineers, and contractors. Most literature on design brief formulations and design briefings focuses on developing

comprehensive and prescriptive methods for presenting clear statements of products' goals or specifications at an early stage of a design process. Guidelines and checklists for design brief formulations are derived from these few case studies (Turner, 1994; Ryd, 2004; Green & Simister, 1999) to improve the uses and writings of design briefs in specific disciplines. Since this approach is also descriptive and elaborative, it reveals intricate relationships of a design brief in actual practices and describes potential issues of worldly design brief implementations and executions which are not covered by the previous two approaches. Nonetheless, a difficulty of employing this approach is that the knowledge required to formulate a design brief is highly contextualized and mainly relies on individual experience. In addition, the results of design brief formulations can only be studied or applied on a case by case basis because there are many contextual and social factors affecting the final design outcome. Due to its pragmatic origin, the approach also lacks theories to explain or evaluate competing design brief formulations or to establish basis for improving current practices.

1.6. Reflections on the three approaches to design brief formulations

These three different approaches for design brief formulations are acknowledged respectively within their practising paradigms and disciplines. Each approach also provides paradigmatic exemplars to justify their respective positions. At first sight, readers may obtain an impression that these different approaches actually describe the same phenomenon from different perspectives and at different levels of abstraction. A potential observation may be that the first approach is closer to theories while the third approach is closer to actual practices and the

second approach is somewhere in the middle. If the observations were justifiable, readers would have been tempted to accept that there is always a gap between theories and practices. However, without examining underlying assumptions and research methods employed by different approaches, researchers would not be able to determine whether these three approaches reflect reality or simply reflect researchers' perceptions of the situation bounded by convenience and tradition.

Firstly, in terms of research methods, the first approach utilizes mostly quantitative research methods aiming to produce generalisable results. The other two approaches favour qualitative and mixed research methods including verbal protocol analyses and case studies that lead to a better understanding of the phenomenon. Since differences in research methods employed already reveal basic differences of assumptions in epistemology and ontology, it may be inappropriate to compare results derived from these three approaches directly. Table 1.1 displays the implicit assumptions and worldviews associated with the three different approaches. Greene and Caracelli (2003, p. 97) recognized that different paradigms give rise to opposing and contradictory ideas and perspectives. These tensions, contradictions, and oppositions are features of research that are to be honoured but cannot be reconciled. Even though reconciliation may not be possible, making these differences explicit and examining each approach at a more pragmatic level would shed light on their strengths and weaknesses. Figure 1.3 uses simplified models to illustrate the key differences among the three approaches. The first approach emphasizes the design brief itself. The second approach stresses the receiving designer while the last approach is interested in the context of design brief usages.

The strength of the cognitive approach lies in its simplicity and explicitness in modelling the causal relationship between a design brief formulation and a design outcome. The rational problem-solving tradition provides reliable quantitative

Design brief formulations	The cognitive approach (1st)	The design expertise approach (2nd)	The contextual approach (3rd)
Origins	Rational / Creative problem-solving	Reflective practice	Professional / Social context
Research methods	Quantitative research methods	Qualitative / Mixed research methods	Qualitative research methods
Area of focus	Design brief	Perceiving designer	Context of design brief usages
Other related research interests	Design performance, heuristic design methods, expert knowledge structure	Design process, design cognition, design expertise	Normative design guidelines, experiential knowledge
Epistemology	Post-positivism	Interpretivism	Pragmatism
	Modified dualism-objectivity Results probabilistically true Experimental science in search of laws, multiplicity of theories for the same fact Goal: explanation Generalizations: provisional laws, open to revision	Non-dualism; non-objectivity Researcher and object of study are not separate, but interdependent Interpretive science in research of meaning Goal: comprehension Generalizations: opportunity structures; ideal types	Practicality Researchers collect data by 'what works' to address research question. Researchers include both biased and unbiased perspectives. Goal: Problem-centered Generalizations: Real-world practice oriented applications
Ontology	Singular reality	Multiple realities	Singular and multiple realities
	Critical realism: social reality is 'real' but knowable only in an imperfect and probabilistic manner	Constructivism: the knowable world is that of meanings attributed by individuals. Relativism: these constructed realities vary in form and content among individuals, groups, and cultures	Researchers test hypotheses and provide multiple perspectives. Understanding of multiple contexts Value both objective and subjective knowledge
Methodology	Deductive	Inductive	Combined
	Modified experimental-manipulative observation Observation: Observer-observed detachment Mostly deduction (disproof of hypotheses) Quantitative techniques with some qualitative Analysis 'by variables'	Empathetic interaction between scholar and object studied Interpretation: Observer-observed interaction Induction (knowledge emerges from the reality studied) Qualitative techniques Analysis 'by cases'	Pluralistic approaches and oriented toward 'what works' and practice Mixed research methods Both quantitative and qualitative techniques

Partially adapted from Guba and Lincoln (1994, p. 167), Creswell and Clark (2007, p. 24-25), and Corbetta (2003, p. 27)

Table 1.1.: Worldviews offered by the three different approaches to design brief formulations

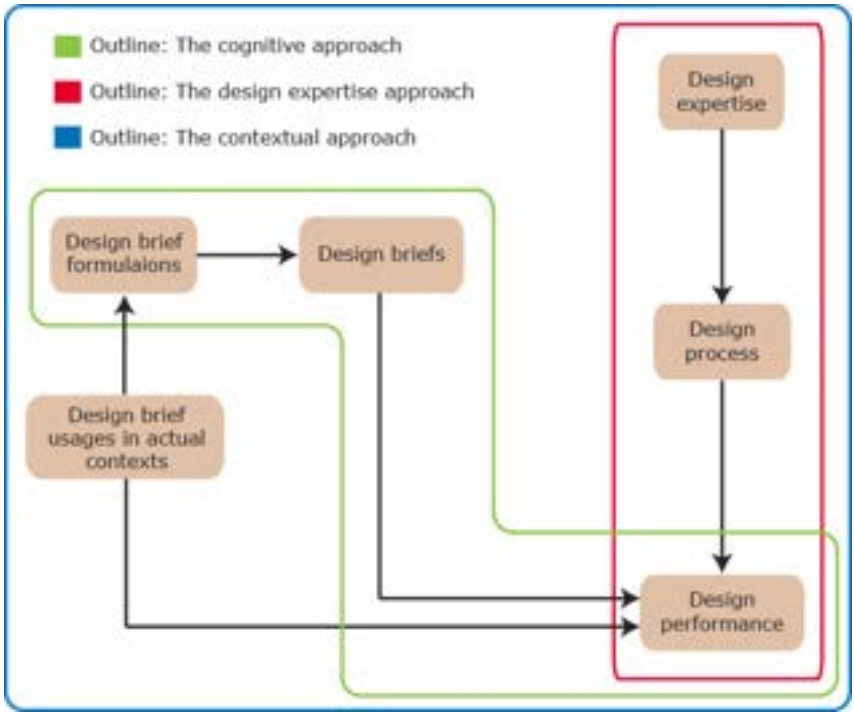


Figure 1.3.: Simplified models used to describe three separate approaches to design brief formulations

research methods for studying and experimenting the proposed relationship. The evaluation of design performance based on expert reviews of design sketches and the technique of consensual assessment of outcome's creativity produces a coherent framework for empirical verifications. In addition, the theoretical model based on the notion of an objectively-defined problem and solution space also seems to be powerful in explaining the subsequent design performance differences associated with different design brief formulations. Nonetheless, a potential weakness seems to originate from the contrived experimental setting that is perceived to have limited practical applications and design brief formulations are considered only as a heuristic method to promote creative outcomes. Another limitation is related to the simplicity of the causal relationship model. On the one hand, the model reduces a complex phenomenon into two variables. At the same time,

the model also prevents researchers from studying the phenomenon in a more holistic manner, even though some successes (Adelson, 1985; Adelson, 1984) have been reported by including design expertise as an additional variable to study design performance. Previous studies have exhausted many implications (e.g. content vs. presentation) related to the two variables (design brief formulations and design performance) and there seems to lack a direction to advance this particular approach to formulate design briefs. In comparison, the design expertise approach uses a more holistic perspective and takes the complex design process into consideration when studying expert designers' cognition, strategy, behaviours, and their performance. This approach emphasizes design expertise and how it may influence designers' decision-making process during a design process. The focus has been shifted from the design brief to the design process. The strength of this approach lies in the elaborative description of how designers actively frame a given problematic situation. Even though verbal protocols are used to illustrate the co-evolutionary nature of the design issue and the design outcome in a design process, it is unclear how designers perceive a design brief before initiating the design process. The relationship between design brief perceptions and design expertise has not been investigated. The assumption of the model seems to imply that once a design brief is given, designers' performance is solely influenced by their expertise and results from this approach seem to be mainly descriptive. Since the ability of actively framing a given design issue is developed over a long period of time, there is no need to change neither the design brief content nor its presentation. Discussions of the contextual approach seem to be quite recent in comparison with the first two approaches. The approach's strength lies in studying the complex phenomenon in a real-world context that leads to a better understanding in design brief preparation and design brief usages. Nonetheless, the results from

this approach are highly contextualized that may not be generalisable and there are many contextual variables (e.g. business factors, cultural and social factors) that are implicitly presented in the model. In addition, there seems to be many purposes, besides promoting creative design outcomes, which are associated with a design brief in different contexts. For instance, design briefs function primarily as tools for communication among various parties involved in design projects and a single interpretation of a design brief is desirable. There are also many different kinds of design briefs that are used in different stages of a design project and for different audiences. Typical media for design communication are natural languages, sketches, diagrams and physical models. More formal notations, terms, plans or representations are supplemented in more technical design environments or in concluding design stages when outcomes need to be communicated clearly to other trades.

1.7. Motivations and research questions

After analysing the strengths and weaknesses of these three existing approaches, I concluded that existing discussions of design brief formulations tend to be situated at the methodological level, essentially asking the ”how” question to satisfy immediate needs. This issue is probably due to the pragmatic nature of design brief formulations in the professional context. This pragmatic origin leads me to realize that the contextual approach seems to be useful in improving existing practices despite its prescriptive nature and can be used to assist design brief formulations in a real-world context. Since existing findings of the contextual approach seem to be derived mainly based on the western professional context, these results may not be applicable and there seems to be a lack of equivalent studies in the Hong Kong context. Can a universal contextual approach to design brief formulations based

on the western context be adopted by other culture contexts? This concern leads to my first research question.

1. What contextual factors related to design brief formulations are unique in the Hong Kong context and how are these factors compared to existing knowledge in the western context?

Two of the contexts that are of immediate interest to design researchers are the design education context and the professional practice context. Even though the use of design briefs as a teaching and learning tool has been investigated in previous studies (Sigmon, 1997; Tufte Jr, 2005), both researchers target children as their primary subjects. The lack of discussion regarding to the role played by design briefs in the tertiary design education context may be due to its omnipresent nature. Design educators often utilize design briefs in studio-based design courses making the brief formulating process a routine and transparent issue to design researchers. One of my aims is to improve these existing approaches. Nonetheless, one cannot improve the situation without a basic understanding of the inherent needs in different contexts. My first aim is to extend the contextual approach to design brief formulations relating existing findings to the Hong Kong context. The analysis results also suggest that current discussions of the three existing approaches seem to be isolated. The discussion of findings from one model tends to exclude findings from another model. The relationships between different approaches seem to be missing and some findings based on a single approach may appear to be reductionist or even contradictory to findings from other approaches. For instance, the cognitive approach emphasizes the use of a design brief to promote creative design outcomes while the design expertise approach emphasizes individual expertise to superior design performance. If both approaches are assumed to be valid, it is not possible to determine which factor is more essential

in affecting a designer's performance. These well-established models from the cognitive approach and the expertise approach seem to be too efficient and abstract the complex phenomenon of design communication to an extreme that impede rather than assist the integration of their respective findings. Under the existing separate model, the combining effect of design brief formulation and design expertise seems to be somewhat unpredictable. The factor of a design context may complicate the discussion further although the contextual factor is assumed to be a single holistic factor. The relationships among design brief formulations, design expertise and design context to designer's performance seem to be missing since no study has investigated all three factors at the same time. The missing gap in existing theories leads to the second research question.

2. What are the relationships among design brief formulations, design expertise and design context to designer's performance?

A potential reason of lacking study to relate all three factors is due to the lack of an appropriate research method and practical limitations. Nonetheless, a common framework is needed that can accommodate these three factors related to design brief formulations, design expertise and design context explicitly at a pragmatic level so that empirical studies can be conducted.

Under close examination, all three existing approaches tend to be prescriptive and most of the efforts seem to be spent on refining ways to formulate or prepare a design brief. Nonetheless, results of any refinements or improvements are not evaluated reflecting a lack of a systemic perspective to investigate design brief formulations in the field. A potential reason might be related to the lack of an explicit feedback mechanism built into these models to further improve existing approaches. Without a feedback mechanism, any progress made in a single study cannot be incorporated into existing approaches. Every new study related to

design brief formulations has to begin at the same initial point. Even though the contextual approach that aims to improve existing conditions appears to escape from the criticism, the contextual approach actually lacks an explicit model for the complex relationships between various contextual factors. As a result, iterative improvements are not possible based on these current approaches. The concern leads to the third research question.

3. How to improve the existing predominately prescriptive nature of design brief formulations?

In view of the second and third research questions, my first effort is to search for a unified framework that can be used to accommodate the discussions of the three approaches to design brief formulations. The next chapter on research design and methodology describes the details of how to systematically and empirically answer these questions.

CHAPTER 2

METHODOLOGY

Chapter 2 discusses the three parts of research design. The first part of research design aims to extend existing knowledge of design brief formulations in the Hong Kong educational and professional context utilizing qualitative methods including semi-interviews and content analysis. The second part of research design aims to consolidate the cognitive approach to vary design briefs into a theoretical framework for design brief production that is validated in a pilot study with industrial design students. The pilot study used a questionnaire survey and statistical analysis to examine the effects of various design brief formulations on designers' perceptions. The last part of the study aims to empirically construct a tentative framework for design brief reception using a mixed method. Card-sorting exercises with content analysis and semi-structured interviews were proposed to investigate how design briefs are perceived by designers with various levels of design expertise and in different contexts.

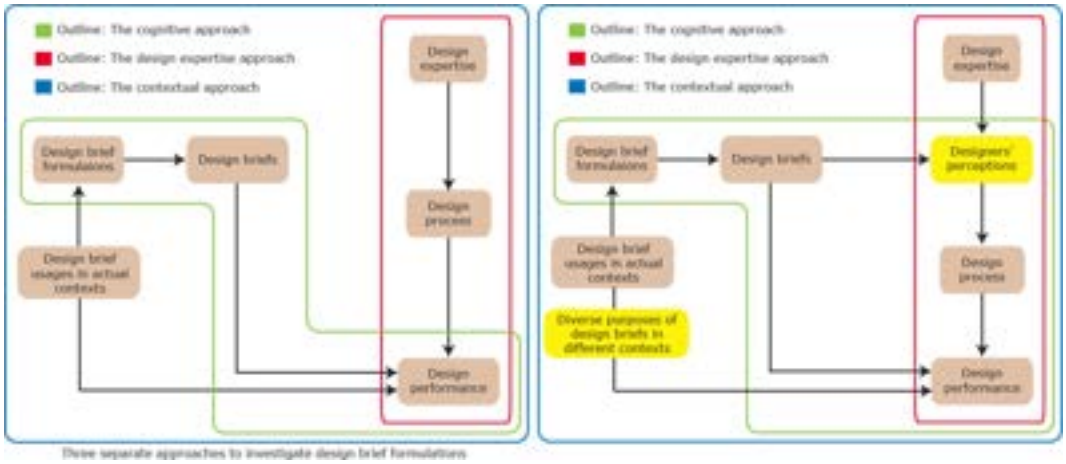


Figure 2.1.: A conceptual framework (right) integrating existing approaches to investigate design brief formulations

2.1. Research design

A conceptual framework (figure 2.1) aiming to provide a simplified overview is established by summarising results from the literature review chapter. The three approaches to investigate design brief formulations introduced earlier (on the left) are outlined by different colours. These approaches are currently considered separately from one another suggesting that each approach seems to consider only a single factor. The cognitive approach focuses on the causal relationship between design brief formulations and design performance. The design expertise approach concentrates on the uniqueness of design processes and how design cognition affects these processes. The contextual approach takes on a pragmatic perspective aiming to improve existing practices of writing design briefs in the professional context. Even though each approach has been utilized previously to investigate design brief formulations, each approach seems to have certain limitations that prevent its further development. I shall briefly summarize these weaknesses before connecting the research questions with the research aim and research design of this study.

The cognitive approach has a narrowly-defined goal of varying design brief formulations in order to achieve innovative design solutions. Using statistical techniques as their research methods, previous studies from problem-solving literature have examined many variation techniques in terms of presentation format and content for achieving the dominant objective. Nonetheless, the direction for further investigations seems to stall due to a heavy reliance on explaining design performance differences solely from an objectively-defined problem-solution space. The causal relationship assumption modelled after cognitive concepts appears to limit explorations of other potential mechanisms originated from design briefs affecting design performance (that is often defined as originality and functionality of design outcomes). A potential direction for this approach is to become more explorative and investigate diverse purposes of design brief formulations in different contexts.

Even though the design expertise approach emphasizes designers' problem-framing skills as a crucial ability of expert designers, design briefs are not explicitly modelled in the relationship between design expertise and design performance. The solution-focus and opportunistic nature of the design process appears to be a natural strategy adopted by expert designers regardless of given design brief formulations. The assumption seems to imply that design brief formulations do not affect expert designers and contradict with results from the cognitive approach. Another assumption in this approach is that design performance is guaranteed to correlate with design expertise. This assumption seems to be the reason of neglecting external factors such as design brief formulations that may influence expert designer performance. The relationship between design brief formulations and design expertise needs to be modelled explicitly for further investigations.

The contextual approach has been discussed rarely outside the western profes-

sional context and mainly focuses on large-scale projects related to urban planning and building construction. Guidelines developed for formulating design brief are mainly prescriptive and based on a specific context and situation. Since many contextual factors have not been clearly identified, these guidelines may not be transferable to other contexts. In addition, a primary goal of this approach is assumed to be minimizing miscommunications among various stakeholders while the consideration of design performance becomes secondary. Due to differences in priority, evaluation of design performance in the professional context may require a different set of criteria from those of the other two approaches.

The weaknesses of existing approaches discussed above can be summarized into two major issues. One issue is the lack of a systemic perspective to investigate design brief formulations since each approach seems to neglect factors presented in the other two approaches. Design brief formulations, designers' expertise and different contexts are considered independently from one another. Another issue is the prescriptive and heuristic nature of existing approaches that does not explicitly model potential relationships among various factors. In addition, diverse purposes related to design brief formulations in different contexts are also neglected. These issues lead to the three research questions of this study. The order of these questions is presented according to the perceived difficulty of investigation.

1. What contextual factors related to design brief formulations are unique in the Hong Kong context and how are these factors compared to existing knowledge in the western context?

The first research aim is to construct context-based models for design brief formulations in different contexts so that the brief formulating process becomes more explicit and is useful for identifying diverse purposes behind design brief formulations in different contexts. The Hong Kong design educational context is

selected due to the omnipresent uses of design briefs in many studio-based design courses and the lack of understanding of how a design brief is used as a teaching and learning tool for higher design education in current literature. Even though traditional design brief formulations focus on promoting creative design outcomes, design educators are concerned mainly with students' development when students participate in a studio-based design course. The additional purpose of design brief to facilitate learning is of practical value to design educators. The purpose of selecting the educational context is to understand some of the intentions behind design brief writers, who are also design educators in this context, and how they incorporate different kinds of learning objectives into a design brief. Educators' reflections of writing design briefs and observing the consequent design outcomes associated with the brief can provide insights for improving existing approaches to formulate design briefs in different contexts. By identifying contextual factors that are essential for formulating design briefs for design students, it is hoped that a descriptive reference model can be established so that future design educators do not have to go through the trial-and-error stage of learning how to formulate design briefs. Hong Kong design practice is another context selected for investigation. The professional context is of practical importance to design researchers since existing findings of the contextual approach are derived from the western professional context and there is a lack of studies related to the Hong Kong context. Existing findings (Fairweather & Larkham, 2000) stated that there seems to be a disparity between design brief preparation and design brief usage. The aim of studying the professional context is to compare and contrast with existing findings and identify factors that are universal across cultural contexts and factors that are presented only in the Hong Kong environment. Since design brief formulations are shown to influence designers' performance, it is unclear whether design managers are

aware of this relationship. Other contextual factors including business strategy, project scale, and company size may also affect design brief formulations in the professional context. Understanding how design briefs are formulated in the professional context may enable clients and designers to better articulate their project needs to design managers and avoid potential miscommunication.

2. What are the relationships among design brief formulations, design expertise and design context to designer's performance?

3. How to improve the existing predominately prescriptive nature of design brief formulations?

The second and third research questions are closer in nature. Both questions seek to answer how the three existing approaches to design brief formulations can be integrated and how existing approaches can be improved progressively. The second research aim is to explicitly relate the three existing approaches so that the three independent factors including design brief formulations, design expertise and design context can be studied empirically. Based on the conceptual framework presented in figure 2.1, there are two possible paths that a design brief can influence a designer's performance. The direct path is assumed by the cognitive approach while the indirect path can be integrated into the expertise approach through a new intermediate variable. The intermediate variable is assumed to be influenced by design expertise and being manifested as an initial perception of a design brief since expert designers often show unique problem-framing ability. If this assumption is valid, the variable related to designers' initial perceptions of design briefs is empirically observable. Another reason of using initial design brief perceptions is that designers are assumed to act naturally according to their usual role and context when forming their first impression of a design brief. For instance, a Yr1 design student is likely to perceive a design brief based on an educational context while a

design manager is likely to consider a design brief from a business perspective. The concern with a given context is implicitly associated with designers' perceptions. These assumptions make it possible to investigate the relationship among design brief formulations, design expertise and design context based on this intermediate variable.

The third research aim is to develop a more systemic perspective to investigate design brief formulations in order to systematically improve existing practices. Since all three approaches tend to be predominately prescriptive, it may be possible to consolidate these approaches of design brief formulations into a quasi-theory of design brief production. A tentative framework of design brief production can be established based on the dominant cognitive approach since it already suggests many noticeable ways to vary a design brief in previous studies (e.g. functions vs. structures, specifications vs. user scenarios). Other potential methods to vary a design brief can be formalized into this framework for guiding design brief formulations. Nonetheless, prescribing guidelines is often considered to be a heuristic approach to improve performance. For instance, it is not possible to know whether prescribed guidelines actually improve designers' performance or the change in performance can be related to other hidden factors. From a systemic point of view, existing approaches seem to lack an explicit feedback mechanism to understand how design briefs are perceived and interpreted by designers. A complementary framework of design brief reception is needed in order to complete the cycle between design brief production and design brief reception. The intermediate variable introduced earlier can be utilized to investigate designers' perceptions to different design brief formulations. Based on these two tentative frameworks of design brief production and design brief reception, hypotheses related to various design brief formulations would become empirically testable

and findings can be used to iteratively improve and evolve existing approaches to design brief formulations.

2.2. Research methods

In the literature review chapter, the three approaches to design brief formulations have been identified with their respective paradigms (table 1.1). One major challenge of selecting appropriate research methods for the study is the incompatible worldviews offered by three existing approaches to design brief formulations since different worldviews already limit the kind of research methods available to researchers for inquiry. Nonetheless, the study aims to integrate existing approaches and needs to adopt pragmatism as an epistemology so that a variety of qualitative, quantitative and mixed research methods can be utilized to investigate design brief formulations in different contexts. An overview of the research design with selected research methods is presented in table 2.1. The study can be considered to be having three stages corresponding to the three research questions.

The first stage aiming to investigate design brief formulations in the Hong Kong educational and professional context tends to be explorative since studies of similar nature do not exist yet. My goal is to understand the diverse purposes associated with design brief formulations and how evaluation of design performance might be different from the cognitive approach in actual contexts. A qualitative method based on data collection from semi-structured interviews and data analysis using content analysis was selected due to the fact that earlier studies of the contextual approach also employed similar research methods to study design brief formulations in real-world situations. Semi-structured interviews are appropriate in identifying potential unique factors in the Hong Kong context and enriching the understanding of design brief formulations from design practitioners. Content

Research aim	To create context-based models of design brief formulations in different contexts	To create a tentative framework for design brief production	To create a tentative framework for design brief reception
Research purpose	To investigate diverse purposes of formulating design briefs and assessing the results of design briefs in the Hong Kong educational and professional context (explorative)	To consolidate existing approaches of formulating design briefs into an abstraction framework that would be validated by statistical methods	To investigate how design expertise and different contexts affect designers' perceptions of design briefs
Research method	Qualitative method	Quantitative method	Mixed method
Subjects	Design educators and design managers	Industrial design students	Industrial design students, professional industrial designers, design managers and design educators
Sample size	7 design educators and 8 design managers	52 (Yr1, Yr2 and Yr3) industrial design students	Total: 40, 8/8/8/8/8 (Yr1/Yr3/Prof./Mgr./Edu.)
-Data collection	Semi-structured interview	Survey	Card-sorting exercise and semi-structured interview
Procedures	1. Semi-structured interviews with design educators and design managers are tape-recorded 2. Interview questions focus on 4 areas (nature of a design brief, preparation of a design brief, evaluation criteria and designers' understanding of a design brief)	1. An abstraction framework is constructed by summarizing existing approaches to formulate design briefs 2. Sample design briefs formulated by the abstraction framework are rated by design students on their perceived abstraction	1. 24 design briefs are formulated based on the abstraction framework for design brief production 2. Subjects are asked to sort these 24 design briefs into meaningful piles and provide rationales for grouping 3. Semi-structured interviews are conducted after the card-sorting exercises
Products	Interview transcripts, sample design briefs used in studio-based design courses	Abstraction and complexity ratings on various design brief formulations assessed by design students	Initial card-sort results, sorting rationales, sorting protocol transcripts and semi-structured interview transcripts
-Data analysis	Content analysis	Descriptive statistics and factor analysis	Content analysis and correlation analysis
Procedures	1. Interview transcripts are segmented into smaller chunks for coding 2. Major coding categories and sub-categories are established based on inductive thematic coding 3. Agreements among subjects are calculated	1. Factor analysis on abstraction and complexity ratings for various design briefs 2. Pair-samples t tests on design brief formulation pairs (e.g. functions vs. structures, specifications vs. scenarios, etc.)	1. 7 main coding categories and 59 sub-categories are derived from subjects' group names and their sorting rationales 2. Comparisons of subjects' sort results within and across expertise levels 3. Semi-structured interview data are used to correlate with results of content analysis
Products	Descriptive models of design brief formulations in the Hong Kong educational and professional context	A partial validation of the abstraction framework for design brief production	Simplified models of design brief perception based on design expertise and context

Table 2.1.: An overview of the research design with selected research methods

analysis provides a systematic way to organize collected data and enhances reliability of findings ameliorating a weakness of qualitative methods that is the lack of generalizability. Design brief writers including design educators and design managers were considered to be more appropriate informants than designers, who are receivers of design briefs. The reason is that design brief writers often participate in the creation of design briefs as well as witness the outcomes of a particular design brief leading them to have a more complete picture of design brief usages in actual contexts. In addition, the interview questions focusing on four specific areas including nature of a design brief, preparation of a design brief, evaluation criteria and designers' understanding of a design brief require subjects to be familiar with the process of formulating design briefs.

In the educational context, 7 design educators (industrial design (4), visual communication (2) and interior design (1)) were the initial sample size that could be adjusted in case of high disagreements among subjects. Three design disciplines were selected for the explorative nature of the study. Results of content analysis showed that even though subjects came from 3 design disciplines, educators seemed to achieve a high agreement with respect to the role of design briefs in studio-based design courses. In the professional context, 8 design managers were selected based on convenience sampling but the author did not expect that many contextual factors including company size (Small and Medium Enterprises vs. Large Corporation), business strategy (Original Equipment Manufacturer vs. Original Design Manufacturer vs. design consultancy) and product type, all seemed to contribute to the diverse views of design briefs in the professional context. Even though some of the findings were agreeable (e.g. popularity of verbal design briefs), most of the content analysis results seemed to be unique and should be considered to be informative instead of representative in the given context.

Findings from the professional context need to be further verified in a large-scale study. With these limitations, results of content analysis were summarized into two descriptive models of design brief formulations in the Hong Kong educational and professional context.

The second stage of the study aims to consolidate existing ways of varying a design brief so that principles for design brief formulations can be captured in an quasi-theoretical framework for design brief production (figure 4.6). Different kinds of design brief formulations aiming to enhance designers' performance were reviewed from design-related literature. There are many heuristic methods to vary a design brief (including varying a design brief's presentation format and content). These format variations not only generate perceptual differences to their readers, they can also be distinguished by their corresponding formal characteristics. In other words, variations of design briefs are defined "objectively" and operationalized in the rational problem-solving paradigm. Due to the tradition of this paradigm, quantitative research methods including statistical analyses often are employed to evaluate design performance differences resulting from design brief variations. Nonetheless, the main challenge is to relate these existing formulations back to more abstract theories and principles.

Three major principles were proposed to assist the categorization of various heuristic methods that were organized by the notion of abstraction since many existing formulation pairs (e.g. functions vs. structures) seem to be related to certain forms of language abstraction and design notations used in various stages of the design process. The abstraction framework can be considered to be an instrument to change a given design brief into other formulations based on the concept of varying the problem-solution space of the cognitive approach. Three criteria were used to assess the usefulness of the framework of design

brief production. It should be able to categorize existing formulations and it should be a practical instrument to assist formulations of design briefs used in actual contexts. In addition, designers who receive these design briefs should notice certain perceptual differences that are assumed to be leading to consequent designers' performance differences. The first criterion was fulfilled by using the framework to analyze design brief formulations for enhancing designers' performance in earlier studies. The last two criteria were examined using a quantitative method since many previous studies based on the cognitive approach also relied on statistical analysis to verify design performance differences resulting from design brief formulations. The stage can be considered to be a validation process of the abstraction framework. A pilot study using a questionnaire survey was utilized to study various design briefs systemically generated by the abstraction framework. The survey asked industrial design students to rate various design brief formulations on a 5-point scale based on the notion of abstraction and complexity. Statistical techniques including factor analysis and paired-samples t-tests were used to analyze the collected data to verify whether different design brief formulations actually lead to different designers' perceptions. For instance, design outcomes' creativity has previously been identified to comprise two orthogonal components, originality and functionality (Finke, 1990) using factor analysis. The quantitative nature of this study provides an opportunity to statistically validate whether designers' underlying perceptions can be influenced by design briefs formulated by the framework. Results from the quantitative method are considered generalizable and could establish the framework of design brief production as a reference point for reflections and further improvements.

From the conceptual framework, it is noticed that both design expertise and context seem to be crucial in affecting designers' perceptions of design briefs. The

last part of the study aims to empirically derive a framework to understand how design briefs are perceived by designers with various levels of design expertise and in different contexts. The purpose is to complete the cycle between design brief production and reception so that design brief formulations can be improved from a systemic perspective.

Nonetheless, the new intermediate variable of designers' perceptions has not been studied before and there seems to lack a well-established research method to study the newly operationalized variable. A potential mixed research method often used in design studies to analyze designers' verbal protocols during the design process can be utilized to infer influences of various design brief formulations. However, there is a tradeoff between depth and breadth of analysis as well as generalisability and explanatory power of results with different sample size selections.

A common constraint for design studies is the limited access to participants for empirical studies, in most cases under 20. This practical constraint offers researchers a further incentive to resort to qualitative research methods. In this study, I encountered a similar constraint, which became most evident in the task of balancing the number of design brief variations and the number of available participants.

Since many design brief variations (e.g. 24 design briefs without counting various expertise levels) are needed to study designers' perceptions with various levels of design expertise, the minimum sample size of subjects per expertise level can easily be over 100. Verbal protocol analysis used to study the design process seems inefficient due to these practical limitations. Besides, Lawson (2004) suggests that designers' perceptions of design situations are probably best pursued not so much by studies of actions designers take but more from the way in which they

classify and conceptualize the bank of precedent based on episodic memories upon which they rely, in particular how design situations are recognized and classified. Focusing on how designers perceive design briefs at the beginning of a design process may be more efficient than studying the entire design process.

Card-sorting exercises have been previously shown to be a reliable and efficient method to study knowledge structures. Card-sorting is used extensively for constructing mental models and knowledge structures for information design and expert system design (Burton, Shadbolt, Rugg & Hedgecock, 1990). The set of cards also provide a bounded setting to analyze and compare individual sorting rationales as well as designers' attention to the various design briefs. Due to this characteristic, card-sorting is often utilized in human-computer-interaction (HCI) studies to construct end-users mental models for work-flow analysis so as to enhance usability of interfaces. Since card-sorting has never been utilized in the investigation of design brief formulations and data obtained from this method cannot be compared immediately to those of previous studies, researchers need to be cautious regarding the reliability of analysis. In order to enhance reliability of the card-sorting results, semi-structured interviews are conducted after the card-sorting sessions for data triangulation.

For the card-sorting exercises, multiple design briefs are written in individual cards with different underlying relationships based on presentation formats and dimensions of the abstraction framework. The number of design briefs was selected to be 24 and 8 subjects were selected for each expertise level to balance the amount of data needed for analysis after the card-sorting exercises. Designers' verbal protocols during the sorting sessions are expected to evoke in-depth and immediate responses to the design briefs that are indicative of the designers' perceptions of the design briefs. Since sort results and sorting protocols can be

used for content analyses and correlation analyses respectively, the mixed method incorporates characteristics of both quantitative and qualitative methods and makes data analysis more manageable. Results of content analysis and correlation analysis can be used to construct simplified models of design brief perceptions in order to explain how designers' perceptions are affected by design expertise and their context.

2.3. Detailed methodology

2.3.1. Semi-structured interviews with design educators and design managers

The interview sessions were audio-recorded and subsequently transcribed for content analysis. Recordings of some of the interviews that were conducted in Cantonese, were translated and transcribed before content analysis. The transcripts were grouped into 20-40 seconds audio segments concerning individual topics of interest for the inductive coding process. The variation in audio segment length is primarily due to individual subjects' speaking styles. Since there is no deductive or a priori coding scheme developed specified for educational brief formulations, I have adopted an inductive approach based on instructional design and learning theory (Thomas, 2000), which emphasizes explicit goal-setting and the characteristics of the learners. A computer software, NVivo, was utilized to code interview segments into different categories. Agreements among subjects on various categories were calculated and the main coding categories were used to identify the simplified models (figure 2.1) of design brief formulations aiming at illustrating essential contextual factors related to design brief formulations. The methodological procedures for conducting the qualitative study with design

managers in the professional context were comparable to those used in the educational context.

2.3.2. A theoretical framework for design brief production

This part of the study aims to consolidate existing approaches into an abstraction framework (figure 4.6) with three theoretical dimensions to analyze and generate various design brief formulations. One dimension originates from cognitive psychology and it is concerned with human perception and categorization of physical objects as they are for example reflected in taxonomies of man-made objects. The second dimension is concerned with language abstraction and how language is used to present ideas and meanings at various levels of abstraction. The last dimension of the tentative framework is concerned with designers' personal use of different linguistic presentations during the design process. Some informal methods (including comparing with design briefs used in previous studies) were used to consider the pragmatic value of the framework. Since the theoretical framework is developed primarily based on the cognitive approach, a quantitative research method is appropriate for its validation. The validation to investigate whether different design briefs formulated by the framework can generate different perceptions is conducted in a pilot study using a questionnaire survey and statistical analysis. Since the abstraction framework is aligned by three dimensions related to language abstraction, the statistical tool is used to verify whether designers' perceptions are respectively influenced by various design briefs.

A pilot study using a questionnaire survey

Since industrial design students are my study targets, an email was used to solicit all students (approx. 100) studying in BA (Hons) in Industrial and Product Design

at the School of Design. Only half of the students responded and the questionnaire was distributed to 52 design students (Yr1: 9; Yr2: 38; Yr3: 5, 24 Male: 28 Female). All subjects were paid volunteers and enrolled in the second semester of a three-year BA(Hons) program in Industrial and Product Design. Each student was asked to take up to 1 hour to finish the questionnaire independently. The duration has been shown to be adequate for students to finish the questionnaires in preceding pilot studies. Since English is the second language of most participants in the study and some pilot subjects did express uncertainty regarding English vocabulary in the original questionnaire, in order to alleviate this potential obstacle, Chinese translations (Hornby, 2002) at comparable abstraction levels were provided in the final version. In the questionnaire, the subjects were asked to rate the perceived levels of abstraction and complexity of 13 pairs of design tasks based on a 5-point scale (i.e. from very abstract(5) to very concrete(1) and from very complex(5) to very simple(1)). The order of various design task items was randomized in the questionnaire. The survey results were quantitatively analyzed using Paired-Samples T-tests and factor analysis. Paired-Samples T-tests compare the rating difference of each design task pair as evaluated by an individual subject. Significant results were reported if the average differed from 0. Factor analysis compared correlations of the perceived ratings for various design tasks. It was used as a data reduction method to identify the underlying variables that constituted students' perceptions of design briefs. Furthermore, the empirical results are used to compare with various dimensions conceptualized by the abstraction framework.

2.3.3. A tentative framework for design brief reception

Preparations of design briefs for card-sorting exercises

I formulated 24 design briefs using the abstraction framework for design brief production and design brief examples from a standard product design textbook (Roozenburg & Eekels, 1995).

These design briefs were written on individual 5.5′ x 4′ sized postcards and were formulated based on various dimensions (number of cards) of the abstraction framework described in section 4.2: superordinate CA+ (2), subordinate CA- (4), functions AH+ (5), structures AH- (3), specification LA0 (5), and scenarios LA4 (5). The design briefs were presented on the cards in three different formats: single statements (9), bullet-point forms (7) and short compositions (8). These formulations included elements that could potentially be perceived as related to abstract design principles or concrete surface features of the given design brief. One way of categorizing the cards is by the proposed abstraction dimensions. Otherwise, these cards can also be categorized by other elements including presentation formats, application domains, design disciplines and other surface features such as keywords. Design briefs used in the card-sorting exercises are shown in table 5.1. The rationale behind these variations is to provide sufficient elements so that designers can sort the design briefs based on their own perceptions. Designers' knowledge structures can be inferred from the sort results and the sorting protocols as described by (Chi, Feltovich & Glaser, 1981).

Card-sorting subjects

40 designers with various levels of design expertise were invited to participate in the card-sorting exercises. Many of the subjects were recruited by snowball sampling where existing study subjects recruit future subjects and by referral. My subjects included design students (first year and third year BA(Hons) in Industrial

and Product Design), during their second semester, design educators from the industrial design discipline, professional designers (3+ years of professional/post-graduation experience) and design managers (10+ years of post-graduation experience), which capture data from designers with different expertise levels and contexts even though the contextual factor is an implicit assumption with each subject. The expertise intervals are designed to roughly correspond to the five developmental stages for the acquisition of design expertise proposed by Lawson (2004) and the six distinct levels of expertise suggested by Dorst (2008). 8 subjects per expertise level are suggested by earlier studies (Chi et al., 1981).

Card-sorting procedure

Before the actual experiments, all subjects were required to practise with the "think-aloud" training exercise (see appendix C) which is adapted from Ericsson and Simon (1984). The purpose is to allow the subjects to become familiar with thinking-aloud their thoughts through concurrent and retrospective verbalizations. Some of the subjects expressed anxieties when asked to perform a mental mathematical calculation (i.e. multiplication of two double-digit numbers). Those subjects were asked to relax and continue with other parts of the training exercise before going back to complete the mental calculation. After the subjects were familiar with the process, they were invited to read the card-sorting instructions (see appendix C) to categorize the cards into stacks that they find meaningful according to their knowledge structures. The sorted stacks of cards were required to contain not too many or too few cards. The final stacks also did not need to contain an equal number of cards. The session began by asking the subjects to read aloud the design tasks given on the cards and to lay out all the cards on a table. They then followed the think-aloud procedure throughout the sorting sessions. When there was a

long period of silence, the subjects were reminded to continue verbalizing. Post-it notes and markers were provided so that subjects could write down anything that they found important during their sorts. There was no time limit for the sorting session. Subjects were asked to re-sort the cards until they arrived at the most satisfactory final results and each sorting time was recorded. These experiments were videotaped, and the verbalizations were transcribed into written protocol data. Since most of the subjects speak Cantonese in the exercises, the verbal protocols had to be translated and transcribed. Their sort results were analyzed by content analysis and correlation analysis.

Content analysis of card-sorting results

Since initial perceptions of design briefs are of primary interests, only the 1st sort time and results were analyzed. The total number of sorts and other information are presented as reference. 7 main coding categories (related to the theoretical framework, business/design management, design knowledge, design discipline, personal/individual preference, presentation format, and product category) and 59 sub-categories were derived from subjects' group names and their rationales for grouping the design briefs. One of the advantages of using both the group names and sorting rationales is that both labels can be presented in the excel worksheets. When conducting a correlation analysis, a single standard category must be used and thus more restrictive. However, a correlation analysis can present a different kind of information. The content analysis only investigates the subjective categorizations of groups but does not check whether the card description actually states or relates objectively to the group label. The approach is closer to the intended notion of initial perception of a design brief based on subjective judgments of subjects. Another kind of correlation analysis can also

be performed on the data and check whether the card description actually has anything to do with the sorted group. 5 expertise levels and two contexts were implicitly assumed in the results. Overall sort results from all the subjects and sort results by each expertise level were plotted on excel worksheets for easy comparisons. Comparisons of their sorting results within and across different cases can be expected to shed light on various factors affecting designers' perceptions and the growth of design expertise on designers' perceptions. The card-sorting exercises were followed by semi-structured interviews. The purpose is to solicit designers' reflections on the card-sorting sessions. The concurrent data from the sorting sessions and the retrospective data from the interviews were triangulated in order to ensure reliable findings.

CHAPTER 3

CONTEXT-BASED MODELS OF DESIGN BRIEF FORMULATIONS

This chapter reports on the collection and analysis of interview data obtained from design educators and design managers. Background of formulating design briefs in the Hong Kong educational and professional context is investigated. This part of the study aims at extending the understanding of the contextual approach to design brief formulations that is mainly developed in the western context. A content analysis is conducted on the interview data. The results suggest that design educators and design managers both seem to take on a systemic perspective considering many contextual factors before formulating design briefs and reveal the diverse purposes behind design brief formulations. Findings are summarized into two context-based descriptive models of design brief formulations that serve as a basis for discussing design brief production and design brief reception in the following chapters.

3.1. Introduction

Even though the use of design briefs as a teaching and learning tool has been investigated in previous studies (Sigmon, 1997; Tufte Jr, 2005), both researchers target children as their primary subjects. The lack of discussion regarding the role played by design briefs in the tertiary design education context may be due to its omnipresent nature. Design educators often utilize design briefs in studio-based design courses, making the brief formulating process a routine and transparent issue to design researchers. In addition, existing knowledge of the contextual approach to design brief formulations is constructed mainly based on data from the western context. The use of design briefs in professional practice in Hong Kong has not been discussed before. The study presents an opportunity to investigate any cultural factors that are missing in the current model. Based on semi-structured interviews with design educators and design managers, two context-based descriptive models of design brief formulations are introduced in this chapter aiming to extend knowledge of the contextual approach to other relevant contexts. Findings from the Hong Kong educational context seem to reflect educators' intuitive understanding of the direct (the cognitive problem-solution) and indirect (students' perceptions) effects of design briefs on students' performance. Educators tend to consider students' performance from a systemic perspective and stated that a design brief should be formulated according to not only the design issue, but also the ability of individual students. Findings from the professional context in Hong Kong are more complex. Some results are universal across cultural context including clients' uncertainty and not knowing what they want in design projects and matching expectations between clients and designers are crucial to successful projects. A unique aspect seems to be the extensive uses of verbal design briefs in the Hong Kong context and the emerging trend of

relying heavily on visual materials. Other findings include the distinction of an external brief and an internal design brief for different audience and the diverse purposes (defensive products based on competitors' product specifications vs. winning design competition) behind design brief formulations. Finally, design managers discussed the need to find a balance between their responsibilities of facilitating design project efficiency and inspiring junior designers to utilize their potential. The results seem to suggest a systemic perspective relating the simplified models (figure 2.1) used in the cognitive approach and the expertise approach to design brief formulations. The insight is further developed in the following chapters unifying different approaches into two frameworks based on design brief production and design brief reception.

3.2. Semi-structured interviews with design educators

This exploratory stage of the presented research study develops a descriptive framework of design brief formulations in the tertiary educational context. Having established design education as the context for this part of this study, it is possible to conceptualize design performance as a combination of the learning progress of students and quality of respective design outcomes. While design educators play the roles of both the brief writers as well as the assessors of student performance, they are in a practitioner's position to inform and reflect on the current status of design education. A method based on semi-structured interviews was selected to probe and to record the educators' knowledge of teaching studio-based projects (see respective discussions in chapter 2). In this context it must be acknowledged that, as discussed in the literature review, design brief formulations seem to rely to some extent on tacit knowledge of educators. The interview questions focus on four aspects of design brief formulations including the structuring of design briefs,

Educational interview (discipline)	No. of main categories and sub-categories used for each interview (total categories: 76)	No. of segments coded
Educator E1 (industrial design)	50	115
Educator E2 (industrial design)	45	119
Educator E3 (industrial design)	46	106
Educator E4 (industrial design)	33	69
Educator E5 (visual comm.)	45	121
Educator E6 (interior design)	56	155
Educator E7 (visual comm.)	32	67

Table 3.1.: Coding statistics for the educational interviews

the direct and indirect effects of design briefs, assessment of student performance and relating the students, the briefs and creativity. A full list of the questions is presented in Appendix A. As a primary objective of design education is to prepare students for professional practice, many studio-based projects aim to simulate "real-world" design projects. The following interviews with educators therefore seek to identify relationships between educational design brief formulations and the professional design context. Content analysis is then used to summarize the findings from the interviews and coding categories are created inductively to construct a descriptive model of practice-oriented motivations underlying brief formulations in the educational context.

3.2.1. Data collection and preparation for content analysis

Semi-structured interviews were used to solicit verbal data from seven experienced design educators at the School of Design at the Hong Kong Polytechnic University in February, 2007. The interview subjects come from three design disciplines (See table 3.1) and have diverse cultural backgrounds (Hong Kong, Canada, France and Germany). The subjects' numbers of years of teaching experience vary from 7 years to 25 years and offer a cross-section of different generations of design educators. The interview sessions lasted for 35 minutes to an hour. They were

audio-recorded and subsequently transcribed for content analysis. Recordings of some of the interviews originally conducted in Cantonese were translated and transcribed before content analysis. In order to ensure the reliability of the transcripts, the transcription process was performed in a two-step process according to (Michelene, 1997). After the initial transcription and a one-month waiting period before all the transcripts were re-examined and compared with the recordings again, the transcripts were grouped into 20-40 seconds audio segments concerning individual topics of interest for the inductive coding process. The variation in audio segment length is primarily due to individual subjects' speaking styles. Since there is no deductive or a priori coding scheme developed specified for educational brief formulations, I have adopted an inductive approach based on instructional design and learning theory (according to (Thomas, 2000)), which emphasizes explicit goal-setting and the characteristics of the learners. 13 main categories and 63 sub-categories were derived. Table 3.1 presents the coding results by educators.

3.3. Results of content analysis

The results of the content analysis are summarized into tables below. The tables show the number of educators who independently rose given issues during the interviews and the number of segments coded under the main categories. Detailed discussions of the categories along with example citations from the interviews follow each table. The main categories are also mapped onto the simplified model of performance (figure 3.1) for comparisons.

Main category	Specific category	No. of educators discussed	No. of segments coded
educators reflections on their own briefs		6	25
	students get stuck, confusion is part of the learning process	6	10
	students are inexperienced to make decisions, filter information	4	7
	students have similar ideas	3	3
	students do not get enough inspirations, feel bored	3	3
	students are lost, do not understand the brief	2	4
		Subtotal	52
educators' responsibilities		2	4
	encourage students to develop their unique way of seeing	7	24
	teach transferable skills	6	8
	educators' pitfalls	4	15
	stimulate higher level thinking, a sense of purpose	3	9
	challenge but not reject students'decisions	3	6
		Subtotal	66
learning objectives built into the design brief		3	9
	emphasize specific issues	7	13
	skill-based learning, learning by doing	7	17
	simulation of real world projects	7	14
	teach students to ask questions	6	17
	learning by examples	5	8
		Subtotal	78
educators assessing students' performance		2	14
	educators' high expectations of students	5	7
	concept generation influenced by examples, secondary research	4	9
	research tools, internet, information	2	8
	creating student portfolios, artifacts	2	3
	practical issues of assessment	2	2
		Subtotal	43

Table 3.2.: The first four coding categories related to educators

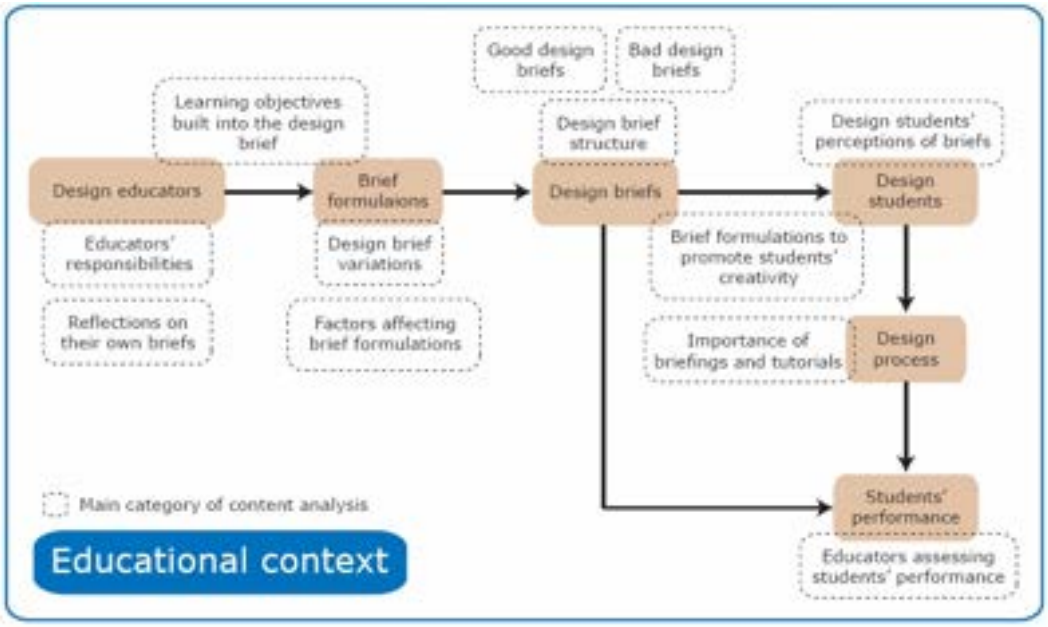


Figure 3.1.: Relationships of main coding categories with the direct and indirect effects of design briefs on students' performance

3.3.1. Educators' responsibilities and educators' reflections on their own briefs

The first four categories presented in table 3.2 are related to design educators. All interviewed educators seem to agree that their utmost priority is to develop students' unique ways of seeing in design. They try to stimulate students' higher levels of thinking and a sense of purpose in every design project so that students can find their answers for what it means to be a designer and what design means to them. Educators also play supportive roles in nurturing the students by constantly challenging the students' decisions and asking the students to externalize their decision-making process.

> *[The second role of a tutor is a challenger to a student's decision. Challenging the student's decision should be very tactful; a tutor should not reject everything from the student. Otherwise, the student will be very disillusioned,*

disappointed, disinterested. The student may simply give up or turn in a marginal work. //23:24 E5]

Educators aim to prepare the students to adapt to various situations and to be flexible in using their knowledge in seemingly unrelated circumstances. There are many pitfalls that educators have to consciously avoid in order not to affect students' performance. The pitfalls include "knowing the right answer to the problem", "letting students take an easy way out", "expressing apathy towards students' progress", and "operating in a yes or no style".

[The tutors should be more open-minded, not to take things too personally. Never, which is tough because things do get personal. There are a lot of sensitivities. //31:36 E2]

[However, you cannot over do this kind of encouragements. The student may think he can fool you and continue without any effort to improve. //26:48 E3]

Educators' reflections on their own design briefs come in the forms of students' reactions to the brief and their subsequent behaviour. Educators said that if everything goes smoothly, they will not learn anything. However, the reflections are more striking when good students fail to perform in a project because of a given design brief. In those cases, the students may get stuck, lost or simply do not understand the brief. Junior students are unable to filter out irrelevant information and are inexperienced in making decisions, which often leads to students' procrastination, frustration and confusion. Educators are then required to give much guidance during tutorials to reset the course for the students. However, these are parts of the learning process for both the students and educators.

[Especially for new subjects and projects, we thought the students can handle the project but it may turn out that the project is too difficult or the schedule is

too tight. That is the process of a tutor's learning and I think part of my job is self-learning to be a better design educator. //11:57 E3]

[There are cases for mismatch of students' ability and project difficulties and we try to improve the situation every year through students' feedback and self-reflection. //12:07 E3]

Design brief formulation is an iterative process in the educational setting. Educators may have set the expectation too high or there is not enough time for the project. Students build up confidence and become more mature each time when they recover from these moments and become stronger designers in the process.

3.3.2. Learning objectives built into the design brief

Design educators are concerned with training design students the right skills for professional practices. The training includes domain-specific knowledge, procedural knowledge (learning by doing) and transferable skills (research skills, teamwork, etc). The studio-based project is a simulation of a real world project so that students are prepared to operate in their profession when they graduate and begin their practice. At the School of Design, the BA(Hons) in industrial design program requires all the design projects to focus on specific social or cultural issues such as sustainability or the Ming dynasty furniture style. There is also an emphasis on teaching students to ask questions and to be pro-active in seeking out issues that are meaningful to them.

3.3.3. Educators' assessing students' performance

Assessment is a challenging task for educators because they need to know their students thoroughly in order to fairly assess the students' performance. Educators

need to assess the design outcomes and the students learning progress throughout the design process which includes aspects of research, aspects of concept generation and aspects of implementation. The educators' expectation also plays an important role. The expectation is different for a year 1 student in comparison to a final year student. The assessment often intertwines with the educators' expectations of the students and thus likely involves personal (as opposed to "objective") judgments. Therefore, multiple educators co-assess many subjects to offer a fair assessment of the students' performance and to avoid too strong and unfair personal basis.

> *[Students are sensitive. Tutors are sensitive. We talked about creativity. These are very hard things to define. //31:48 E2]*

Educators acknowledged that the design brief can be very important during early stages of the design process especially when students frame their understanding of it and seek additional information. Apart from the design brief, technology also affects students' way of conducting research and of generating design concepts.

> *[Reading books and magazines were the stages of their research phase of a project in the past. Whereas now, we are facing a population of youth who knows nothing but the web . . . In the sense that, you need to understand the vocabulary, analogical, search practices on the web is not an exercise in logic but in analogy. //18:56 E2]*

> *[These [research tools] are not fool-proof tools. These can only be understood and practised if the designer can understood more complex structures. That's why a more complex brief is needed now. //54:33 E2]*

Main category	Specific category	No. of educators discussed in the interview	No. of segments coded
students' perceptions of design briefs		4	7
	wide open briefs, vague briefs	6	15
	students' confidence, self-efficacy	4	9
	students dissatisfaction with rigid briefs	3	7
	students seek self-fulfillment	1	1
		Subtotal	39

Table 3.3.: Coding categories related to students' perceptions of design briefs

Digital communication has resulted in fundamental changes to the nature of designing, especially to the information-seeking behaviour of design students. The more traditional way is to refer to books and trade magazines for information. The Internet has made information more accessible. Students are more likely to collect vast amounts of online data using keywords obtained from the design brief, but many students do not have the ability to filter irrelevant data from the project. This particular way of conducting secondary research can be detrimental to students' performance because students may attach to concepts solely derived from their online search results.

3.3.4. Students' perceptions of briefs

Students' perceptions of design briefs are determined by both their ability and their self-efficacy. Self-efficacy means one's belief regarding one's ability to perform a given task (Jonassen, 2000). A wide-open brief (without much guiding information) is often more difficult for students regardless of ability because students do not know where or how they should engage in the project. However, students with more self-efficacy are likely to persist than to give up during the course of the project. Experienced students are more confident and have the ability to handle

Main category	Specific category	No. of educators discussed in the interview	No. of segments coded
design brief structure		7	22
	assessment criteria	7	15
	design requirements	5	12
	deliverables, conducting research	4	9
	project schedule	4	7
		Subtotal	65
good design briefs		5	19
	build in a lot of questions	7	22
	briefs as learning contracts, a tool for communication	5	12
	establish project boundaries,	7	13
	a reference point for students	6	20
	encourage students to exercise creativity	5	11
	show clear expectations of the educators	4	11
	challenge the students	2	9
		Subtotal	117
bad design briefs		3	4
	instruction following exercises	4	11
	easy solutions	3	7
	too tight, dictate outcomes	2	3
		Subtotal	25

Table 3.4.: Coding categories related to the design brief

open briefs and they may even prefer an open brief as a challenge for their self-fulfilment to a rigid brief that dictates the design strategy or outcome. In their final year, students are required to create their own design briefs for the final year projects so as to experience the process of writing design briefs. The findings seem to confirm Jonassen's view that individual differences in both cognitive and conative factors can affect designers' perceptions of the task and performance (Jonassen, 2000).

3.3.5. Brief structure, good briefs and bad briefs

From the educators' points of view, a design brief is an important tool for communication with students. If students do not understand or do not read the brief, the brief loses its primary function. This may happen for a number of reasons including lengthy briefs, difficult vocabulary, uninteresting topics, or a monotonic briefing session. The structure of design briefs tends to be rather formal; it contains information regarding design requirements, deliverables, project schedule and assessment criteria. Design briefs sometimes prescribe strategies of conducting design research. Besides the obvious structure of a brief, the interviewed educators seem to agree about the nature of a good design brief. A good brief, in their view, has to pose questions and establishes the boundary of a project. It serves as a reference point and as a source of inspiration for students. It encourages students to take risks and exercise their creativity. It should also indicate the expectations the educators have on the students. Bad design briefs prompt for instruction-following exercises, which are often perceived as too tight and as dictating the design outcomes. They can be specific to the point that students can guess the educators' expected outcomes and perform accordingly, without engaging in designing.

3.3.6. Importance of briefings and tutorials

Briefing sessions facilitate the communication between design educators and students. Students have the opportunity to ask questions directly and educators can observe the students' reaction immediately during an initial briefing session. In the design education context, educators also play a special role as tutors as evidenced by the name, tutorials. Educator E2 stated that the etymology of the word, tutor, has a French origin.

[The origin of the word tutor comes from tueri which is a gardening tool, stiff

Main category	Specific category	No. of educators discussed in the interview	No. of segments coded
importance of briefings and tutorials		6	21
	walk through the design process together with students	6	12
	keep track of students' progress	5	8
	tutors and peers feedbacks	4	9
		Subtotal	50
design briefs in the professional context		7	15
	client's needs in design terms, market needs	6	18
	client's abilities, values, expectations	4	13
	returned briefs, contractual briefs	3	7
	verbal briefs, briefing with clients	3	4
	evolution of a design brief	3	7
		Subtotal	64

Table 3.5.: Coding categories related to briefings and tutorials

stick deeply planted in the ground for a plant to grow. The plant can rely on its firmness. The analogy here is adequate. //33:40 E2]

Tutorials are as useful as the design brief in varying the design outcomes. The educators' tutorial feedback can open-up or narrow-down the students' options in the design process. It also gives students individual feedback from educators and peers. The discussions among peers provide a semi-formal critique environment for students to further develop their initial ideas and concepts. Moreover, tacit knowledge is passed on to the students during tutorials, which can only be experienced together with the educators, as in a master-apprentice relationship. Educator E1 said in the interview that he is not too concerned with the role of the design brief because there are tutorials to set things right or to keep track of the students' progress. He agreed that there will not be such a luxury if the project duration is too short, in which case a brief will play a more important role.

However, educator E5 believes that individual tutorials should be led by students and initiated by students. Otherwise, students may rely too much on educators' advice in the design process. E5 notes that students have to become more independent when advancing in their education. Some educators also raised the issue that tutorials are absent in the professional context, in which the students are primarily trained.

> *[Students are fairly junior within the profession; they have the opportunity to come to tutorials which professions don't. A professional will be given a brief and then have to run with it and there is no one coming in twice a week to check on the progress. //54:00 E1]*

> *[In the industry, if you are a supervisor or a boss, their version of tutorial is very simple. When a designer brings his works for your opinion, you only have to say which one is good and which one is bad. You then ask the designer to go back to work and don't waste your time. //23:54 E5]*

In addition, educator E5 noted that many design educators who have left the industry recently tend to exhibit a habit of telling the students what to do without offering explicit reasons. This raises a sharp contrast between the educational and professional contexts.

> *[A boss often just told a designer to continue with certain works without explicit reasons. In that case, a designer does not learn anything from the boss's decision. As tutors, we should not act like that. //24:21 E5]*

3.3.7. Design briefs in the professional context

Most of the educators are familiar with practice in the industry. They are able to offer some comparisons and contrasts of design briefs between design education

and professional practice. There are at least two kinds of design briefs common in the industry. One kind is the client's brief and the other kind is internal to the design consultancy. Senior designers find out the client's abilities, manufacturing capabilities, values, and expectations through a briefing session with the clients. The result of the meeting is a client's brief or a return brief which captures all the pertinent points of the conversation with the clients, which can also be a contractual brief which clients need to sign and agree to the deliverables specified in the return brief. The internal brief is often formulated by senior designers or market specialists who translate the client's needs into design terms, which can be understood by junior designers. Because the business environment is always changing, the internal brief is constantly evolving with the market and economic situations. A client's project schedule or time constraint also affects design exploration and openness of the brief. The internal brief seems to be more comparable to the design brief that is discussed in the educational context. These insights from eductors seem to suggest that there are many unique factors (e.g. external brief, internal brief, clients, marketing department, business strategy, etc.) that are presented in the professional context and may lead to a more complex model of design brief formulations in the professional context. A separate discussion of design brief formulations in the professional context is desirable in understanding these additional context factors and is presented in section 3.5.

3.3.8. Design brief formulations to promote students' creativity

In the educational context, educators believe that creativity lies in the students. Creative artefacts or outcomes only manifest themselves when students exercise their creativity to exceed educators' expectations. Design brief formulations that aim to promote creativity focus mainly on the students. A general consensus is

Main category	Specific category	No. of educators discussed in the interview	No. of segments coded
brief formulations to promote students' creativity		2	4
	arouse students interests and commitments	7	22
	present an interesting problem to solve	4	8
	minimize hints for expected outcomes	4	13
	to experiment, to get first hand experience	4	15
	look at things in different ways	3	4
	get students involved in brief formulations	3	8
	force students out of their comfort zone	3	8
	shorter projects generate more interesting concepts	2	10
	prescribe creativity techniques in the design process	2	8
		Subtotal	100
factors affect design brief formulations		2	2
	based on students ability, experience, preference	7	25
	project time, research time, execution time	5	12
	context of Hong Kong	5	17
	individuals, multi-disciplinary teams, overseas teams	3	13
		Subtotal	69
design brief variations		0	0
	not to built-in preconception	2	5
	providing descriptions or functions	2	5
	built-in preconception at an appropriate level	1	4
	providing situations	1	6
		Subtotal	20

Table 3.6.: Coding categories related to design brief formulations

that design briefs should serve to arouse students' interests and commitments to the design project, for example by involving students in formulating the brief or by presenting an interesting problem that students might not have seen before. Educators may ask students to experiment and get first hand experience in understanding the issue tackled in a subject, which aims to make an engaging impression and to encourage students to look at a design problem from multiple perspectives. Based on this observation, educators seem to support and practise the assumption of an indirect effect of design briefs on designers' performance even thought the affective approach of design brief formulations is often neglected in existing theories. In addition, educators should minimize hints at expected outcomes and encourage students to leave their comfort zones, or strongly discourage students from taking obvious paths. In longer projects, in which learning processes are more iterative, the educator acts as a mediator between the design challenges and the students. The feedback process is very delicate, as far as the educator is in a constant reflection with the student and her or his performance. The educator then influences the course of actions based on the students' responses, which involves risk-taking on the educators' side. On the one hand, if the challenges are set too high, students may experience frustration and, in extreme cases, give up. On the other hand, if there is not enough challenge, students may proceed by merely fulfilling minimum requirement, by recalling existing solutions and by treating the project as trivial without trying to break existing boundaries. Educators are responsible to keep learning processes continuously climbing, while students may rest on certain plateaus occasionally but they must feel the pain or confusion over the course of a project. Otherwise, no genuine learning can occur without students overcoming obstacles with considerable effort. This mediating process keeps the challenge on the edge by formulating design briefs according to students' ability.

In this way, the design brief is challenging to students which may promote the outcomes' creativity as a side effect. When Csikszentmihalyi (1990) describes the "flow experience" of individuals, he said that subjects become frustrated with an activity if the challenge is set too high for their ability or the subjects become bored if there are not enough challenges built-in the task. Design educators seem to implicitly understand this rule and consider students' ability when formulating design briefs.

> *[All of these techniques help and anything that can bring, doesn't allow a straight obvious path that make students accountable. //33:44 E6]*

> *[Things that I don't even know the answer for, that I as a tutor, maybe that an important point, that also forces me as a tutor not to take the easy way out either. //33:58 E6]*

The coding segments also reveal evidence of more conventional approaches of prescribing design methods and creativity techniques for the design process. For shorter subjects such as intensive seminars followed by workshops, succinct design briefs result in outcomes that are very positively received by both educators and students. This kind of workshop allows students to focus and to concentrate on being creative without having to consider the practicality of their outcome. Students' concentration and process intensity resulting from shorter project durations can be regarded as an environmental factor or technique to enhance outcomes' creativity. Nonetheless, educator E2 reports that any methods to promote creativity remains external, motivations lie within individual students.

> *[There is only so much you can control on the students' outcome. You can have a cohort that is very difficult to deal with. //43:44 E2]*

3.3.9. Factors that affect design brief formulations and brief variations

Following the above discussion of project time and students' abilities, experience and preferences, I will now consider other contextual factors that influence design brief formulations. Educators should, according to the interview subjects, pay attention to group dynamics because an extra layer of communication exists in group projects. Globalization of design education also provides students many chances to collaborate with overseas designers and in multi-disciplinary teams. A design brief can pose significant challenges if different team members interpret the brief in their own, strongly deviating ways. As the interviewees come from diverse cultural backgrounds, they notice that the cultural context of Hong Kong is an essential factor.

Hong Kong students are described as less likely to ask questions or to challenge the educators' decisions. Students are keen to know exactly what they have to follow in order to receive a good grade.

> *[Hong Kong students are more inclined to follow instructions; therefore, the school should provide the students the experience of writing their own brief. //15:31 E7]*

> *[In a Chinese context, which is not very tolerant when it comes to educators admitting errors or admitting where they don't know something or where they made a mistake. //43:36 E1]*

> *[Hong Kong students; they are very keen to know what is expected. What they feel comfortable with is that if they have an extremely clear description of what is expected of them. Then, they know this is what I have to do and I will do it. //25:52 E6]*

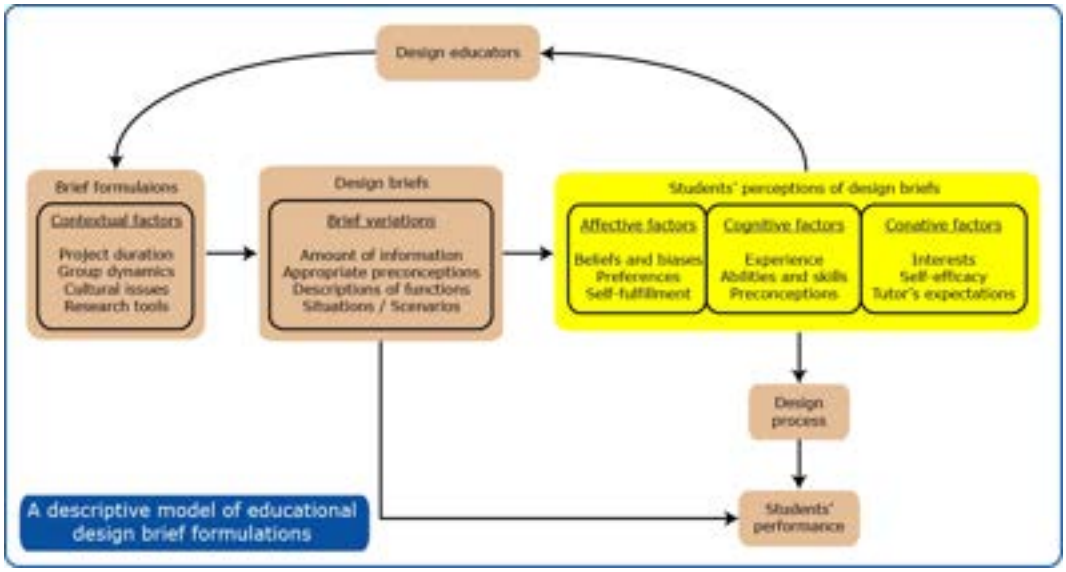


Figure 3.2.: A descriptive model of educational design brief formulations

[After reading the brief, the students will mainly focus on what they need to do for the deliverables. //17:22 E3]

All of these contextual factors can critically affect brief formulations as well as subsequent design performance.

3.4. Discussion of educational design brief formulations

The descriptive model shown in figure 3.2 identifies various factors influencing educational design brief formulations and their potential effects on design performance. (Note that this is not offered as a normative or prescriptive model to guide educators' action). Summarizing from the collected data, it can be stated that design brief formulation is not a straightforward process of promoting creative outcomes.

My first impression of the descriptive model confirms that design educators already have an implicit understanding of using a student-centered approach of formulating design briefs.

Some key observations on how educators formulate design briefs for students:

- motivate students through personal preferences, interests, and self-fulfilment.
- take students' ability and expertise into consideration when setting the challenge.
- show confidence in students and encourage them to develop strong personal styles.
- challenge oneself when formulating design briefs.
- shorten design project durations to increase students' intensity and concentration.
- formulate open design briefs and narrow down the design brief during tutorials.

Nonetheless, educators' knowledge of and competence in design brief formulation is based on an ongoing trial-and-error effort of design educators and their own reflections. The experienced educators also have advantages based on accumulations of previous interactions with design students. Experienced educators can give concrete examples of what actually happened with respect to different design brief formulations while it is mostly a trial-and-error effort for less experienced educators.

Even though educators do not seem to explicitly relate their briefing practices to formal learning theories, educators are intuitively aware of student characteristics that can influence students' perceptions of design briefs. Educators encourage students to make strong commitments and take design very personal in a design project and their primary emphasis is to increase students' motivation. They are concerned with students' preferences, interests, and self-fulfilment which can be

considered to be affective factors of design brief formulations. These affective factors have been shown to affect problem-solving performance and may be related to intrinsic motivations of designers (Jonassen, 2000). However, "theories about cognito-affective processes specific to designing are not easily included in the positivist cognitive science model of cognition (Love, 2002, p. 351)."

The second cognitive factor is similar to the expertise factor, which is related to students' abilities, knowledge and experience. Educators encourage students to reach new heights in every project by providing reference points that allow students to reach personal (if not universal) originality. The design brief can sometimes be confusing to students because educators have to balance posed challenges and students' abilities to avoid students feeling boredom or anxiety, which can pose a critical threat on the "flow" experience described by Csikszentmihalyi (1990). The last conative factor is related to self-efficacy, confidence and educator's expectations. The mission of developing students' unique ways of interpreting design brief in educational contexts can be regarded as laying the seed for a strong personal style in their future professional practice. If these findings are reliable, design students are taught not to operate in the classical hermeneutics model that aims for a single interpretation of a design brief. In this case, design brief communication is interested not only in presenting factual information, but also in stimulating designers to interpret a design brief in a non-trivial way. Investigations of design brief reception (chapter 5) should enable researchers to improve existing approaches to design brief formulations. Nonetheless, there seem to be limits to what an educator can do to promote creativity; one cannot force students to be creative; one can only be suggestive and provide an environment that is favourable for students to exercise their creativity.

A rule of thumb for educational brief formulations seems to be that brief should

initially be as open as possible, to be narrowed down in tutorials together with the students along the project. Through this iterative process of tutorials, educators are in an interactive position to monitor the student progress. For instance, open design briefs without much guiding information may not be suitable for junior students. Rigid briefs tend to generate dissatisfaction in more experienced students. Project duration also plays a moderating role in affecting the intensity of students' engagement and the creative quality identified in resulting outcomes. Educators should avoid long design projects which seem to curtail creativity and energy of the students. The ubiquitous use of online and sophisticated research tools also has a great impact on student performance. Unfortunately, the content analysis did not reveal how these digital research tools could be used to enhance students' performance. Educators should be cautious that these tools may hamper students' creativity if they are not capable of filtering the information obtained from the Internet.

In educational institutions, class projects set out in a curriculum may remain unchanged while students are different individually as well as from cohort to cohort. This situation offers educators opportunities to iteratively improve the design brief for a project. The interview data allow a differentiated view on design brief formulations and design brief variations. It becomes apparent that, on the one hand, design brief formulations exist within a broader context that requires educators to consider various contextual factors relevant to the project but these factors may not be as direct as notions such as an objectively-defined problem-solution space. On the other hand, language variations in altering the briefing statements may have a direct influence on students as students tend to read the problem statement first and to immediately form an initial perception of the project. However, the descriptive model of design brief formulations suggests that

designers' perceptions of design briefs are integrated and should be investigated from a systemic perspective relating design brief formulations, design expertise and design context. An empirical study is designed to investigate design brief reception and the results are presented in chapter 5.

3.5. Semi-structured interviews with design managers

Semi-structured interviews were also conducted with design managers (with at least 10 years of experience) in the Hong Kong design industry. The coding categories on the design manager interview data are again inductive. The analysis procedure is similar to the one used for the design educator interviews. 8 design managers were interviewed and the interview sessions lasted from 15 minutes to 35 minutes. Design managers' responses were usually shorter and more concise than those from design educators. A coding statistics summary is presented in table 3.3. Areas of interest covered by the interviews seem to be quite diverse since subjects' specialties were equally split between industrial design and design consultancy. Subjects specialized in industrial design tend to work for larger companies (more than 50 design staff, excluding manufacturing staff) while subjects in design consultancy usually are employed by small and medium enterprises (SME). The different role taken by design managers in smaller-scale projects as opposed to larger-scale projects may explain the more diverse views reported in the interview data. Nonetheless, perspectives offered by the two groups of managers seem to be complementary in understanding professional practice of design brief formulations in the Hong Kong context. Most of the main categories (figure 3.4) are related to contextual factors that have not been discussed before in the educational context. The results of analysis are divided into four main sections relating to business factors in the Hong Kong context, design brief formulations, designers' perceptions

Design manager interview (specality)	No. of main categories coded (total main categories: 17)	No. of segments coded
Mgr_A (industrial design)	12	33
Mgr_B (industrial design)	13	45
Mgr_C (design consultancy)	12	30
Mgr_D (design consultancy)	15	67
Mgr_E (design consultancy)	15	54
Mgr_F (design consultancy)	9	32
Mgr_G (industrial design)	14	58
Mgr_H (industrial design)	9	37
	Total	356

Figure 3.3.: Coding statistics for the design manager interviews

of design briefs and design managers' reflections. Since earlier findings obtained from the contextual approach are all conducted in the western professional context, the content analysis results can be used to make comparisons and identify potential unique factors related to the Hong Kong design industry. An important issue is noticed early on in the interviews that there were at least two kinds of design briefs distinguished by design managers. The first kind of design briefs is a formal document used to communicate with clients and the other kind is a reinterpreted version of the formal brief that is used internally for circulations with other departments within the company or for junior designers to follow upon the design project. This observation suggests that not only can a design brief be formulated based on different purposes but also be formulated for different audience. Even though both kinds of design briefs are utilized in the professional context, the reinterpreted version or the internal design brief seems to affect designers to a larger extent and is the main focus of the analysis.

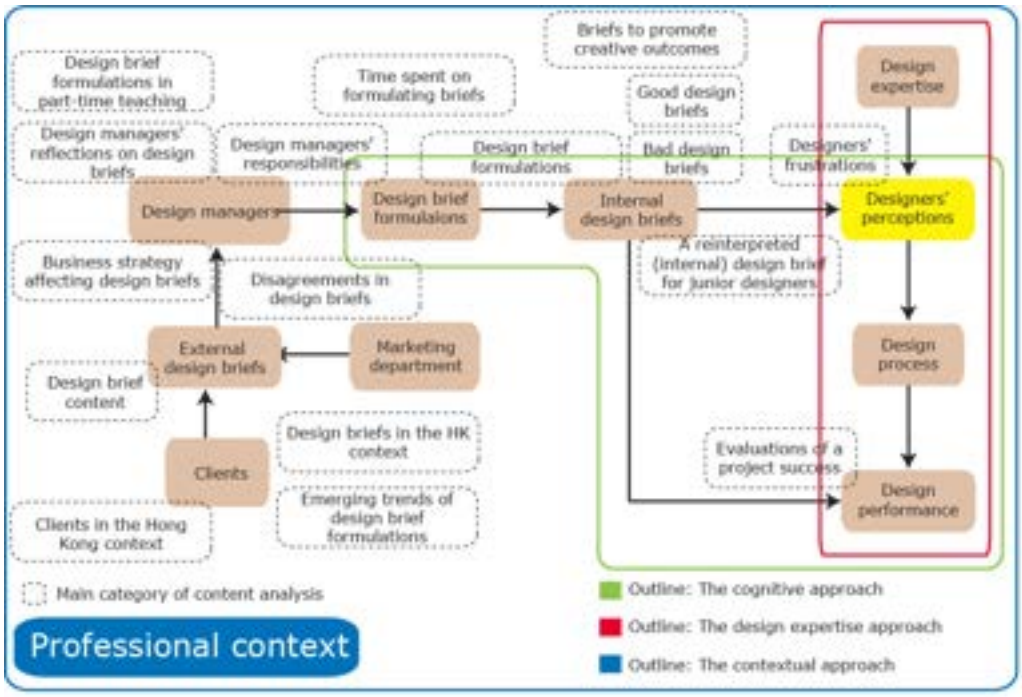


Figure 3.4.: Relationships of main coding categories with the three approaches to design brief formulations

3.5.1. Business factors affecting design brief formulations in the Hong Kong context

Many subjects reported that Hong Kong clients tend to rely on using a verbal design brief delivered in a briefing session instead of preparing a more formal written document. Even when design briefs are available, they are reported to contain little information or simply a title for smaller design projects. The reason is partially due to the short time-frame of small-scale design projects that makes clients believe that it is a waste of time to write a written design brief. Another reason seems to be related to clients' uncertainty of what they want in a project. Clients' uncertainty also seems to be common in the western context (Darlington & Culley, 2004). The tendency of using verbal design briefs appears to influence some design managers who in turn brief their junior designers only verbally. Design managers report that clients sometimes take advantages of the situation of not having a written design brief and make sudden changes in the middle of a project leading to a lot of tension in the design team. Actually, the same situation also happens to design managers who rely on verbal briefs.

> *[Sometimes a verbal one has a weakness, which is that I cannot assure how much they [my design team] understood. //28:57 Mgr-E, Sometimes when I was not satisfied with their work, more work has to be redone, or they have to start over again. //29:12 Mgr-E]*

Even though there is much inefficiency associated with verbal design briefs, design managers have to accept the fact that verbal design briefs are norms instead of exceptions. The extensive uses of verbal design briefs in the Hong Kong context are in contrast with no mention of verbal design briefs in the western context.

Main category	Specific category	No. of design managers discussed in the interview	No. of segments coded
design briefs in the HK context		1	2
	clients mainly rely on verbal briefs	5	11
	senior management verbal instructions as briefs	3	4
	afraid of being held responsible for misinterpretations of briefs	2	5
	have little information or only a title	2	4
	short descriptions w ith a general direction	1	2
	too open-ended briefs may get designers' ideas banned	1	1
		Subtotal	29
clients in the Hong Kong context		1	1
	uncertain of w hat they w ant	3	24
	misunderstood designers' roles as draftmen	2	6
	mainly concern w ith costs or trends	2	4
	tend to ignore the brief	1	1
	client personal preferences cannot be argued	1	2
	risk-averse	1	1
		Subtotal	39
business strategy affecting design briefs		1	1
	changes of briefs due to market dynamics	4	13
	existing and future product lines	3	3
	market/client driven in the Hong Kong context	3	4
	innovative products vs. copycat products	2	7
	need to consider client's brand image	2	2
	market may not accept innovative products	1	2
	OEM vs. ODM	1	2
	reuse existing products w ith slight modifications	1	2
	w inning design competition	1	2
		Subtotal	38
disagreements in design briefs			
	resolved by rational discussions	3	5
	engineers' perspective vs. designers' perspective	1	4
	resolved by senior management	1	1
		Subtotal	10
evaluations of a project success			
	Product success = good sales	4	15
	due to many factors (market timing / reasonable price)	4	13
	matching expectations (designers and clients)	4	8
	for designers (success = meeting brief requirements)	3	3
	good design briefs tend to produce good design outcomes	2	2
	for designers (success = a have chance to further develop initial concepts)	1	1
		Subtotal	42

Figure 3.5.: Coding categories related to business factors in the Hong Kong context

The interview data also show that there are many kinds of design briefs behind various business strategies and purposes. Most product development in Hong Kong is market-driven and many product design briefs are formulated by a marketing department containing existing product specifications with slight modifications and price information. Design managers report that these design briefs are likely to be used externally presenting to clients while they have to reformulate an internal brief based on their experience for junior designers to follow upon the design work. In many cases, client's and company's strategies do not allow for the development of innovative products since their expertise tends to focus on manufacturing ability. Many clients are also risk-averse and are afraid that innovative products may not be acceptable by the market. Nonetheless, innovative product and design briefs are developed by some design consultancies targeting to win design competitions and attract potential clients' attention.

Regarding to a product success, many design managers believed that achieving good sales is a reflection of a successful product. Designers consider themselves successful if they are able to fulfill the design brief requirements since a product success is influenced by many unforeseen factors including economic condition, promotional strategy, and market timing. Besides sales, the most important aspect to evaluate a project success is whether expectations from clients and designers are equally matched since design managers aim to foster a long-term and trusting relationship with clients that is also reported in Ryd's (2004) study of the Swedish building industry.

3.5.2. Professional design brief formulations

Even though the use of verbal design is widely adopted in the Hong Kong context, the formulation of an external design brief seems to follow a traditional

Main category	Specific category	No. of design managers discussed in the interview	No. of segments coded
design brief content			
	target users, product market, unique selling points, product price, schedule	6	10
	deliverables: sketches / 3D drawings / renderings / mockups / trend study	5	9
	client background/purpose/business strategy	5	9
	price range	3	4
	product functions / style / packaging	2	3
	design brief format is not important	1	1
		Subtotal	36
design brief formulations		3	4
	design brief as a guideline or direction	4	5
	an iterative process, feedback from marketing department and senior management	3	6
	different kinds of design briefs (internal vs. external)	3	4
	collaborative work from different departments	2	6
	detail briefs required for large-scale projects with multiple stakeholders	2	5
	marketing department as a middleman between clients and designers	2	2
	from brainstorming sessions	2	4
	innovations mean different things in different products	2	4
	concepts exist before briefs	1	5
	based on competitor products	1	3
	based on verbal briefs, briefing with clients	1	2
	foreign clients may have very detailed briefs	1	1
	difficult to translate insights into clear design directions	1	1
	conducting own research if nothing is offered by clients	1	1
		Subtotal	53
design brief formulations in part-time teaching			
	adapting a brief to match with a designer's ability and interest	1	3
	Individualized design briefs (able to motivate students, part-time teaching) vs a generic brief (generic results)	1	3
		Subtotal	6
time spent on formulating briefs			
	(<1 day)	2	2
	depend on nature of the project	1	2
	not enough time for writing a design brief	1	1
	(<1 week)	1	1
		Subtotal	6

Figure 3.6.: Coding categories related to professional design brief formulations

standard. Clients, marketing department and senior management are involved in the formulation of an external brief that may be revised a few times before finalization. The collaborative way of formulating a design brief from multiple stakeholders seems to be standard for new product development (Puttre, 1993). Subjects described that the external design briefs are likely to contain information related to target user groups, product market and price, unique selling features, and a project schedule. Deliverables are also typical including sketches, CAD drawings, mock-ups, and initial market responses. Besides the standard information, a more detailed design brief contains information related to clients' background and their business strategy. In addition, design consultancy is more likely to concern with product aesthetics and styles that remain a distinctive aspect representing industrial design tradition.

On the one hand, the internal brief appears to be a logical step following the external brief since design managers need to integrate clients' information and their own experience in order to develop a design direction for the project. Design managers reported that they have to conduct some background research on the project before they can generate any useful insights since market competition is severe and a copycat product has a slim chance to be accepted by clients. Due to tight project schedules (less than 3 months), design managers usually finish their internal design briefs in a single day. The resulting internal brief usually has clear guidelines and directions that are understandable to junior designers. A brainstorming session is often held following the formulation of the internal brief so that members of the design team can offer their own perspective to the project. On the other hand, an internal design brief can be the result of an interesting idea generated internally within a company. The workflow is reverse in this case where design managers already have a rough idea about the final outcome and need to

create a design brief to communicate with other departments and potential clients.

> *[We usually start with a concept first and then we have a brief. //40:55 Mgr-H, We don't have brief that does not have an initial concept. It will be too board and too difficult to grasp.* //41:10 Mgr-H]*

The results so far suggest that the internal brief is mainly determined by design managers and appears to be quite restrictive using instructions and in order to avoid unnecessary ambiguity and expedite the project.

> *[It's [the design brief] an instruction, which allows designers, or others to work something out. It's more like an instruction booklet or guideline. //03:12 Mgr-A]*

Varying design brief formulations seems to be a mere academic exercise that lets design students explore their interests but has no use in the professional setting. A design manager who is also a part-time design tutor reported that junior designers are very inefficient if they are given an open-ended design brief.

> *[From my experience, when I give briefs to colleagues, the brief is loose. I allow them to work creatively. But the outcome reflects a big waste of time before my goal can be reached. //26:50 Mgr-E]*

At the same time, he asked his students to set their own design briefs based on his given framework so that students are motivated to work on areas of their interests. He noticed that students are able to produce work of good quality as a result.

> *[If you give the same brief to every student, the outcome would be more even. But if some modifications can be made on students, they can develop their potential and put more efforts into the project. //20:21 Mgr-E]*

Main category	Specific category	No. of design managers discussed in the interview	No. of segments coded
bad design briefs			
	junior designers cannot understand	2	2
	stating only product specifications and price range	1	4
	Closed-ended briefs, but no longer adequate due to competition	1	3
	reuse materials from previous projects	1	1
	brief w riter is uncertain of w hat he w ants	1	1
	an ordinary brief leads to an ordinary outcome	1	1
		Subtotal	12
good design briefs		2	2
	clear goal and design direction, a reference document	3	5
	bullet-point form is preferable	3	4
	leave room for designers to think	2	3
	standardized forms, fill-in the blanks	1	8
	appropriate to the receiving designers	1	1
		Subtotal	23
briefs to promote creative outcomes			
	multiple interpretations of briefs (from briefs and additional researched materials)	2	2
	multiple interpretations of briefs (from individuals)	1	3
	story-telling can leave rooms for designers' interpretations	1	1
	briefs don't stimulate designers' creativity	1	1
		Subtotal	7
emerging trends of design brief formulations			
	A visual brief is more popular than a w ritten brief	2	7
	back to a trial and error approach to innovations (rely on ambiguity in briefs)	1	1
		Subtotal	8

Figure 3.7.: Coding categories related to designers' perceptions of design briefs

This dissonance seems to be irreconcilable meaning having efficiency must sacrifice designers' motivation and vice versa. It appears that some design managers are able to satisfy both of their responsibilities. The next two sections discuss how design managers are able to find a balance between ensuring project efficiency and inspiring junior designers to utilize their talents.

3.5.3. Designers' perceptions of design briefs

When discussing designers' perceptions of design briefs, the results seem to be very subjective. Even though design managers cite many characteristics related to good and bad design briefs, there are few censuses. Managers agreed that a good design brief should be a reference document with clear directions and preferably

presented in a bullet-point format. A good brief also emphasizes leaving enough room for designers to exercise their imagination while a bad brief emphasizes a product specification and price. The other descriptions of a good brief and a bad brief are rather vague. A bad brief is the one that cannot be understood by junior designers and the opposite is true for a good brief. Design managers also notice that not only verbal briefs become more popular but also visual briefs that contain a lot of visual information are emerging.

A design manager reported that her company uses a standardized template for formulating design briefs that contains all the necessary information that designers will ever need to know about the project. Nonetheless, she stated that the template is often misused (wrong or outdated information inputted to the wrong section of the template) intentionally or due to negligence, making the ideal template rather useless.

> *[Very often the content of the form is incorrect. So eventually I find that working with form or not doesn't matter. //19:21 Mgr-G, I once read a form with wrong information that hasn't been updated for decades. Forget it. So we just read for the content, like the age. They might not put such content in their e-mails. Though of course, an accurately filled-out form is better than e-mails. //19:32 Mgr-G]*

Similarly, both Cartmell (1995) and Turner (1994) also suggested using standardized templates to formulate design briefs to facilitate pro-active planning and implementations. However, Cartmell reported that the issue must be tackled at both ends, design brief preparation and design brief usage. Without a change in the attitude and training of relevant staff, no improvements can be realized. These observations seem to be universal and suggest that solely changing hardware

of a complex system is insufficient to improve overall performance without corresponding changes in users' attitudes.

Design brief managers' approaches to promote creative design outcomes are different from the cognitive approach that relies on changing the objectively-defined problem-solution space. They considered that creative outcomes seem to be the result of multiple perspectives associated with individual interpretations of a design brief. A manager may include unrelated materials from different domains in the design brief in order to stimulate unusual concepts. Another manager considered that different individual background and experience would lead to different interpretations even when designers perceive the same design brief especially in a group brainstorming session.

> *[The design brief may contain some information which is not directly related to the end product. If I have to make this [an alarm clock], I may source something about furniture or cars. Actually you can put anything you think relevant in the brief in order to stimulate non-ordinary ideas. //14:59 Mgr-A]*

> *[Different designers will absorb [the brief] and bring back different materials because of [their individual] interpretations. //19:40 Mgr-D]*

The observation seems to post an interesting juxtaposition that the cognitive approach tends to vary a design brief formulation alone to promote creative outcomes while the design manager's approach tends to vary a designer interpretation of a design brief or rely on multiple interpretations from a team of designers to promote creative outcomes. One approach focuses on the design brief and the other approach focuses on the designer. In terms of cost and time efficiency, varying a design brief formulation is more convenient than varying a team of designers. There does not seem to be any inherent barriers preventing design managers from

using a single approach and ignoring the other except for being habitual in their thought patterns. Nonetheless, design managers do not seem to recognize the possibility of combining both approaches. A potential reason may be related to the assumed role taken by design managers in different contexts. For instance, the earlier discussion of a design manager as a part-time design tutor who considered the function of a design brief to be cognitively incompatible in the educational and professional context. It is believed that context seems to play an important role in determining a subject's behavior and decision-making process. The influence may be more evident in the Hong Kong context since interpretation of Chinese language is highly contextualized. Nonetheless, one design manager considered that a design brief cannot stimulate designers' creativity.

3.5.4. Design managers' reflections on design brief formulations

The last section focuses on design managers' responsibilities and designers' frustration related to design brief formulations. As mentioned in the earlier section before, design managers seem to take on a double role to mediate demands from clients as well as from junior designers in their design team. Design managers are responsible for digesting information from an external brief before formulating an interpreted version to junior designers in the design team. On the receiving side, managers have to probe clients for their needs and wants even when clients sometimes are unsure of what they want. They also have to educate clients to have a realistic expectation and understand the role of designers in a design project. On the briefing side, they need to keep their junior designers working effectively on a design project. A design brief for junior designers needs to contain clear instructions although some of their designers may be eager to exercise their creativity and pursue their own ideas. Some design managers seem to pay attention

Main category	Specific category	No. of design managers discussed in the interview	No. of segments coded
design managers' responsibilities			
	educating clients about design	2	6
	get clients to explicitly elaborate their needs and w ants	2	5
	encourage junior designers to be more pro-active	2	4
	fulfill client needs first and leave room for designers to pursue their ow n concepts	1	6
	fostering long term relationships w ith clients	1	3
		Subtotal	24
design managers' reflections on design briefs		1	1
	a loose (too open-ended) brief is very inefficient for junior designers	2	4
	generic briefs w ith no direction are difficult for junior designers	2	5
	abstract (open-ended) design briefs to be more fun	2	4
	junior designers don't like to read texts / prefer visual information	1	4
	handling uncertainty requires experience	1	3
	verbal briefs to junior designers often lead to misunderstanding	1	2
	junior designers cannot handle abstract w ords such as beauty, innovative, etc.	1	2
	designer's personal interest may persuade a design manager to change a product specifications	1	2
	no information = design freedom	1	1
	Brief uncertainty becomes designers' uncertainty	1	1
	verbal briefs might reflect that design managers also are uncertain of w hat they w ant to tell junior designers	1	1
	junior designers alw ays have different perspectives from their superior	1	1
	junior designers are more efficient w ith given guidelnes	1	1
		Subtotal	32
A reinterpreted (internal) design brief for junior designers		2	2
	digest client information and reformulated based on a design manager's experience	4	5
	accustom to follow design managers' instructions	2	3
	use language understood by junior designers	1	2
	most important information: target users and price range	1	1
		Subtotal	13
designers' frustrations			
	brief changes due to clients' uncertainty	2	2
	very rigid cost limitations	1	7
	brief changes due to management uncertainty	1	3
	no w ritten briefs	1	2
		Subtotal	14

Figure 3.8.: Coding categories related to design managers' reflections on design brief formulations

to the individual personality of the design team since more experienced designers can handle more open-ended design briefs and seem to enjoy more with an abstract brief. There seems to be some conventional wisdom in formulating design briefs for designers. Design managers seem to be able to find a balance between getting the job done and satisfying designers' appetite for fun.

> *[True that as a designer, you do as you're told; but when it comes to personality ...Do as you're told, that's your job. But I won't bury your [designer's] creativity or special traits, so if you think you have time [designers can create their own designs], but you can't just do your own stuff. My condition is that you have to first finish the task that I requested. //27:38 Mgr-G]*

Junior designers are used to follow given instructions and any uncertainty of briefs may lead to their frustration. Nonetheless, there is a dilemma for design managers. If a junior designer always receives a very concrete design brief containing clear design instructions, the junior designer will remain quite passive and will not mature over time. Since the notion of an internal brief for junior designers is closer to the notion of a design brief used in the educational context, lessons learned from the educational setting may be useful for understanding and improving professional design brief formulations.

3.6. Discussion of professional design brief formulations

Based on the semi-structured interviews with design managers, relationships between verbal and written design briefs formulated in a professional context are simplified and summarized in figure 3.9. The descriptive model derived from the professional context in Hong Kong provides some basic concerns that are universal in design brief formulations across different cultures while the

results also suggest that some areas are unique in the Hong Kong context. For instance, verbal design briefs are as common as written design briefs in commercial settings. Design briefs generated for internal design projects are different from formulating design briefs for projects that are initiated by external parties (as in the case of client briefs). Moreover, the formulation process appears to be less structured as the ones I analysed in educational settings. Sometimes, the commercial briefing process is very opportunistic. Design briefs can be formulated on various occasions including individual sudden insights, group brainstorming sessions, or evaluations of existing products. Different goals of innovations and market needs are associated with different design brief formulations. Design brief formulations based on prior specifications are often used for projects aiming at improving current-generation products while function-oriented formulations are typical for developing new kinds of products. Other contextual factors including the size of the company, the length of the design project, current and future economic environment also appear to play certain roles in affecting design brief formulations in commercial settings. Furthermore, there are unavoidable limitations when varying design brief formulations in a "real-world" setting. For instance, many stakeholders are typically involved in commercial design projects including external clients, marketing and sales personnel, design team members, senior management of the company and so forth. Different stakeholders usually come from diverse educational and professional backgrounds. Design briefs acting as communication documents already post challenges to design brief writers who want to provide effective communication among various stakeholders.

Since design brief formulations in the professional context are more complex, the results of the content analysis seem to be quite diverse and results from a specific category with only a few agreements may not be generalisable when

compared to results obtained from the educational context. Nonetheless, the interview data seem to cover many minor contextual factors related to design brief formulations. For instance, in a small OEM company, manufacturing capabilities pre-determine the product range. Designers may have to tackle similar design projects repeatedly. The situation may be reverse for designers working for design consultancies. Every situation is unique in the professional context where design managers may or may not have the opportunity to iteratively develop a design brief. The use of tutorials would seem to be a valuable tool for junior designers to receive guidance from more experienced designers. Nonetheless, the current form of "Yes/No" tutorial in the professional setting might be counter-productive especially for junior designers. Design educators seem to be more proactive and use a more effective way to communicate with design students and formulate design briefs that can be used to challenge as well as inspire student work. Design managers seem to be more passive delivering mainly clear design instructions to junior designers that may be due to their priority as project managers. Even though there are inherent differences in purposes between design brief formulations in the educational and professional context, both educators and managers may have an intuitive understanding of how to formulate appropriate design briefs to designers with different abilities in order to motivate designers in a design project. They seem to consider design brief formulations from a systemic perspective including the design issue, the receiving designer, and the design context.

Two context-based models of design brief formulations are derived in the educational and the professional context in Hong Kong. Both of these models seem to suggest that design brief writers should pay as much attention to the receiving designer as to the design brief. In the educational context, design educators use students' initial perceptions of design briefs and the tutorial session to evaluate

the effectiveness of a design brief. This is an explicit feedback mechanism from the educator perspective that he or she can iteratively improve the design brief before giving the brief to another group of students. In the professional context, design managers mainly formulate clear design instructions to junior designers even though they also pay attention to how designers perceive the design brief and whether the brief is indeed appropriate for a particular designer. These results seem to support the tentative framework of modelling design brief formulations from a communication perspective that emphasizes equally the side of design brief production and the side of design brief reception. The next chapter establishes a theoretical model for design brief production that will be used to empirically test the proposed model for design brief reception. These explicit models aim to provide a starting point to improve existing approaches to design brief formulations for different purposes and contexts.

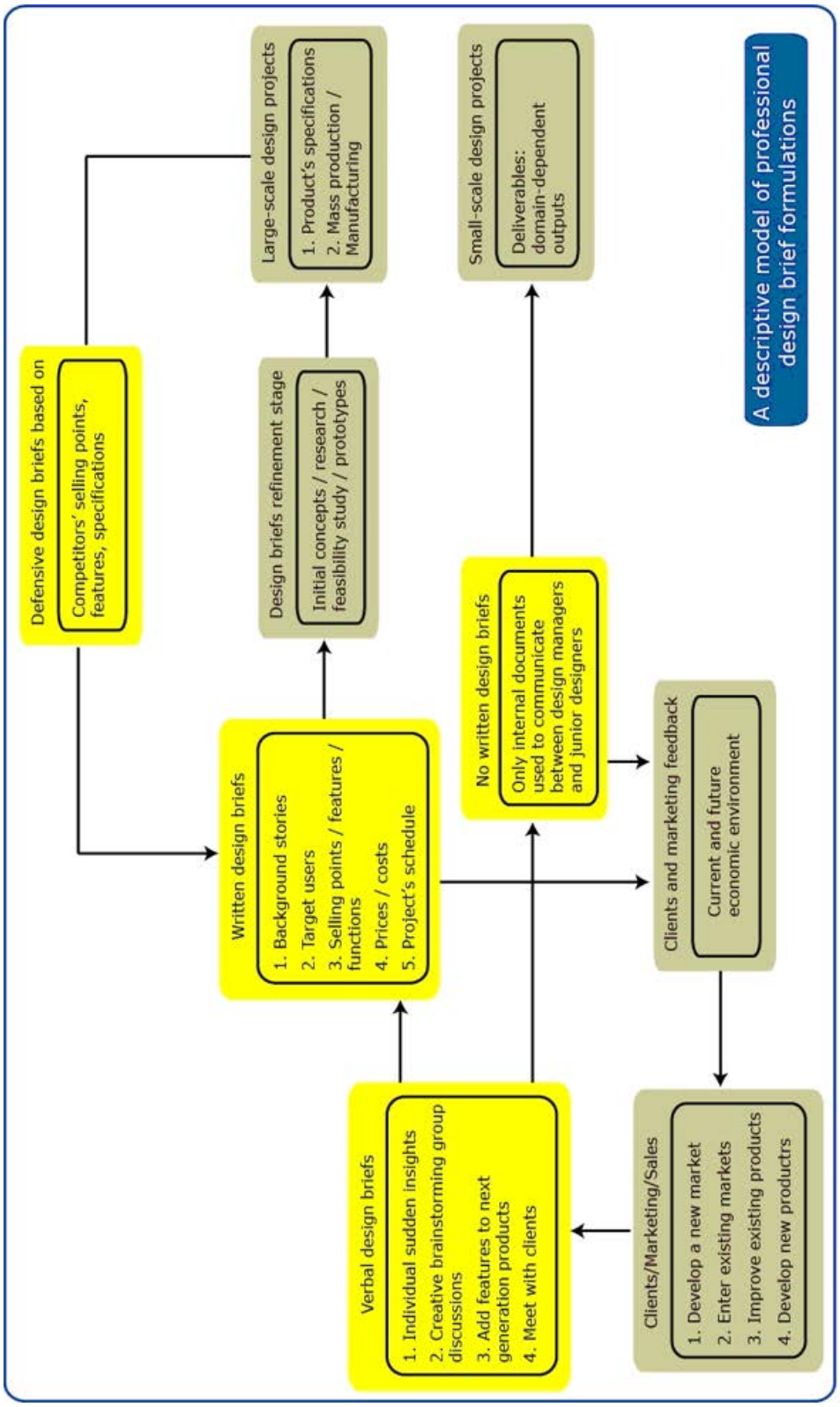


Figure 3.9.: A descriptive model of professional design brief formulations

CHAPTER 4

A THEORETICAL FRAMEWORK FOR DESIGN BRIEF PRODUCTION

Existing theories related to design brief production are consolidated and formalized resulting in an integrated abstraction framework. The framework provides three theoretical bases to examine and generate different design brief formulations that are compared with previous studies. A pilot study is used to empirically validate the effect of various design brief formulations on designers' initial perceptions. Since existing approaches to design brief formulations remain prescriptive, the validated framework is an essential component acting as a reference point for the discussion related to design brief reception in the following chapter. The explicit framework is the first step to bridge the existing gap between design brief production and reception.

4.1. Introduction to a theoretical framework for design brief production

The tentative framework developed in this chapter incorporates three dimensions, which address linguistic variables that have been described in three different fields of study. One dimension originates from cognitive psychology and it is concerned with human perception and categorization of physical objects as they are for example reflected in taxonomies of man-made objects. Categorization is understood as a basic human cognitive process by which variant stimuli are grouped into categories at different levels in order to facilitate recognition and differentiation. This study considers design briefs to be a kind of external stimulus that initiates processes of categorization in design processes. It is hence assumed that the use of language at different levels of categorization offers a mechanism by which designers' perceptions of design briefs can be influenced.

The second dimension is concerned with language abstraction and how language is used to present ideas and meanings at various levels of abstraction. Fundamental building blocks of natural language are nouns used to denote entities such as physical objects. Physical objects form the closest abstraction to reality.

Human ability of abstraction allows ideas and concepts to be represented in language. By the same principle, designers not only create physical forms but also attach artefacts with meanings through a shared understanding of language among its speakers. Individual experience and cultural background are crucial in interpreting the meanings conveyed in design briefs. The design and use of artefacts are interconnected in language abstraction (Krippendorff, 2006).

The last dimension of the tentative framework is concerned with designers' personal use of different linguistic presentations during the design process. Designers'

articulations have been shown to vary not only across levels of abstraction but also across levels of precision. Different levels of abstraction enable designers to attend to different aspects of the design problems. Expert designers are shown to jump into various levels in order to reflect with the situations. They might also pass through certain representations and proceduralize their decisions in familiar situations. Using the Abstraction Hierarchy as a reference, the last dimension investigates whether there are design brief representations preferred by designers with various levels of expertise. The following sections (4.1.1 to 4.1.3) describe in details the underlying theoretical background for creating the three dimensions of the framework. If readers are familiar with Rosch's linguistic categories, Krippendorff's classifications of language uses in communication and Rasmussen's Abstraction Hierarchy, they are encouraged to proceed directly into section 4.2 that discusses the integration of these three dimensions using a Cartesian-like notational system. The abstraction framework aims to consolidate and formalize existing approaches to formulate design briefs so that the framework can become an explicit model for criticisms and improvements. It should therefore satisfy two main criteria. It should be comprehensive enough to allow the analysis of commonly used design briefs in different contexts and explain the possible effects of given brief formulations. The second criterion is that the framework can be used as a practical tool to assist design brief writers to generate different formulations of a design brief. The framework is examined with respect to the two criteria under empirical and pragmatic considerations. Practical limitations and additional insights of using the framework are offered before the subsequent validation process in a pilot study with industrial design students.

4.1.1. Basic categories

According to findings in cognitive psychology, humans categorize stimuli in a predetermined way. Non-identical stimuli can be treated as equivalent in order to reduce a virtually infinite variety of stimuli into behaviourally and cognitively usable proportions. Rosch (1976) pioneers the study in the field seeking to understand how humans perceive the physical world and how information of physical objects is encoded in human mind. Based on the concept of taxonomy in Biology, she hypothesises that it is advantageous for a person not to differentiate one stimulus from others if it is irrelevant to the purpose at hand. Due to this practical reason, humans categorize objects in order to facilitate their decision-making processes such as avoiding dangers.

Using snake bites as an example, for an average person to avoid snake poisoning, it is more practical to avoid all snakes at any given time than to make a fine distinction between poisonous snakes and non-poisonous snakes at the incident. Therefore, the category of snake is more accessible to an average person than the category of reptile or cobra for this purpose and is called a basic category. However, for a forest ranger, due to expertise in the area or a need to distinguish various kinds of cobra when performing certain duties, the category of cobra may be the basic category. All the basic categories then form a basic level of abstraction for physical objects. The use of English nouns only reflects the categorization in a particular language and culture. This human characteristic also carries to the categorization of nonbiological objects.

For designers, there are practical needs to distinguish the category of artefacts being designed. The language used in a design brief for designing a chair or a barstool can direct designers' attention to different categories of objects depending on design expertise. Details of Rosch's study are discussed below.

There are several concepts that are essential to categorization. A category contains a number of objects that are considered equivalent. A taxonomy is a system consisting of various categories and categories are related by class inclusion. ”Each category within a taxonomy is entirely included within one other category (unless it is the highest level category) but is not exhaustive of that more inclusive category (Rosch et al., 1976).” The level of abstraction refers to a particular level of inclusiveness as viewed by the person under consideration.

One principle involved in categorization is called cognitive economy. Cognitive economy states that ”basic categorization is the most general and inclusive level at which categories can delineate real-world correlational structures (Rosch et al., 1976).” A person does not seem to gain any advantages or additional information by encoding more or fewer categories. The basic level of abstraction is the most differentiable. Cue validity is a probabilistic term that quantifies the concept of cognitive economy.

Rosch (ibid.) demonstrated the idea of basic objects using taxonomies of common concrete nouns in English. She observed that when categorizing common English nouns for concrete objects, subjects show that there is a basic level of abstraction for concrete objects. Basic objects are categorized at the basic level, i.e. the most inclusive level of abstraction, which maximizes cue validity. For instance, the category ”table” is at the basic level of abstraction. Any categories above this level of abstraction are called superordinate (e.g. furniture), while the ones below are called subordinate (e.g. kitchen table). These basic levels are found in both biological (e.g. tree, fruit) and nonbiological (e.g. furniture, tool, musical instruments) taxonomies. Table 4.1 shows two non-biological taxonomies used as stimuli by Rosch (Rosch et al., 1976).

The basic level of abstraction is evaluated by three experimental tests: the

Rosch's non-biological taxonomies			
Superordinate	**Basic level**	**Subordinates**	
Furniture	Table	Kitchen table	Dining room table
	Lamp	Floor lamp	Desk lamp
	Chair	Kitchen chair	Living room chair
Musical instrument	Guitar	Folk guitar	Classical guitar
	Piano	Grand piano	Upright piano
	Drum	Kettle drum	Base drum

Table 4.1.: Rosch's non-biological taxonomies

common attributes test, the motor movements test and shape similarity test which are derived by Rosch to test her hypothesis using multiple instruments. The common attributes test requires subjects to list all of the attributes related to the objects and shows that the basic objects elicit the greatest increase in the number of attributes. The motor movements test asks the subjects to describe the possible sequences of interactions with the objects while the shape similarity test computes overlapping scores using outlines of the shape of two-dimensional representations of objects. Results of all three tests independently agree upon a single basic level of abstraction.

In addition, "basic objects also appeared to be the most abstract categories for which an image could be reasonably representative of the class as a whole (Rosch, 1978)." Results of the study suggest that the basic level of abstraction is learnt throughout childhood development and reinforced in daily language use. Rosch also noticed that individual knowledge in a specific area might affect the basic level of abstraction. For instance, according to Rosch's proposition, an interior designer might consider kitchen tables to be a more basic category than tables due to his or her experience and expertise in kitchen design. However, experts' knowledge seems to be confined to specific parts of taxonomies.

If design briefs are written to ask for the design of artificial objects at the

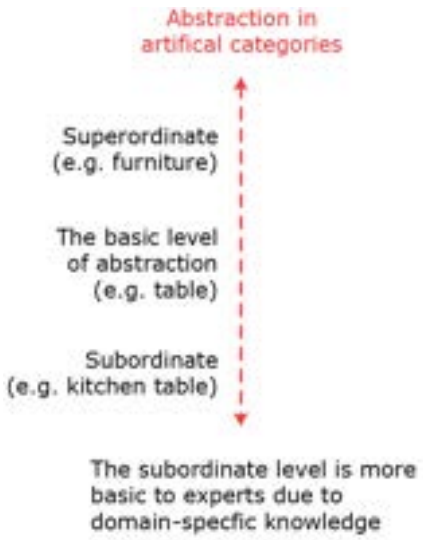


Figure 4.1.: The abstraction in artificial categories dimension

basic level, designers are more likely to form prototypical representations based on the information encoding objects' shapes, functional attributes, and potential interactions with users. As designers are required to offer their own input into each of their projects, designers may assume the normal context or situation for occurrence of the object if the specification of a less common context is not given in the brief (see (Rosch, 1978)). Likewise, determining the meaning of a specific word is based on the contextual information given in the paragraph. Designers may be likely to make assumptions and constraints according to the information given in a design brief. Moreover, Rosch also introduces a complementary concept of "prototype" within each category. The prototypical effect states that the most cognitively economical code for a category is a concrete "image" of a prototypical member, which represents an average category member with certain generic elements (Rosch, 1978). Since designers tend to be visual thinkers (Arnheim, 1969; Oxman, 1997), the basic level is more likely to activate designers to form a concrete image of the category as a whole. At the superordinate level, designers are unlikely

to form a single image because of competing images in the same category. For the subordinate level, designers are less likely to form a concrete image without having specific knowledge related to a given object. It is rather difficult to form a concrete image about a red oak or a silver maple if one is not familiar with the domain. Both factors may affect designers most when they are generating design requirements during the conceptual design stage. Design brief writers should pay special attention to the basic level of abstraction, which varies with design expertise since one and the same noun can generate different meanings and perceptions depending on the perceivers' knowledge in the area. The concept of categories abstraction is summarized in figure 4.1.

4.1.2. Language and communication

Krippendorff (2006) argues from a communication studies perspective that natural language is instrumental in understanding design and artefacts in our society. He regards language as a process of coordinating the perceptions and actions of its speakers (Krippendorff, 2006). Verbal exchange is the most important mode of design communication as it has been shown that 90 percent of critical situations occurred during collaboration while designers work individually 70 percent of the entire working time (see (Badke-Schaub & Frankenberger, 2004)).

Besides categories which often appear in language such as nouns, Krippendorff suggests that characters, identities, metaphors and narratives in language all play an important role in interacting with designers' perceptions and understanding of artefacts. For the convenience of discussions, Krippendorff seems to elaborate each aspect individually. Nonetheless, formulation of a detailed design brief probably involves aggregating elements from multiple aspects and the resulting brief formulation may not be as conceptually distinct as we would prefer. As

a result, only design briefs formulated by formal specifications and scenarios are examined in the following empirical studies since these formulations are commonly used in design domains.

Characters

Characters in language refer to adjectival modifiers (e.g. powerful, beautiful, high class, and comfortable), which people use to express feelings and emotion towards entities (such as artefacts). Characters are often used by all stakeholders in a design project to describe the design requirements in the most general terms that are directly related to how people sense and feel in the environment. Designers take cues from these general descriptions and integrate them into semantics of artefacts. Solution-oriented designers have been shown to be more inclined to use nouns (Cross, 1997). They tend to name their ideas at earlier design stages, which may contribute to design fixation. Problem-oriented designers favour the use of verbs and adverbs and the design of a function instead of an object (Cross, 1997). For instance, designers may refer to actions and transformations to label their design objectives rather than to aspects of form, as in ”make the workspace more flexible” versus ”design of a desk” (Restrepo, 2004).

Identities

Identities are propositional statements that deal with social identification and differentiation. For instance, the statement ”driving a Mercedes” involves a brand identity and associated connotations and is thus different from the statement ”driving a car”. Assumptions and social associations are evoked when someone is using or is being labelled by an identity. This property is also referred to as the second order of signification in semiotics.

Metaphors

The use of metaphors seems to be a suitable candidate for design problem formulations. One purpose of metaphors is to facilitate understanding of a new concept based on familiar identities by describing something new in resemblance of previous experience from another domain. Schön describes the use of metaphors in describing ”a paintbrush is kind of a pump” to change the designers’ perceptions that lead to better paintbrushes and several patents (Schön, 1979). Designers are reported to employ verbal metaphors to alter existing perceptions and introduce new vocabulary for innovations (Schön, 1979). However, understanding of metaphors often requires knowledge in multiple experiential domains, which may not be present in any given case. In addition, design briefs can not always be formulated into metaphors and there is no systematic approach of creating a ”good” metaphor to enhance design performance. When metaphors are used appropriately (that is, when arising and evaluating within a given design project), the results are great innovations. The use of metaphor is a hit-or-miss approach within design processes.

Narratives and scenarios

Humans listen to other peoples’ stories and tell their own stories every day. A narrative is a story consisting of an opening, a middle part and an ending. It thus represents a relatively large unit of language. The format of narratives is accustomed to virtually everyone. It is a powerful tool to explain and inform each other of what is happening in the world. Narratives are commonly used in the design profession and presented in the form of storyboards to exchange and develop ideas amongst designers, decision makers and clients. User scenarios are used by designers to seek out concrete design requirements from generally

made-up but realistic narratives. Expert designers are described as particularly skilful at creating user scenarios from (comparatively more abstract) formal specifications. "The defining property of a scenario is that it projects a concrete description of activity that the user engages in when performing a specific task, a description sufficiently detailed so that design implications can be inferred and reasoned about (Carroll, 1995)." Using scenarios and mental simulations as tools, designers can also evaluate early concepts and discover hidden problems and new design requirements. Carroll (2002) comments on the solution-first strategy of designers that solutions are generated too quickly and designers may have trouble abandoning the early concept when it is no longer appropriate and suggests that scenarios can be used to ameliorate the difficulty by generating, investigating, and integrating problem analyses and partial solutions. Expert designers employ scenario simulation for understanding given requirements. As a result, designers are able to infer new requirements, restructure their understandings of the given design problem and discover partial solutions at various levels of abstraction throughout the design process (Guindon, 1990).

Scenarios are also used as problem formulations by clients to describe their particular needs or the problematic situations. This strategy assists in bridging the communication gap among different stakeholders of a design project and can act as a medium for feedback and discussions. Nonetheless, there is a distinction between creating one's scenario and being presented with a scenario. The production of scenarios by designers lies at one end of the spectrum that requires designers to actively imagine their own scenarios. The latter case (the use of scenarios as design brief formulations) provides designers with design contexts and events of user-artifact interaction. Scenes or sequences of events communicated in scenarios trigger the perceivers' expectations. As a result, perceivers are likely to evoke

their own experience similar to the given context. Scenarios as a medium for design briefing are inherently concrete in comparison, for example, to textual specifications. In the case where a concrete scenario acts as a stimulus, designers are confined to the given scenario instead of generating their own ones. However, the degree to which scenarios as a problem formulation impedes or fosters design performance with respect to designers' levels of expertise has to my knowledge not yet been investigated. Narratives and scenarios are considered to be parts of the linguistic aggregation dimension in the framework.

Culture

The last component of aggregating meanings in language is culture, which is omnipresent and inseparable from language. Different from other aspects, culture provides the context for understanding interpretation and meaning of language. Human perception can be considered to be a cultural activity that signifies the presence of a community and a way of living together. Designers take part in the creation of artefacts to sustain the practice of living and are also affected by the collective understanding of the use of artefacts within the community. Culture thus impacts design while design impacts culture. "The medium in which culture is in a continuous process of being negotiated is language, conversation and discourse (Krippendorff, 2006, p. 175)." Oftentimes, culture can be encapsulated and presented by a single word or a simple phrase. "Metonyms are parts taken to stand for the whole to which they belong" (ibid. p. 114). It can involve a strong relationship between expressions and meanings that are embedded in our experience. For instance, "Tai Chi" is taken to mean the balance between the forces "Yin" and "Yang" in Chinese culture. Designers who are not part of this specific culture may not be aware of the social stereotyping and conception that is imposed

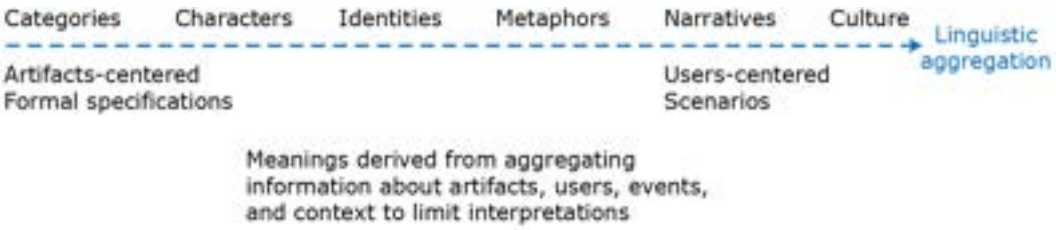


Figure 4.2.: The linguistic aggregation dimension

by this particular use of language.

Linguistic aggregation (figure 4.2) is used to summarize the various components in language use from artefacts, users, to culture.

4.1.3. Language and abstraction

Previous sections discuss certain properties of language use in creating meanings to designers and other stakeholders. Since natural language is involved in every design projects, creation of new artefacts must be preceded by designers' understandings of the expected artifact through verbal and textual communication. This section focuses on how language abstraction might influence designers' representations and understandings. The concept of abstraction was introduced in the discussion of categories. The working definition is related to the removal of redundancy in concrete objects for representations and can be summarized by the following statement. "A more abstract level is characterized through a reduced level of detail in the representation and abstract levels model the world in a less precise way, but still capture certain, important properties (Bergmann & Wilke, 1996)."

There is a complementary definition for abstraction. Heskett describes "abstractions as the ability to move beyond an accumulation of pragmatic experience into the realm of ideas (Heskett, 2005, p. 11)." The extended definition characterizes human ability of high-level thinking based on intangible ideas and concepts.

Figure 4.3.: An example for abstraction in language

Abstract thoughts enable theorizing, self-reflection, and imagination. He elaborates that "perhaps the greatest example of abstraction is language, words have no innate meaning in themselves and are arbitrary in their application. The ability to abstract into language, allow ideas, knowledge, processes and values to be accumulated, preserved, and transmitted to subsequent generations (Heskett, 2005)." Natural language is used to represent the world at various levels of abstraction. It can denote not only physical objects in the world, but also intangible ideas and concepts. This property is especially important for the case of design brief communications that the artifact or service request by the brief often does not exist. The challenge is magnified when designers need to communicate a truly innovative product to clients or various stakeholders. Language abstraction is probably an evolutionary process that facilitates communication and cooperation. Even though it is unclear whether language affects thought or vice versa. It is widely believed that language affects mental representations and in turn, our actions shape the use of language. Language use also creates a shared understanding of the physical world among its speakers.

Figure 4.3 shows four distinct levels of abstractions to visually represent an apple. The leftmost picture is a realistic photo capture of an apple. The next picture is a sketch of an apple and is followed by an outline of an apple. The rightmost is a symbolic representation of an apple in English language. The abstraction process goes from an object in the physical world to a concept in a symbolic representation.

One may consider the various levels of abstraction may have equivalence in mental representations. However, mental representations may not be as discontinuous as we think. The logical sequence of eliminating details only reflects our understanding rather than the actual sequence. Different levels of abstraction may be as useful as the others depending on the purposes at hand. Even though the process of human abstraction is more complex, the principle of abstraction is to reduce redundant information but still capture the essence of certain objects or events for a more efficient memory structure and retrieval system (Rosch et al., 1976).

But different levels of abstraction convey different kinds of information to the perceiver. In figure 4.3, the first representation might draw attention to the apple as a fruit. The second representation may evolve equal amount of attention to the brushstrokes, colour and the apple. The last two representations can have multiple interpretations depending on the frame of reference of the perceiver and the given context.

Language abstraction is more subtle than visual abstraction. Concepts and ideas that correspond to concrete objects are likely to constrain the number of interpretations and generate similar perceptions. Concrete representations are those that possess close resemblance to objects in the physical world. However, when abstract concepts and ideas (e.g. freedom, happiness) are expressed in language, they are likely to be interpreted in different ways and generate different kinds of perceptions to the receivers. The meanings perceived are highly context- and person-dependent. The more abstract the representation, the more contextual information must be assumed or supplemented by the receivers. In this case, the experience of the receiver is reflected by the chosen interpretation. Expert designers infer additional information from prior experience.

Since there is a close relationship between language use and mental representations, verbal protocols can be used to reveal the different levels of abstraction a designer might go through during the design process. Visser (2006) notices that designers' mental representations not only vary in abstraction but also in precision. She labels the variations as the levels of abstraction and the degrees of precision. Different levels of abstractions seem to offer designers different kinds of information for explorations and design constraints. Expert designers are shown to exhibit opportunistic design thinking and behaviour for which they jump to various levels of abstraction sporadically during the design process. The variation in precision during the design process does not seem to be as opportunistic as the variation in abstraction. Precision follows a more predictable path of going from being imprecise at the initial stage to being precise at the later stage of the design process.

One of the earliest work to aid system design using various levels of abstraction was conducted by Rasmussen (1986) based on information processing theory and human-machine interaction. Using verbal protocols from complex system design and control-related task analysis, he identifies distinct stages of knowledge for processing information and making decisions. The different stages of knowledge correspond to framing the problematic situation at different levels of abstraction. The associations between different states of knowledge may not follow logical sequences. Skilled operators often bypass certain stages and proceduralize their actions without making explicitly reasoning when encountering familiar situations or activities based on prior experience. This observation concurs with the seemingly opportunistic behaviour of expert designers.

He later formalizes and prescribes two orthogonal dimensions called the abstraction hierarchy and the part-whole hierarchy to model various mental representa-

tions that are useful for complex system design. The complete abstraction hierarchy consists of five levels: functional purpose, abstract function, generalized functions, physical functions and physical forms. The abstraction hierarchy is referred sometimes as the abstract (i.e. artefact's purpose or function) to concrete (i.e. artefact's structure or physical properties) dimension while the middle stages are omitted for simplicity and can be restored if necessary. The part-whole hierarchy is concerned with the relationships between sub-components and the whole system.

The abstraction hierarchy has been used to construct a model of humans for human-machine system design (figure 4.4, adapted from (Rasmussen, 1986, p.65)). Design tasks are considered to be inputs at the mental information processing level while additional layers of cultural and emotional influences are models at the higher social system level and the lower psychological level. In this case, the process of abstraction is developed over time and is likely to be affected by language, culture and individual experience. There also seems to be a preferred level of abstraction when processing familiar activities. For instance, we think in more abstract level goals such as ”opening a door” instead of a sequence of sensorimotor movements (Rasmussen, 1986).

The abstraction hierarchy can be used to model designers' representations (stages of knowledge) using three essential levels explaining the purpose, process, and implementation of a system design. The AH dimension (figure 4.5) corresponds to explain the ”why”, ”what”, ”how” representations of a design project. These representations are essential components in a design project. Why is a design needed? What are needed in terms of design requirements? How can the artifact be implemented? However, whether these representations follow any orders is not crucial for the study. This study focuses on whether design brief formulated at different levels of abstractions might limit or enhance design performance.

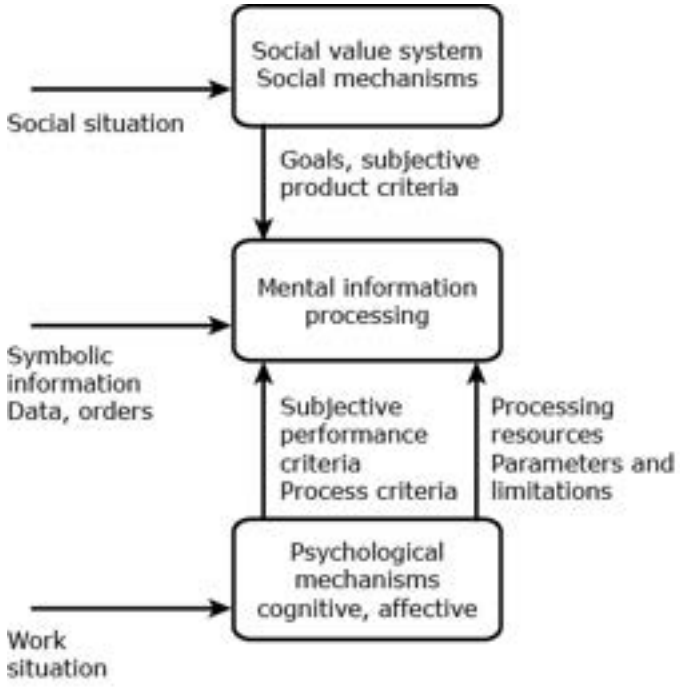


Figure 4.4.: A simplified model for different levels of human-machine-interactions

Designers' attention is affected by the resolutions of information governed by different levels of abstraction. Each level enables unique considerations and constraints. Abstraction in this case, not only encapsulates detail information, but also adds higher level principles and concepts into designers' representations. However, designing can happen at either end of the spectrum. For instance, new materials can propel the search of new applications and new goals propel the search of new implementations. By varying the levels of abstraction, designers may notice that the same physical structure may serve multiple purposes while the same purpose may be implemented by multiple physical arrangements.

"A change of level of abstraction involves a shift in concepts and structures for representation as well as a change in the information suitable to characterize the state of the function or operation at the various levels of abstraction. Thus, an observer asks different questions of the environment depending on the nature of

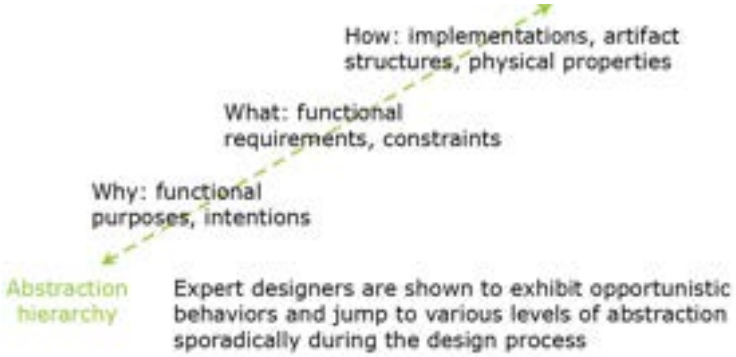


Figure 4.5.: The abstraction hierarchy dimension

the currently active internal representations. (Rasmussen, 1986, p. 121)." This change in information-seeking behaviour is likely to be the result of conventions and designers might have a preferred level of abstraction which might affect the supposed problem-solution space and the design strategies. A "why" formulation is more abstract and requires adequate problem-scoping skills while a "how" formulation is more concrete to designers. C. Alexander also discusses the differences of the two formulations for design projects.

"Every form can be described in two ways: form the point of view of what it is, and from the point of view of what it does. What it is is sometimes called the formal description. What it does, when put in contact with other things, is sometimes called the functional description. The solution of a design problem is really only another effort to find a unified description. The search for realization through constructive diagrams is an effort to understand the required form so fully that there is no longer a rift between its functional specification and the shape it takes. (Alexander, 1964, p. 89-90) as quoted in (Rasmussen, 1986, p. 122)."

4.2. The abstraction framework for design brief production

Previous sections introduce three theoretical dimensions that may affect designers' perceptions of design briefs. The notion of abstraction seems to connect all three dimensions and can be used as a guiding principle to establish the framework for design brief formulations. Precise relationships of the three dimensions are proposed and integrated into a single framework. Cartesian-system-like notations are adopted to structure the problem formulation space (See figure 4.6).

Categories abstraction (CA) describes a basic level of abstraction based on the cognitive economy. This dimension informs design brief writers how concrete objects are perceived and categorized with a given expertise. The abstraction level is reflected in artificial and biological taxonomies in English language.

CA+: Superordinate

CA0: The basic level

CA-: Subordinate

Linguistic aggregation (LA) begins with language abstraction in concrete objects which coincides with categories at the basic level (CA0). Words have no innate meanings but acquire their meanings by people use during communication. Categories are nouns that represent concrete objects in the physical world. Language can be used to represent not only objects but also intangible ideas, concepts and principles which are essential for the development of high level thinking. On the one hand, complexity of the physical world reflects the tendency to accumulate meanings by concatenating words to phrases, to sentences, to narratives. On the other hand, certain words or phrases are embedded with various layers of meanings connecting to artefacts, daily practice, experience and culture. Lengthy descriptions and elaborations may not be as effective as metonyms when used in

design briefs for design communication.

LA0: Categories

LA1: Characters

LA2: Identities

LA3: Metaphors

LA4: Narratives

LA5: Culture

Abstraction hierarchy (AH) reflects that designers' mental representations may correspond to different levels of abstractions in problem formulations. Higher levels represent goals and intentions while lower levels represent physical properties and structures. Different levels of abstractions are equally useful in the iterative design process because innovations can happen at different levels. However, different levels of problem formulations seem to direct designers' attention to criteria that are available only at the particular level, not only affecting their perceptions of the situations, but also their information-seeking behaviour. Since AH0 is concerned with design requirements and specifications of artefacts, it can be related to LA0 and CA0 of the other two dimensions. By connecting these three theoretical dimensions at the origin (See figure 4.6), the abstraction framework can be used as an analytical instrument to examine and generate various design brief formulations.

AH+: purposes, intentions

AH0: functional requirements

AH-: structures, physical properties

The abstraction framework is conceptually consistent but certain issues must be addressed in order to validate the framework.

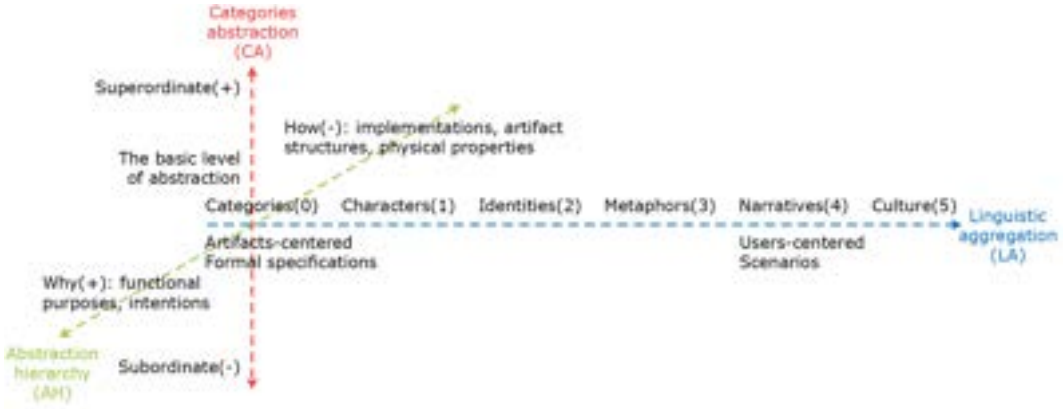


Figure 4.6.: The proposed abstraction framework

A foremost issue is whether the framework is exhaustive enough to analyze design brief formulations commonly used in different design contexts. Another issue is whether the framework is practical enough as a tool for design brief writers to formulate design briefs. Finally, whether design briefs formulated by the framework actually convey different perceptions to designers and affect design performances.

The validation process takes several stages. The first stage uses an empirical approach to compare the framework with interview data collected from design educators. The comparison is used to relate the framework to design brief formulations in an educational context. Design briefs collected from various sources are classified using the proposed notations to investigate the analytical power of the framework. The second stage proposes practical guidelines and rationales for using the framework to formulate design briefs. Difficulties of operationalizing theoretical constructs of the framework in practice are reported as potential limitations. The final stage takes the form of a quantitative analysis to assess the usefulness of the framework in actual usage.

4.3. Empirical considerations

4.3.1. Comparisons with interview data

In the previous chapter, design educators share their first-hand experience about design brief formulations as well as their reflections on interacting with design students in studio-based courses. Educators speak of good design briefs as having built-in many good questions that lead design students to seek out information related to the design project. If students are more familiar with the expected artifact, they are more likely to assume the features of the artifact and ask fewer questions. Educators also discuss how design briefs can be varied in different formats depending on students' abilities and the brief's openness. An open brief often does not contain much information and is subjected to wider interpretations which forces students to work harder to get their own answers. An open brief is usually more difficult to junior students who may not find any directions on how or where to proceed with the design project. Sometimes, educators also try not to name the artifact directly and use functional descriptions to avoid preconceptions. Nonetheless, preconceptions are not always undesirable. It can act against or favour design performance depending on circumstances. If students are having troubles with a design brief, situations or scenarios are often used to assist design students to think in concrete terms.

The content analysis shows that there are at least four approaches to vary brief formulations and the potential relationships with the abstraction framework are listed on table 4.2.

Under the informal comparison, the framework seems to account for the possible brief variations used by design educators in the interviews. However, the comparison also suggests that the origin of the framework (where CA0, LA0, and

	Design brief variations	How do the variations relate to the framework?
1	Avoiding familiar objects that promotes preconceptions	The basic level (CA0) seems to be the most accustomed and familiar abstraction and may result in students asking fewer questions.
2	The amount of contextual information provided on the design brief	Linguistic aggregation (LA) seems to limit interpretations by adding layers of meanings through successive levels
3	Using functional descriptions instead of naming the artifact	This seems to correspond to the position AH0 of Abstraction hierarchy (AH)
4	Scenarios and situations	User-centered scenarios is labeled as LA4

Table 4.2.: Comparisons of design brief variations with educational interview data

AH0 coincide) seems to be the most accustomed design brief format to design students. The point of familiarity may be crucial for determining the creativity of the design outcomes. In the next section, 12 sample design briefs that are used by design educators in actual courses are analyzed by the abstraction framework. The analysis reveals that more propositions are needed to address the relationships of the three dimensions in the abstraction framework.

Design briefs can be fairly long documents. The length of a design brief may vary from one to four A4 pages which may include additional reference materials. It may take more than half an hour for design students to digest all the information provided in a brief. Design students tend to avoid reading the whole document but focus mainly on the topic or keywords in a design brief. Therefore, a design brief often contains a design task statement or a problem statement to capture the essence of the design project. The analysis of design task statements are presented in table 4.3.

The notations of the framework are designed to be self-explanatory. The first two characters correspond to the name of the dimension and the last character denotes the position on the dimension. Using design task statement no.1 in table 4.3 as an example, a ”plaything” belongs to the superordinate categories which should be labelled as CA+. There are also functional requirements stated in the

task statement which should be labelled as AH0. Task no.1 is therefore identified by a pair of labels, (CA+, AH0). The design task statements can be mapped onto the dimensions of the abstraction framework.

However, it is unclear at this stage how different dimensions compete against one another for the designers' attention. Our basic assumption is that designers tend to attend to information that is familiar and fits with their basic level of abstraction. The origin is assumed to represent the most typical and accustomed design brief formulations encountered by designers. Both CA0 and AH0 should attract the most attention and influence designers' perceptions accordingly. LA works in a slightly different way. The LA dimension is responsible for determining the amount of background information provided in the design task. Increment in the LA dimension provides more and more contextual information to designers. Essentially, design briefs that are identified with a position LA4 or LA5 are highly contextualized.

The first observation is that cultural context seems to play an important role in design communication because culture is commonly used as a metonym to embed various layers of meanings in the design requirements. 7 out of 12 design tasks are related to either culture (LA5) or identities (LA2).

Another observation is that the longer the design task statements, the more likely the formulations will include elements from all 3 dimensions which can be seen in Task statement no.12. It is expected that real world design briefs are even more complex and combining elements from the three dimensions may be inevitable. These lengthy design briefs may signal a potential limitation of the abstraction framework. Nonetheless, the abstraction framework is considered here in isolation from the complementary theory of design brief reception that is discussed in the following chapter. In a system of design brief communication, it is not possible

to resolve the current issue unless how a design brief is read and perceived by designers is also available for reflection. For instance, designers may only focus on a design brief title but pay little attention to the rest of the document. Besides, the framework shows some promises as an analytical tool to classify design briefs in an educational context.

4.3.2. Comparisons with previous studies

The second exploration comes from investigating design problem formulations used in previous studies. Design problem formulations usually appear in juxtaposing pairs so that design outcomes can be evaluated and compared. One commonly recognized pair is ”open-ended formulations versus close-ended formulations.” A closed formulation is often considered less desirable because it leads to unsatisfactory outcomes. Goldschmidt (1996) reports the use of this particular pair of problem formulations in a previous study (See table 4.4). The operational definitions are summarized below.

”A closed formulation is phrased using concept (word) that is clearly associated with existing, familiar solutions of similar design problems”

”An open formulation presents the same design problem, but is phrased so as to avoid concepts related to existing solutions.”

The main difference between the two design problem formulations is presented in bold letters. The solutions for the open-ended problem formulations are evaluated as more ”creative” than those of close-ended problem formulations. The open-ended formulations state the functional requirements or the purposes of the design project which are reflected with AH labels while both close-ended formulations involve the use of nouns to name the expected artefacts (CA labels), knee protector and drier, respectively. By closely examining the solutions, we

#	Design task statements	Framework	Explanations
1	Design a plaything based on one of the five senses: sight, touch, hearing, taste, or smell.	CA+ **AH0**	- playing (superordinate) - describing functional requirements
2	Imagine that you are required to develop one of the following products for a local niche market segment: 1. Mobile phone, 2. Food processor	LA2 **CA0**	- local niche market (Identities) - Mobile phone, Food processor (basic level)
3	Propose an interactive preschool toy concept, in which the arrangement of tangible blocks is used as an expressive means to support an interesting play pattern.	CA- AH-	- preschool toy (subordinate) - physical properties of the expected artifact
4	Propose a visual style / theme that allows a family of characters useful in 2D and 3D.	CA+	- visual style / theme (superordinate)
5	Develop 28+20 characters representing Olympic and Paralympics disciplines in 2D and 3D.	LA2	- Olympic, Paralympics (Identities)
6	Propose designs for improving the total environment of the Children and Youth centre for its users, emphasis on providing barrier free environments to users.	LA4	- user-centered scenarios
7	Design an Asian lifestyles exposition booth consists of four main functions: 1) retail, 2) showroom, 3) Office, 4) Storage	**LA5** **AH0**	- cultural context - describing functional requirements
8	To collaboratively develop Web contents on topics about Asian lifestyles.	CA+ **LA5**	- web contents (superordinate) - cultural context
9	Design next generation hotels for Hong Kong	**CA0** **LA5**	- hotels (basic level) - cultural context
10	Design a new generation of microflats	CA-	- micoflats (subordinate)
11	Redesign new uniforms for HS facilities management team with logo etc	AH- LA2	- physical properties of the expected artifact - HS facilities management (Identities)
12	Create print advertising that will raise the profile of public parks in Hong Kong and inspire people to use them more.	CA+ AH+ **LA5**	-print advertising (superordinate) -describing purposes - cultural context

Table 4.3.: Analysis of sample design briefs using the abstraction framework

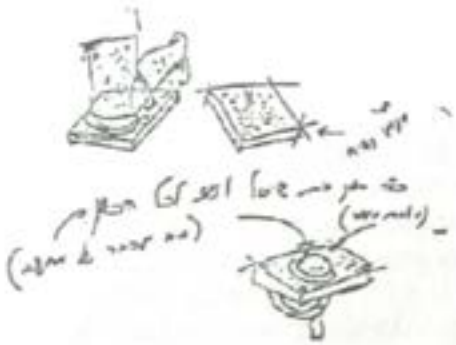
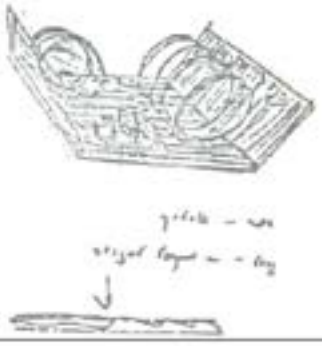
Open-ended problem formulation	Close-ended problem formulation
1a) "**Design a device that will ease the paver's knee-ache, by avoiding contact between his knees and the paved surface**. The device should be convenient, light-weight and usable for long hours." (CA+, AH+) **A sample solution:** 	1b) "**Design a knee protector for the paver**, that will be convenient, light-weight and usable for long hours." (CA-) **A sample solution:** 
2a) "**Solve the problem of drying the dishes in the tent** so as to accommodate a maximum capacity of dishes with minimal addition of volume and weight to the tent." (AH0, LA4) **A sample solution:** 	2b) "**Design a drier where the dishes can be placed to dry in the tent.** The drier should be of minimal weight, minimal dimensions and maximum dish-capacity." (CA0, AH0) **A sample solution:** 

Table 4.4.: Analysis of design briefs used in a previous study

notice that both creative solutions seem to be very specific to the given context and the less creative outcomes are more generic solutions which can be applied regardless of context. The solution outcomes are evaluated as creative because the judges have not expected or seen the solutions applied to the given context. This observation suggests another proposition for the LA dimension. Creative solutions tend to be a combination of avoiding existing preconceptions and generic solutions. It is believed that the problem-solution space is enlarged by avoiding familiar or existing solutions. The LA dimension can be seen as not only limiting interpretations but also providing highly contextualized criteria for designers to evaluate their initial concepts.

Another commonly distinguished pair of problem formulations is "imprecise formulations versus precise formulations." This distinction is derived from practical circumstances that design problem formulations depend on clients' needs and their understanding of the project. On the one hand, clients often describe their needs in general terms using natural language which is inherently imprecise to designers who needs to translate the needs using more technical terms of the discipline. On the other hand, competitors' specifications and existing products in the market are readily available to serve as references to generate design briefs for new projects. In both cases, designers might have to deal with design brief formulations that correspond to different stages of the typical design process (See table 4.5). According to the abstraction hierarchy, innovations can happen at either ends of the dimension. The abstraction framework seems to be able to formulate both imprecise and precise design briefs for investigations.

Disciplines		Imprecise	to	Precise		Deliverables
Mechanical engineering	intentions /purposes	functional requirements	sketches	requirements specifications	engineering drawings	prototypes
Computer Science	intentions /purposes	functional requirements		program specifications	algorithms /flowcharts	binary executables
Product Design	intentions /purposes	functional requirements	sketches	embodiment design	technical drawings	prototypes
Architectures	intentions /purposes	functional requirements	sketches		technical drawings	building plans
Electrical engineering	intentions /purposes	functional requirements			circuit diagrams	electronic circuits

Table 4.5.: Disciplines' use of custom representations at various stages of the design process

4.3.3. Pragmatic considerations

Even though the abstraction framework seems to be promising in analyzing design briefs and explaining potential performance differences in design outcomes, it is necessary to empirically investigate how designers' perceptions are influenced by design briefs formulated by the framework. In this section, a few propositions are suggested on how the abstraction framework can be used to formulate simple design briefs based on individual dimensions. The rationales for selecting a specific position of the dimension for a design brief are explained. More complex design briefs can also be formulated by combining elements from multiple dimensions.

Since research methods used in previous studies for design problem formulations require design tasks to be formed in pairs for comparisons, the framework is used to generate 13 sample pairs of design briefs based on individual dimensions. Each design task in a pair is labelled as either abstract or concrete depending on the relative positions on the dimension. In general, a (+) sign is more abstract and a (-) sign is more concrete. If a pair is formed by [Task 1 (CA0), Task 2 (CA-)], Task 1 is more abstract than Task 2 in this pair formulations. These task pairs are presented to design students in a pilot empirical study so that the results of designers' perceptions can be available for statistical comparisons.

Since the CA dimension is only concerned with concrete objects, it is the simplest

#	Abstract formulations	Concrete formulations	Dimensions
1	Design a table (CA0)	Design a kitchen table (CA-)	Single
2	Design a piece of clothing (CA+)	Design a dress shirt (CA-)	Single
3	Design a furniture set (CA+)	Design a children sitting sofa set (CA-)	Single
4	Design a vehicle (CA+)	Design a sport coupe(CA-)	Single

Table 4.6.: Sample pairs of design brief formulations based on the CA dimension

dimension of the framework. The CA dimension aims to promote creativity of design outcomes by avoiding designers' preconceptions at the basic level of abstraction with respect to design expertise. It is proposed that designers are more likely to seek out further information or ask additional questions relating to the design tasks that are not formulated at their basic level. Design tasks presented at the basic level tend to involve preconceptions based on familiarity. Sample pairs of design brief formulations based on CA are listed in table 4.6.

Formulation 1) Design a piece of furniture (CA+)

Formulation 2) Design a table (CA0)

Formulation 3) Design a stainless steel kitchen countertop (CA-)

Considering the three formulations above, formulation 2 is at the most basic level for novice designers that may prime them to recall existing solutions. Both formulations 1 and 3 are at a less familiar abstraction which forces designers to seek further clarification of the design task. Moreover, formulation 3 is more basic than the other two formulations for interior designers with additional domain-specific knowledge.

The LA dimension is more complex because it is extensive enough to generate many variations of design briefs based on the English language. By aggregating different layers of meanings with words, design briefs can provide a lot of contextual information and become lengthy as in narratives. This posts a challenge to convey the essence of narratives formulations to designers while minimizing the

#	Abstract formulations	Concrete formulations	Dimensions
11	Design a flash memory-based portable music player (LA0)	Design a music player that will let a jogger enjoy listening to music when jogging (CA+, LA4)	Hybrid
12	Design an automatic door (CA-)	Design the front door for a busy department store (CA-, LA4)	Hybrid
13	Design a desktop lamp (CA-)	Design a bedside lamp for people who like to read at night before going to bed (CA-, LA4)	Hybrid

Table 4.7.: Sample pairs of design brief formulations based on the LA dimension

length difference between the design brief pair. In addition, when formulating design briefs for this dimension, we notice that there are a few similarities between formal specifications and the subordinate categories. Moreover, narratives formulations also involve the use of concrete objects to describe the design situations. It is inevitable to involve the use of categories because concrete objects are fundamental components of the LA dimension. This study has to take these limitations into consideration when analyzing the comparison results from this dimension. In a real-world context, two specific kinds of formulations related to LA are commonly used in practice. The two formulations represent artifact-centered specifications (LA0) and user-centered scenarios (LA4). The interaction of these two formulations with design expertise is still uncertain. Literature only suggests that expert designers often create and simulate their own scenarios to discover hidden design requirements during the design process. At this stage, we can only speculate that scenario-based design may be related to design fixation. Scenarios might assist novice designers to generate initial solutions because novice designers may lack the experience to create concrete scenarios. For expert designers, providing concrete scenarios may be counterproductive because the scenarios may contradict their experience and interfere with their own scenarios. Sample pairs of design brief formulations based on LA are listed in table 4.7.

Similarly, the AH dimension also involves the use of categories for design brief formulations. However, the difficulties of using this dimension are different from those of the LA dimension. The LA dimension focuses on adding contextual information to limit designers' interpretations while the AH dimension focuses on influencing designers' preferred representations with respect to design expertise. The abstraction hierarchy suggests that different representations are preferred by designers with different levels of expertise. This AH dimension is proposed to affect novice and expert designers differently. On the one hand, expert designers prefer higher levels of abstraction (AH+) so that they select or define the functional requirements according to their experience while novice designers may have troubles framing or scoping the (AH+) problem formulations. On the other hand, novice designers may prefer lower levels of abstraction (AH-) because a concrete representation of the artifact enables novice designers to plan their design activities accordingly. Concrete problem formulations may be perceived as instructions-following exercises by expert designers. In addition, the AH formulations involve the process of design brief writers' subjectively translating purposes and intentions into functional and structural requirements for design briefs. For most of the cases, the process can be very straightforward if the expected artifact is known. Design brief writers can simply describe the functions or structures of the artifact. Most AH+ formulations are built on superordinate categories which serve to avoid preconceptions and familiar solutions. Sample pairs of design brief formulations based on AH are listed in table 4.8.

#	Abstract formulations	Concrete formulations	Dimensions
5	Design a ventilation system for a kitchen (CA+, AH+)	Design an exhaust fan outlet for a kitchen (AH-)	Hybrid
6	Design a device to remind important day and time for the visually impaired (CA+, AH+)	Design a talking alarm clock (AH-)	Hybrid
7	Design a wearable time-telling device (CA+, AH0)	Design a diamond watch (CA-)	Hybrid
8	Design a new board game that friends and family can enjoy playing together (CA+, AH+)	Design a new game board for the game Monopoly (AH-)	Hybrid
9	Design a lighting device that enables books reading at night (CA+, AH+)	Design a desktop lamp (CA-)	Hybrid
10	Design a kids' toy for learning the English alphabet (CA+, AH+)	Design an English alphabet playing set (AH-)	Hybrid

Table 4.8.: Sample pairs of design brief formulations based on the AH dimension

4.4. A pilot study of design brief perception with industrial design students

In this pilot study, various design task pairs are used in an empirical study to investigate the effects on designers' perceptions. The empirical study conducted with design students contains a questionnaire survey. BA (Hons) in Industrial and Product Design students (Year 1, 2 and 3) are asked to evaluate their perceptions of abstraction and complexity regarding design task pairs by providing numerical ratings. The quantitative nature of this study provides an opportunity to statistically validate the abstraction framework using a factor analysis technique. Factor analysis is a data reduction technique that assists in identifying the underling compositions of certain concepts. For instance, design outcomes' creativity has previously been identified to comprise two orthogonal components, originality and functionality (Finke, 1990). Since the abstraction framework is aligned by three dimensions related to language abstraction, the statistical tool is used to verify whether designers' perceptions are respectively influenced by various design tasks.

4.4.1. Data collection

The questionnaire was distributed to 52 design students (Yr1: 9; Yr2: 38; Yr3: 5, 24 Male: 28 Female). All subjects were paid volunteers and enrolled in the second semester of a three-year BA(Hons) program in Industrial and Product Design. Each student was asked to take up to 1 hour to finish the questionnaire independently. The duration has been shown to be adequate for students to finish the questionnaires in preceding pilot studies.

Since English is the second language of most participants in the study and some pilot subjects did express uncertainty regarding English vocabulary in the original questionnaire. In order to alleviate this potential obstacle, Chinese translations (Hornby, 2002) at comparable abstraction levels were provided in the final version. In the questionnaire, the subjects were asked to rate the perceived levels of abstraction and complexity of 13 pairs of design tasks based on a 5-point scale (i.e. from very abstract(5) to very concrete(1) and from very complex(5) to very simple(1)). The order of various design task items was randomized in the questionnaire. The survey results were quantitatively analyzed using Paired-Samples T-tests and factor analysis. Paired-Samples T-tests compare the rating difference of each design task pair as evaluated by an individual subject. Significant results were reported if the average differs from 0. Factor analysis compared correlations of the perceived ratings for various design tasks. It was used as a data reduction method to identify the underlying variables that constituted students' perceptions of design briefs. Furthermore, the empirical results could be used to compare various dimensions conceptualized by the abstraction framework.

4.4.2. Results of the questionnaire survey

Mean values are calculated for the abstraction and complexity score and Paired-Samples T-tests are performed on the 13 pairs of design tasks. Higher scores signify higher perceived abstraction and complexity respectively. The results shown in table 4.9 indicate that there is a significant difference in abstraction perception for task pairs formulated by the CA dimension. Design students perceive distinct levels of abstraction respectively based on design tasks formulated by nouns of superordinate, basic and subordinate categories. Students may evoke significant different categories of objects when designing the design tasks. The result is in agreement with previous studies of psychological categories of concrete objects (Rosch et al., 1976). Upon closer examination, the abstraction score comparisons of furniture set (3.5) $>$ table (3.1) $>$ kitchen table (2.7) seem to support Rosch et al.'s findings of a basic level of abstraction. Since the basic level of abstraction is, according to Rosch (1976), the most available representation when recognizing an object, design tasks formulated under this abstraction may promptly be recognized by the subjects, which can explain the lowest complexity score reported among the three design tasks, furniture set (3.2) $>$ table (2.6) $<$ kitchen table (2.8). The complexity scores for task 4a) vehicle, (4.3) and 4b) sport coupe, (4.1) seem to be much higher than the rest of the design tasks. The results may indicate that the scale of the artifact affects perceived complexity.

The results of the LA dimension (table 4.10) suggest that detailed descriptions and elaborations of use situations in language lead designers to construct more concrete scenarios of given design tasks. The lower abstraction scores tend to be associated with scenario formulations when compared with the specifications counterparts. Even though the complexity scores of the tasks remain relatively invariant, designers seem to receive more information in concrete formulations.

Abstraction Dimensions	Design brief questionnaire items abstract (a) vs. concrete (c)	Abs. Mean	Comp. Mean
Categories Abstraction CA	1a) Design a table (CA0)	**3.1***	2.6
	1c) Design a kitchen table (CA-)	**2.7***	2.8
	2a) Design a piece of clothing (CA+)	**3.8***	2.9
	2c) Design a dress shirt (CA-)	**3.0***	3.0
	3a) Design a furniture set (CA+)	**3.5***	3.2
	3c) Design a children sitting sofa set (CA-)	**2.6***	3.0
	4a) Design a vehicle (CA+)	**3.5***	4.3
	4c) Design a sport coupe (CA-)	**2.9***	4.1

*denote a significant pair at $p < 0.05$ level, ^denote a significant reverse pair at $p < 0.05$ level

Table 4.9.: Abstraction and complexity ratings of design briefs formulated by the CA dimension

Abstraction Dimensions	Design brief questionnaire items abstract (a) vs. concrete (c)	Abs. Mean	Comp. Mean
Linguistic Aggregation LA	11a) Design a flash memory-based portable music player (LA0)	2.7	3.1
	11c) Design a music player that will let a jogger enjoy listening to music when jogging (CA+, LA4)	3.0	3.3
	12a) Design an automatic door (CA-)	**3.2***	**3.4***
	12c) Design the front door for a busy department store (CA-, LA4)	**2.8***	**3.1***
	13a) Design a desktop lamp (CA-)	**2.8***	2.8
	13c) Design a bedside lamp for people who like to read at night before going to bed (CA-, LA4)	**2.4***	2.8

*denote a significant pair at $p < 0.05$ level, ^denote a significant reverse pair at $p < 0.05$ level

Table 4.10.: Abstraction and complexity ratings of design briefs formulated by the LA dimension

One exception is observed in task pair 11. The specifications aim to provide an object-oriented formulation, which is supposed to be more abstract than scenario formulations (Carroll, 1995). Nonetheless, the abstraction score indicates that the specifications are more concrete than the use scenario. A possible explanation may be attributed to the fact that not all the subjects have made personal experiences of using a music player when jogging while the experience of using portable music player is made universal by iconic images including Apple IPod and alike, which may explain the lower complexity score. The observation seems to suggest that scenario formulations only facilitate communication to designers when the use scenarios can be related to designers' actual prior experience. Otherwise, designers are less likely to relate to unfamiliar scenario formulations.

The results of the AH dimension (table 4.11) are unexpected. Since the ab-

straction framework proposes that functions and structures are two different design brief formulations located at the extreme ends of the AH dimension, the results suggest that design students perceive no difference in abstraction between functions and structures oriented formulations. The distinctions do not lie in the perceived abstraction but seem to be a design-specific convention learned early by designers in their design education. Moreover, the perceived complexity scores also suggest that perceived task complexity is not related to perceived task abstraction. An exception is the reverse scoring pair for task 6 where the function formulation is more concrete than the structure formulation. The exception may be explained by the inclusion of a target user group in the formulation. However, the abstraction scores of the remaining task pairs are inconclusive. The results might be explained by several reasons. Abstractions in CA and LA are developed and affected by daily use of language in a specific community or environment. Compared to the other two dimensions, Abstraction Hierarchy is related to domain-specific representations that are learned and developed through professional practices. Experience is a critical factor required to distinguish between functions and structures. The results indicate insignificant distinctions between functions and structures design pairs, which may be due to the subjects' early stage of design education and lack of prolonged practical experience. In addition, the AH dimension relies mainly on design brief writers' ability to formulate different representations. I notice that to me it seems natural to think of a design problem in terms of its intentions and purposes leading to the formulations but it is difficult to formulate problems in terms of their structures. Lacking specific domain knowledge, I can only refer back to existing objects or familiar solutions for structures formulations. This reflection is probably encountered by other design brief writers who may be unaware of similar situations formulating design briefs

Abstraction Dimensions	Design brief questionnaire items abstract (a) vs. concrete (c)	Abs. Mean	Comp. Mean
Abstraction Hierarchy AH	5a) Design a ventilation system for a kitchen (CA+, AH+) 5c) Design an exhaust fan outlet for a kitchen (AH-)	2.7 2.5	3.6 3.4
	6a) Design a device to remind important day and time for the visually impaired (CA+, AH+) 6c) Design a talking alarm clock (AH-)	**2.2^** **2.7^**	**3.7*** **3.0***
	7a) Design a wearable time-telling device (CA+, AH0) 7c) Design a diamond watch (CA-)	3.0 2.8	3.2 3.2
	8a) Design a new board game that friends and family can enjoy playing together (CA+, AH+) 8c) Design a new game board for the game *Monopoly* (AH-)	3.3 2.4	3.4 3.4
	9a) Design a lighting device that enables books reading at night (CA+, AH+) 9c) Design a desktop lamp (CA-)	2.6 2.8	2.8 2.8
	10a) Design a kids' toy for learning the English alphabet (CA+, AH+) 10c) Design an English alphabet playing set (AH-)	2.7 3.0	**3.3*** **3.0***

*denote a significant pair at $p < 0.05$ level, ^denote a significant reverse pair at $p < 0.05$ level

Table 4.11.: Abstraction and complexity ratings of design briefs formulated by the AH dimension

that are limited by their own experience and preconceptions.

Pair-samples t-test and factor analysis

Individual designers' perceptual differences of each design task pair were examined by the Pair-samples t-test. This statistical method restricts the comparison and analysis to two design tasks at any given time. The method seems to be sufficient to interpret the results of the CA and the LA dimensions. However, this restriction poses a challenge to the understanding of the results of the AH dimension where all the task pairs generate relatively similar abstraction ratings when compared in pairs. This limitation prompts me to use another statistical method, factor analysis, to investigate the data from a broader perspective. Factor analysis, specifically a data reduction method aiming to uncover hidden structures of statistical data, is performed on all the design tasks formulated by the three dimensions. All the design tasks are first separated into two groups. One group is called abstract formulations while another group is called concrete formulations. The groups are used to represent the notions of abstraction and concreteness respectively. From

Abstraction Dimensions	Abstract design task formulations	Component factor		
		1	2	3
CA	1a) (CA0)	.748		
	2a) (CA+)	.653		
	3a) (CA+)	.635		
	4a) (CA+)	.765		
LA	11a) (LA0)			.698
	12a) (CA-)	.595		
	13a) (CA-)	.777		
AH	5a) (CA+, AH+)			.847
	7a) (CA+, AH0)		.696	
	8a) (CA+, AH+)		.812	
	9a) (CA+, AH+)		.759	
	10a) (CA+, AH+)		.713	

Table 4.12.: Rotated component matrix for the abstraction dimensions

the framework, abstraction is assumed to have 3 sub-dimensions.

The notion of abstraction is analyzed first. Using SPSS, both the KMO and Bartlett's Test are used to examine the correlation matrix and detect any violations to the factor analysis assumptions. The correlation matrix shows adequate validity to proceed with the analysis. Task 6a) is eliminated following the analysis procedure because it bridges into multiple factors, which might explain the unexpected results of the reverse task pair. VARIMAX rotation is used to minimize the number of items on each factor and simplify the interpretation of resulting factors. The results indicate that approximately 58 % of the variance is accounted for by three component factors (table 4.12). The Cronbach's Alpha = 0.67, which is a reliability indicator showing the internal consistency of the questionnaire items (whether the notion of abstraction is being assessed by the items), is acceptable for an exploratory study (Hair Jr, Anderson, Tatham & Black, 2006).

The results shown in table 4.12 with the proposed notations stated next to the design tasks are encouraging because the first two factors fit predominately with the CA and AH dimensions while the last factor contains items from both the AH and LA dimensions. The first factor is composed of design tasks that

describe the artefacts using nouns. Tasks 12a) and 13a) from the LA dimension are incorporated into the first factor which indicates those two formulations should be grouped into the CA dimension. The inclusion is reasonable as the notations next to the two tasks show a close relationship with the CA dimension. Since task 11a) indeed belongs to the third factor, the results of task 12a) and 13a) probably reflect my own inexperience in determining appropriate specification formulations. As I noticed above, design brief formulations require sufficient domain-specific knowledge. Subordinate formulations (within CA) can easily be mistaken as specifications formulations (within LA) if design brief writers or designers do not possess sufficient domain knowledge. The finding indicates that the abstraction framework can be used to formulate design briefs with respect to design expertise because expert designers are more capable of distinguishing certain design briefs while novice designers may treat design briefs equally.

The second component factor contains most of the design tasks from the AH dimension. The factor is made up of design tasks that describe the functions or goals of the artefacts. The results appear to support the necessity of having a perceptual dimension aligned with abstraction hierarchy in the framework. The last factor only contains 2 design tasks that seem to relate to specifications formulations. Moreover, it is reasonable to assume that the first two dimensions dominate designers' perceptions. The two dimensions of naming the artefacts and describing the artefacts' functions coincide with other researchers' intuitions to formulate design problems (Goldschmidt et al., 1996).

I conducted a similar procedure to examine the notion of concreteness. The results show a higher reliability with Cronbach's Alpha = 0.72, indicating an acceptable consistency of the entire questionnaire items. However, there is not a clear structure of relating the factors to the abstraction framework. A possible

explanation is that all the concrete elements are related to physicality and the notion of concreteness cannot be separated into distinct sub-dimensions. These results agree with my intuition that perceptions at the physical level are limited by interactions with physical objects. Physical reality seems to be the basic building blocks of human perceptions. Nonetheless, there are many different ways to abstract information beyond the physical level depending on how designers selectively attend to different aspects of given situations. The factor analysis shows that physical appearances, functions and specifications of artefacts are potential candidates used by designers for abstract representations.

4.4.3. Discussion of the pilot study

A few limitations of this study should be noted. Firstly, English is the second language of most participants in the study. Some pilot subjects did express uncertainty regarding English vocabulary in the original questionnaire. In order to alleviate this potential obstacle, Chinese translations (Hornby, 2002) at comparable abstraction levels were provided in the final version. Secondly, I made the implicit assumption that the Sapir-Whorf hypothesis, which states that the nature of a language (such as Chinese or English) influences thought, has a minimal effect on the results of this study (Heider, 1972).

In the pilot study, a quantitative research approach was used to explore the complex notions of perceived abstraction. Some preliminary results are shown regarding the evaluation of the proposed abstraction framework to formulate different design briefs. During the validation process, both the samples-t test and factor analysis indicate that Categories Abstraction (CA) is the most influential abstraction dimension, which perhaps reflects human basic ability to differentiate and categorize physical objects. The other two dimensions (AH and LA) appear

to be more flexible when formulating design briefs for the intangibles. The factor analysis results illustrate that the perceived notion of abstraction is composed of at least three distinct elements. These elements can be interpreted as three different ways based on the artefacts' names, functions or use scenarios to represent a design task.

4.5. Conclusion

The results of the pilot study suggest a potential limitation of using quantitative methods to investigate designers' initial perceptions of design briefs since more complex design briefs often involve all the dimensions of the abstraction framework. These complex briefs contain too many variables and are likely to increase the difficulty of interpreting the results from statistical analysis. In addition, design expertise and design context are shown in existing models to influence designers' perceptions of design briefs. A mixed research method (card-sorting) taking into account of these two factors is more appropriate to explore the effects of complex design brief formulations. The establishment of an explicit framework for design brief production is the first step to ameliorate the prescriptive nature of existing approaches to design brief formulations. With only a prescriptive component, it is not possible to determine which aspect of a design brief is useful in affecting designers' perceptions. A tentative framework of design brief reception derived empirically is proposed in the next chapter to complement and complete the cycle related to design brief communication. With frameworks related to design brief production and reception properly established, systematic improvements can be implemented in an evolving system of design brief communications.

CHAPTER 5

A TENTATIVE FRAMEWORK FOR DESIGN BRIEF RECEPTION

This chapter presents results of card-sorting exercises and semi-structured interviews from subjects with various expertise levels (Yr1 design students, Yr3 design students, design educators, professional designers and design managers). Comparisons of subjects' sorting results within and across different cases shed light on various factors affecting designers' perceptions and the growth of design expertise on designers' perceptions. Findings are discussed in relation to the theoretical framework and simplified models of design brief perceptions are proposed to account for the perception differences of design briefs. Tentative designer-centered guidelines are formulated in order to assist future design brief formulations.

5.1. Introduction

Even though the cognitive abstraction framework was shown to be partially successful in formulating various design briefs and enhancing design performance, the results seem to suggest that current understanding of designers' perceptions of design briefs is insufficient to provide a designer-centered approach to formulating briefings for designers. There may furthermore be other non-cognitive but equally important factors influencing design brief perceptions and design performance. This part of the study attempts to empirically construct a tentative framework for design brief receptions so that an explicit feedback mechanism can be explicitly modelled and understood. Based on the knowledge of how designers with various levels of design expertise perceive design briefs, design brief writers should be able to formulate design briefs that not only communicate with designers but also motivate designers to fully utilize their potential. Since some of the design briefs used in the card-sorting exercises only contain a design task title, the word design brief and design task are used interchangeably in this chapter.

5.2. Card-sorting exercises and semi-structured interviews

In order to investigate designers' initial perceptions of design briefs, it is necessary to understand the structure of their knowledge. Given the large number of design brief formulations must be used to explore the diverse perceptions of designers, the use of card-sorting exercises has been shown to be the more efficient knowledge elicitation technique than structured interviews, protocol analysis and laddered grid (Burton et al., 1990) to investigate mental models and knowledge structures. Card-sorting focuses on identifying key concepts that are generated by the subjects as they sort the given tasks. This technique requires the subjects

Figure 5.1.: Various subjects participated in the card-sorting exercises

to think aloud when making their sorting decisions and to give reasons for their choices afterwards.

Details of the card-sorting exercises including nature of the design tasks and card-sorting procedures are discussed in section 5.2.1. Figure 5.1 shows a few subjects participated in the card-sorting exercises.

Variations of design brief formulations are still based on the abstraction framework. The framework is used as a reference point for including different elements in the design brief formulations. Different areas including the levels of abstraction, presentation formats, and application domains, are expected to influence designers' decisions when sorting the cards. Mathematically, the number of

possible sorted outcomes is immense. Subjects can apply numerous meaningful relationships or principles to arrange the cards. The sorting principles used by designers with different levels of expertise are crucial to the understanding of subjects' perceptions of design briefs in a real world setting. Some sorting principles used by individual subjects may be considered to be more abstract or concrete with respect to the abstraction framework. However, the sort results should reflect the subjects' own views on the information presented on the cards and may be used to infer the subjects' knowledge structure regarding the design tasks.

In this part of the study, card-sorting exercises are first used to investigate design brief formulations. Designers' perceptions of design briefs are initially generated when designers comprehend and interpret the design brief. Since the sort results and verbal protocols can differ greatly between different subjects, the priority is to analyze cases within the same expertise level so that an overall impression of designers' perceptions of design briefs can emerge. Three levels of design expertise and two contexts are distinguished in this study. Subjects include Yr1 industrial design students, Yr3 industrial design students, industrial design educators, professional designers with 3+ yrs of experience and design managers with 10+ yrs of experience. Three techniques were used to analyze the sort results and sorting rationales including content analysis, correlation analysis and semi-structured interviews. Both content analysis and correlation analysis aim to reveal hidden patterns associated with designers' perceptions with different levels of design expertise and contexts. The semi-structured interviews are used to complement the results of content analysis and correlation analysis with unique characteristics of individual subjects since individual sorting sessions are omitted for brevity.

Since many design tasks are formulated based on the abstraction framework, the cognitive framework provides a theoretical context within which to analyze the verbal protocols. Through comparing and contrasting the sort results from various expertise levels and contexts, I am able to hypothesize how perceptions of design briefs may affect designers' subsequent behaviour and strategies towards the design tasks. Subjects' actual sorting principles and grouping categories are then used to construct an inductive model of design brief perceptions. Any inconsistencies observed are useful to further the understanding of design brief formulations. Finally, semi-structured interviews are also used to investigate the kinds of design brief formulations that are preferred by designers with different expertise levels. Based on the findings of the card-sorting exercises and designers' first-hand experience of interacting with design briefs, a designer-centered approach of formulating design briefs is discussed in section 5.7. A designer-centered approach of formulating design briefs should be viewed as a first step for providing tailored means of communication for designers with different levels of design expertise to enhance design performance.

5.2.1. Preparations of design briefs

I took 24 design tasks from the pilot study and a product design textbook (Roozenburg & Eekels, 1995). These design tasks are written on individual 5.5' x 4' sized postcards and are formulated based on various dimensions (number of cards) of the abstraction framework described in section 4.2: superordinate CA+ (2), subordinate CA- (4), functions AH+ (5), structures AH- (3), specification LA0 (5), and scenarios LA4 (5). The design tasks are presented on the cards in three different formats: single statements (9), bullet-point forms (7) and short compositions (8). Theses formulations include elements that can potentially be perceived as related

to abstract design principles or concrete surface features of the given design task. One way of categorizing the cards is by the proposed abstraction dimensions. Otherwise, the cards can also be categorized by other elements including the presentation formats, application domains, design disciplines and other surface features such as keywords. Design tasks used in the card-sorting exercises are shown in table 5.1. The aim is to provide sufficient elements for variations so that designers have sufficient space for their sorting decisions based on their own perceptions of the cards. Designers' knowledge structures can be inferred from the sort results and the sorting protocols as described by (Chi et al., 1981).

5.2.2. Data collection

40 designers (subjects' demographics are presented in table 5.3) with various levels of design expertise were invited to participate in the card-sorting exercises. My subjects include design students (first year and third year BA(Hons) in Industrial and Product Design) during their second semester, design educators from the industrial design discipline, professional designers (3+ years of professional/post-graduation experience) and design managers (10+ years of post-graduation experience), which capture data from designers with different expertise levels and contexts even though the contextual factor is an implicit assumption with each subject. The expertise intervals are designed to roughly correspond to the five developmental stages for the acquisition of design expertise proposed by Lawson (2004) and the six distinct levels of expertise suggested by Dorst (2008). 8 subjects per expertise level is suggested by earlier studies (Chi et al., 1981).

#	Card identifier (not shown on cards)	Descriptions printed on cards	Abstraction	Format
1	Coffee maker	To design a coffee maker with -10 cups capacity -removable filter basket -auto start/stop	Specifications LA0	Point-form
2	Margarine storage device	To design a storage device which can -store margarine that also can be reused -a measurable amount (e.g. 20g) of margarine can be taken out every time -try to avoid greasy fingers when using the margarine	Functions AH+	Point-form
3	Beverage vending machine	To design a beverage vending machine which is consisted of a selection window and panel, a payment receiver, a beverage collection box, a refrigerator and a compressor.	Structures AH-	Composition
4	Window cleaner	To design a window cleaner that is used to wash and dry windows which has an extendable arms for cleaning higher windows, with multiple changeable cleaning brushes and an ergonomic handle to reduce fatigue.	Specifications LA0	Composition
5	Garden chair	To design a garden chair which is made up of -stainless steel or cast aluminum -using a modular design -required easy assembly	Structures AH-	Point-form
6	Coin-operated payphone	To design a coin-operated payphone	Subordinate CA-	Single
7	Bedside lamp	To design a bedside lamp for people who like to read books at night before going to bed.	Scenarios LA4	Single
8	Diamond watch	To design a diamond watch	Subordinate CA-	Single
9	Revolving door	To design an automatic revolving door	Subordinate CA-	Single
10	Card game	To design a new card game that friends and family can enjoy playing together. The card game should let players cooperate or play against one another. The card game should be interesting and challenging.	Functions AH+	Composition
11	Footwear	To design a footwear	Superordinate CA+	Single
12	Coffee mug	It is 8 am in the morning; a college student is rushing to prepare 2 cups of freshly brewed coffee to drink inside his car and during his 8:30 am lecture. Design a coffee mug for the college student.	Scenarios LA4	Composition
13	Ventilation system	To design a ventilation system for a Chinese restaurant kitchen.	Functions AH+	Single

Table 5.1.: The 24 design tasks formulated for the card-sorting exercises

14	Food preparation area	To design a food preparation area for cooking Chinese dinner - an area for cutting raw fish and meat - a rice cooking area	Functions AH+	Point-form
15	Dashboard	To design a dashboard for a car, the dashboard should contain - an odometer - a speedometer - a fuel gauge - a trip meter	Specifications LA0	Point-form
16	Clothing	To design a piece of clothing	Superordinate CA+	Single
17	Trash can	In front of a busy restaurant, there are a lot of cigarette light buds on the ground since the smoking ban, can you design a trash can to improve the existing condition.	Scenarios LA4	Composition
18	Can opener	To design a can opener - leaves no sharp edges on can or lid - makes no contact with can contents - easy-turn, soft-grip knob and non-slip handles -dishwasher-safe	Specifications LA0	Point-form
19	Sofa set	When children are watching TV. They always sit in front of the TV and blocking the adults from viewing the shows. Can you design a sofa set that can improve the situation?	Scenarios LA4	Composition
20	Time-telling device	To design a wearable time-telling device	Functions AH+	Single
21	Heart rate monitor	To design a heart rate monitor that can display ECG accurate heart rate, track calories consumed against a daily target, calculate calories burned during exercise and subtracts them from your daily calorie target and display your personalized % of maximum heart rate	Specifications LA0	Composition
22	Dress shirt	To design a dress shirt	Subordinate CA-	Single
23	Flower vase	To design a flower vase -should use ceramic or clay -must use blue / red / yellow / black for color combination -should be less than 2 kgs	Structures AH-	Point-form
24	Office ladies shoes	Office ladies usually have long working hours and they do not have a lot of chance to exercise. Can you design a pair of walking shoes that can promote the concept of healthy living and exercises among the office ladies?	Scenarios LA4	Composition

Table 5.2.: The 24 design tasks formulated for the card-sorting exercises (Continued)

Subject	Male	Female
Yr1	1	7
Yr3	3	5
Prof	5	3
Mgr	4	4
Edu	5	3
Total	18	22

Table 5.3.: Profiles of subjects participating in the card-sorting exercises

5.2.3. Procedure

Before the actual experiments, all the subjects were required to practise with the ”think-aloud” training exercise (see appendix C) which is adapted from Ericsson and Simon (1984). The aim is to allow the subjects to become familiar with thinking-aloud their thoughts through concurrent and retrospective verbalizations. Some of the subjects expressed anxieties when asked to perform a mental mathematical calculation (i.e. multiplication of two double-digit numbers). Those subjects were asked to relax and continue with other parts of the training exercise before going back to complete the mental calculation.

After the subjects were familiar with the process, they were invited to read the card-sorting instructions (see appendix C) to categorize the cards into stacks that they find meaningful according to their knowledge structures. The sorted stacks of cards were required to contain not too many or too few cards. The final stacks also did not need to contain an equal number of cards. The session began by asking the subjects to read aloud the design tasks given on the cards and to lay out all the cards on a table. They then followed the think-aloud procedure throughout the sorting sessions. When there was a long period of silence, the subjects were reminded to continue verbalizing. Post-it notes and markers were provided so that subjects could write down anything that they found important during their sorts.

There was no time limit for the sorting session. Subjects were asked to re-sort the cards until they arrived at the most satisfactory final results and each sorting time was recorded. These experiments were videotaped, and the verbalizations were transcribed into written protocol data. Since most of the subjects speak Cantonese in the exercises, the verbal protocols had to be translated and transcribed. Their sort results were analyzed by content analysis and correlation analysis with respect to each expertise level. Samples of full-length verbal protocols are provided in appendix D.

5.3. Content analysis of the card-sorting results

Since initial perceptions of design briefs are of primary interests, only the 1st sort time and results were analyzed. The total number of sorts and other information are presented in table 5.4 and 5.5. Examining the two tables, it is noted from the sorting protocols that the first two sort results of Yr1 subjects usually are very similar while the third sort results usually are based on a different kind of principles from those of earlier sorts. In addition, Yr1 subjects also tend to have many more attempts for sorting the tasks. For Prof subjects, the number of groups for the 1st sort results seems to vary a lot within the group with the highest standard deviation from the rest of the group. It seems that Prof subjects may potentially employ two different sorting principles, one principle seems to be based on their increased expertise (domain knowledge) and another principle seems to be based on a quick visual scan. Many Prof subjects also seem to converge to a single sort result. Another interesting observation seems to come from Mgr and Edu subjects who seem to take on or switch to different roles (even within a single sorting session) when sorting the cards leading to diverse sort results. From the sorting protocols, it is noted that some Mgr subjects may suddenly switch to a client role or

Yr1 subject	# of sort attempted	1st sort time (mins)	1st sort time (round to the nearest min)	# of group for the 1st sort
Yr1_A	4 (different)	6:30	7	5
Yr1_B	2 (similar)	8:30	9	9
Yr1_C	3 (different)	10:45	11	6
Yr1_D	3 (different)	11:06	11	8
Yr1_E	3 (similar)	13:42	14	7
Yr1_F	2 (similar)	18:41	19	6
Yr1_G	3 (similar)	24:13	24	5
Yr1_H	3 (different)	12:26	12	6
		Median	12	6
		Average	13	7
		Standard deviation	6	1
Yr3 subject	# of sort attempted	1st sort time (mins)	1st sort time (round to the nearest min)	# of group for the 1st sort
Yr3_A	3+ (different)	16:53	17	5
Yr3_B	2(similar)	14:14	14	5
Yr3_C	2 (different)	6:44	7	8
Yr3_D	2 (similar)	14:07	14	9
Yr3_E	3 (different)	24:30	25	8
Yr3_F	1	25:50	26	5
Yr3_G	3 (different)	8:15	8	6
Yr3_H	1	20:01	20	7
		Median	16	7
		Average	16	7
		Standard deviation	7	2

Table 5.4.: The 1st sort time and the number of sorts attempted by Yr1 and Yr3 subjects

a junior designer role when trying to make senses of the cards. Two subjects (Yr3-A and Edu-E) also indicated that they could have produced many more different sort results if they were given more time. Their sort attempts are accompanied by a "+" sign.

7 main coding categories (related to the theoretical framework, business/design management, design knowledge, design discipline, personal/individual preference, presentation format, and product category) and 56 sub-categories were derived from subjects' final groups' names and their rationales for grouping the design briefs. The 7 main categories are self-explanatory and are elaborated into corresponding sub-categories. 5 expertise levels and two contexts were implicitly assumed in the results. Overall sort results from all the subjects and sort results

Prof subject	# of sort attempted	1st sort time (mins)	1st sort time (round to the nearest min)	# of group for the 1st sort
Prof_A	2 (similar)	9:38	10	5
Prof_B	1	22:27	22	5
Prof_C	2 (similar)	28:25	28	4
Prof_D	1	37	37	10
Prof_E	2 (different)	20:20	20	5
Prof_F	1	6:35	7	3
Prof_G	1	16:42	17	10
Prof_H	1	13:12	13	4
		Median	19	5
		Average	19	6
		Standard deviation	10	3
Manager subject	# of sort attempted	1st sort time (mins)	1st sort time (round to the nearest min)	# of group for the 1st sort
Mgr_A	2 (similar)	9:11	9	5
Mgr_B	1	16:23	16	7
Mgr_C	2(different)	15:25	15	6
Mgr_D	1	7	7	3
Mgr_E	2 (different)	12:08	12	6
Mgr_F	2 (different)	18:54	19	7
Mgr_G	2 (different)	14:39	15	4
Mgr_H	2 (similar)	7:30	8	4
		Median	14	6
		Average	13	5
		Standard deviation	4	1
Educator subject	# of sort attempted	1st sort time (mins)	1st sort time (round to the nearest min)	# of group for the 1st sort
Edu_A	3 (different)	25:42	26	4
Edu_B	2 (similar)	29:45	30	4
Edu_C	2 (different)	12:23	12	6
Edu_D	2 (similar)	14:18	14	4
Edu_E	2+ (different)	31:30	32	7
Edu_F	2 (different)	6:35	7	5
Edu_G	2 (similar)	10:45	11	6
Edu_H	2 (similar)	18:15	18	5
		Median	16	5
		Average	19	5
		Standard deviation	9	1

Table 5.5.: The 1st sort time and the number of sorts attempted by Prof, Mgr, and Edu subjects

by each expertise level were plotted on excel worksheets for easy comparisons. Comparisons of their sorting results within and across different cases can be expected to shed light on various factors affecting designers' perceptions and the growth of design expertise on designers' perceptions. The card-sorting exercises are followed by semi-structured interviews. The aim is to solicit designers' reflections on the card-sorting sessions. The concurrent data from the sorting sessions and the retrospective data from the interviews are triangulated in order to ensure reliable findings. Before presenting the content analysis results, it is necessary to introduce the excel worksheet summarizing all the information. Every worksheet (e.g. table 5.6) has five major columns including the main category, sub-category, inclusiveness of sub-category, number of subjects utilizing the sub-category, and the actual subject group labels. The first two columns are the usual content analysis categories informing us the nature of a certain label. Inclusiveness of sub-category tells us whether any one subject from an expertise level actually uses the particular category. 5 is the highest mark indicating that at least one subject from each expertise level has used the category to label their groups. Number of subjects utilizing the sub-category counts subjects instead of expertise level and the last column simply is a visual presentation of the previous column. The bottom part contains some basic statistics for the column information. It is not difficult to pick up these notions once a reader has gone through a single analysis.

5.3.1. Content analysis results of Yr1 subjects

Investigating the summary of Yr1 subjects (table 5.6), they seem to be familiar with and have strong mental distinctions for scenarios and specifications types of design briefs. Main categories that are populated with Yr1 group labels tend to be related to the abstraction framework that is related to common design domain knowledge

and the product category. The highest three sub-categories are family/daily use, Public/Commercial facilities and household products. Many Yr1 subjects also seem to use the concept of target users in their sorting process. Most of other categories including design knowledge and design management are missing in their sorting except one or two categories may be utilized by a single subject. Each subject on average generated 6.6 sub-category labels.

5.3.2. Content analysis results of Yr3 subjects

Yr3 results (table 5.7) seem to shift towards the design knowledge and discipline categories while less concentrate on the main product category. The uses of sub-category related to the abstraction framework are still very prominent. Even though there were only 5 female subjects in the Yr3 group (compared to 7 in the Yr1 group), many Yr3 subjects utilize the sub-category, fashion/accessories. Another interesting sub-category related to design freedom and fun for designers also achieves high usages. Some Yr3 subjects also utilize labels (expressing vagueness of a design brief and being a very straight forward design task) that have not been used by Yr1 subjects before. The ability to recognize vagueness or ambiguity of a design brief seems to require certain experience. On average, each Yr3 subject used 7.1 labels.

5.3.3. Content analysis results of Prof subjects

Prof subjects seem to achieve a rather flat result suggesting that they may come from diverse background. Most of the labels (table 5.8) have less than 4 usages except for scenarios, specifications, and target users. Many more Prof subjects articulate categories related to design knowledge. Prof subjects also seem to attend to teamwork and collaboration with other experts. The perceptions seem to be

		Inclusiveness of sub-category (5 = mentioned by every expertise level)					# of subjects utilizing the sub-category (8 = every subject of the expertise level)					
Main category (7)	Sub-category (59)	Yr1	Yr3	Prof	Mgr	Edu	Yr1	Total				
Abstraction framework	Functions / Functional requirements	4	Yes	Yes	No	Yes	Yes	2	2	Yr1	Yr1	
Abstraction framework	Scenarios / Problem-solving situations / Background / Introduction	5	Yes	Yes	Yes	Yes	Yes	4	4	Yr1	Yr1	Yr1 Yr1
Abstraction framework	Specifications / Specific requirements / Constraints	5	Yes	Yes	Yes	Yes	Yes	3	3	Yr1	Yr1	Yr1
Abstraction framework	Structures / Features / Components	1	No	No	No	No	Yes	0	0			
Abstraction framework	Subordinates / Specific product name	3	No	No	Yes	Yes	Yes	0	0			
Abstraction framework	Superordinates / Generic product type	2	No	No	Yes	Yes	No	0	0			
Business / Design management	Budget / Production cost / Manufacturing / Project scale	3	No	No	Yes	Yes	Yes	0	0			
Business / Design management	Business strategies / Marketing strategies	1	No	No	No	Yes	No	0	0			
Business / Design management	ODM products / Require research / Share R&D	2	No	No	No	Yes	Yes	0	0			
Business / Design management	Target customers / corporate clients	1	No	No	No	Yes	No	0	0			
Design knowledge	Arbitrary (not logical) requirements	2	No	Yes	No	No	Yes	0	0			
Design knowledge	Design context	1	No	No	No	No	Yes	0	0			
Design knowledge	Form / Style	2	No	Yes	No	Yes	No	0	0			
Design knowledge	Insufficient information for designing	1	No	No	No	No	Yes	0	0			
Design knowledge	No design requirements / No constraints	3	Yes	No	Yes	Yes	No	1	1	Yr1		
Design knowledge	Open-ended (topic / problem)	3	No	No	Yes	Yes	Yes	0	0			
Design knowledge	Redesign / Existing products	3	Yes	Yes	Yes	No	No	1	1	Yr1		
Design knowledge	Require other experts in the area / Teamwork	3	No	No	Yes	Yes	Yes	0	0			
Design knowledge	Target users / Special needs / user-centered	5	Yes	Yes	Yes	Yes	Yes	3	3	Yr1	Yr1	Yr1
Design knowledge	Technology / Technical knowledge	4	No	Yes	Yes	Yes	Yes	0	0			
Design knowledge	Usability / Ergonomics	2	No	No	No	Yes	yes	0	0			
Discipline	Automotive design	2	No	Yes	Yes	No	No	0	0			
Discipline	Game design	1	No	No	No	Yes	No	0	0			
Discipline	Interface / Interaction design	3	No	Yes	Yes	Yes	No	0	0			
Discipline	Interior / environmental design	4	Yes	Yes	No	Yes	Yes	3	3	Yr1	Yr1	Yr1
Discipline	Mechanical / Engineering / System design	5	Yes	Yes	Yes	Yes	Yes	3	3	Yr1	Yr1	Yr1
Discipline	Product / Industrial design	3	No	No	Yes	Yes	Yes	0	0			
Personal / Individual	Arbitrary sorting / Infinite ways of sorting	1	No	No	No	No	Yes	0	0			
Personal / Individual	Boring (design tasks)	1	No	No	No	No	Yes	0	0			
Personal / Individual	Design instructions to junior designers / Design commands	2	No	No	No	Yes	Yes	0	0			
Personal / Individual	Lots of design freedom / creative freedom / fun for designers / playful / many possible solutions	5	Yes	Yes	Yes	Yes	Yes	1	1	Yr1		
Personal / Individual	Not a design brief	1	No	No	No	No	Yes	0	0			
Personal / Individual	Straight forward tasks / Clear goals / Ready for design action	4	No	Yes	Yes	Yes	Yes	0	0			
Personal / Individual	Vague / Not sure / No ideas / Others	4	No	Yes	Yes	Yes	Yes	0	0			
Personal / Individual	Working priority of tasks	2	No	No	Yes	Yes	No	0	0			
Presentation format	A short composition / Paragraph	4	Yes	No	Yes	Yes	Yes	1	1	Yr1		
Presentation format	A single statement / Task statement	3	No	No	Yes	Yes	Yes	0	0			
Presentation format	Bullet point-forms	4	Yes	No	Yes	Yes	Yes	1	1	Yr1		
Presentation format	Title (design task)	1	No	No	No	No	Yes	0	0			
Product category	Art-related	1	No	No	Yes	No	No	0	0			
Product category	Card game	2	Yes	No	Yes	No	No	1	1	Yr1		
Product category	Chinese restaurant theme / Food / Cooking / Catering / Eating	4	No	Yes	Yes	Yes	Yes	0	0			
Product category	Coffee	2	No	Yes	No	Yes	No	0	0			
Product category	Electronics / Appliances	2	Yes	Yes	No	No	No	2	2	Yr1	Yr1	
Product category	Family / Home / Everyday living / Daily uses	5	Yes	Yes	Yes	Yes	Yes	4	4	Yr1	Yr1	Yr1 Yr1
Product category	Fashion / Accessories	5	Yes	Yes	Yes	Yes	Yes	3	3	Yr1	Yr1	Yr1
Product category	Fun and games, Children products / Toy	4	Yes	Yes	Yes	Yes	No	2	2	Yr1	Yr1	
Product category	Furniture	2	Yes	Yes	No	No	No	1	1	Yr1		
Product category	Health-related	4	Yes	Yes	Yes	Yes	No	2	2	Yr1	Yr1	
Product category	Household products / domestic products / Kitchenwares	5	Yes	Yes	Yes	Yes	Yes	4	4	Yr1	Yr1	Yr1 Yr1
Product category	Lifestyle products	1	Yes	No	No	No	No	2	2	Yr1	Yr1	
Product category	Luxurious products	1	Yes	No	No	No	No	2	2	Yr1	Yr1	
Product category	Personal uses	3	No	No	Yes	Yes	Yes	0	0			
Product category	Public / Commercial facilities	4	Yes	Yes	No	Yes	Yes	4	4	Yr1	Yr1	Yr1 Yr1
Product category	Timepiece	2	Yes	No	Yes	No	No	1	1	Yr1		
Product category	Wearables	3	Yes	Yes	Yes	Yes	Yes	2	2	Yr1	Yr1	
		Yr1	Yr3	Prof	Mgr	Edu	Yr1	Total				
	# of sub-categories covered per expertise level	24	26	33	39	36	53	53	Total # of sub-category labels generated per expertise level			
							6.6	1.3	Average # of sub-category labels generated per subject			

Table 5.6.: Content analysis results of Yr1 subjects

		Inclusiveness of sub-category (3 = mentioned by every expertise level)					# of subjects utilizing the sub-category (3 = every subject of the expertise level)					
Main category (7)	Sub-category (59)	Yr1	Yr3	Prof	Mgr	Edu	Yr3	Total				
Abstraction framework	Functions / Functional requirements	4	Yes	Yes	No	Yes	Yes	4	4	Yr3	Yr3	Yr3	Yr3
Abstraction framework	Scenarios / Problem-solving situations / Background / Introduction	5	Yes	Yes	Yes	Yes	Yes	3	3	Yr3	Yr3	Yr3	
Abstraction framework	Specifications / Specific requirements / Constraints	5	Yes	Yes	Yes	Yes	Yes	3	3	Yr3	Yr3	Yr3	
Abstraction framework	Structures / Features / Components	1	No	No	No	No	Yes	0	0				
Abstraction framework	Subordinates / Specific product name	3	No	No	Yes	Yes	Yes	0	0				
Abstraction framework	Superordinates / Generic product type	2	No	No	Yes	Yes	No	0	0				
Business / Design management	Budget / Production cost / Manufacturing / Project scale	3	No	No	Yes	Yes	Yes	0	0				
Business / Design management	Business strategies / Marketing strategies	1	No	No	No	Yes	No	0	0				
Business / Design management	ODM products / Require research / Share R&D	2	No	No	No	Yes	Yes	0	0				
Business / Design management	Target customers / corporate clients	1	No	No	No	Yes	No	0	0				
Design knowledge	Arbitrary (not logical) requirements	2	No	Yes	No	No	Yes	1	1	Yr3			
Design knowledge	Design context	1	No	No	No	No	Yes	0	0				
Design knowledge	Form / Style	2	No	Yes	No	Yes	No	3	3	Yr3	Yr3	Yr3	
Design knowledge	Insufficient information for designing	1	No	No	No	No	Yes	0	0				
Design knowledge	No design requirements / No constraints	3	Yes	No	Yes	Yes	No	0	0				
Design knowledge	Open-ended (topic / problem)	3	No	No	Yes	Yes	Yes	0	0				
Design knowledge	Redesign / Existing products	3	Yes	Yes	Yes	No	No	1	1	Yr3			
Design knowledge	Require other experts in the area / Teamwork	3	No	No	Yes	Yes	Yes	0	0				
Design knowledge	Target users / Special needs / user-centered	5	Yes	Yes	Yes	Yes	Yes	4	4	Yr3	Yr3	Yr3	Yr3
Design knowledge	Technology / Technical knowledge	4	No	Yes	Yes	Yes	Yes	2	2	Yr3	Yr3		
Design knowledge	Usability / Ergonomics	2	No	No	No	Yes	yes	0	0				
Discipline	Automotive design	2	No	Yes	Yes	No	No	1	1	Yr3			
Discipline	Game design	1	No	No	No	Yes	No	0	0				
Discipline	Interface / Interaction design	3	No	Yes	Yes	Yes	No	2	2	Yr3	Yr3		
Discipline	Interior / environmental design	4	Yes	Yes	No	Yes	Yes	2	2	Yr3	Yr3		
Discipline	Mechanical / Engineering / System design	5	Yes	Yes	Yes	Yes	Yes	1	1	Yr3			
Discipline	Product / Industrial design	3	No	No	Yes	Yes	Yes	0	0				
Personal / Individual	Arbitrary sorting / Infinite ways of sorting	1	No	No	No	No	Yes	0	0				
Personal / Individual	Boring (design tasks)	1	No	No	No	No	Yes	0	0				
Personal / Individual	Design instructions to junior designers / Design commands	2	No	No	No	Yes	Yes	0	0				
Personal / Individual	Lots of design freedom / creative freedom / fun for designers / playful / many possible solutions	5	Yes	Yes	Yes	Yes	Yes	4	4	Yr3	Yr3	Yr3	Yr3
Personal / Individual	Not a design brief	1	No	No	No	No	Yes	0	0				
Personal / Individual	Straight forward tasks / Clear goals / Ready for design action	4	No	Yes	Yes	Yes	Yes	1	1	Yr3			
Personal / Individual	Vague / Not sure / No ideas / Others	4	No	Yes	Yes	Yes	Yes	2	2	Yr3	Yr3		
Personal / Individual	Working priority of tasks	2	No	No	Yes	Yes	No	0	0				
Presentation format	A short composition / Paragraph	4	Yes	No	Yes	Yes	Yes	0	0				
Presentation format	A single statement / Task statement	3	No	No	Yes	Yes	Yes	0	0				
Presentation format	Bullet point-forms	4	Yes	No	Yes	Yes	Yes	0	0				
Presentation format	Title (design task)	1	No	No	No	No	Yes	0	0				
Product category	Art-related	1	No	No	Yes	No	No	0	0				
Product category	Card game	2	Yes	No	Yes	No	No	0	0				
Product category	Chinese restaurant theme / Food / Cooking / Catering / Eating	4	No	Yes	Yes	Yes	Yes	2	2	Yr3	Yr3		
Product category	Coffee	2	No	Yes	No	Yes	No	1	1	Yr3			
Product category	Electronics / Appliances	2	Yes	Yes	No	No	No	2	2	Yr3	Yr3		
Product category	Family / Home / Everyday living / Daily uses	5	Yes	Yes	Yes	Yes	Yes	1	1	Yr3			
Product category	Fashion / Accessories	5	Yes	Yes	Yes	Yes	Yes	5	5	Yr3	Yr3	Yr3	Yr3	Yr3
Product category	Fun and games, Children products / Toy	4	Yes	Yes	Yes	Yes	No	3	3	Yr3	Yr3	Yr3	
Product category	Furniture	2	Yes	Yes	No	No	No	1	1	Yr3			
Product category	Health-related	4	Yes	Yes	Yes	Yes	No	2	2	Yr3	Yr3		
Product category	Household products / domestic products / Kitchenwares	5	Yes	Yes	Yes	Yes	Yes	3	3	Yr3	Yr3	Yr3	
Product category	Lifestyle products	1	Yes	No	No	No	No	0	0				
Product category	Luxurious products	1	Yes	No	No	No	No	0	0				
Product category	Personal uses	3	No	No	Yes	Yes	Yes	0	0				
Product category	Public / Commercial facilities	4	Yes	Yes	No	Yes	Yes	2	2	Yr3	Yr3		
Product category	Timepiece	2	Yes	No	Yes	No	No	0	0				
Product category	Wearables	5	Yes	Yes	Yes	Yes	Yes	1	1	Yr3			
		Yr1	Yr3	Prof	Mgr	Edu	Yr3	Total					
	# of sub-categories covered per expertise level	24	26	33	39	36	57	57 Total # of sub-category labels generated per expertise level					
							7.1	1.4 Average # of sub-category labels generated per subject					

Table 5.7.: Content analysis results of Yr3 subjects

very balanced except that they have an overwhelming focus on scenarios and specifications. An interesting observation seems to be that some subjects actually use presentation format to group the design briefs that seems to be against the tradition belief that presentation format is a superficial factor affecting novice designers only. These subjects attention to presentation format may be related to practice in the professional context. Each subject utilized 8.1 labels.

5.3.4. Content analysis results of Mgr subjects

Table 5.9 shows the sort results of design managers. Mgr subjects are again quite even and mainly focus on the categories related to the abstraction framework. Mgr subjects also use the business/design management categories the most when compared with other groups. Nonetheless, the personal / individual category seems to attract a lot of attention especially many subjects express vagueness and uncertainty towards some of the design briefs. The usages seem to be comparable with usages of the typical abstraction framework categories (scenarios). Mgr subjects seem to achieve the second highest average 8.6 labels across the 5 groups.

5.3.5. Content analysis results of Edu subjects

The results (table 5.10) for Edu subjects seem to be a little bit different from the evenness observed for both the Prof and Mgr subjects. A lot of spikes are observed in the chart suggesting that Edu subjects seem to be very focused or specialized. The spikes include categories related to functions, specifications, design context, target users and not a design brief. The results (functions vs. specifications, design context vs. target users, design brief vs. not a design brief) seem to suggest that Edu subjects' have either a strong discriminating power or a black/white kind of thinking. Nonetheless, Edu subjects are the only subjects to label the design tasks

		Inclusiveness of sub-category (5 = mentioned by every expertise level)					# of subjects utilizing the sub-category (8 = every subject of the expertise level)		
Main category (7)	Sub-category (59)		Yr1	Yr3	Prof	Mgr	Educ	Prof	Total
Abstraction framework	Functions / Functional requirements	4	Yes	Yes	No	Yes	Yes	0	0	
Abstraction framework	Scenarios / Problem-solving situations / Background / Introduction	5	Yes	Yes	Yes	Yes	Yes	5	5	Prof Prof Prof Prof Prof
Abstraction framework	Specifications / Specific requirements / Constraints	5	Yes	Yes	Yes	Yes	Yes	6	6	Prof Prof Prof Prof Prof Prof
Abstraction framework	Structures / Features / Components	1	No	No	No	No	Yes	0	0	
Abstraction framework	Subordinates / Specific product name	3	No	No	Yes	Yes	Yes	3	3	Prof Prof Prof
Abstraction framework	Superordinates / Generic product type	2	No	No	Yes	Yes	No	1	1	Prof
Business / Design management	Budget / Production cost / Manufacturing / Project scale	3	No	No	Yes	Yes	Yes	1	1	Prof
Business / Design management	Business strategies / Marketing strategies	1	No	No	No	Yes	No	0	0	
Business / Design management	ODM products / Require research / Share R&D	2	No	No	No	Yes	Yes	0	0	
Business / Design management	Target customers / corporate clients	1	No	No	No	Yes	No	0	0	
Design knowledge	Arbitrary (not logical) requirements	2	No	Yes	No	No	Yes	0	0	
Design knowledge	Design context	1	No	No	No	No	Yes	0	0	
Design knowledge	Form / Style	2	No	Yes	No	Yes	No	0	0	
Design knowledge	Insufficient information for designing	1	No	No	No	No	Yes	0	0	
Design knowledge	No design requirements / No constraints	5	Yes	No	Yes	Yes	No	3	3	Prof Prof Prof
Design knowledge	Open-ended (topic / problem)	3	No	No	Yes	Yes	Yes	2	2	Prof Prof
Design knowledge	Redesign / Existing products	3	Yes	Yes	Yes	No	No	1	1	Prof
Design knowledge	Require other experts in the area / Teamwork	3	No	No	Yes	Yes	Yes	3	3	Prof Prof Prof
Design knowledge	Target users / Special needs / user-centered	5	Yes	Yes	Yes	Yes	Yes	4	4	Prof Prof Prof Prof
Design knowledge	Technology / Technical knowledge	4	No	Yes	Yes	Yes	Yes	1	1	Prof
Design knowledge	Usability / Ergonomics	2	No	No	No	Yes	yes	0	0	
Discipline	Automotive design	2	No	Yes	Yes	No	No	1	1	Prof
Discipline	Game design	1	No	No	No	Yes	No	0	0	
Discipline	Interface / Interaction design	3	No	Yes	Yes	Yes	No	2	2	Prof Prof
Discipline	Interior / environmental design	4	Yes	Yes	No	Yes	Yes	3	3	Prof Prof Prof
Discipline	Mechanical / Engineering / System design	5	Yes	Yes	Yes	Yes	Yes	1	1	Prof
Discipline	Product / Industrial design	3	No	No	Yes	Yes	Yes	1	1	Prof
Personal / Individual	Arbitrary sorting / Infinite ways of sorting	1	No	No	No	No	Yes	0	0	
Personal / Individual	Boring (design tasks)	1	No	No	No	No	Yes	0	0	
Personal / Individual	Design instructions to junior designers / Design commands	2	No	No	No	Yes	Yes	0	0	
Personal / Individual	Lots of design freedom / creative freedom / fun for designers / playful / many possible solutions	5	Yes	Yes	Yes	Yes	Yes	3	3	Prof Prof Prof
Personal / Individual	Not a design brief	1	No	No	No	No	Yes	0	0	
Personal / Individual	Straight forward tasks / Clear goals / Ready for design action	4	No	Yes	Yes	Yes	Yes	1	1	Prof
Personal / Individual	Vague / Not sure / No ideas / Others	4	No	Yes	Yes	Yes	Yes	2	2	Prof Prof
Personal / Individual	Working priority of tasks	2	No	No	Yes	Yes	No	2	2	Prof Prof
Presentation format	A short composition / Paragraph	4	Yes	No	Yes	Yes	Yes	2	2	Prof Prof
Presentation format	A single statement / Task statement	3	No	No	Yes	Yes	Yes	1	1	Prof
Presentation format	Bullet point-forms	4	Yes	No	Yes	Yes	Yes	1	1	Prof
Presentation format	Title (design task)	1	No	No	No	No	Yes	0	0	
Product category	Art-related	1	No	No	Yes	No	No	1	1	Prof
Product category	Card game	2	Yes	No	Yes	No	No	1	1	Prof
Product category	Chinese restaurant theme / Food / Cooking / Catering / Eating	4	No	Yes	Yes	Yes	Yes	1	1	Prof
Product category	Coffee	2	No	Yes	No	Yes	No	0	0	
Product category	Electronics / Appliances	2	Yes	Yes	No	No	No	0	0	
Product category	Family / Home / Everyday living / Daily uses	5	Yes	Yes	Yes	Yes	Yes	3	3	Prof Prof Prof
Product category	Fashion / Accessories	5	Yes	Yes	Yes	Yes	Yes	1	1	Prof
Product category	Fun and games, Children products / Toy	4	Yes	Yes	Yes	Yes	No	1	1	Prof
Product category	Furniture	2	Yes	Yes	No	No	No	0	0	
Product category	Health-related	4	Yes	Yes	Yes	Yes	No	2	2	Prof Prof
Product category	Household products / domestic products / Kitchenwares	5	Yes	Yes	Yes	Yes	Yes	2	2	Prof Prof
Product category	Lifestyle products	1	Yes	No	No	No	No	0	0	
Product category	Luxurious products	1	Yes	No	No	No	No	0	0	
Product category	Personal uses	3	No	No	Yes	Yes	Yes	1	1	Prof
Product category	Public / Commercial facilities	4	Yes	Yes	No	Yes	Yes	0	0	
Product category	Timepiece	2	Yes	No	Yes	No	No	1	1	Prof
Product category	Wearables	5	Yes	Yes	Yes	Yes	Yes	1	1	Prof
			Yr1	Yr3	Prof	Mgr	Educ	Prof	Total	
	# of sub-categories covered per expertise level		24	26	33	39	36	65	65	Total # of sub-category labels generated per expertise level
								8.1	1.6	Average # of sub-category labels generated per subject

Table 5.8.: Content analysis results of Prof subjects

		Inclusiveness of sub-category (5 = mentioned by every expertise level)					# of subjects utilizing the sub-category (8 = every subject of the expertise level)	
Main category (7)	Sub-category (59)	Yr1	Yr3	Prof	Mgr	Edu	Mgr	Total
Abstraction framework	Functions / Functional requirements	4 Yes	Yes	No	Yes	Yes	3	3 Mgr Mgr Mgr
Abstraction framework	Scenarios / Problem-solving situations / Background / Introduction	5 Yes	Yes	Yes	Yes	Yes	4	4 Mgr Mgr Mgr Mgr
Abstraction framework	Specifications / Specific requirements / Constraints	5 Yes	Yes	Yes	Yes	Yes	2	2 Mgr Mgr
Abstraction framework	Structures / Features / Components	1 No	No	No	No	Yes	0	0
Abstraction framework	Subordinates / Specific product name	3 No	No	Yes	Yes	Yes	2	2 Mgr Mgr
Abstraction framework	Superordinates / Generic product type	2 No	No	Yes	Yes	No	1	1 Mgr
Business / Design management	Budget / Production cost / Manufacturing / Project scale	3 No	No	Yes	Yes	Yes	2	2 Mgr Mgr
Business / Design management	Business strategies / Marketing strategies	1 No	No	No	Yes	No	1	1 Mgr
Business / Design management	ODM products / Require research / Share R&D	2 No	No	No	Yes	Yes	3	3 Mgr Mgr Mgr
Business / Design management	Target customers / corporate clients	1 No	No	No	Yes	No	2	2 Mgr Mgr
Design knowledge	Arbitrary (not logical) requirements	2 No	Yes	No	No	Yes	0	0
Design knowledge	Design context	1 No	No	No	No	Yes	0	0
Design knowledge	Form / Style	2 No	Yes	No	Yes	No	1	1 Mgr
Design knowledge	Insufficient information for designing	1 No	No	No	No	Yes	0	0
Design knowledge	No design requirements / No constraints	3 Yes	No	Yes	Yes	No	1	1 Mgr
Design knowledge	Open-ended (topic / problem)	3 No	No	Yes	Yes	Yes	1	1 Mgr
Design knowledge	Redesign / Existing products	3 Yes	Yes	Yes	No	No	0	0
Design knowledge	Require other experts in the area / Teamwork	3 No	No	Yes	Yes	Yes	1	1 Mgr
Design knowledge	Target users / Special needs / user-centered	5 Yes	Yes	Yes	Yes	Yes	3	3 Mgr Mgr Mgr
Design knowledge	Technology / Technical knowledge	4 No	Yes	Yes	Yes	Yes	1	1 Mgr
Design knowledge	Usability / Ergonomics	2 No	No	No	Yes	yes	2	2 Mgr Mgr
Discipline	Automotive design	2 No	Yes	Yes	No	No	0	0
Discipline	Game design	1 No	No	No	Yes	No	2	2 Mgr Mgr
Discipline	Interface / Interaction design	3 No	Yes	Yes	Yes	No	1	1 Mgr
Discipline	Interior / environmental design	4 Yes	Yes	No	Yes	Yes	2	2 Mgr Mgr
Discipline	Mechanical / Engineering / System design	5 Yes	Yes	Yes	Yes	Yes	1	1 Mgr
Discipline	Product / Industrial design	3 No	No	Yes	Yes	Yes	1	1 Mgr
Personal / Individual	Arbitrary sorting / Infinite ways of sorting	1 No	No	No	No	Yes	0	0
Personal / Individual	Boring (design tasks)	1 No	No	No	No	Yes	0	0
Personal / Individual	Design instructions to junior designers / Design commands	2 No	No	No	Yes	Yes	2	2 Mgr Mgr
Personal / Individual	Lots of design freedom / creative freedom / fun for designers / playful / many possible solutions	5 Yes	Yes	Yes	Yes	Yes	3	3 Mgr Mgr Mgr
Personal / Individual	Not a design brief	1 No	No	No	No	Yes	0	0
Personal / Individual	Straight forward tasks / Clear goals / Ready for design action	4 No	Yes	Yes	Yes	Yes	3	3 Mgr Mgr Mgr
Personal / Individual	Vague / Not sure / No ideas / Others	4 No	Yes	Yes	Yes	Yes	4	4 Mgr Mgr Mgr Mgr
Personal / Individual	Working priority of tasks	2 No	No	Yes	Yes	No	0	0
Presentation format	A short composition / Paragraph	4 Yes	No	Yes	Yes	Yes	1	1 Mgr
Presentation format	A single statement / Task statement	3 No	No	Yes	Yes	Yes	1	1 Mgr
Presentation format	Bullet point-forms	4 Yes	No	Yes	Yes	Yes	1	1 Mgr
Presentation format	Title (design task)	1 No	No	No	No	Yes	0	0
Product category	Art-related	1 No	No	Yes	No	No	0	0
Product category	Card game	2 Yes	No	Yes	No	No	0	0
Product category	Chinese restaurant theme / Food / Cooking / Catering / Eating	4 No	Yes	Yes	Yes	Yes	2	2 Mgr Mgr
Product category	Coffee	2 No	Yes	No	Yes	No	1	1 Mgr
Product category	Electronics / Appliances	2 Yes	Yes	No	No	No	0	0
Product category	Family / Home / Everyday living / Daily uses	5 Yes	Yes	Yes	Yes	Yes	2	2 Mgr Mgr
Product category	Fashion / Accessories	5 Yes	Yes	Yes	Yes	Yes	4	4 Mgr Mgr Mgr Mgr
Product category	Fun and games, Children products / Toy	4 Yes	Yes	Yes	Yes	No	1	1 Mgr
Product category	Furniture	2 Yes	Yes	No	No	No	0	0
Product category	Health-related	4 Yes	Yes	Yes	Yes	No	2	2 Mgr Mgr
Product category	Household products / domestic products / Kitchenwares	5 Yes	Yes	Yes	Yes	Yes	2	2 Mgr Mgr
Product category	Lifestyle products	1 Yes	No	No	No	No	0	0
Product category	Luxurious products	1 Yes	No	No	No	No	0	0
Product category	Personal uses	3 No	No	Yes	Yes	Yes	1	1 Mgr
Product category	Public / Commercial facilities	4 Yes	Yes	No	Yes	Yes	1	1 Mgr
Product category	Timepiece	2 Yes	No	Yes	No	No	0	0
Product category	Wearables	5 Yes	Yes	Yes	Yes	Yes	1	1 Mgr
		Yr1	Yr3	Prof	Mgr	Edu	Mgr	Total
	# of sub-categories covered per expertise level	24	26	33	39	36	69	69 Total # of sub-category labels generated per expertise le
							8.6	1.7 Average # of sub-category labels generated per subject

Table 5.9.: Content analysis results of Mgr subjects

as boring. Edu subjects also achieve the highest score (9.0 labels) when labeling the sorted groups.

5.3.6. Content analysis results of all subjects

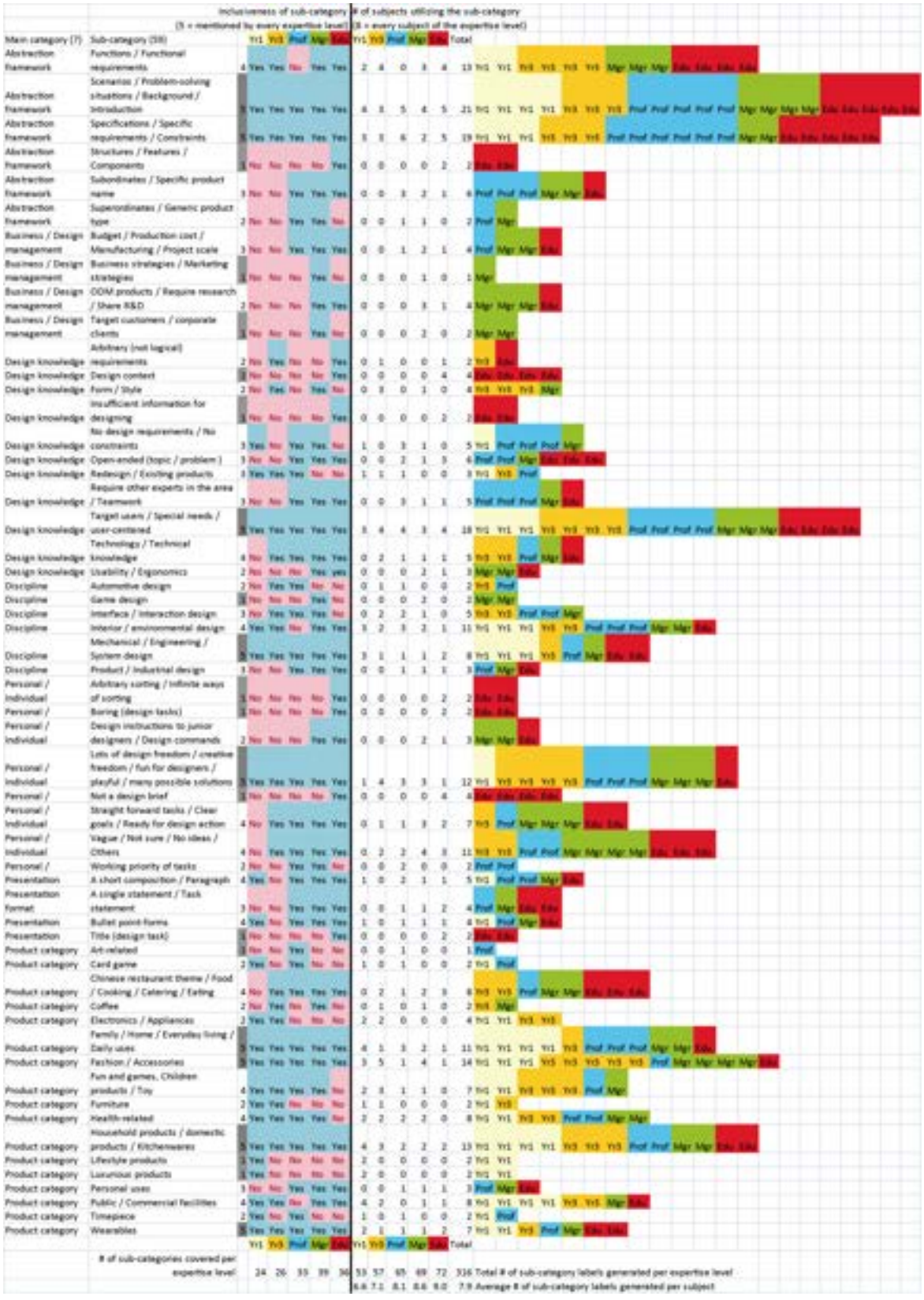
Table 5.11 shows the overall results of all the subjects. Looking at the third column, we can visually see the pattern of how design expertise influences perceptions of the same set of design briefs. At the very top, it is surprising to see that Prof subjects did not use the function category to identify their group that may be due to the elevated prototypical level associated with expertise. Since most of the design tasks that they see every day are related to functions and the criterion no longer serves the categorizing purpose. Regarding to the level of abstraction, both Prof and Mgr subjects utilize labels related to subordinates and superordinates that seem to further confirm the presence of design expertise in these subjects. The notion of structure also confirms the results from the earlier pilot study related to concreteness that it is a concept used in an academic research setting. The same is true for the design category. Category that achieves a 1 or 5 is worthy of investigation since a low number indicates a low priority in designers' perceptions while a high number indicates a high priority in perceptions with respect to a particular expertise level. Yr1 subjects (novice) do not seem to be able to recognize intrinsic vagueness in design tasks that may lead to uncertainty or frustration when they are actually given such a design task. Yr1 subjects are the only group that uses the labels of lifestyle and luxurious products that may suggest a recent lecture given in these topics. There seems to be a gradually increasing trend for the number of sub-category (broadness of perception) utilized by each expertise level peaking at the Mgr level (from Yr1 24-26-33-39 Mgr). On the individual level (concerning the average # of sub-category labels generated per subject), design educators seem to be

		Inclusiveness of sub-category (5 = mentioned by every expertise level)						# of subjects utilizing the sub-category (8 = every subject of the expertise level)		
Main category (7)	Sub-category (50)	Yr1	Yr3	Prof	Mgr	Edu	Edu	Total		
Abstraction framework	Functions / Functional requirements	4	Yes	Yes	No	Yes	Yes	4	4	Edu Edu Edu Edu
Abstraction framework	Scenarios / Problem-solving situations / Background / Introduction	5	Yes	Yes	Yes	Yes	Yes	5	5	Edu Edu Edu Edu Edu
Abstraction framework	Specifications / Specific requirements / Constraints	5	Yes	Yes	Yes	Yes	Yes	5	5	Edu Edu Edu Edu Edu
Abstraction framework	Structures / Features / Components	1	No	No	No	No	Yes	2	2	Edu Edu
Abstraction framework	Subordinates / Specific product name	3	No	No	Yes	Yes	Yes	1	1	Edu
Abstraction framework	Superordinates / Generic product type	2	No	No	Yes	Yes	No	0	0	
Business / Design management	Budget / Production cost / Manufacturing / Project scale	3	No	No	Yes	Yes	Yes	1	1	Edu
Business / Design management	Business strategies / Marketing strategies	1	No	No	No	Yes	No	0	0	
Business / Design management	ODM products / Require research / Share R&D	2	No	No	No	Yes	Yes	1	1	Edu
Business / Design management	Target customers / corporate clients	1	No	No	No	Yes	No	0	0	
Design knowledge	Arbitrary (not logical) requirements	2	No	Yes	No	No	Yes	1	1	Edu
Design knowledge	Design context	1	No	No	No	No	Yes	4	4	Edu Edu Edu Edu
Design knowledge	Form / Style	2	No	Yes	No	Yes	No	0	0	
Design knowledge	Insufficient information for designing	1	No	No	No	No	Yes	2	2	Edu Edu
Design knowledge	No design requirements / No constraints	3	Yes	No	Yes	Yes	No	0	0	
Design knowledge	Open-ended (topic / problem)	3	No	No	Yes	Yes	Yes	3	3	Edu Edu Edu
Design knowledge	Redesign / Existing products	3	Yes	Yes	Yes	No	No	0	0	
Design knowledge	Require other experts in the area / Teamwork	3	No	No	Yes	Yes	Yes	1	1	Edu
Design knowledge	Target users / Special needs / user-centered	5	Yes	Yes	Yes	Yes	Yes	4	4	Edu Edu Edu Edu
Design knowledge	Technology / Technical knowledge	4	No	Yes	Yes	Yes	Yes	1	1	Edu
Design knowledge	Usability / Ergonomics	2	No	No	No	Yes	yes	1	1	Edu
Discipline	Automotive design	2	No	Yes	Yes	No	No	0	0	
Discipline	Game design	1	No	No	No	Yes	No	0	0	
Discipline	Interface / Interaction design	3	No	Yes	Yes	Yes	No	0	0	
Discipline	Interior / environmental design	4	Yes	Yes	No	Yes	Yes	1	1	Edu
Discipline	Mechanical / Engineering / System design	5	Yes	Yes	Yes	Yes	Yes	2	2	Edu Edu
Discipline	Product / Industrial design	3	No	No	Yes	Yes	Yes	1	1	Edu
Personal / Individual	Arbitrary sorting / Infinite ways of sorting	1	No	No	No	No	Yes	2	2	Edu Edu
Personal / Individual	Boring (design tasks)	1	No	No	No	No	Yes	2	2	Edu Edu
Personal / Individual	Design instructions to junior designers / Design commands	2	No	No	No	Yes	Yes	1	1	Edu
Personal / Individual	Lots of design freedom / creative freedom / fun for designers / playful / many possible solutions	5	Yes	Yes	Yes	Yes	Yes	1	1	Edu
Personal / Individual	Not a design brief	1	No	No	No	No	Yes	4	4	Edu Edu Edu Edu
Personal / Individual	Straight forward tasks / Clear goals / Ready for design action	4	No	Yes	Yes	Yes	Yes	2	2	Edu Edu
Personal / Individual	Vague / Not sure / No ideas / Others	4	No	Yes	Yes	Yes	Yes	3	3	Edu Edu Edu
Personal / Individual	Working priority of tasks	2	No	No	Yes	Yes	No	0	0	
Presentation format	A short composition / Paragraph	4	Yes	No	Yes	Yes	Yes	1	1	Edu
Presentation format	A single statement / Task statement	3	No	No	Yes	Yes	Yes	2	2	Edu Edu
Presentation format	Bullet point-forms	4	Yes	No	Yes	Yes	Yes	1	1	Edu
Presentation format	Title (design task)	1	No	No	No	No	Yes	2	2	Edu Edu
Product category	Art-related	1	No	No	Yes	No	No	0	0	
Product category	Card game	2	Yes	No	Yes	No	No	0	0	
Product category	Chinese restaurant theme / Food / Cooking / Catering / Eating	4	No	Yes	Yes	Yes	Yes	3	3	Edu Edu Edu
Product category	Coffee	2	No	Yes	No	Yes	No	0	0	
Product category	Electronics / Appliances	2	Yes	Yes	No	No	No	0	0	
Product category	Family / Home / Everyday living / Daily uses	5	Yes	Yes	Yes	Yes	Yes	1	1	Edu
Product category	Fashion / Accessories	5	Yes	Yes	Yes	Yes	Yes	1	1	Edu
Product category	Fun and games, Children products / Toy	4	Yes	Yes	Yes	Yes	No	0	0	
Product category	Furniture	2	Yes	Yes	No	No	No	0	0	
Product category	Health-related	4	Yes	Yes	Yes	Yes	No	0	0	
Product category	Household products / domestic products / Kitchenwares	5	Yes	Yes	Yes	Yes	Yes	2	2	Edu Edu
Product category	Lifestyle products	1	Yes	No	No	No	No	0	0	
Product category	Luxurious products	1	Yes	No	No	No	No	0	0	
Product category	Personal uses	3	No	No	Yes	Yes	Yes	1	1	Edu
Product category	Public / Commercial facilities	4	Yes	Yes	No	Yes	Yes	1	1	Edu
Product category	Timepiece	2	Yes	No	Yes	No	No	0	0	
Product category	Wearables	5	Yes	Yes	Yes	Yes	Yes	2	2	Edu Edu
		Yr1	Yr3	Prof	Mgr	Edu	Edu	Total		
	# of sub-categories covered per expertise level	24	26	33	39	36	72	72	Total # of sub-category labels generated per expertise level	
								9.0	1.8 Average # of sub-category labels generated per subject	

Table 5.10.: Content analysis results of Edu subjects

slightly better than design managers. Another way of presenting the same data is to plot the percentage of labels extracted from the sort results to the 7 main categories with respect to each expertise level. Table 5.12 is calculated by summing all the sub-category labels within a main category and then divided by the total number of labels. For instance, based on all Yr1 subjects sort results, 9 labels related to the abstraction framework were extracted and the total number of labels extracted from all Yr1 sort results was equal to 53. On average, Yr1 subjects spent roughly 17%, (9/53*100%=17%) of their efforts or attention on concepts related to the abstraction framework when sorting the given design briefs. Figure 5.12 suggests that Yr1 and Yr3 subjects are mostly concerned with a product category (57% and 40% respectively) when sorting the cards and other categories cannot compete with this dominant perception. In contrast, Prof subjects extremely focus on (68% of the labels) areas including the abstraction framework, design knowledge and product category. These aspects are often considered to be a core set of design domain knowledge. Design Mgr subjects' perceptions are very balanced when compared to other subjects' perceptions except that some of the Mgr subjects' attention have been shifted to business and manufacturing-related issues. Design Edu subjects' perceptions tend to be more abstract and they paid more attention to the personal and individual factor instead of the product category factor.

Two trends seem to emerge from the overall results (figure 5.2). The first trend is the drastic drop of attention in the product category factor with increasing expertise when subjects labelled their sort results. The result probably can be explained by the recognition and development of more abstract design principles in subjects' perceptions with additional design trainings. Even though the product category factor seems to influence all the subjects, novice designers (Yr1 and Yr3 subjects) seem to be affected by this factor the most. According to the abstraction



Main category (7)	Sub-category (38)	Inclusiveness of sub-category (3 = mentioned by every expertise level)					# of subjects utilizing the sub-category (3 = every subject of the expertise level)					
		Yr1	Yr3	Prof	Mgr	Edu	Yr1	Yr3	Prof	Mgr	Edu	Total
Abstraction framework	Functions / Functional requirements	Yes	Yes	No	Yes	Yes	2	4	0	3	4	13
Abstraction framework	Scenarios / Problem-solving situations / Background / Introduction	Yes	Yes	Yes	Yes	Yes	4	3	5	4	5	21
Abstraction framework	Specifications / Specific requirements / Constraints	Yes	Yes	Yes	Yes	Yes	3	3	6	2	5	19
Abstraction framework	Structures / Features / Components	No	No	No	No	Yes	0	0	0	0	2	2
Abstraction framework	Subordinates / Specific product name	No	No	Yes	Yes	Yes	0	0	3	2	1	6
Abstraction framework	Superordinates / Generic product type	No	No	Yes	Yes	No	0	0	1	1	0	2
Business / Design management	Budget / Production cost / Manufacturing / Project scale	No	No	Yes	Yes	Yes	0	0	1	2	1	4
Business / Design management	Business strategies / Marketing strategies	No	No	No	Yes	No	0	0	0	1	0	1
Business / Design management	ODM products / Require research / Share R&D	No	No	No	Yes	Yes	0	0	0	3	1	4
Business / Design management	Target customers / corporate clients	No	No	No	Yes	No	0	0	0	2	0	2
Design knowledge	Arbitrary (not logical) requirements	No	Yes	No	No	Yes	0	1	0	0	1	2
Design knowledge	Design context	No	No	No	No	Yes	0	0	0	0	4	4
Design knowledge	Form / Style	No	Yes	No	Yes	No	0	3	0	1	0	4
Design knowledge	Insufficient information for designing	No	No	No	No	Yes	0	0	0	0	2	2
Design knowledge	No design requirements / No constraints	Yes	No	Yes	Yes	No	1	0	3	1	0	5
Design knowledge	Open-ended (topic / problem)	No	No	Yes	Yes	Yes	0	0	2	1	3	6
Design knowledge	Redesign / Existing products	Yes	Yes	Yes	No	No	1	1	1	0	0	3
Design knowledge	Require other experts in the area / Teamwork	No	No	Yes	Yes	Yes	0	0	3	1	1	5
Design knowledge	Target users / Special needs / user-centered	Yes	Yes	Yes	Yes	Yes	3	4	4	3	4	18
Design knowledge	Technology / Technical knowledge	No	Yes	Yes	Yes	Yes	0	2	1	1	1	5
Design knowledge	Usability / Ergonomics	No	No	No	Yes	yes	0	0	0	2	1	3
Discipline	Automotive design	No	Yes	Yes	No	No	0	1	1	0	0	2
Discipline	Game design	No	No	No	Yes	No	0	0	0	2	0	2
Discipline	Interface / Interaction design	No	Yes	Yes	Yes	No	0	2	2	1	0	5
Discipline	Interior / environmental design	Yes	Yes	No	Yes	Yes	3	2	3	2	1	11
Discipline	Mechanical / Engineering / System design	Yes	Yes	Yes	Yes	Yes	3	1	1	1	2	8
Discipline	Product / Industrial design	No	No	Yes	Yes	Yes	0	0	1	1	1	3
Personal / Individual	Arbitrary sorting / Infinite ways of sorting	No	No	No	No	Yes	0	0	0	0	2	2
Personal / Individual	Boring (design tasks)	No	No	No	No	Yes	0	0	0	0	2	2
Personal / Individual	Design instructions to junior designers / Design commands	No	No	No	Yes	Yes	0	0	0	2	1	3
Personal / Individual	Lots of design freedom / creative freedom / fun for designers / playful / many possible solutions	Yes	Yes	Yes	Yes	Yes	1	4	3	3	1	12
Personal / Individual	Not a design brief	No	No	No	No	Yes	0	0	0	0	4	4
Personal / Individual	Straight forward tasks / Clear goals / Ready for design action	No	Yes	Yes	Yes	Yes	0	1	1	3	2	7
Personal / Individual	Vague / Not sure / No ideas / Others	No	Yes	Yes	Yes	Yes	0	2	2	4	3	11
Personal / Individual	Working priority of tasks	No	No	Yes	Yes	No	0	0	2	0	0	2
Presentation	A short composition / Paragraph	No	Yes	Yes	Yes	Yes	1	0	2	1	1	5
Presentation format	A single statement / Task statement	No	No	Yes	Yes	Yes	0	0	1	1	2	4
Presentation	Bullet point forms	Yes	No	Yes	Yes	Yes	1	0	1	1	1	4
Presentation	Title (design task)	No	No	No	No	Yes	0	0	0	0	2	2
Product category	Art-related	No	No	Yes	No	No	0	0	1	0	0	1
Product category	Card game	Yes	No	Yes	No	No	1	0	1	0	0	2
Product category	Chinese restaurant theme / Food / Cooking / Catering / Eating	No	Yes	Yes	Yes	Yes	0	2	1	2	3	8
Product category	Coffee	No	Yes	No	Yes	No	0	1	0	1	0	2
Product category	Electronics / Appliances	Yes	Yes	No	No	No	2	2	0	0	0	4
Product category	Family / Home / Everyday living / Daily uses	Yes	Yes	Yes	Yes	Yes	4	1	3	2	1	11
Product category	Fashion / Accessories	Yes	Yes	Yes	Yes	Yes	3	5	1	4	1	14
Product category	Fun and games, Children products / Toy	Yes	Yes	Yes	Yes	No	2	3	1	1	0	7
Product category	Furniture	Yes	Yes	No	No	No	1	1	0	0	0	2
Product category	Health-related	Yes	Yes	Yes	Yes	No	2	2	2	2	0	8
Product category	Household products / domestic products / Kitchenwares	Yes	Yes	Yes	Yes	Yes	4	3	2	2	2	13
Product category	Lifestyle products	Yes	No	No	No	No	2	0	0	0	0	2
Product category	Luxurious products	Yes	No	No	No	No	2	0	0	0	0	2
Product category	Personal uses	No	No	Yes	Yes	Yes	0	0	1	1	1	3
Product category	Public / Commercial facilities	Yes	Yes	No	Yes	Yes	4	2	0	1	1	8
Product category	Timepiece	Yes	No	Yes	No	No	1	0	1	0	0	2
Product category	Wearables	Yes	Yes	Yes	Yes	Yes	2	1	1	1	2	7
		Yr1	Yr3	Prof	Mgr	Edu	Yr1	Yr3	Prof	Mgr	Edu	Total
	# of sub-categories covered per expertise level	24	26	33	33	36	53	57	65	69	72	316 Total # of sub-category labels generated per expertise level
							6.6	7.1	8.1	8.6	9.0	7.9 Average # of sub-category labels generated per subject

Table 5.11.: Content analysis results of all subjects

Main category	Yr1 Avg. (%)	Yr3 Avg. (%)	Prof Avg. (%)	Mgr Avg. (%)	Edu Avg. (%)
Abstraction framework	17.0	17.5	23.1	17.4	23.6
Business / management	0.0	0.0	1.5	11.6	2.8
Design knowledge	9.4	19.3	21.5	14.5	23.6
Discipline	11.3	10.5	12.3	10.1	5.6
Personal / Individual	1.9	12.3	12.3	17.4	20.8
Presentation format	3.8	0.0	6.2	4.3	8.3
Product category	56.6	40.4	23.1	24.6	15.3

Table 5.12.: Percentages of the 7 main categories with respect to expertise

framework, one approach of promoting innovative concepts in design briefs is to avoid or delay designers' initial fixations about a product type. The result suggests that the approach should be effective for novice designers (Yr1 and Yr3 subjects) by preventing their initial recognition and adoption of an established product boundary. Nonetheless, the approach may be less effective for more experienced designers whose perceptions seem to be influenced by other factors. The other trend is a gradual increase of subjects' attentions to the personal and individual factor with increasing expertise. Sub-categories of the personal and individual factor are listed in table 5.13. These sub-categories seem to be related to subjective perceptions related to the design briefs. Since the abstraction framework seems to have little information accounting for these factors in designers' perceptions, it is necessary to further investigate how these subjective perceptions are related to the descriptive information presented on the design briefs and how these subjective factors are tied in with designers' perceptions. The next section aims to investigate the trend in detail. Based on correlation analysis of subjects' sort results, I aim to investigate which design brief formulations seem to promote more diverse interpretations that are crucial for promoting innovative design concepts. Based on comparing and contrasting subjects' card-sorting sessions for each expertise level, I aim to relate how objective information presented on the design briefs affects

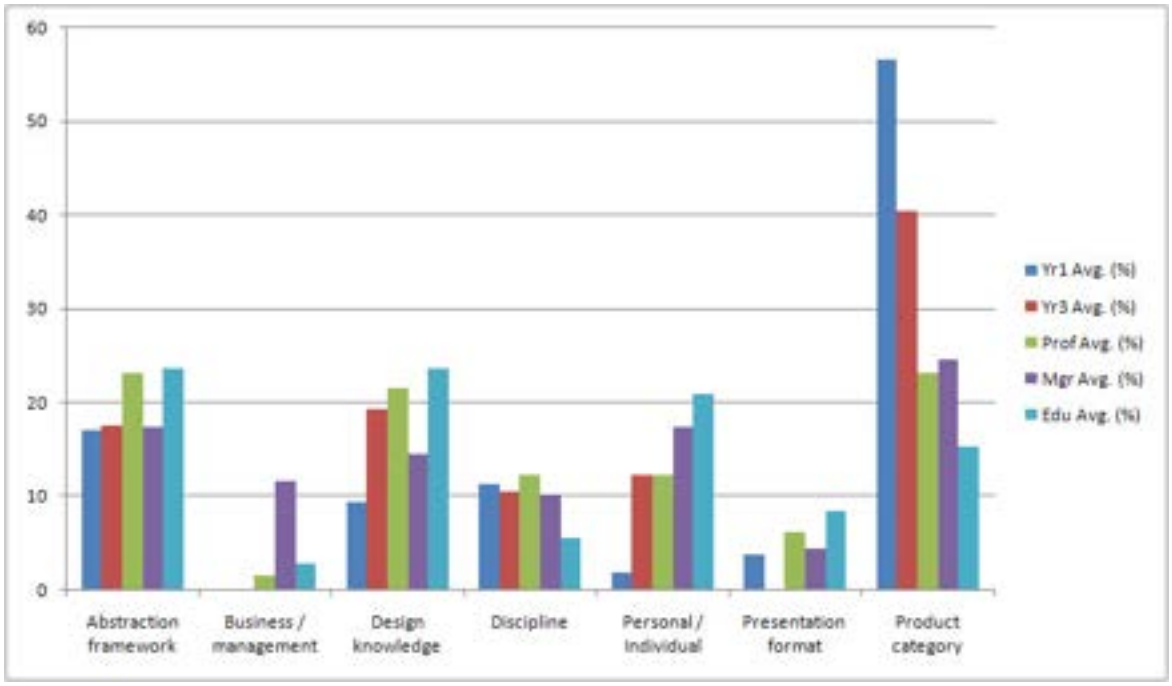


Figure 5.2.: Distributions of the 7 main categories with respect to expertise

subjects' subjective perceptions. The detailed discussion can reveal crucial aspects affecting designers' perceptions.

5.4. Correlation analysis of the card-sorting results

The previous analysis focuses on understanding the sort results from designers' subjective perspectives and utilizes only the group names and rationales related to the sort results. The correlation analysis is a more conventional procedure to investigate card-sort results that takes into account actual groupings of individual design briefs and calculates the agreement among different subjects. For instance, if 8 subjects all group a design brief (e.g. To design a dress shirt) under the fashion/accessories group, the design brief achieves a high agreement (100%) among subjects. The correlation analysis can distinguish between design briefs that seem to promote a similar perception to all subjects and design briefs that

Main category	Sub-category
Personal / Individual	Arbitrary sorting / Infinite ways of sorting
Personal / Individual	Boring (design tasks)
Personal / Individual	Design instructions to junior designers / Design commands
Personal / Individual	Lots of design freedom / creative freedom / fun for designers / playful / many possible solutions
Personal / Individual	Not a design brief
Personal / Individual	Straight forward tasks / Clear goals / Ready for design action
Personal / Individual	Vague / Not sure / No ideas / Others
Personal / Individual	Working priority of tasks

Table 5.13.: Sub-categories of the personal and individual factor

are likely to generate different perceptions to different subjects. The results can show how objective elements in design briefs interact with subjects' subjective perceptions across different expertise levels. The correlation analysis assumes that design brief perceptions from 8 subjects can be concatenated and averaged to represent a typical designer perception at a particular level of design expertise. Nonetheless, the correlation analysis is more elaborated but also more restrictive requiring all subjects' group names to be standardized. Subjects' group names were standardized based on the 56 sub-categories from the previous analysis. A correlation template designed by Spencer (2009) is used for consolidating the results. Since a subject group name may belong to multiple sub-categories, the sub-category that can uniquely identify the group is selected. For instance, if a group is called household products and functions while another group is called public facilities with functions, the groups are standardized into the household products sub-category and the public facilities sub-category respectively. In order to complement for the lack of details of correlation analysis, a typical card-sorting session for each expertise level is discussed comparing and contrasting sorting sessions from subjects of the same expertise level. The results are used to construct

#	Card name	Abstraction framework	Business / management	Design knowledge	Discipline	Personal / Individual	Presentation format	Product category	Categories for this card
1	Coffee maker, specifications, point	13%	0%	13%	13%	0%	13%	50%	5
2	Margarine storage device, functions, point	13%	0%	13%	25%	0%	13%	38%	5
3	Beverage vending machine, structures, composition	13%	0%	25%	38%	0%	13%	13%	5
4	Window cleaner, specifications, composition	0%	0%	25%	0%	0%	13%	63%	3
5	Garden chair, structures, point	13%	0%	13%	0%	0%	13%	63%	4
6	Coin-operated payphone, subordinate, single	0%	0%	13%	13%	13%	13%	50%	5
7	Bedside lamp, scenarios, single	0%	0%	25%	0%	0%	0%	75%	2
8	Diamond watch, subordinate, single	0%	0%	0%	0%	13%	13%	75%	3
9	Revolving door, subordinate, single	0%	0%	0%	25%	13%	13%	50%	4
10	Card game, functions, composition	13%	0%	0%	0%	0%	13%	75%	3
11	Footwear, superordinate, single	0%	0%	0%	0%	13%	13%	75%	3
12	Coffee mug, scenarios, composition	38%	0%	13%	0%	0%	0%	50%	3
13	Ventilation system, functions, single	0%	0%	13%	38%	0%	0%	50%	3
14	Food preparation area, functions, point	0%	0%	0%	38%	0%	13%	50%	3
15	Dashboard, specifications, point	0%	0%	13%	25%	0%	13%	50%	4
16	Clothing, superordinate, single	0%	0%	0%	0%	13%	13%	75%	3
17	Trash can, scenarios, composition	50%	0%	13%	0%	0%	0%	38%	3
18	Can opener, specifications, point	13%	0%	25%	13%	0%	13%	38%	5
19	Sofa set, scenarios, composition	50%	0%	25%	0%	0%	0%	25%	3
20	Time-telling device, functions, single	0%	0%	13%	13%	0%	13%	63%	4
21	Heart rate monitor, specifications, composition	0%	0%	13%	25%	0%	13%	50%	4
22	Dress shirt, subordinate, single	0%	0%	0%	0%	13%	13%	75%	3
23	Flower vase, structures, point	0%	0%	13%	0%	0%	13%	75%	3
24	Office ladies shoes, scenarios, composition	50%	0%	25%	0%	0%	0%	25%	3
	Cards in this category	10	0	17	11	6	18	24	

Table 5.14.: Correlation results of Yr1 subjects

a simplified model of design brief perceptions for each expertise level as a tentative framework for design brief reception.

5.4.1. Correlation results of Yr1 subjects

Table 5.14 presents the percentages of agreement ($\leq$25% low, medium, $\geq$75% high) between individual design briefs and the main categories selected by subjects. The left column represents the 24 design briefs used in the card-sorting exercise and the top row represents the 7 main categories that are the results of combining the smaller sub-categories for concise presentation. The design brief agreement is calculated by the number of Yr1 subjects who grouped a design brief under

a particular category divided by the total number of subjects. Since there are 8 subjects for each expertise level, 75% agreement is equal to 6 subjects grouping a design brief under the same main category. For instance, the no. 1 coffee maker design brief was grouped based on the notion of a product category by 4 out of 8 Yr1 subjects (50%). The rest of the Yr1 subjects selected to group the design brief under the 4 other main categories. Many high and medium agreements are observed from the product category factor even though design briefs may use different kinds of formulations. Most subjects seem to utilize a sorting principle based on established product categories and neglected other information presented on the design briefs. Design briefs (no.12, 17, 19, 24) based on scenario formulations are exceptions that seem to be identified as relating to problem-solving by many subjects. Yr1 subjects seem to be unaware of other design brief formulations related to the abstraction framework while they were able to classify design briefs and identify potential design requirements based on the design knowledge factor. Besides the high agreements in the product category factor, Yr1 subjects seem to disagree with many different design briefs (no.1, 2, 3, 6, 18) since a design brief was considered by 8 subjects to be grouped into 5 different main categories (last column of table). The results may imply a subject's fragmented organization of design knowledge. Subjects' sorting principles may be opportunistic depending on the element that caught a subject's attention at a particular moment. In addition, 18 design briefs were grouped by the presentation format factor suggesting Yr1 subjects may be strongly affected by format. Yr1 subjects seem to have a flat perception mainly focusing on the product category factor. When this sorting principle is insufficient or not applicable, they may rely on their limited domain knowledge and clues given on design briefs including presentation format. As a result, presentation format influences how subjects percept and identity potential

design requirements. The next section discusses all Yr1 subjects' sorting sessions providing a finer image to complement the results of correlation analysis in order to assist the construction of simplified models of design brief perception.

Discussions of Yr1 subjects' sorting sessions

The verbal protocols and the sort results suggest that all eight novice designers (Yr1 subjects) behaved quite similarly which may be due to the fact that most of the Yr1 subjects were female. My first observation is that all eight subjects seem to start the sorting session based on a common sense approach. They were attracted firstly by the application areas of the artifacts. The group names (e.g. home use, kitchen, and household) are common in their 1st sort results. The subjects then attended to areas including design disciplines (e.g. engineering, interior design), problem-solving situations and finally design requirements of the artifact. Application areas and design requirements of the artifact both seem to compete for novice designers' attentions. However, application areas of the artifact seem to be the primary concern during their 1st sort.

Subjects' understandings of the design briefs appear to change with time since subjects discovered additional information in successive sorts and made refinements to the sort results accordingly. An interesting observation is that many subjects did not stop exploring possibilities after obtaining their initial results. Not only were the subjects not satisfied with arriving at the same sort results but the subjects were eager to use completely different approaches to re-sort the given briefs. This observation is unexpected because card-sorting exercises in other domains often report stable sort results within the first two sorts even for novice subjects. This explorative nature could be a characteristic of novice designers or is due to design trainings that promote inspecting objects from multiple perspectives.

In addition, design requirements and the amount of information provided on the cards often became a guiding principle in these subsequent explorations. The reasons for novice subjects to place design requirements as secondary can be twofold. Novice designers may not be sensitive to the different kinds of design requirements. Subjects seemed to revert to more general strategies based on common sense to prioritize the cards initially based on application areas of the artifact and design disciplines. The common sense strategy would be a reasonable choice when the subjects do not perceive themselves as successful or efficient in using their newly acquired domain-specific design knowledge. Subjects also seem to have many competing priorities in their knowledge structures leading them to produce multiple sort results. Besides application areas (product categories) and design disciplines, problem-solving situations seem to be a recognizable form of design brief formulations identified by novice designers. These problem-solving situations are formulated based on user-focused scenarios of the abstraction framework. This is the only formulation initially perceived by novice designers.

An unexpected observation is that two subjects included some forms of ordering principles based on personal and individual factors. Yr1-A ordered the design briefs according to her personal preferences explaining how she would prefer to work on certain design briefs that were considered more interesting while avoiding the more ”boring” briefs. Yr1-C also expressed similar affective preferences by labelling design briefs that she considered ”boring” and ”annoying” based on the perceived amount of design freedom given by the design briefs. The conative factor is related to how Yr1-A would select to work on design briefs corresponding to her own strengths. These evoked responses seem to constitute a natural and integral part of the subjects’ perceptions of design briefs. The effects of these non-cognitive factors on design brief formulations should be further discussed together with sort

#	Card name	Abstraction framework	Business / management	Design knowledge	Discipline	Personal / Individual	Presentation format	Product category	Categories for this card
1	Coffee maker, specifications, point	50%	0%	13%	0%	0%	0%	38%	3
2	Margarine storage device, functions, point	50%	0%	13%	0%	0%	0%	38%	3
3	Beverage vending machine, structures, composition	25%	0%	25%	13%	0%	0%	25%	4
4	Window cleaner, specifications, composition	38%	0%	25%	0%	13%	0%	25%	4
5	Garden chair, structures, point	25%	0%	25%	0%	13%	0%	38%	4
6	Coin-operated payphone, subordinate, single	0%	0%	38%	13%	13%	0%	25%	4
7	Bedside lamp, scenarios, single	25%	0%	13%	0%	0%	13%	50%	4
8	Diamond watch, subordinate, single	0%	0%	0%	0%	25%	0%	75%	2
9	Revolving door, subordinate, single	0%	0%	38%	13%	13%	0%	25%	4
10	Card game, functions, composition	25%	0%	25%	0%	25%	0%	25%	4
11	Footwear, superordinate, single	0%	0%	0%	0%	25%	0%	75%	2
12	Coffee mug, scenarios, composition	38%	0%	13%	0%	13%	0%	38%	4
13	Ventilation system, functions, single	0%	0%	13%	13%	25%	0%	38%	4
14	Food preparation area, functions, point	0%	0%	25%	25%	13%	0%	38%	4
15	Dashboard, specifications, point	50%	0%	13%	25%	0%	0%	13%	4
16	Clothing, superordinate, single	0%	0%	0%	0%	25%	0%	75%	2
17	Trash can, scenarios, composition	25%	0%	25%	13%	0%	0%	25%	4
18	Can opener, specifications, point	50%	0%	13%	0%	0%	0%	38%	3
19	Sofa set, scenarios, composition	50%	0%	0%	0%	25%	0%	25%	3
20	Time-telling device, functions, single	0%	0%	25%	0%	38%	0%	38%	3
21	Heart rate monitor, specifications, composition	25%	0%	25%	13%	0%	0%	38%	4
22	Dress shirt, subordinate, single	0%	0%	0%	0%	25%	0%	75%	2
23	Flower vase, structures, point	25%	0%	38%	0%	0%	0%	38%	3
24	Office ladies shoes, scenarios, composition	38%	0%	0%	0%	13%	0%	50%	3
	Cards in this category	15	0	18	8	15	1	24	

Table 5.15.: Correlation results of Yr3 subjects

results of other subjects. Final sort results of all Yr1 subjects are listed in appendix F.

5.4.2. Correlation results of Yr3 subjects

Table 5.15 presents the correlation analysis of all Yr3 subjects. The results show a clear shift to the abstraction framework suggesting Yr3 subjects began to percept design briefs from more abstract design principles. In addition to scenario formulations, Yr3 subjects also attended to specification formulations (design briefs no.1, 4, 15, 18). Design briefs formulated by the abstraction framework seem to match with Yr3 subjects' perceptions suggesting that potential design

requirements were recognized by many Yr3 subjects. Design knowledge and personal/individual factor become more important criteria than design discipline. Design briefs (no.8, 11, 13, 16, 20, 22) formulated by a single statement seem to evolve more individual and personal judgements. Different perceptions can be evolved from the same design brief to different subjects. Some subjects might percept a boring design brief or a straightforward design task while other subjects may see a lot of design freedom or vagueness inherent in a design brief. A potential reason might be that designers need to provide more assumptions when there is not much information given by a design brief. Nonetheless, the pattern of how design brief formulations interact with the personal and individual factor is not clear yet. The next section on Yr3 subjects' sorting sessions may shed light on the issue. The effect of presentation format also seems to diminish (from 18 to 1) while many design briefs (no.8, 11, 16, 22) formulated in a single statement remained to be grouped by the product category factor. Yr3 subjects' perceptions also seem to be more uniform than Yr1 subjects' perceptions since all design briefs were grouped into 4 or less main categories (last column).

Discussions of Yr3 subjects' sorting sessions

One major difference from Yr1 subjects was that application areas of the artifacts played a secondary role in all Yr3 students. Yr3 students seemed to employ design requirements or design strategies as their initial sorting principle. They were able to differentiate among different kinds of design requirements especially for functional versus structural and stylistic requirements which were reflected by the Abstraction Hierarchy (AH) of the framework. When Yr3 students were ready to label the sorted groups, the group names were more descriptive and contained multiple complementary identifiers. For instance, a group was called, home

situations-functional requirements. Both identifiers co-existed in the same group. In addition, the rationales for grouping were hierarchical and could be organized into several essential points. In contrast to Yr1 students, they usually utilized one identifier at a time or had to make a choice when competing identifiers were deemed appropriate for the group. The results suggested that Yr3 students were more experienced in prioritizing and organizing design concepts and requirements than Yr1 students.

Moreover, Yr3 students often associated various potential design strategies and design directions for each group of tasks unlike Yr1 students who seemed to employ one general strategy towards all the presented design tasks. This observation of employing different strategies towards different categories of design tasks seemed to agree with the assumption that perceived distinctions (or the abilities to differentiate) were crucial in determining subjects' subsequent behaviour and design strategies towards design tasks. Similar observations were reported in the study of sorting physics problems (Chi et al., 1981). Subjects needed to be capable of perceiving differences in tasks in order to employ different strategies. If no distinctions could be perceived when sorting the cards, a subject was likely to employ the same design strategy to tackle design tasks within the same group.

The personal and individual factor also seems to become more influential for Yr3 subjects. Subject Yr3-C used his personal interest explicitly to sort out design briefs that were considered boring while three additional Yr3 subjects also revealed personal and individual perceptions relating to design briefs in their interviews.

> *[Yr3-F: If the title is interesting, many ideas and initial concepts will pop up immediately. //I7:37]*
>
> *[Yr3-G: It is more interesting for the designers if you have an interesting topic and inspire more creativity of the designers. //I18:24*

[Yr3-G: In my opinion, without a brief, any design tasks can become very boring, you are only drawing sketches over and over, years after years. //I16:44]

[Yr3-H: I trend to mis-interpret a boring project. It is not intentional. If it is a boring project, I tend to add my own opinions into the project which may contain elements that the client does not agree. Then, it may become a mis-interpretation of a brief. //I20:55]

Even though I did not intend to measure subjects' motivations in this study, Yr3-H consistently displayed the notion of interest when discussing design briefs. The notion of interest was one of the four independent factors used in the quantitative model (QCM, Questionnaire of Current Motivation models motivation by four factors including challenge, confidence in success, fear of failure and interest (Vollmeyer & Rheinberg, 1998) to assess motivation. One of the questionnaire items used to assess interest was whether the subject would work on the design tasks in his free time. The protocols suggested that Yr3-H showed strong interests towards those design tasks that he perceived as redesign projects since he would keep them in mind wherever he goes.

[Yr3-H: I can start a new file on these redesign projects and work on these products even on the street, and work on the product from time to time. //I2:04]

Yr3-H displayed his preferences and said that he already found several projects that interested him in the card-sorting exercises. This observation seemed to coincide with design educators' understanding of conative factors that affect design students' performance (section 3.3.4). However, it was unclear what kinds of design brief formulations affected subjects' interests, motivation and thus design performance. Could it be merely based on individual preferences? The next section shows that the influence of the personal and individual factor seems to

#	Card name	Abstraction framework	Business / management	Design knowledge	Discipline	Personal / Individual	Presentation format	Product category	Categories for this card
1	Coffee maker, specifications, point	38%	13%	0%	13%	13%	0%	25%	5
2	Margarine storage device, functions, point	50%	13%	0%	13%	13%	0%	13%	5
3	Beverage vending machine, structures, composition	38%	0%	13%	25%	0%	0%	25%	4
4	Window cleaner, specifications, composition	50%	0%	13%	13%	0%	0%	25%	4
5	Garden chair, structures, point	25%	13%	13%	13%	13%	0%	25%	6
6	Coin-operated payphone, subordinate, single	0%	0%	25%	13%	50%	0%	13%	4
7	Bedside lamp, scenarios, single	38%	0%	38%	0%	0%	0%	25%	3
8	Diamond watch, subordinate, single	0%	0%	25%	0%	50%	0%	25%	3
9	Revolving door, subordinate, single	0%	0%	25%	25%	50%	0%	0%	3
10	Card game, functions, composition	13%	0%	38%	0%	0%	0%	50%	3
11	Footwear, superordinate, single	13%	0%	25%	0%	38%	0%	25%	4
12	Coffee mug, scenarios, composition	50%	0%	25%	13%	0%	0%	13%	4
13	Ventilation system, functions, single	0%	0%	25%	13%	50%	0%	13%	4
14	Food preparation area, functions, point	25%	0%	0%	38%	13%	0%	25%	4
15	Dashboard, specifications, point	25%	0%	0%	50%	13%	0%	13%	4
16	Clothing, superordinate, single	13%	0%	25%	0%	38%	0%	25%	4
17	Trash can, scenarios, composition	63%	0%	13%	25%	0%	0%	0%	3
18	Can opener, specifications, point	38%	13%	0%	13%	13%	0%	25%	5
19	Sofa set, scenarios, composition	63%	0%	25%	0%	0%	0%	13%	3
20	Time-telling device, functions, single	13%	0%	25%	0%	38%	0%	25%	4
21	Heart rate monitor, specifications, composition	25%	0%	13%	13%	13%	0%	38%	5
22	Dress shirt, subordinate, single	0%	0%	25%	0%	50%	0%	25%	3
23	Flower vase, structures, point	25%	13%	0%	13%	13%	0%	38%	5
24	Office ladies shoes, scenarios, composition	63%	0%	13%	0%	0%	0%	25%	3
	Cards in this category	19	5	18	15	16	0	22	

Table 5.16.: Correlation results of Prof subjects

become even more dominant in Prof subjects. The conative factor of design brief perceptions is further discussed with other cases in section 5.8.

5.4.3. Correlation results of Prof subjects

Table 5.16 presents the correlation analysis of all Prof subjects. The results suggest that the product category factor becomes less dominant with Prof subjects since only 2 or 3 subjects utilized the category to group design briefs. The abstraction framework category and the design knowledge category received much more attention while most scenario formulations were perceived to be related to problem-solving situations. Function and specification formulations were also

clearly identified by subjects. Following the trend from Yr1 to Yr3 correlation analysis, the personal and individual factor was used increasingly to analyze design briefs (no.6, 8, 9, 13, 22) formulated in a single statement. Three common perceptions with these single statement design briefs were noted including a lot of design freedom, clear design goals, and vagueness of briefs. Nonetheless, two trends seem to be reversed. The first one is subjects' attention to the design discipline category. It seems that Prof subjects recognized the need to collaborate with experts from other fields in order to tackle certain design briefs. The second trend is subjects' perceptions seem to become more diverse again (last column). For instance, the garden chair brief (no.5) was grouped into 6 different categories by 8 subjects. These two trends may be the result of subjects assuming a practitioner's role in the professional context. Prof subjects' perceptions seem to be quite balanced and distinctive suggesting that they are able to cater for different needs arisen from various design brief formulations.

Discussions of Prof subjects' sorting sessions

Compared to Yr1 and Yr3 cases, sort results for the professional cases seemed to be more diverse. The transition form Yr1 cases to Yr3 cases was incremental and continuous with the additional of domain-specific knowledge and development of design strategies. Some Yr3 subjects were able to evaluate design tasks from multiple perspectives and to incorporate business and marketing considerations in their sort results. The transition from Yr3 cases to professional cases was more abrupt and more multi-facetted. Professional subjects seemed to develop their own unique characteristics based on immediate needs from their practice. Even though professional subjects did not seem to pay much attention to design requirements, the sorting principles of Prof-A, Prof-B, Prof-E, Prof-F and Prof-H were all related

to the amount of design freedom perceived in design briefs and their working priority in practice. Prof-C and Prof-G chose an object-oriented approach to sort the design tasks while Prof-D's approach was analytical and exhaustive in understanding the purposes of various design tasks. The working priority was a unique perspective attributed to the practice of professional designers because professional designers had to handle multiple projects simultaneously and they had to prioritize their projects accordingly. The priority seemed to be developed based on daily operations of designing and scheduling. The working priority seemed to coincide with the presentation formats of the cards. Design tasks with definitive requirements, which were presented in bullet-point forms received a top priority. Design tasks provided with situations received a lower priority because subjects reasoned that additional information was needed to refine the situations. The working priority for design briefs with only a single statement was very controversial. Different subjects had different perceptions. Some subjects (in senior positions) reasoned that the design brief has given a lot of design freedom and they are delighted to exercise their imagination while some subjects (in junior positions) suspected that the boss (author of the briefs in question) probably had not decided any directions yet and the design brief should have the lowest priority.

Prof-H made an interesting comment regarding different design brief formulations that various groups only represented design tasks at different stages of design projects. He reasoned that different kinds of design tasks afforded different kinds of designing activities including brainstorming, researching on the topic, seeking out additional information, sketching, and making technical drawings. Some activities were described as more ”routine” and ”mechanical” while others were described as more ”challenging” and ” interesting”.

[Prof-H: Your boss might tell you that he wants a nice-looking form but there

are so many directions, nice as in hip-hop or nice as in Jazz or Ballet, etc. //I6:34]

[Prof-H: So, I don't know what my boss means when he said nice but I like to take on the challenge to investigate the meaning myself. //I6:36]

[Prof-H: The difficult ones are also more interesting, the out-of-the-blue group, you can exercise your imagination, there is no right or wrong answer. //I23:20]

[Prof-H: A 11-cup size will be wrong for a 10-cup size specification of a coffee maker. //I23:21]

Prof-H scheduled work on different kinds of design tasks so as to make work more enjoyable, even though in his practice he had to work on all design tasks that were assigned to him. He would be bored if he had to repeat routine tasks over and over. Besides showing personal preferences towards design briefs in the protocols, Prof-H constantly sought a balance among design, business, and his own beliefs and interests. As a junior designer, he had to be realistic regarding design projects and their requirements. Compromises must be made under given circumstances.

[Prof-H: This is not about being a talented designer and making your own calls. A designer needs to negotiate with others and to be more realistic about the project. //I2:26]

[Prof-H: You need to be more realistic. You can make a very innovative product but the company can go into bankruptcy the next day. There are numerous examples like that. //I30:29]

However, Prof-H said that being true to himself and observing a certain ethical conduct was his bottom line as a designer. Prof-H believed that a designer is not a drafter and refused to simply follow orders from superiors. Prof-E also

expressed a similar concern that she was frustrated when the boss often gives a verbal design brief asking designers to figure out a similar, but different product based on competitors' specifications. Prof-C seems to confirm that the practice is the norm rather than an exception. It seems that designers' perceptions are strongly affected by the professional context.

> *[Prof-H: As a designer, I think the minimal moral conduct is not to be a copy-cat. Besides that, profit-making probably is the 2nd priority. //I30:21]*
>
> *[Prof-H: Design is no doubt a business but it is also very important that you need to be true to yourself in the business. //I24:53]*
>
> *[Prof-H: Being true to yourself doesn't mean you should not compromise with your boss under some circumstances. It means you should not be a copy-cat. There needs to be a bottom line in every compromise. //I25:08]*
>
> *[Prof-C: Usually we don't have briefs. We're just shown our competitors' products and told to 'take care of it'. //05:34]*

The professional cases were challenging to classify even in relation to the Yr1 and Yr3 cases. All the professional subjects related their sorting principles to their professional practice. Different subjects articulated different aspects of the given design tasks. The diverse sort results seemed to explain the difficulties of studying design rationales of professional designers. Some subjects displayed consideration that was relevant only to their personal factors and practice environment. Any methods used to devise appropriate design brief formulations for professional designers without considering the above two factors would probably fail. The personal and individual factor also seems to be contextualized reflecting how designers' perceptions are influenced by their positions, experience, and attitudes towards design. For instance, if Prof-H's views of various design brief formulations

as representing various stages of a design project are justifiable, specification formulations would be perceived to be near the end of a design project and only routine kinds of design activities are required. In addition, specification formulations may prime Prof subjects to perceive a copycat type of design project that requires a drafter to follow rigid instructions. These initial perceptions may precondition designers to evolve some negative responses although designers may try to strike a balance between the business aspect and their personal aspect in the Hong Kong professional context. Albeit only half of the subjects seem to bring along these personal concerns in their sorting sessions, results from the Prof subjects may be useful for understanding the contextual and personal factor affecting design brief perceptions.

5.4.4. Correlation results of Mgr subjects

Design Mgr subjects as a whole seem to have more diverse perceptions (table 5.17) than Prof subjects since many design briefs (no.7, 9, 20, 23) were grouped into 7 different main categories by 8 subjects. Mgr subjects seem to split their attention between the abstraction framework and the product category. Medium agreements are achieved for many scenario formulations (no.12, 17, 19, 24) under the abstraction framework while specification and function formulations also achieve much attention. Under the product category, single statement design briefs seem to achieve medium agreements. In addition, presentation format actually comes back as a factor affecting subjects' perceptions while the personal and individual factor seems to diminish. The business and design management category also received some attention. It was unexpected to find that Mgr subjects put so much emphasis on a product category since the factor was believed to be affecting mostly novice designers (Yr1 and Yr3 subjects). The

#	Card name	Abstraction framework	Business / management	Design knowledge	Discipline	Personal / Individual	Presentation format	Product category	Categories for this card
1	Coffee maker, specifications, point	25%	13%	13%	13%	0%	13%	25%	6
2	Margarine storage device, functions, point	38%	0%	13%	13%	0%	13%	25%	5
3	Beverage vending machine, structures, composition	38%	13%	0%	25%	0%	0%	25%	4
4	Window cleaner, specifications, composition	38%	13%	25%	0%	0%	0%	25%	4
5	Garden chair, structures, point	13%	13%	13%	13%	13%	13%	25%	7
6	Coin-operated payphone, subordinate, single	0%	13%	13%	13%	38%	13%	13%	6
7	Bedside lamp, scenarios, single	38%	0%	25%	13%	0%	0%	25%	4
8	Diamond watch, subordinate, single	0%	13%	25%	0%	13%	13%	38%	5
9	Revolving door, subordinate, single	13%	13%	13%	13%	13%	13%	25%	7
10	Card game, functions, composition	25%	13%	0%	13%	13%	0%	38%	5
11	Footwear, superordinate, single	13%	0%	25%	0%	0%	13%	50%	4
12	Coffee mug, scenarios, composition	50%	13%	13%	0%	0%	0%	25%	4
13	Ventilation system, functions, single	25%	13%	13%	13%	0%	13%	25%	6
14	Food preparation area, functions, point	25%	0%	13%	25%	0%	13%	25%	5
15	Dashboard, specifications, point	25%	13%	13%	25%	13%	13%	0%	6
16	Clothing, superordinate, single	13%	0%	25%	0%	0%	13%	50%	4
17	Trash can, scenarios, composition	50%	0%	0%	25%	0%	0%	25%	3
18	Can opener, specifications, point	38%	0%	13%	13%	0%	13%	25%	5
19	Sofa set, scenarios, composition	50%	13%	0%	0%	0%	0%	38%	3
20	Time-telling device, functions, single	13%	13%	13%	13%	13%	13%	25%	7
21	Heart rate monitor, specifications, composition	25%	13%	25%	0%	13%	0%	25%	5
22	Dress shirt, subordinate, single	13%	0%	25%	0%	0%	13%	50%	4
23	Flower vase, structures, point	13%	13%	13%	13%	13%	13%	25%	7
24	Office ladies shoes, scenarios, composition	50%	13%	0%	0%	0%	0%	38%	3
	Cards in this category	22	16	19	15	9	15	23	

Table 5.17.: Correlation results of Mgr subjects

attention to a common sense perspective is further discussed in the sorting sessions. Nonetheless, the results seem to suggest that design managers do not simply continue to develop their design expertise but actually shift to the role as mediators in a design project. As suggested in the earlier interviews with design managers, design briefs actually serve many different purposes in the professional context. Design brief formulations should be tied in with these purposes including facilitating communication with junior designers, clients and marketing department. Understanding Mgr subjects' perceptions is useful for connecting design brief formulations to actual brief usages in the professional context.

Discussions of Mgr subjects' sorting sessions

The sorting sessions of design managers seem to be more diverse than the rest of design students and professional designers. Besides their emphasis on the business and manufacturing aspect of a design project, the most significant difference of the Mgr subjects is their ability to take on multiple roles when sorting the design briefs. A subject might take on the role of clients or the marketing department to determine whether a design brief is appropriate for certain business strategies. They may also consider the design briefs from junior designers' perspectives and suggested that presentation format is influential to junior designers' perceptions. Some Mgr subjects also exhibited their designers' instincts in the sorting session and tried to generate potential design directions with different design briefs. As a result, Mgr subjects' sorting principles were similar to both Yr1 and Prof subjects but with an additional sense of project feasibility in the professional context. Their focus on a product category may be due to the need to perceive a design project from a common sense perspective that is often adopted by clients. Mgr subjects'

sort results appear to be determined largely by the role that they have chosen at the particular moment. The sort results seem to suggest that Mgr subjects' primary responsibility is to ensure effective communication among various stakeholders in a design project. These multiple roles taken on by design managers in the professional context may suggest that different ways of communication are needed for different purposes and audience.

Design managers' perceptions were affected by many contextual factors including the common use of verbal design brief in the Hong Kong context. All professional subjects and some Yr3 subjects expressed similar sentiments that there might not be any written design briefs in their practice especially for smaller scale projects. They explained that design projects began with client meetings. During the meeting, clients might describe their needs in general terms or have a vague idea of how they want to proceed with the project. Design managers had to translate the background information into more definitive design requirements to junior designers. However, there were cases that clients were unsure of the project direction and did not want to commit to a written design brief. Design managers could only obtain a single task statement from clients and often had to guess the clients' requirements by other means. Some design managers were using ambiguous interpretations as a technique to promote outcomes' creativity. When no written design briefs were given or little information was provided on the design briefs, design outcomes became a hit-or-miss affair. Mgr-D reported that when the outcomes failed to meet clients' requirements, the mis-interpretation led to decreased morale of her junior staff and longer turn-around time.

> *[Mgr-D: The current trend is that many people are using ambiguous interpretations as a way to create something new instead of formulating a detailed design brief. //I23:30*

[Mgr-D: There are many chances that the project becomes a hit or miss situation and there are far more chances for misses which will eventually lead to lower morale, a serious problem. //I23:54

[Mgr-D: Compared to a more detailed brief, no brief or a single statement usually leads to longer turn around time. In this case, I have less material to discuss with the client. //23:44]

Without a written design brief, no one would bear the responsibility if the project failed. Nonetheless, a verbal design brief could not serve as a contractual document. This observation suggested that there might be a contradiction between the function of verbal design briefs as legal documents and as stimuli of the design process. Legal documents tend to require concrete languages (at least, less ambiguous) in order to avoid disputes while verbal design briefs are more abstract and fluid so as to stimulate designers' imagination. This inconsistency seems to be another factor influencing design brief formulations in the professional context and needs to be addressed in future studies.

5.4.5. Correlation results of Edu subjects

The correlation analysis (table 5.18) of design Edu subjects is not surprising since the context-based model of design brief formulations discussed earlier has provided some clues on educators' perceptions of design briefs. Design educators' responsibilities include disseminating domain-specific knowledge and inspiring design students to exceed educators' expectations. Both aspects are reflected in subjects' attention to design knowledge as well as presentation format when sorting design briefs. The personal and individual factor seems to focus on many single statement design briefs indicating that individual design knowledge and personal interpretations are required to provide enough information before sorting

#	Card name	Abstraction framework	Business / management	Design knowledge	Discipline	Personal / Individual	Presentation format	Product category	Categories for this card
1	Coffee maker, specifications, point	63%	0%	13%	0%	0%	0%	25%	3
2	Margarine storage device, functions, point	50%	0%	13%	0%	0%	13%	25%	4
3	Beverage vending machine, structures, composition	25%	0%	25%	0%	0%	13%	38%	4
4	Window cleaner, specifications, composition	38%	0%	13%	0%	13%	25%	13%	5
5	Garden chair, structures, point	63%	0%	0%	0%	0%	13%	25%	3
6	Coin-operated payphone, subordinate, single	0%	0%	25%	13%	50%	13%	0%	4
7	Bedside lamp, scenarios, single	38%	0%	25%	0%	0%	25%	13%	4
8	Diamond watch, subordinate, single	13%	0%	25%	0%	25%	13%	25%	5
9	Revolving door, subordinate, single	13%	0%	25%	13%	38%	13%	0%	5
10	Card game, functions, composition	38%	0%	13%	0%	13%	13%	25%	5
11	Footwear, superordinate, single	13%	0%	25%	0%	25%	13%	25%	5
12	Coffee mug, scenarios, composition	75%	0%	13%	0%	0%	0%	13%	3
13	Ventilation system, functions, single	13%	0%	13%	13%	13%	25%	25%	6
14	Food preparation area, functions, point	50%	0%	13%	0%	0%	0%	38%	3
15	Dashboard, specifications, point	63%	0%	13%	0%	13%	13%	0%	4
16	Clothing, superordinate, single	13%	0%	25%	0%	25%	13%	25%	5
17	Trash can, scenarios, composition	75%	0%	0%	0%	0%	0%	25%	2
18	Can opener, specifications, point	63%	0%	0%	0%	13%	13%	13%	4
19	Sofa set, scenarios, composition	63%	0%	0%	0%	25%	0%	13%	3
20	Time-telling device, functions, single	0%	0%	25%	13%	25%	13%	25%	5
21	Heart rate monitor, specifications, composition	25%	0%	25%	0%	13%	25%	13%	5
22	Dress shirt, subordinate, single	13%	0%	25%	0%	25%	13%	25%	5
23	Flower vase, structures, point	63%	0%	0%	0%	0%	13%	25%	3
24	Office ladies shoes, scenarios, composition	63%	0%	13%	0%	13%	0%	13%	4
	Cards in this category	22	0	19	4	15	18	21	

Table 5.18.: Correlation results of Edu subjects

decisions can be made. Edu subjects' emphasis on the abstraction framework also exceeded those on the product category for the first time among all the subjects. Most design briefs (specification, function, structure, and scenario formulations) actually achieved high agreements except the single statement design briefs (no.6, 8, 9, 11, 13, 16, 20, 22). The result may indicate that these mental constructs originate from the educational context. Design students are taught to perceive design briefs from these perspectives. Both educators' and managers' perceptions of design briefs appear to indicate that perceptions are strongly influenced by the assumed context.

Discussions of Edu subjects' sorting sessions

Design educators were more explicit in their sorting sessions and often employed a visual approach to scan through all the design briefs at the beginning before re-reading individual design briefs meticulously. They explicitly aimed to find similarities or patterns among different design briefs. They identified design briefs based on the amount of information and details available for immediate design actions. They seemed to be the only group who paid much attention to the context of design briefs as well as theoretical concepts related to the abstraction framework and target users. Some subjects suggested that there are many different ways to sort the design briefs and inquired the purpose of the exercise. Some subjects integrated a student perspective to analyze whether some of the design briefs are more difficult for students. Subjects' sort results were also very visual. Edu-A and Edu-B organized their sort results in a 2-dimenaional spider-web like structure delineating relationships among various groups of design briefs. Edu subjects also shared certain traits with Prof subjects including sorting based on personal preferences and interests. Edu-F and Edu-C utilized their personal preferences to differentiate

#	Card name	Abstraction framework	Business / management	Design knowledge	Discipline	Personal / Individual	Presentation format	Product category	Categories for this card
1	Coffee maker, specifications, point	38%	5%	10%	8%	3%	5%	33%	7
2	Margarine storage device, functions, point	40%	3%	10%	10%	3%	8%	28%	7
3	Beverage vending machine, structures, composition	28%	3%	18%	20%	0%	5%	25%	6
4	Window cleaner, specifications, composition	33%	3%	20%	3%	5%	8%	30%	7
5	Garden chair, structures, point	28%	5%	13%	5%	8%	8%	35%	7
6	Coin-operated payphone, subordinate, single	0%	3%	23%	13%	33%	8%	20%	6
7	Bedside lamp, scenarios, single	28%	0%	25%	3%	0%	8%	38%	5
8	Diamond watch, subordinate, single	3%	3%	15%	0%	25%	8%	48%	6
9	Revolving door, subordinate, single	5%	3%	20%	18%	25%	8%	20%	7
10	Card game, functions, composition	23%	3%	15%	3%	10%	5%	43%	7
11	Footwear, superordinate, single	8%	0%	15%	0%	20%	8%	50%	5
12	Coffee mug, scenarios, composition	50%	3%	15%	3%	3%	0%	28%	6
13	Ventilation system, functions, single	8%	3%	15%	18%	18%	8%	30%	7
14	Food preparation area, functions, point	20%	0%	10%	25%	5%	5%	35%	6
15	Dashboard, specifications, point	33%	3%	10%	25%	8%	8%	15%	7
16	Clothing, superordinate, single	8%	0%	15%	0%	20%	8%	50%	5
17	Trash can, scenarios, composition	53%	0%	10%	13%	0%	0%	23%	4
18	Can opener, specifications, point	40%	3%	10%	8%	5%	8%	28%	7
19	Sofa set, scenarios, composition	55%	3%	10%	0%	10%	0%	23%	5
20	Time-telling device, functions, single	5%	3%	20%	8%	23%	8%	35%	7
21	Heart rate monitor, specifications, composition	20%	3%	20%	10%	8%	8%	33%	7
22	Dress shirt, subordinate, single	5%	0%	15%	0%	23%	8%	50%	5
23	Flower vase, structures, point	25%	5%	13%	5%	5%	8%	40%	7
24	Office ladies shoes, scenarios, composition	53%	3%	10%	0%	5%	0%	30%	5
	Cards in this category	23	18	24	18	21	20	24	

Table 5.19.: Correlation results of all subjects

between interesting and boring design briefs. Some subjects challenged the stated design requirements on the briefs. Edu-G called a design brief outrageous because the brief provided an interesting background but also predetermined the design solution. The observation suggests that design educators possibly pass along some of their working habits and styles when interacting with their students in studio courses.

5.4.6. Correlation results of all subjects

The overall results represented in table 5.19 cannot be conclusive since subjects from each expertise level seem to have their own patterns of perceptions due to

expertise as well as the assumed context. Nonetheless, the results can show a universal aspect of design brief perception regardless of expertise and context. Scenario formulations were recognized highly to be related to problem-solving situations by most subjects while function and specification formulations also attract much attention. Design briefs formulated by a single statement are rather interesting. These design briefs were grouped by either the personal/individual factor or the product category factor. Essentially, this presentation format lack detailed information and subjects must provide their own knowledge and judgements in order to fill in the missing piece of information. The last column of the table also confirms that the group perceptions are very diverse (7 is the highest number) compared to the individual sub-group perceptions.

Discussions of all the subjects' sorting sessions

The overall results seem to resonate with empirical observations of designers' behaviour during design processes. For instance, novice designers oftentimes employed a common-sense approach to tackle design tasks, which was perceived by design researchers as trying to solve a simple design problem unaware of potential criteria and difficulties (Christiaans & Dorst, 1992). In the study, when Yr1 subjects were given the sorting task, they employed generic problem-solving skills to efficiently sort various design tasks without realising other potential relationships among design tasks. Since Yr1 subjects were accustomed to using general problem-solving skills, they could be regarded as experts in utilising domain-independent knowledge for the product design domain. They were effective sorters. This common sense approach of tackling design tasks led to the shortest sort time for Yr1 subjects.

Sometimes, intermediate designers were reported to show uncertainty and

confusion about design tasks in the design process. They were unable to adequately scope the design task and appeared to be stuck in the problem-definition stage or the information-gathering stage (Christiaans & Dorst, 1992; Atman et al., 1999). Yr3 subjects in the study tried to strike a balance between a design and non-design perspective because they perceived relevance of design tasks from both perspectives. They were able to elaborate differences in design requirements and design strategies based on their domain-specific knowledge. They spent considerable amounts of time engaging with design tasks from multiple perspectives before making their sorting decisions. Many subjects from this group spent amongst the longest time sorting the design tasks. The reason could be related to acquisition of an extensive amount of domain-specific knowledge typically required from Yr3 subjects, but their knowledge did not seem to be effectively organized or assimilated to make sorting decisions. In addition, they might possess declarative knowledge but they did not have sufficient practical experience to utilize the knowledge effectively in an applied situation.

In previous studies, competent designers were exposed to a number of problems and solutions within their domain. They were reported to develop a guiding principle that assisted them in framing problematic situations (Lloyd & Scott, 1995). Adequate problem-scoping often led to satisfactory design outcomes. Professional subjects did not elicit every potential relationship for various design tasks but they spent enough time prioritizing the information given on the cards before making their sorting decisions. Professional subjects were using domain-specific design knowledge and knowledge from professional practice to sort the design tasks. Their sorting principles were often associated with their professional practice environment.

5.5. Discussion with respect to the abstraction framework

All of the above sections utilized an inductive approach to analyze and discuss the sort results by various expertise levels. Since design tasks given on the cards were formulated based on the abstraction framework discussed in chapter 4.1, one question that remains unanswered is how are the sort results compared to the expectations suggested by the framework. The abstraction framework has been shown to mainly match with design educators' perceptions while a lot of contextual and personal factors seem to affect other subjects' perceptions. The next section discusses how design briefs formulated by the abstraction framework are perceived by our target users of design briefs (Yr1, Yr3 and Prof subjects). The abstraction framework consists of three cognitive dimensions, namely categories abstraction (CA), linguistic aggregation (LA), and abstraction hierarchy (AH). Categories abstraction (CA) is concerned with a basic level of abstraction of physical objects. An exemplary design brief formulation pair is ″superordinate″ versus ″subordinate″. Linguistic aggregation (LA) is concerned with accumulating meanings in design briefs by concatenating words to phrases, to sentences, to narratives. An exemplary design brief formulation pair is ″specification″ versus ″scenario″. Abstraction hierarchy (AH) is concerned with reflecting designers' mental representations with higher level goals and intentions to lower level physical properties and structures. An exemplary design brief formulation pair is ″function″ versus ″structure″. Figure 5.3 is a concise summary of the abstraction framework. Readers may refer back to section 4.2 for detailed descriptions of the framework. The following section analyzes the sort results based on the exemplary formulation pair corresponding to each dimension.

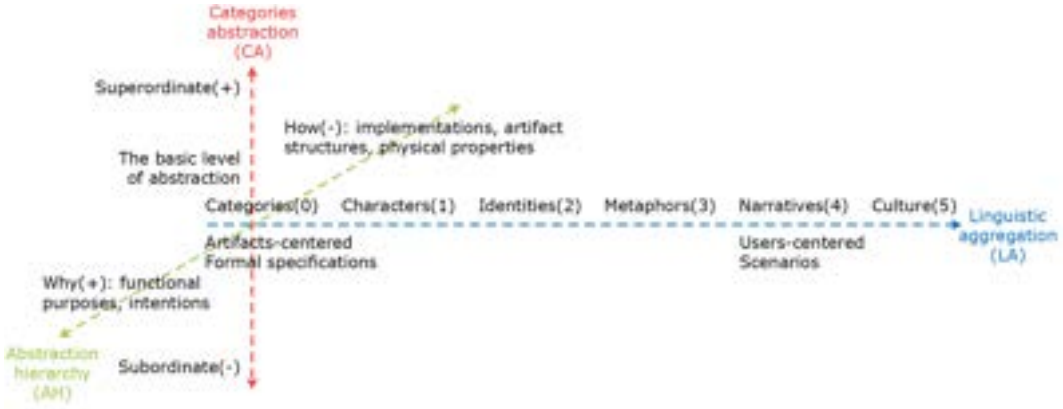


Figure 5.3.: The abstraction framework

5.5.1. The CA dimension: Superordinates versus subordinates

Most subjects did not perceive any differences derived from this dimension. Their initial perceptions seem to attend to the presentation format. Since this dimension resulted in design tasks expressed in single statements on the cards (e.g. To design a Furniture (Superordinate) > Table (Basic) > Kitchen Table (Subordinate)) , many subjects quickly identified these cards and made sorting decisions based on the presentation format (These design briefs were presented all in single-statement format). Therefore, the perceptions of design tasks derived from this dimension did not seem to depend on the abstraction levels of the artefacts but instead depended on expertise levels of the subjects. Interpretations of design tasks again were two-folded. Novice designers (Yr1 subjects) often considered the tasks to be simple with no constraints. They viewed the tasks literally as a yes or no affair. Yr1 subjects reasoned that these tasks had given them a lot of design freedom because no design requirements were stated on the cards. Some subjects were delighted to have so much design freedom for the tasks while professional designers viewed these tasks with caveats. Competent designers (professional subjects) were concerned with the lack of information in these design task formulations. Three potential

interpretations of professional subjects were observed. The first one is similar to Yr1 subjects' perceptions that the design brief has built-in a lot of design freedom and they can exercise their imagination for the project. The second kind of interpretations regarded the design brief as straightforward and they can proceed to concept generation. The last interpretation considered the design brief to be very vague and ambiguous. Professional subjects reflected with their experience and reasoned that these design tasks are at an initial concept stage and must be further defined before proceeding into the next stage. Even with subordinate objects, professional subjects appeared insecure with only a task label and would ask for further information to elaborate the design tasks. Professional subjects said these were difficult tasks because the clients or supervisors (those who formulated the respective briefs) apparently did not know what they want in a project. In between the two extremes, some Yr3 subjects were confused and frustrated because they were uncertain about what was expected from the tasks and noticed that there might be additional criteria not yet provided on the cards. The inherent lack of information of the CA dimension requires designers to provide their own assumptions and anchors to interpret the design brief. The results suggest that levels of abstraction of physical objects might only play a minor role in affecting designers' perceptions of design tasks. Novice designers seemed to be influenced by the CA dimension because they were more likely to take design tasks at face value. However, competent and expert designers were trained to handle this kind of design task formulation in the professional context. The theoretical CA dimension seemed to neglect the information-sensitive nature of professional designers and failed to be a practical dimension to guide design brief formulations as originally proposed in this study. The results also indicate that the degree to which theoretical understandings contrast with design expertise develops through

professional practice. Nonetheless, design brief formulations based on the CA dimension can be useful in reflecting a subject's prior design experience provided that multiple interpretations of the design brief are intended or expected by the design brief writer.

5.5.2. The LA dimension: Specifications versus scenarios

Novice designers (Yr1 subjects) identified specification-oriented formulations as design tasks having specific design requirements but they failed to label the tasks as specifications. They did not pay any special attention to this group of task and regarded this formulation comparably with the rest of design tasks. In contrast, Yr1 subjects quickly recognized scenarios formulations as problem-solving situations that were related to end-users. The results confirmed the expectation that novice designers had not yet acquired the technical term "specification" to describe specific design requirements while they were familiar with user scenarios and narratives that are often used and encountered in casual conversations.

Yr3 and professional subjects made a strong distinction between these two formulations. They reasoned that specifications were strict requirements that needed to be fulfilled while scenarios presented users in problematic situations which contained softer design requirements. Some Yr3 subjects, Yr3-G and Yr3-H perceived that specification-oriented formulations of requirements were boring and reminded them of sketching exercises or simply following orders. Some professional subjects, Prof-F and Prof-H also expressed discontent towards specification formulations. They said that specifications reminded them of a copy-cat type of design projects or often implied that the design project was near the final stage so that most of the requirements had been finalized. Professional subjects said that they wanted to follow through the entire design project from its initial

conception to final production. The whole design process seems to give many professional subjects a sense of achievement. Specification formulations seemed to elicit negative reactions from both Yr3 and professional subjects although they considered researching competitors' features a routine in their design processes. The results were unexpected because the original assumption was that specifications were considered more familiar to professional designers and thus enhanced their design performance while concrete scenarios were more suitable for novice designers. However, negative responses of professional designers to specification formulations may be a unique characteristic of professional designers in certain design disciplines since it would be unexpected to consider engineers showing emotion to a product specification. A potential reason may be related to designers' training of perceiving an object from a unique perspective that can only be experienced subjectively and holistically. There seems to be a contradiction when designers need to avoid the subjective element when using existing specifications to communicate with clients and other stakeholders. Professional designers' perceptions of design briefs seem to be related partially to cognitive aspects of design requirements but also contain affective and conative factors that can only be discussed at an individual level. Since it is premature to determine the effect of these affective factors on designers' performance, scenario formulations seem to be more appropriate for professional designers. User scenarios or narratives seemed to be recognized by all subjects regardless of expertise levels. Designers preferred to have opportunities to explore the situation and exercised their creativity when the required artefacts were not limited by specifications. Scenario formulations seem to offer the most reliable form of design brief formulations to promote designers' interest in the design project at hand regardless of expertise levels.

5.5.3. The AH dimension: Functions versus structures

Function formulations are often used as a heuristic method to promote creativity of design outcomes. However, function formulations seem to have different influences on subjects with different levels of design expertise. For novice designers (Yr1 subjects), the method seems to guide subjects to avoid considering preconceived or already-existing solutions. Since Yr1 subjects could not adequately distinguish between functional requirements and structural requirements (as noticed in Yr1 subjects' protocols, section 5.4.1) and did not have enough domain-specific knowledge to passively recall known or standard solutions, they had to actively seek potential solutions to fulfil the functional requirements. These potential solutions were often unexpected when compared to known solutions and appeared to be more creative design outcomes.

Nonetheless, the same method did not apply in the same manner to competent designers since they possessed sufficient domain-specific knowledge and were familiar with functional requirements of artefacts. Many Yr3 and professional subjects were able to connect the given functions to existing artefacts. They oftentimes succeeded in guessing the intended artefacts. In order to achieve the same result with competent designers, functional requirements must be far off from designers' immediate associations and knowledge domains or a different mechanism seems to be at work. I noticed that an unintended consequence of the heuristic method might also be at work to influence the design outcomes. Even though competent designers were able to guess the intention of design brief writers using functions formulations, some designers consciously avoided these "trivial solutions" or tried to solve a harder design problem. For instance, a few Yr3 and professional subjects reasoned that one of the cards stated "to design a wearable time-telling device" was related to watches but they also quickly rejected

the idea saying that the brief writers must want them to stay away from the trivial solution. This mechanism seems to rely on individual designers being motivated to overcome trivial solutions rather than the problem-solution space being enlarged intentionally by the heuristic method.

There also seems to be two potential reasons for explaining the relatively long 1st sort time of professional subjects. Professional designers were able to read more into design briefs elaborating the needs of various design briefs from multiple perspectives. They related the given requirements to their professional experience and domain-specific knowledge and provided additional assumptions on an individual basis. In addition, they also generated potential strategies and design directions to various design briefs. Personal factors, such as the volition to pursue a satisfactory solution or to challenge themselves to do the best, seem to play an important role in professional designers. The results of employing a heuristic method with professional designers would be very diverse depending on individual designers' personal factors and their professional practice environment. In general, the effects of using functions against structures or artefact names to formulate design briefs to stimulate designers' creativity seem to be applicable only to novice designers.

5.6. Simplified models of design brief perceptions

In the analysis of card-sorting exercises, design expertise and context were shown to play an important role affecting subjects' perceptions of design briefs. Yr1 and Yr3 subjects' sort results were more predictable while professional designers tended to interpret the design task based on their prior experience and professional practice. The results suggested that design brief perceptions strongly depended on design expertise but the actual relationship between design brief formulations

and design expertise seemed to be more complex than originally expected. As revealed from the verbal protocols, subjects considered the design tasks from multiple perspectives. Since existing design brief formulations by the abstraction framework tend to model only the cognitive aspect of designers' perceptions such as identifying different kinds of design requirements, many aspects of professional subjects' holistic perceptions of design tasks would be neglected and unintended consequences on designers' performance may be resulted.

It was evident from the protocols and interviews (section 5.4.3) that sorting decisions of professional subjects were intertwined with psychological and business perspectives in addition to a design perspective. Design researchers might consider re-examining the complexity of design expertise and interpret design expertise in a broader sense possibly to include psychological elements of individual designers since many subjects' holistic perceptions of design tasks involved non-cognitive elements.

This observation prompted me to reorganize the protocols and interview data into five different aspects including basic design, advanced design, personal factor, educational context and professional context in order to model designers' perceptions of design briefs. Even though professional subjects' protocols were more difficult to be separated into distinct perspectives because they often switched back and forth into different aspects during their sorting processes, the results may assist to illustrate potential areas for future studies. The simplified models that provide a more comprehensive understanding of designers' perceptions of design briefs are summarized. Critical aspects that seem to be pertinent to designers at particular levels of expertise are elaborated.

The sorting principles of Yr1 subjects were similar, which seemed to be based on a common-sense approach. A large portion of Yr1 design students' protocols

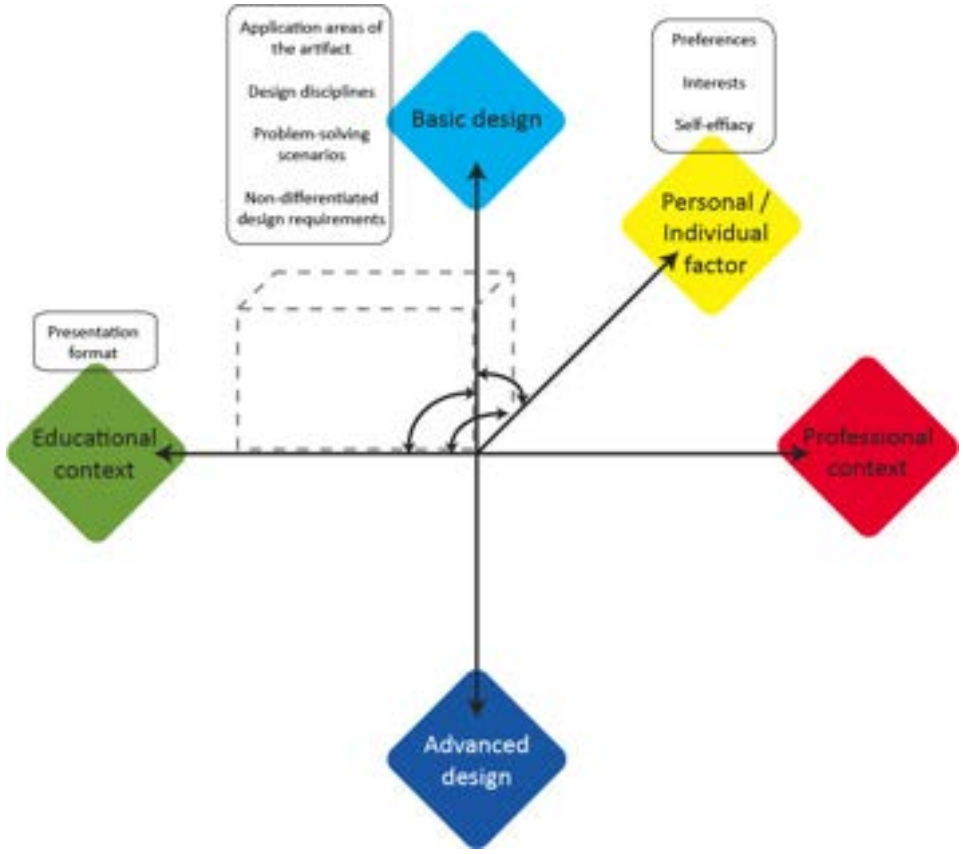


Figure 5.4.: A simplified model of Yr1 subjects' perceptions of design briefs

was related to application areas of the artifact and design disciplines. There was an inclusion of general design requirements but no distinctions were made for different kinds of design requirements. Personal preferences and interests were presented in influencing their perceptions of design briefs. A simplified model was constructed classifying Yr1 subjects' perceptions of design briefs in a tentative framework for design brief receptions (figure 5.4). The dominant perception is highlighted by the dashed box and the curved arrows indicate how each aspect may interact with one another to produce an effect that cannot be predicated by considering a single aspect alone. The interaction effects are more prominent when many aspects are intertwined for professional designers. For instance, specification formulations may evolve unforeseeable perceptions in professional subjects.

Yr3 subjects emphasized differentiating different kinds of design requirements and employing appropriate design strategies accordingly. The distinctions of requirements were thorough including target users, specific markets, functions, structures, styles and materials. Yr3 subjects possessed what have been identified in Yr1 subjects. Moreover, they acquired additional domain-specific knowledge through design education and practical training. Their knowledge was hierarchical and organised since they could prioritise the information provided on the cards. They were able to integrate knowledge and reasoned the design requirements from both design and business perspectives. Some subjects, Yr3-G and Yr3-H, exhibited strong personal preferences towards certain design brief formulations based on their limited professional experience. A simplified model of design brief perceptions for Yr3 is presented in figure 5.5.

The characteristics for professional subjects were diverse (figure 5.6). It was challenging to identify a single sorting principle that was used by professional designers. Their sorting principles seemed to be related to their professional practice. They seemed to associate their beliefs and biases with design and business perspectives. The boundaries of various perspectives were blurring. Their concerns seemed to form a holistic perception of design briefs which covered a wide range of topics from design requirements to interactions with superiors and clients. They not only showed personal interests and preferences towards design tasks but also involved certain emotion and volitions when discussing concrete instances from experience. These affective and conative factors seemed to guide their initial perceptions of design briefs. Professional subjects seemed to develop their unique working styles integrating personal factors into the professional practice environment. They also used their repository to infer requirements of design tasks at hand. The differences compared to Yr3 subjects might suggest a natural

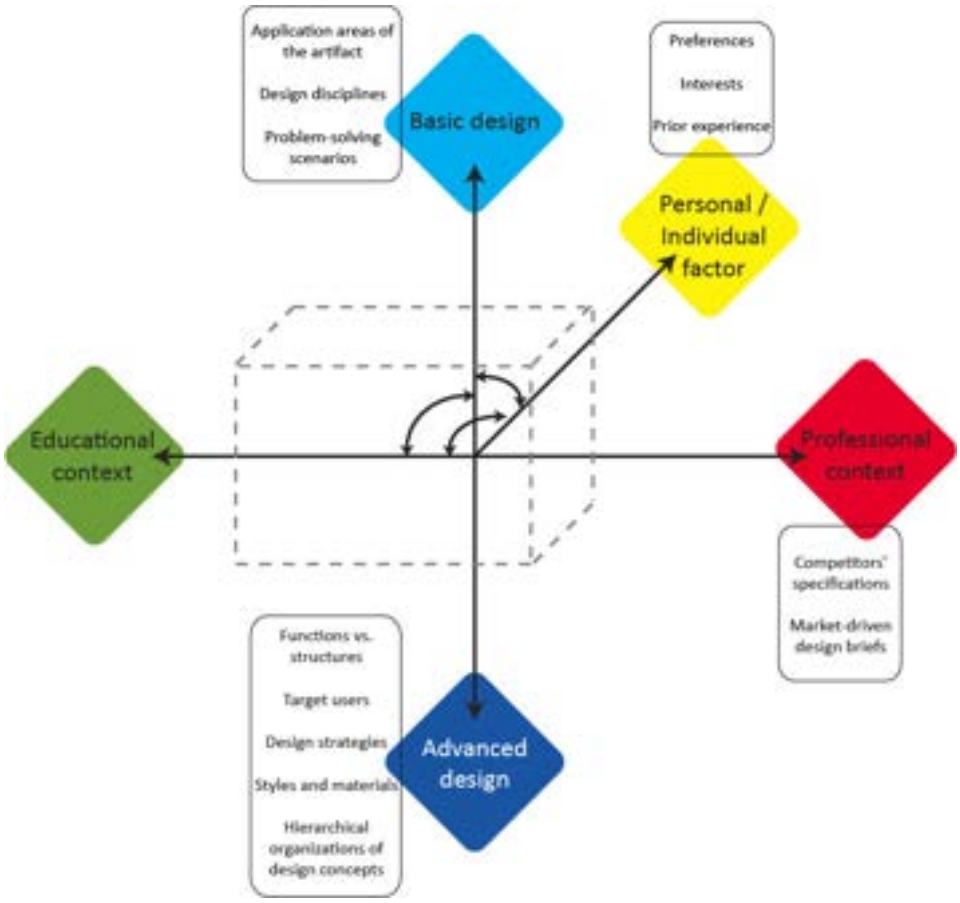


Figure 5.5.: A simplified model of Yr3 subjects' perceptions of design briefs

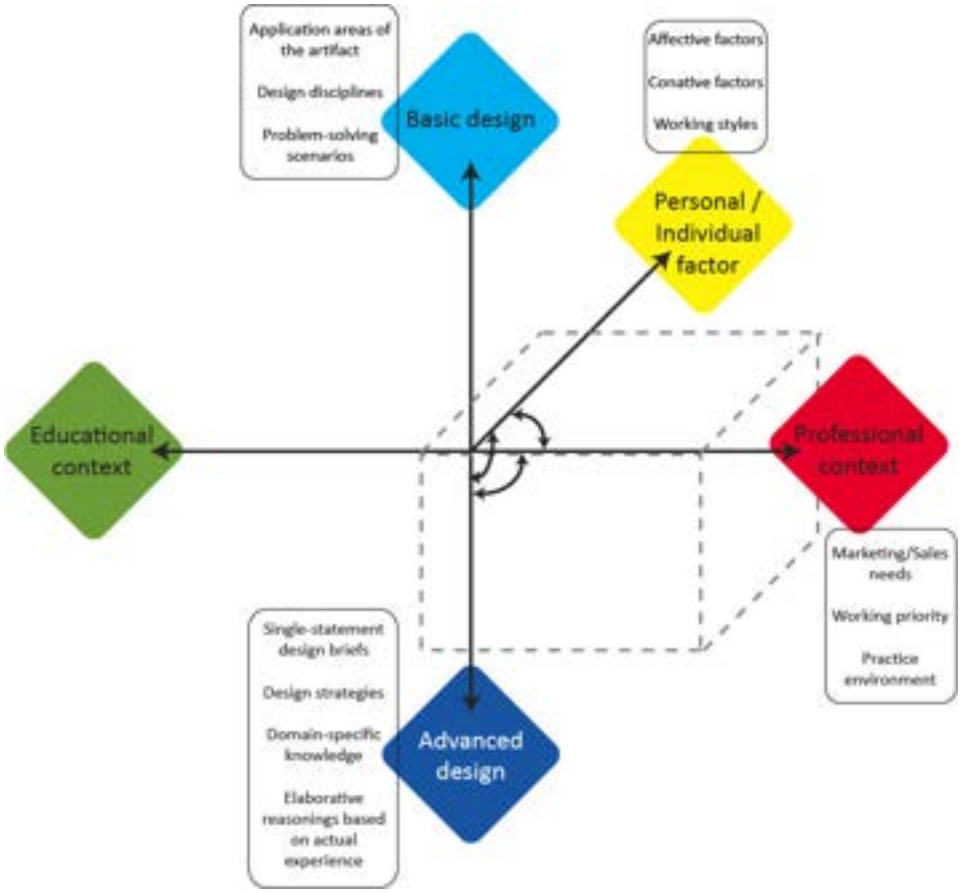


Figure 5.6.: A simplified model of professional subjects' perceptions of design briefs

evolution of professional designers.

The sorting sessions for design managers were different from those of professional designers. A simplified model is presented in figure 5.7. Many subjects focused on communications with various stakeholders in design projects including clients, senior management of the company, junior designers, engineers, marketing and sales. The subjects demonstrated the ability to translate clients' needs into design requirements understood by junior designers. During the design process, they had to keep junior designers' creativity in certain contexts so that the design outcomes could accommodate clients' capabilities and limitations. They also developed certain working styles that assessed priority of design projects, junior

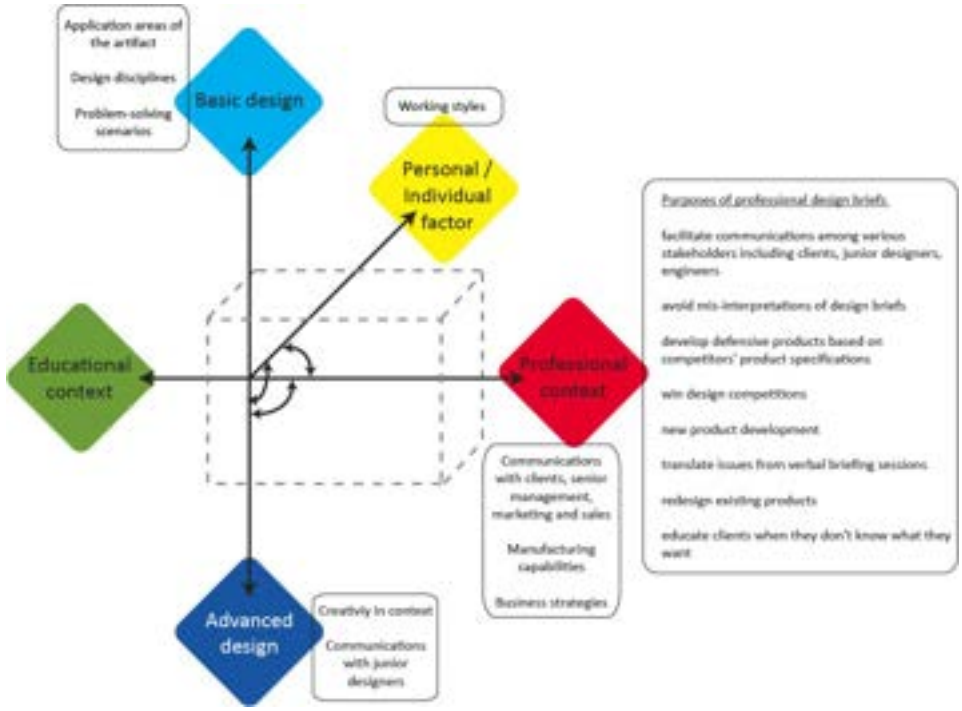


Figure 5.7.: A simplified model of design managers' perceptions of design briefs

designers' abilities and the amount of background information required in design briefs to begin the projects. They were responsible for initiating potential design concepts and judging the feasibility of these concepts from both marketing and business perspectives. Their roles were closer to facilitators than designers and design communications seemed to be a top priority to design managers. Since context seems to play an important role in design brief production and reception, purposes of professional design brief formulations reported in the earlier chapter are presented here in order to contrast with purposes of design briefs in the educational context.

Design educators' perceptions were similar to those of professional designers indicating strong personal preferences and interests in their sorting sessions. The major difference seems to be educators' ability to take on a student perspective when analyzing design briefs and understand how students may be influenced

by various design brief formulations. The simplified model of design educators' perceptions (figure 5.8) tend to reflect how design knowledge is organized and disseminated in the educational context. Design educators' perceptions mainly focused on theoretical concepts related to the abstraction framework and target users. They also tended to be more reflective explicitly stating their assumptions and rationales when grouping the design briefs. A potential reason may be that educators need to be explicit in explaining their rationales to students and act as demonstrators in the educational context. Educators' perceptions of design briefs were within my expectations after analyzing many subjects with various levels of experience.

Nonetheless, understanding the purposes associated with design brief formulations is equally important since the results of design brief formulations can be assessed only with respect to the assumed purposes. The simplified model presents a list of purposes of educational design brief formulations adopted from the earlier chapter. Both design educators and design managers seem to be fixated on formulating design briefs according to their assumed roles in different contexts. Most of the educational purposes seem to be student-centered while the professional purposes seem to be more outcome-centered. The observation suggests that design educators and design managers both tend to consciously isolate their practice within the given context and neglect the possibilities of learning from each other. For instance, Mgr-E explicitly stated that he takes on an educator's role catering to the needs and abilities of individual students when formulating educational design briefs but failed to elicit why the same approach could not be applied to the professional context. Similarly, none of the educators' subjects were interested in emphasizing the mundane side of design projects in the professional context that typical design briefs are formulated by

competitors' product specifications. If the objective of design education is to prepare students for professional practice, students should have a chance to cope with professional design briefs from external clients or the marketing department. Although cooperative projects with industry partners may serve this purpose, the possibility of design managers adopting educators' roles may diminish the intended learning outcome. The issue probably is related to the lack of awareness that professional practitioners and educators have a tendency to follow established conventions and roles and fell blind to their own context. The same Mgr subject was not aware of the potential drawback of verbal design briefs until the issue was raised in the interview. Even if both design educators and managers are aware of these potential differences, they may not perceive the connection between the two contexts. Through comparing their respective purposes and practice explicitly, both design managers and educators can perceive the potential benefits of drawing experiences from each other and incorporate some of the approaches from the other context in order to improve existing practice.

5.6.1. A tentative framework for design brief reception

The tentative framework aims to simplify the results from content analysis and correlation analysis. The results suggest that there are 7 dominant principles (as indicated in the main categories) employed by subjects with various levels of expertise and background to sort the 24 design briefs. Even though most subjects assessed the design briefs based on general design knowledge and domain-specific design knowledge, more experienced subjects seem to prioritize and integrate their decisions based on conventions and personal factor presented in the professional context. The same design brief may convey different meanings to designers in different contexts. The observation is apparent when a design brief only contains

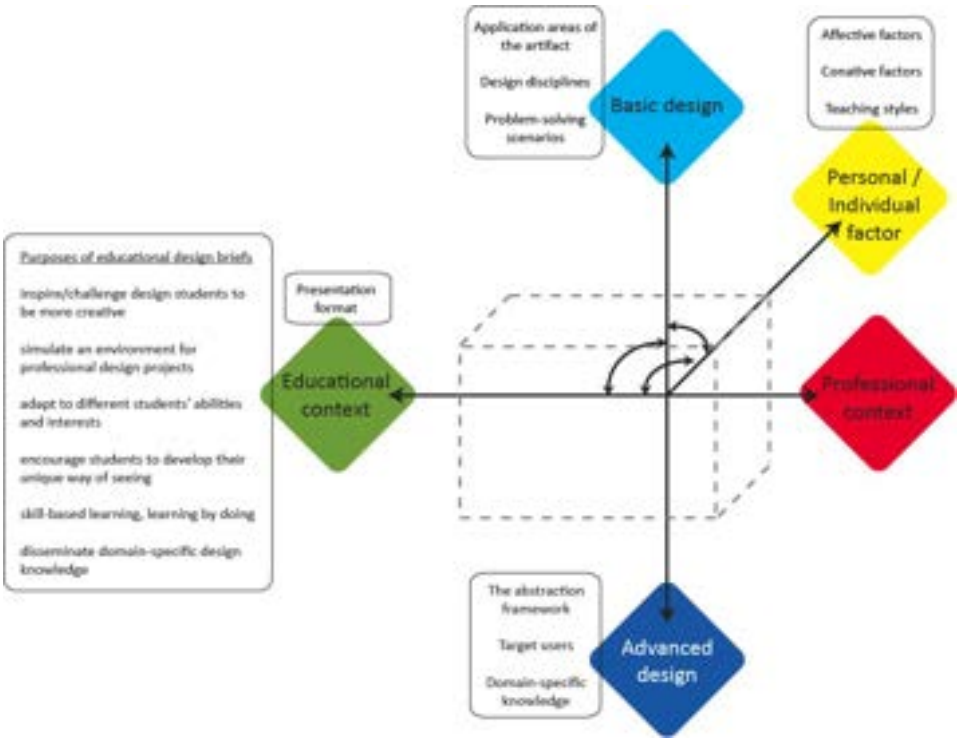


Figure 5.8.: A simplified model of design educators' perceptions of design briefs

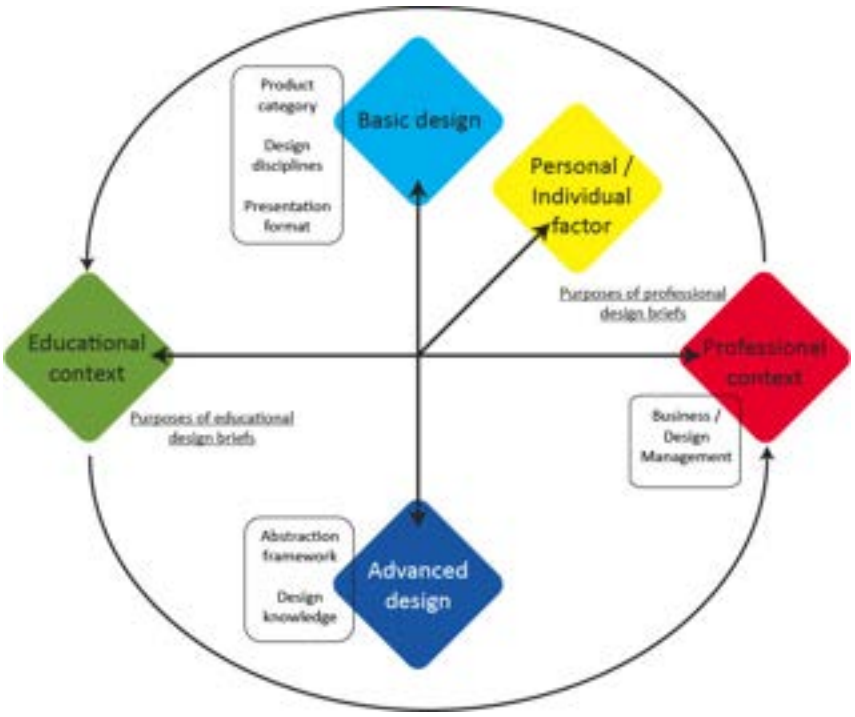


Figure 5.9.: The tentative framework for design brief reception

limited amount of information such as a single statement design task and requires designers to make implicit assumptions that vary from individual to individual (probably also from culture to culture). Novice designers tended to assume less and treated the design brief at face value while more experienced designers tend to read more into the design brief and perceive uncertainties and ambiguities of the design brief writer. Since the abstraction framework was established primarily based on cognitive understandings of perceptions, design brief formulations devised seemed to have the most impact on Yr3 subjects (section 5.4.2) while the influence on other subjects (Yr1 and Prof subjects) seemed to be less significant. Therefore, assumptions that were held true for subjects at one expertise level did not always apply to subjects at another expertise level. For instance, novice designers' perceptions were more straightforward than those of expert designers. Using design brief formulations as heuristic methods to influence cognitive aspects of their perceptions would be effective because they tended to interpret design tasks at face values which were based on a single perspective. Novice designers were more likely to translate various design brief formulations into literal instructions. Heuristic methods to enhance novice designers' performance would often achieve predictable results.

However, the effects of using design brief formulations as heuristic methods to enhance experts' design performance would not be as predictable. Since professional designers' perceptions were intertwined with assessments of design tasks coming from multiple perspectives, it would be difficult to devise design briefs to affect only the cognitive aspect of professional designers' perceptions without interacting with their greater disposition. In addition, expert designers possess the necessary domain knowledge and practical experience to prioritize and translate design brief formulations metaphorically from multiple perspectives. The

case would be similar to a second-order understanding of language as described by Krippendorff (2006) because expert designers might consciously or unconsciously try to deduce the underlying intentions or purposes of design tasks. It would be unreliable to predict professional designers' performance solely based on cognitive dimensions of the abstraction framework. For instance, heuristic methods used to influence the problem and solution space of given design tasks were likely to influence non-cognitive aspects of experts' perceptions. Designers' perceptions of design briefs including prior experience and personal preferences would be present throughout the design process, and thus affect design performance.

The results confirm that designers' perceptions of design briefs and consequent information-seeking behaviour are strongly influenced by context and individual preferences that are often neglected by the existing abstraction framework. Since the study aims to improve design brief formulations from a systemic perspective, the tentative framework for design brief reception (figure 5.9) explicitly states aspects that are pertinent in affecting designers' perceptions and thus their performance. In addition, by relating the two contexts with the personal and individual factor, design educators and managers may notice that their purposes of formulating design briefs are not as incompatible as they originally perceived. Both sides can benefit by understanding how their target audience perceive their design briefs and they can learn from each other's strategy in enhancing designers' motivation and performance. If design researchers seek ways to enhance designers' performance and design outcomes through design brief formulations, they should take dominant aspect of designers' perceptions into consideration. These simplified models assisted in clarifying the expertise-dependent nature of various perspectives. Based on the assumption that the tentative framework adequately captured designers' perceptions, designer-centered guidelines for design brief

formulations could be devised according to the three respective expertise levels distinguished in the card-sorting exercise.

5.7. Towards designer-centered design brief formulations

At this stage of the analysis, the results of card-sorting exercises had been thoroughly compared and discussed with respect to the theoretical framework. The sort results also revealed several existing limitations regarding design brief formulations as a heuristic method to promote creativity of design outcomes. The most important limitation is that oftentimes only cognitive aspects of design requirements were considered to be expertise-dependent characteristics of designers. Professional designers' perceptions had been shown to be indivisible and holistic including influences from both personal and business perspectives.

In this final section, I take a more explorative and inductive approach to summarize what has been articulated towards design briefs by individual designers in the semi-structured interviews. Qualitative data collected from semi-structured interviews were summarized so that design brief writers from both contexts can consider these aspects when formulating design briefs for their audience perspective. Observations are classified into various perspectives affecting designers' perceptions and corresponding guidelines are proposed in ameliorating any unsatisfactory conditions or enhancing preferable conditions. The simplified models (section 5.6) suggest that the personal perspective (including both affective and conative factors) is present in all subjects' protocols regardless of expertise levels while factors related to professional practice environment (working routines, marketing needs) play crucial roles in affecting professional designers' perceptions. Although guidelines devised for each expertise level may reflect only an average case, these guidelines are meant to serve as a template for design brief writers to

reflect upon their own context and facilitate exchanges between design educators and design managers. Since the personal and individual factor seems to be paramount in professional subjects, future studies may investigate how these non-cognitive aspects may be related to designers' emotions and produce more specific guidelines. The results of content analysis are presented in table 5.20, table 5.21, and table 5.22 according to the three expertise levels (Yr1 subjects, Yr3 subjects and professional subjects) used in the study.

Presentation formats of design briefs seemed to be the major concern of Yr1 subjects. Remaining observations focused on students' personal preferences and interests which were articulated by design educators in section 3.4.

Yr3 subjects were concerned with the amount of design freedom given by design tasks. Subjects were able to articulate concrete preferences for design tasks based on their personal interests and preferences.

Professional subjects emphasized communicating and building trust with clients. They seem to develop individual styles to handle various design tasks in their practice. Personal challenges and interests are important factors affecting their perceptions of design tasks.

The overall results suggest that different sets of rules or principles govern designers' perceptions with different levels of design expertise. Hence, designers' performances are likely to be influenced by different sets of factors depending on the levels of design expertise of designers. An inductive approach adopted was to construct models (section 5.6) to account for these expertise-dependent rules in order to enhance designers' performance. The simplified models indicate that one particular rule is shared by all subjects when perceiving design briefs. Psychological factors including individual affections, motivations and volitions are overarching commonalities influencing every subject's perceptions. Design educa-

Subjects / Relating factors	Observations and key findings derived from content analysis, correlation analysis and semi-structured interviews	Potential guidelines for design brief writers (to achieve common purposes associated with the educational context)
Yr1 design students		
Design brief formulations	- look for clues in the actual brief to guide their sorting decisions rather than having some a priori principles. -likely to take single task statement design briefs at face value.	- should consider whether explicit design directions should be provided since any directions provided are likely to be followed without critical assessments.
Design brief formulations	- discover addition information on design briefs in successive sorts and adjust their sort results accordingly. - like to explore new sorting possibilities / not satisfy with initial sort results.	- explicitly state in the design brief to require students to read a design brief slowly and repetitively in order to get additional insights. - encourage students to delay immediate judgments on the design brief (e.g. rearrange sections of a design brief to avoid a routine perception). Use keywords in design briefs so that designers can perform their own search for background information.
Design brief formulations	- were afraid of reading a lot of textual information on design briefs.	- may consider an unconventional (e.g. multi-modal) approach to present information rather than using a typical textual design brief. - lengthy or wordy design briefs seem to be counter-productive and may reduce students' interests. - present crucial information in bullet-point forms.
Design expertise	-Yr1-A and Yr1-C expressed personal preferences on some design briefs calling them interesting, boring or annoying based on the perceived amount of design freedom given in a design brief.	- formulate a design brief that matches a designer's strengths and interests. - may use scenario formulations to provide softer design requirements. - avoid structure formulations or specification formulations.
Design expertise	- seem to lack adequate domain-specific knowledge to associate functions to existing artifacts.	- avoid naming the artifact and utilize function formulations to stimulate creative outcomes.
Design expertise	- mainly focus on a product category. E.g. family/daily use, public/commercial facilities, household products. - are familiar with scenarios and specifications-type design briefs. - use a common-sense sorting priority: product category, design discipline, problem-solving scenario, and some kinds of design requirements (e.g. target users).	- avoid these product categories and familiar presentation formats in order to provide additional challenges to students.

Note: Design brief writers are encouraged to reflect on these key findings in order to adapt to their specific needs and create their own instances.

Table 5.20.: Guidelines towards designer-centered design brief formulations for Yr1 design students

Subjects / Factors	Observations and key findings derived from content analysis, correlation analysis and semi-structured interviews	Potential guidelines for design brief writers (to achieve common purposes associated with the educational context)
Yr3 design students		
Design brief formulations	- start to recognize different kinds of design requirements. - attend to design knowledge required to tackle a design brief. - able to distinguish among various (functional, structural, and stylistic) design requirements and employ appropriate design strategies. - sorting priority: design requirements / design strategies.	- list different kinds of design requirements in separate groups so that students can get a clear structure to find matching design strategies. - consider that students are likely to operate in a pattern-matching frame of reference when considering appropriate design strategies.
Design brief formulations	- sometimes unable to prioritize information presented on design briefs.	- too much information (more than 2 A4 pages) presented on a design brief is counter-productive. - one or two examples included in design briefs should sufficiently convey the message.
Design brief formulations	- perceive bullet-point forms to contain design requirements that must be satisfied.	- consider the advantages and disadvantages of using a bullet-point form presentation.
Design brief formulations	- were disenchanted by rigid design briefs that dictated design directions and design outcomes.	- consider your reasons for using structures, competitors' specifications and marketing-goals as design brief formulations. - avoid providing too concrete examples. - consider using situations that are perceived to be more lively and inspirational. - design requirements should be opened to various implementations.
Design expertise	- start to recognize vagueness or ambiguity of a design brief. - can provide their own assumptions to supplement very short design briefs. - diverse perceptions generated from the same design brief.	- provide sufficient information in the design brief to avoid unnecessary confusion since subjects' own assumptions may lead to miscommunications. - perceived vagueness or ambiguity of a design brief also depends on the observer. - diverse interpretations of a design brief may be desirable but can be minimized by using structure or specification formulations.
Design expertise	- attend to design freedom and fun for designers. - titles often affect designers' first impressions of design projects. - enjoy selecting their own directions and challenge existing solutions.	- provide current situations or user scenarios. - provide interesting titles for design briefs.
Design expertise	- 4 subjects Yr3-C, F, G, and H displayed personal interest and preference when discussing their sort results.	- need to understand a designer's interests and preferences explicitly and individually before formulating a design brief.

Note: Design brief writers are encouraged to reflect on these key findings in order to adapt to their specific needs and create their own instances.

Table 5.21.: Guidelines towards designer-centered design brief formulations for Yr3 design students

Subjects / Factors	Observations and key findings derived from content analysis, correlation analysis and semi-structured interviews	Potential guidelines for design brief writers (to achieve diverse purposes associated with the professional context)
Prof. designers		
Design brief formulations	- heuristics using function formulations to stimulate creative outcomes seem to work due to designers being motivated to avoid trivial solutions and to solve a harder design problem rather than due to variations of the problem-solution space.	- simply ask designers to be more creative when creative solutions are needed. - motivations and volitions seem to be crucial in enhancing designers' performance (future research directions are discussed in the next chapter).
Design expertise	- attend to design freedom, clear design goals and vagueness of design briefs. - emphasize design freedom and working priority in practice (5 subjects, Prof-A, B, E, F, H). - attend to teamwork and collaboration with other experts.	- provide explicit and clear goals in design briefs addressing pertinent issues such as a project budget and schedule. - scenario formulations can be used to provide softer design requirements. - provide flexibility for designers to alternate different types of design tasks and work collaboratively.
Design expertise (subjects' aversion for design briefs)	- design brief formulations based on me-too, copy-cat products' specifications. - marketing-driven and sales-oriented design briefs. - design briefs that presented final products' implementations. - specifications seem to generate frustrations (4 subjects, Prof-C, Prof-E, Prof-F, Prof-H) - specifications are perceived to be strict requirements that need to be fulfilled or only routine kinds of design activities are required.	- avoid using an exact copy of competitors' specifications as a design brief. - target sales and current market trends should be included when deemed necessary. - have an open-ended design brief and avoid naming the artifact. - consider the potential negative effect on professional designers when using specification formulations. - specification formulations may lead to lower performance of professional designers due to a lack of interest.
Design expertise (subjects' preferences for design briefs)	- design briefs that could resonate with personal interests. - design briefs that encourage designers to take risks as opposed to safe design briefs. - design briefs that stroke a balance with design, business and engineering. - design briefs that did not have right or wrong solutions.	- match designer's interests with tasks or projects whenever possible. - provide a trusting work environment and delay judgements on initial concepts. - involve various stakeholders in design brief formulations with feedback loops. - have an open-ended design brief and avoid naming the artifact.
Design context	- implicit assumptions of the presentation format of design briefs in practice seem to coincide with different stages of design projects - bullet-point form – top working priority - scenario – lower priority (need additional information to refine the situation), also contain softer design requirements. - single-task statement – two possible perceptions, given a lot of design freedom and ready for concept generation (perceived by senior designers), or the lowest priority due to no design directions (perceived by junior designers). - a specification formulation signifies the final stage of a design project while a scenario formulation often signifies the beginning stage of a design project. - the frequent use of verbal design briefs in the professional context.	- attend to the presentation format of a design brief that may carry an implicit meaning derived from the professional context. - recognize that a design brief serves many different purposes in the professional context. - different disciplines may have different conventions related to the presentation format of a design brief. - design managers should encourage an open atmosphere to interact with junior designers and vice versa to discuss these implicit working priorities. - avoid a single-task statement design brief to minimize potential miscommunications. - the dual-function of a verbal design brief as a legal document and as a stimulus for a design process may not be compatible.

Note: Design brief writers are encouraged to reflect on these key findings in order to adapt to their specific needs and create their own instances.

Table 5.22.: Guidelines towards designer-centered design brief formulations for professional designers

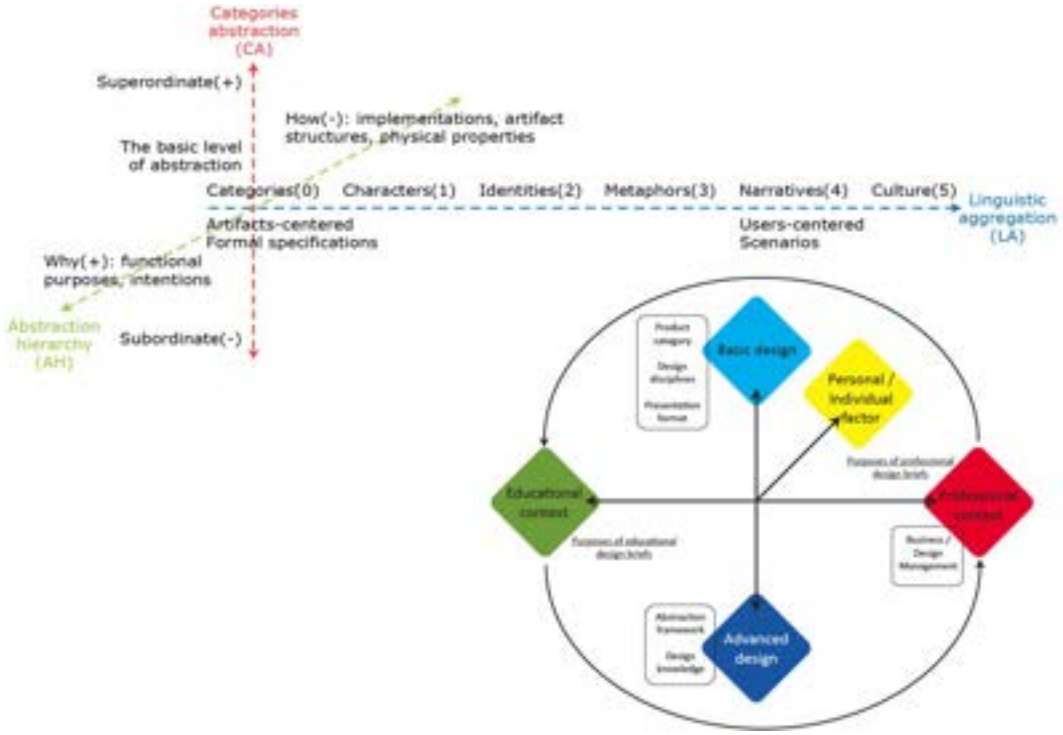


Figure 5.10.: The complementary frameworks of design brief production and design brief reception

tors seem to be familiar with this particular aspect relating to students' performance and take a student-centered approach when formulating design briefs for design students in section 3.4. A thorough understanding of individual student's abilities and preferences require design educators' diligence and patience. Design managers and design brief writers in the professional context probably would benefit from taking a similar approach used by design educators in formulating design briefs for professional designers. The complementary framework of design brief production and design brief reception are juxtaposed in figure 5.10 to illustrate the importance of understanding how various dimensions of the existing production framework may project onto the reception framework.

The above guidelines could be used as a basis from which to approach a more designer-centered framework for future design brief formulations. Moreover, these

Figure 5.11.: A simplified 3-step checklist to illustrate the procedure of formulating a design brief

tentative guidelines are expected to possibly assist design researchers to formulate concrete hypotheses for future testing and further validation.

In terms of practical guidelines for design brief formulations, user scenarios or narratives seem to be a universal format that is preferred by all subjects regardless of expertise levels. Functions and specifications formulations should be used with caution because these formulations seem to affect different designers to different extents. It was unexpected that presentation formats seem to play an important role affecting designers' perceptions, especially with bullet-point forms often indicating authoritative requirements. These conventions might carry significant implications and connotations to designers in the professional context that need to be further investigated in future studies.

In order to demonstrate the use of these guidelines, a simplified 3-step checklist (figure 5.11) is provided to illustrate the procedure of formulating a design brief from a systemic perspective.

0. Be aware of the specific design context (i.e. educational, professional, social, cultural, etc.).

1. Consider the specific purposes and implicit assumptions (in the given context).

2. Consider the design expertise of your audience (i.e. based on the models of design brief reception).

3. Select an appropriate design brief formulation from the abstraction framework based on the proposed guidelines.

Several examples are provided in table 5.23 to demonstrate the potential applications of the designer-centered guidelines. However, the outcomes are open-ended and the 3-step checklist is more concerned with assisting the design brief writer to consider their rationales and assumptions explicitly when formulating a design brief than to select an optimal design brief formulation. This particular approach considers designers to be users of design briefs and aims to better match a design brief formulation to the intended readers of a design brief with the stated purpose. The results are not intended to be prescriptive.

5.8. General conclusion and discussion

Analyses of design process observations are previously used to explain how design cognition and design strategies result in design performance differences. Studies of this kind effectively establish a causal relationship between design expertise and design performance. However, the role and consequences of design brief formulations as observed in this study appear less trivial as indicated in the literature reviewed in chapter 1. Due to the complexity and implicit nature of problem framing, these activities appear difficult to be captured by verbal protocols during the design process. As a result, the design process is not investigated in the study. Instead, a new notion of designers' perceptions of design briefs is introduced in the card-sorting exercises. This new notion is related to individual subjective perceptions based on a qualitative approach aiming to explain individual designers' performance differences. Since the card-sorting focuses on investigating how various design brief formulations are perceived and

0. The assumed context is in the professional context of industrial design			
1. Common purposes associated with the professional context of industrial design	**Implicit assumptions that are often associated with the stated purpose**	**2. Target audience and their perceptions**	**3. Potential design brief formulations and rationales**
Develop a defensive product	- competitors' products already existed on the market. - a short time frame (a few weeks) for product development. - low profit margin and competition based on the cost factor.	Experienced (more than 3 yrs) designers are likely to find this type of design projects boring. Novice designers are more likely to follow the design brief as instructions.	Competitors' specifications can be selected as the desirable design brief formulation for novice designers.
Avoid mis-interpretations of a design brief	- a contractual document may be needed. - multiple stakeholders with diverse background need to agree upon the details of a design project.	A diverse group of audience is likely to misinterpret a single statement design brief.	A design brief should be formulated by the comprehensive contextual approach according to the discipline requirements.
Win design competitions	- exceeding judges' (often expert designers) expectations or going beyond the established frame of reference for the given artifact is needed.	Experienced (more than 3 yrs) designers are likely to be interested in this type of design projects. Novice designers may not have enough domain knowledge to identify attributes and requirements with the given artifact.	A specification formulation can be used to irritate or challenge experienced designers. A scenario formulation can also be used with experienced designers. Various function formulations can be used to stimulate novice designers.
Initiate a new product development	- assuming that the brief writer has some preliminary ideas about the new product, it is essential to communicate the novelty and marketability of the product effectively to senior management.	Senior management and potential clients may have a different understanding of the new product. - for target audience who are designers, design brief formulations proposed are similar to those used in winning design competitions.	Scenario formulations are likely to be more communicative to show potential usages of the product. Note: Beyond the existing model of design brief perception (may be a future direction for research).
Redesign of an existing product	- the existing product has a good sales record and small improvements are needed. - potential directions for improvements can be obtained from users feedback on the existing product.	Designers may generate their own insights by using and experiencing the existing product directly. Designers may propose more changes than required.	Scenario formulations showing usages of the existing product can be used. Structure formulations may be used to suggest minor cosmetic or stylistic changes are needed.

Table 5.23.: Potential applications of the designer-centered guidelines in the professional context

interpreted by individual designers, design performance is not directly measured or evaluated as in the pilot study. Designers' performance differences are inferred based on favourable or unfavourable perceptions articulated by designer subjects after perceiving particular design tasks. This assumption posts a major limitation of using the results to explain design performance differences. The complexity of inferring a causal relationship between design brief formulations and design performance is unavoidable even with statistical methods employed in earlier studies. Nonetheless, this limitation is partially mitigated by other researchers' finding (Latham, 2006; Thomas, 2000; Amabile, 1998) that subjective experience including emotion and conations were crucial to individual's creativity and hence performance.

Another limitation is due to the use of a mixed-method in the study. The results of content analysis might lack generalizability compared to those based on statistical methods. However, the depth of its analysis offers many insights to understand designers' performance beyond those offered by the existing theoretical abstraction framework. Furthermore, the card-sorting exercises could be viewed as 40 case studies with 5 different levels of design expertise. The results suggest that there is some transferability of cases within each level and between levels. One particular aspect regarding the psychological/personal perspective of designers seems to show similarities to all cases, which may be due to the fact that subjects share some innate characters as humans and as designers. This commonality also led me towards a designer-centered framework for design brief formulations.

In contrast, extreme cases are noted amongst the professional subjects that make analyses more difficult but also provide richness of data for analysis. In this study, the effect of interpreter's bias is minimised by using the content analysis method to quantify and recode the interview data. Nevertheless, the diverse sort results of

professional subjects suggest that further studies on more subjects are necessary to understand professional designers' perceptions at a greater level of detail. The descriptive model of professional design briefs formulations (figure 3.9) also suggests that the applied process of formulating design briefs involves complex situations and interactions with multiple stakeholders. The mixed research method selected here seems appropriate in order to achieve an in-depth understanding of designers' perceptions towards design briefs in the professional context.

CHAPTER 6
CONCLUSION AND DISCUSSION

This chapter summarizes findings related to the three research questions. The finding suggests that contextual and personal factors should be considered explicitly when formulating design briefs since these aspects seem to be an integrated feature of design expertise involving designers' emotion. Practical guidelines of design brief formulations are proposed for designers with various levels of expertise. Theoretical contributions and limitations of the study are discussed especially with respect to the abstraction framework. This chapter also discusses the implications of findings in relation to design education and design practice. The gap between design education and design practice appears to be a mental barrier that differentiates perceptions between design educators and design managers. Their assumed roles and responsibility in the given context seem to prevent sharing of knowledge necessary to facilitate interactions with design students as well as junior designers. Future research directions are outlined to iteratively improve the explicit design brief production-reception cycle from a systemic perspective.

6.1. Summary

The three original research questions are presented below:

1. What contextual factors related to design brief formulations are unique in the Hong Kong context and how are these factors compared to existing knowledge in the western context?

2. What are the relationships among design brief formulations, design expertise and design context to designer's performance?

3. How to improve the existing predominately prescriptive nature of design brief formulations?

The study establishes an integrated and systemic perspective to investigate design brief formulations. Beginning with the contextual approach to investigative design brief formulations in the Hong Kong context, the study broadens the scope of both the cognitive approach and the design expertise approach that seem to narrowly define the only purpose and assessment criterion of design brief formulations is to achieve innovative design outcomes. Interviews with design educators and design managers reveal the diverse purposes of design brief formulations and the influence of context on evaluation criteria of design performance. Two aspects seem to be unique in the Hong Kong professional context including the frequent uses of verbal design briefs and specification-type design brief formulations that may be related to the SME and OEM nature of design industry in Hong Kong.

By adopting a systemic perspective, two complementary frameworks for design brief production and reception are established completing the cycle of design brief formulations that has previously been considered to be heuristic methods to enhance creative design outcomes. The abstraction framework consolidates existing approaches to formulate design briefs and provides a systematic instrument to

vary and reflect upon a design brief formulation based on theoretical concepts. By integrating the three existing approaches using an intermediate variable, designers' perceptions of design briefs, the study proposes how design brief formulations, design expertise and design context are related to one another. Since both frameworks are explicit structures that are empirically testable, the models of design brief perceptions suggest that the abstraction framework for design brief production tend to be dominated by cognitive factors and neglect individual and personal factors that are often developed along with design expertise in the professional context. Expert designers' perceptions also seem to suggest that cognitive factors alone cannot adequately predict their performance since expert designers tend to utilize many subjective and emotional elements to interpret design briefs. Overly-detailed design briefs or specification formulations for expert designers may be counter-productive. Expert designers tend to engage in an active form of reading when interpreting a design brief providing their assumptions and context while novice designers tend to be more passive. This observation may explain why guidelines of formulating design briefs for novice designers seem to be effective because novice designers tend to interpret a design brief at face value. This active form of reading also reminds me of a kind of philosophical hermeneutics (the study of the interpretation of texts) proposed by Gadamer (1976) in philosophy that the goal of interpretation is not to recover the single and original intention of the author but instead to call for an authentic understanding to a text since "understanding is not reconstruction but mediation (Gadamer, 1976, p. xvi)." Authentic understanding, which is always contextualised, is achieved through a fusion of horizons when designers bring along their individual understandings and interpret design briefs with openness and respect. When understanding a difficult design brief, designers need to broaden their own horizons. An ideal

situation is where horizon of designers is expanded sufficiently to include the horizon of the design brief. With openness and respect, designers allow the brief to expand their horizons as they read it and achieve a better self-understanding. Superior performance of expert designers may originate from this active form of reading of design briefs. Diverse interpretations of a design brief are desirable for developing a not yet exist artifact when designers imagine and create their unique meaning from a design brief that may consequently lead to more original design outcomes. It also appears that a scenario formulation tends to be the most favourable formulation regardless of design expertise and context. Nonetheless, the existing understanding of a scenario formulation remains limited. A scenario formulation for the study consisted of background information and a user character and the definition has not been discussed in details. If a scenario formulation is similar to story-telling and narrative, it may be beneficial to investigate the formulation from a movie-script writer's perspective. Since movie-script writers need to evolve audiences' emotion in a short period of time and seem to understand the format and structure that capture audiences' attention at the right moment. This potential direction calls for the study of designers' emotion in addition to design cognition. Finally, designers' perceptions of design briefs are influenced heavily by the given context and both design educators and design managers seem to be fixated by their accustomed context. Their perceptions of design briefs seem to differentiate clearly their respective roles in the given context. Design educators tend to regard professional work as routine and boring while design managers tend to regard educational work as too ideal and unrealistic. The disparity of these perceptions seems to originate from the lack of integration between design education and design practice. There also seems to be a mental barrier that separates the role and responsibility between an educator and a manager. When

design managers adopt an educator's role, they become more aware of the needs of students. But once they switch back to their manager's hat, design managers seem to forget about the influence of designers' motivation and emotion on design performance. Both parties appear not to notice that educators' and managers' responsibilities are similar in many aspects. For instance, educators are familiar with adopting a student-centered approach to formulate design briefs in order to enhance students' performance while design managers need to develop strategies to avoid designers being bored by routine design tasks. Both parties would benefit by learning from each other and sharing their knowledge about interacting with design students and junior designers. If a similar designer-centered approach of formulating design briefs can be adopted by design managers and clients in a professional context, designers with different expertise levels can better utilize their potential in every design project.

Even though this study formalised the phenomenon as a cycle between design brief production and reception, design educators seem to recognise intuitively that there is an intricate connection between design briefs and abilities of design students. The finding seems to coincide with design educators' understanding that students' perceptions of design briefs are affected not only by cognitive factors, but also by affective and conative factors (figure 3.2). Nonetheless, designers' perceptions are shown to be highly related to individual, social and cultural contexts, the tentative framework for design brief production probably needs to be broadened to include not only design domain knowledge, but also non-cognitive and contextual factors in future studies. Since the tentative framework for design brief reception already explicitly states factors (context, personal and individual aspects) that are neglected in the existing design brief production framework, design researchers and design brief writers can systematically improve these

aspects when formulating design briefs in different contexts.

6.1.1. Practical contributions

The overall results suggest that different sets of rules or principles govern designers' perceptions with different levels of design expertise. Hence, designers' performances are likely to be influenced by different sets of factors depending on designers' expertise and their assumed context. The simplified models of design brief reception (section 5.6) indicate that psychological factors seem to influence every subject's perceptions besides domain-related knowledge. Psychological factors including individual affections, motivations and volitions are overarching commonalities influencing every subject's perceptions. Design educators are familiar with this particular aspect relating to students' performance and take a student-centered approach when formulating design briefs for design students in section 3.4. A thorough understanding of individual student's abilities and preferences requires design educators' diligence and patience. Design managers and design brief writers in the professional context probably would benefit from taking a similar designer-centered approach when formulating design briefs for professional designers.

In terms of practical guidelines for design brief formulations, user scenarios or narratives seem to be a universal format that is preferred by all subjects regardless of expertise levels. Designers prefer to have opportunities to explore the situation and exercised their creativity when the required artefacts are not limited by specifications or physical structures. Scenarios seem to offer the most reliable form of design brief formulations to promote designers' interest in the design task at hand. Presentation formats also play an important role affecting designers' perceptions, especially with bullet-point forms often indicating authoritative requirements.

Other formulations including functions and specifications formulations should be used with caution because these formulations seem to have many unintended consequences and affect designers to different extents depending on their expertise levels.

Formulating design briefs for novice designers

Novice designers often interpret design requirements given in design briefs literally and regard design briefs as instruction-following exercises. This characteristic seems to enable novice designers to efficiently tackle specifications and structures formulations without challenging the given design requirements. In addition, functions formulations are able to guide novice designers to avoid considering preconceived or already-existing solutions because novice designers may not have enough domain-specific knowledge to passively recall known or standard solutions. Novice designers have to actively seek potential solutions to fulfil the functional requirements. These potential solutions are often unexpected and appear to be more creative when compared to known solutions.

Formulating design briefs for intermediate designers

Intermediate designers often exhibit traits of both novice and expert designers and they tend to attend to design briefs mainly from a design perspective. Nonetheless, intermediate designers seem to be at a cross-road where they may express confusion and frustration towards design briefs if they are uncertain about what is expected from the tasks or if they notice that there may be additional criteria not yet provided on design briefs. Their performance with respect to various design brief formulations would probably be unpredictable and scenarios formulations again are preferred in this situation.

Formulating design briefs for experienced designers

The effect of functions formulations on experienced designers is more complex since they possess sufficient domain-specific knowledge and oftentimes succeed in guessing the intended artefacts. In order to achieve the same result with experienced designers, functional requirements must be far off from designers' immediate associations and knowledge domains. An unexpected consequence is that even though experienced designers are able to guess the intention of design brief writers using functions formulations, some designers consciously avoid these "trivial solutions" or try to solve a harder design problem. This mechanism seems to rely on individual designers being motivated to overcome trivial solutions rather than an intended consequence of functions formulations. In order to enhance experts' performance, the approach is to formulate design briefs that are interesting and meaningful when perceived by expert designers. Scenarios formulations with background information are preferred in this situation. More specific guidelines are described in section 5.7 and can be used as a basis from which to approach a more designer-centered framework for future design brief formulations. Nonetheless, the current understanding of scenarios and narratives for design brief formulations tends to be superficial. If a scenario formulation is similar to story-telling and narratives, it may be beneficial to investigate the formulation from a movie-script writer's perspective. Since movie-script writers need to evolve audiences' emotion in a short period of time and seem to understand the format and structure that capture audiences' attention at the right moment. The reflection also coincides with the simplified models of design brief perceptions that designers' emotion and motivation are crucial aspects in addition to design cognition. In addition, expert designers who have likely developed their own design principles and philosophy tend to consider written design briefs to be too limiting, as in the case

of detailed product specifications. Expert designers would rather hear clients' or users' concerns directly and devise their own design briefs. Under both circumstances, different design brief formulations can have different effects on designers' performance depending on their respective expertise levels. Specifications or structures formulations should be avoided when formulating design briefs for expert designers. Specifications seem to elicit negative reactions from experienced designers although they consider researching competitors' features a routine in their design processes. They said that specifications remind them of a copy-cat type of design projects or often imply that the design project is near the final stage so that most of the requirements have been finalized. Professional designers said that they want to follow through the entire design project from its initial conception to final production. The final product gives designers a sense of achievement. This character is more prominently displayed in experienced and expert designers.

6.1.2. Theoretical contributions

In previous studies design brief formulations were often discussed as heuristic tools to promote outcomes' creativity without any specific qualifications of other contextual variables. This study ventures into uncharted territories in the research landscape and investigates applied cases of design brief formulations in both the educational and professional context in Hong Kong. At a contextual level, design brief formulations in an educational context are more structured and systematic (chapter 3). Design briefs can be iteratively revised by design educators in order to achieve suitable learning conditions for a specific cohort of students every year. Design educators also have opportunities to get acquainted with students' abilities, personalities and preferences beforehand and are able to use the knowledge in trying to enhance students' performance. Even though design educators employ

certain creativity techniques when formulating design brief to enhance students' performance, they consider a holistic design process experience and students' self-fulfilment to be more important than only producing desirable design outcomes. In other words, design educators do not emphasize any design brief variation to stimulate students' creativity but instead provide an environment following a student-centered principle so that students can fully utilize their potential in every design project. Educational design brief formulations based on a student-centered principle seem to be an exemplar strategy for achieving superior design performance.

Design brief formulations in a professional context are more complex because the origin of design briefs is diverse and design briefs may have a conflicting role as legal documents (section 3.3.7). Another reason may be the fact that verbal design briefs are the norm in the design industry especially for innovative and not-yet-existing kinds of products. Verbal design briefs may be ambiguous based on individual intuition and ideas come up during group brain-storming sessions. Written design briefs are formulated only after stakeholders (clients, design managers, sales and marketing personnel) have exchanged their ideas and settled any disagreements. Written design briefs at this stage often contain formal specifications and are comparable to implementation plans rather than stimuli for creative design processes. Nonetheless, design managers would sometimes vary briefing details so as to stimulate junior designers' initial concepts for a design project. In addition, a tentative framework for design brief reception (figure 5.9) is introduced to assist the discussions of various factors affecting designers' performance for future studies.

At an individual level, perceptions of design briefs are often unique and personal. No two subjects seemed to perceive design briefs in the same way in

the card-sorting exercises even though Yr1 design students' sort results tended to share many similarities. Different subjects exert different degrees of personal preferences when perceiving design briefs. The assumption under the rational problem-solving paradigm of conveying the same meaning from a design brief to everyone seems to contradict with the intention of formulating design briefs in order to promote diverse interpretations. From a cognitive viewpoint, the effect of design brief formulations on designers' problem-solution space seems to diminish with increasing design expertise because professional designers tend to rely on their prior experience when perceiving design tasks. Experts' abilities of actively framing design situations seem to negate the influence of design brief formulations. Expert designers seem to engage in an active form of reading when interpreting a design brief while novice designers tend to be more passive. Since experts' perceptions are holistic and integrated with prior experience, expertise also leads to a few disadvantages when perceiving design briefs. One disadvantage is that professional subjects show increasing resistance to alter their initial perception of design briefs while novice subjects are eager to try out different sorting principles. Another characteristic of professional designers is a relatively low tolerance for boredom, routine and repetition. They tend to seek out new challenges in every design project. Expert designers are likely to be disenchanted if the given design brief reminds them of a previous uninteresting project or shows signs of being a routine design task such as specifications of existing products.

This study concludes with simplified models of design brief perceptions that were constructed based on different expertise levels showing respective concerns and priorities of various subjects (section 5.6). Designer-centered guidelines for formulating design briefs are proposed because of the complexity of the processes by which design briefs are formulated in the professional context. If designers were

expected to fully utilize their potential in any given situation, design brief writers should adopt a designer-centered perspective to consider individual professional environment and psychological factors before formulating design briefs.

6.2. Limitations of the study

6.2.1. Implementation of the abstraction framework

In this study, I investigated how design briefs can be formulated with respect to design expertise in order to enhance designers' performance. A major limitation is how to reliably translate and represent theoretical concepts into various design brief formulations. A similar issue in systematic research is called internal validity. It involves operationalizations of constructs or concepts into measurable quantities for testing hypotheses. For instance, design performance is operationalized in the form of creativity ratings of sketches in order to be assessed and evaluated. The same rule applies to design brief formulations, which have to be understood and be useable by other researchers. If researchers interpret a single concept in different ways during design brief formulations, reliability of findings may be affected. Since three dimensions (CA, LA, AH) of the abstraction framework (section 4.2) were used to formulate design briefs, each dimension represented a unique concept that needed to be operationalized into actual design briefs used in the two empirical studies.

Design briefs were formulated in pairs so that the effects on design performance can be analyzed using statistical methods. Design brief pairs formulated based on the categories abstraction (CA) dimension were readily defined based on Rosch's studies (Rosch et al., 1976) of superordinates, basic and subordinates for naming object categories. The distinctions between formal specifications and user scenarios

under the linguistic aggregation (LA) dimension were also distinguishable and commonly acknowledged by designers. On the contrary, when formulating design brief pairs based on the abstraction hierarchy (AH) dimension (i.e. functions versus structures), design brief writers may reach multiple acceptable function formulations of an artifact. For instance, what is the function of a lamp? The artifact can be described as a lighting device. The function can also be described as a decorative art piece for a living room. Stating the function of an artifact depends on design brief writers' intention at the moment of formulating the design brief. During a semi-structured interview, this issue has been raised by one design educator (section 3.3.7), who has experience in varying design brief formulations to avoid design fixations in students' design projects. He cautioned that preconceptions existed in many layers similar to onion peels. Stating a function allowed to avoid the students' most common preconception of an artifact. However, researchers prescribed a preconception at another level. He stated that a kitchen can be replaced by a cooking area in a design task. A cooking area can further be replaced by a meat cutting area and a wash basin. Each replacement built in a different level of preconception, which he described as unavoidable. Actually, it was not his intention to avoid preconceptions when formulating design briefs but instead he wanted to build in appropriate preconceptions so that design outcomes can become more creative than those initiated by other formulations.

From the beginning of this study it was apparent that generally agreeable criteria for function formulation of artefacts are difficult to identify as they depend largely on perspective, culture and context. Nonetheless, design brief writers should be allowed to independently construct comparable function formulations in order to validate the usability of the abstraction framework. Two guidelines were devised in this study to ameliorate this condition. The first guideline was to select the most

common and immediate function associated with an artifact to represent function formulations so as to limit the number of interpretations. The second guideline was to use the structure formulation as a reference point for design brief writers since any function formulation was formulated in pair with a structure formulation. Design brief writers can use this reference point to refer the function back to a physical artifact. Design briefs used in the two empirical studies were revised based on these guidelines. In addition, some design briefs were taken from a standard product design textbook (Roozenburg & Eekels, 1995). All of these efforts assisted in producing more reliable function formulations. The effect of diverse interpretations also influenced design brief formulations of the remaining two dimensions but to a lesser extent since distinctions had been established formally in previous studies.

In retrospect, implementations of the abstraction framework to formulate design briefs inevitably relied on design brief writers' interpretations and experience of the design domain. The abstraction framework, which focuses on a cognitive basis, regards designers as information processors but neglects other non-cognitive aspects of humans' understanding and behaviour. The exploratory nature of the card-sorting exercises enabled me to solicit designers' perceptions of design briefs inductively rather than simply confirming or rejecting the expectation of the abstraction framework. Even though design briefs were still formulated in accordance with the framework, the research focus shifted to designers and the aim was to interpret what designers had to say regarding the given design brief formulations.

6.2.2. Relationships between design brief formulations and design performance

In the literature review chapter 1, I model design brief formulations as having both a direct effect and an indirect effect on designers' performance. The direct path is based on a historical understanding of how an objectively-defined problem-solution space influences performance under the rational problem-solving paradigm. The indirect path introduces designers' perceptions of design briefs as an observable intermediate variable, which can be viewed as involving designers' abilities to actively frame the problematic situation. Since the dynamics of the design process is not explicitly investigated in this study, the above relationships between design brief formulations and design performance are assumed to be causal and are studied in the two empirical studies respectively.

Nonetheless, results of both studies suggest that connections between design brief formulations and design performance are complex and probably do not justify the assumption of a linear cause-and-effect relationship. This seems to be due to the complex interaction between design brief perceptions and design expertise that is difficult to be modelled precisely and measured reliably. The concept of a trivial cause-and-effect relationship, which is inherited from natural-scientific disciplines, may not be directly applicable to the study of design performance. Similar cause-and-effect assumptions also plague other design studies. Researchers have previously tried to identify independent variables that led to superior design performance. The only variable that researchers identified was the holistic notion of design expertise that seemed to explain and correlate to superior design performance. When other intermediate variables such as expert designers' strategies and behaviour are introduced to the study of design performance, results are often inconclusive, especially when expert strategies were prescribed to independent

designers. The result may imply that expert design strategies are unique and need to be integrated with a suitable designer's profile on an individual basis. This study suffers from the same limitation when a new variable, namely designers' perceptions of design briefs, is introduced to investigate, and possibly to explain designers' performance differences.

The pilot study employed self-reporting questionnaires to solicit designers' perceptions of design briefs. The method is shown to be largely ineffective in accessing designers' perceptions since only the notions of abstraction and complexity were evaluated.

Moreover, the card-sorting exercises did not measure or evaluate design performance directly but instead inferred performance differences based on favourable or unfavourable perceptions articulated by subjects with various expertise levels. However, when designers' perceptions of design briefs are evaluated based on subjects' verbal protocols, qualitative models of designers' perceptions (section 5.6) are constructed based on multiple perspectives articulated by subjects. The models provide plausible explanations to the interaction among design brief formulations, design expertise and design context. This new variable is shown to offer explanations to complement the quantitative analysis in the pilot study.

The relationship between design brief formulations and design performance may not be as direct and influential as suggested by the cognitive approach, especially in the professional context. Designers' perceptions are shown to be heavily influenced by many contextual and personal factors. In other words, design brief formulations probably are only necessary but not sufficient conditions leading to superior design performance. On the one hand, a preferred design brief formulation offers designers' opportunities to excel, but design outcomes are determined by designers' abilities to tackle the design task. On the other

hand, designers' superior performance should be accounted for and preceded by a preferred design brief formulation or an appropriate frame created by individual designers.

6.3. Implications for design education and design practice

6.3.1. Development of expertise in design education

Various stages of design expertise development are described in the literature review section 1.4. Two distinctive development periods can be identified. One period describes the gradual development of naive designers to intermediate designers. This development period is targeted by the current study and training curricula in formal design education. Another period is less structured and more unpredictable, namely the development from intermediate designers to master or visionary designers. Dorst (Dorst, 2008) suggests that intermediate designers can reach another stage in certain areas before completing the previous stage. This escape clause is useful in showing the difficulty of describing expertise development which does not seem to follow a linear process. Since this study investigates snapshots of design brief perceptions with respect to various levels of design expertise, results of the card-sorting exercises provide opportunities to reflect upon the development of design expertise.

In terms of domain-specific knowledge, Yr1 design students express a small amount of domain-specific knowledge in their sorting protocols. Most protocols are related to various design disciplines and a general understanding of product design based on common senses. Yr3 design students' perceptions of design briefs are more hierarchical and elaborated containing many domain-specific knowledge and concepts. They are able to view design briefs from multiple perspectives.

However, their articulations are sequential meaning that they consider a single aspect at a time. Professional designers' perceptions are the most holistic and their protocols are often perceived to be opportunistic because they switch back and forth from various perspectives seamlessly and multiple perspectives seem to appear in parallel in their protocols. Popovic (2004) reports similar findings in her study of the presence of domain-specific knowledge in designers with various levels of expertise. She describes the transition of novices to experts based on the notion of knowledge structures. Domain-specific knowledge is scarce and scattered, and the links between concepts are weak in novice designers' knowledge structures (Yr1 design students). Intermediate designers' structures contain some grouped concepts and limited experiential knowledge (Yr2-Yr3 students) while experts' domain-specific knowledge and experiential knowledge are rich and organised (graduates with 3-10 yr. of practical work experience). Both studies suggest that novice designers become more competent through gradual accumulations of domain-specific knowledge in formal design education and experiential knowledge in professional practice.

Under the current design curriculum, the transition of novice designers to intermediate designers is monitored and scrutinised by design educators whereas the transition of some intermediate designers to expert designers is generally taken for granted and not actively supported by formal design education. However, Subject Prof-C and Prof-G sort results are not too different from those of many Yr3 subjects. I speculate that the skills and knowledge of intermediate designers may remain the same over the years if the professional practice environment is not suitable for expertise development. A worse scenario would be that professional experience may act against the development of design expertise for junior designers when design decisions are frequently overruled by business or

sales considerations. Subject Prof-G stated that he is frustrated because his ideas are frequently rejected by his supervisor.

Therefore, the first three years after graduation seem to be crucial as graduates often work as junior designers at a point in their professional development when they start to develop their own design strategies and personal styles. Practicing graduates not only gradually accumulate design cases but also build up their own schema to analyze design tasks. However, junior designers are unavoidably influenced by decisions and behaviour of their superiors. Superiors are authoritative figures, communicators and role models to junior designers. Under authoritative influences, junior designers may tend to reinforce certain relationships and concepts while simultaneously weaken those relationships that do not seem to be valued in the professional context. Junior designers can become frustrated or disillusioned in practice without proper guidance or reference similar to a low-scoring student who does not know what is wrong with his design outcome. One difference is that students would receive guidance from educators while junior designers may not have the needed supports since many design managers and supervisors are not trained as educators. They were used to provide an absolute (yes/no) answer without any explicit rationales when making decisions in front of junior designers (see section 3.3.1). The relationship between some senior and junior designers can be regarded as giving and following orders. Junior designers may not recognise that some decisions were based solely on a business perspective or do not regard the given design tasks as meaningful.

This observation may simply reflect the current design curriculum that emphasizes the acquisition of domain-specific knowledge first and practical experience later. The importance ascribes to apprenticeship in some strands of design education may give clues to the continuing training and development for design

graduates. Apprenticeships are also common in other professional fields in which professional performance is critically dependent on experience, including medicine and law. The rationale is that certain important tacit knowledge and values can only be transmitted in an applied practical setting. Under tutelage, apprentices observe and listen to what the master says and does during the design process. A master also encourages apprentices to reflect on their decisions. This kind of post-graduated development seems to be more important than formal education since once certain working patterns had been reinforced in practice, such habits cannot be broken easily. Interviews of professional subjects (section 5.8) indicate that subjects' working priority and routines play an important role in assessing design briefs. Habits or strategies acquired in professional practice are likely to influence designers' expertise development. If design managers lean overwhelmingly towards a business perspective without articulating their reasons to junior designers, junior designers are likely to develop their views and decisions from a similar perspective. Some subjects (Yr3-H, Prof-B, Prof-F and Prof-H) also expressed that there is a need to have a balance between design considerations and business considerations in any design projects. Junior designers and graduates seem to be more susceptible to these influences.

If the goal of design education is to foster expert designers, not just intermediate designers, future design curricula should actively and explicitly consider the early professional period after graduation. An internship stage shortly after graduation can be adopted in the training of industrial design students in order to assist their expertise development. Otherwise, expertise development after formal design education is left to chance or individual aptitudes to pursue excellence. Nonetheless, the length of formal education cannot easily be extended due to many practical limitations. Industrial collaboration experience during undergraduate

training can be a potential substitute where design students spend alternate semesters at school and at work. In that case, design educators can supervise students' professional development.

6.3.2. Discrepancies of design brief formulations in theory and in practice

I originally assumed that written design briefs are primary initiators of design processes. This assumption is shown to be true in the educational context (section 3.3.6) where design educators use written design briefs and a briefing session to initiate design projects. Written design briefs also serve as "contractual" documents that contain evaluation and assessment criteria for design students and design outcomes. Design educators can iteratively revise design briefs based on previous results of students' performance. This cycle of design brief formulation is adequately reflected in the study.

Nonetheless, this study indicates that the role design briefs play in the professional context is neither consistent, nor trivial, nor causal in a straightforward sense. Verbal design briefs are encountered as commonly as written design briefs in professional practice while verbal briefs seem to dominate small-scale projects. These two forms of design briefs serve different purposes depending on the nature of given design projects. Design projects are roughly classified into small improvements and new product developments. Improvements are associated with existing products while innovations are associated with non-existing, new kinds of products. Economic conditions and individual companies' business strategies determine projects' orientations. It is common to utilize previous generation products' specifications or competitors' features as written design briefs for small improvement projects. New product development usually relies on verbal design

briefs during brainstorming sessions. Verbal design briefs are also utilized during initial meetings with clients as in the case of design consultancies. Verbal design briefs can be unstructured, vague, and spontaneous which may represent a hunch of design managers or clients. Written design briefs are formulated as contractual documents only after a series of exchanges among stakeholders. Design direction may be chosen and initial concepts may be agreed upon by various stakeholders in these contractual documents. In this case, written design briefs serve as implementation documents (specifications) rather than as creative stimuli for the design process.

The impact of using verbal design briefs can be complex as verbal form of language enables flexible variations of design brief formulations and interpretations. Participants in these discussion sessions also receive immediate feedback from stakeholders. Intensive discussions involving multiple parties seem to be a traditional wisdom to generate new products' concepts before anything is written in design briefs. Moreover, the essence of design brief formulations aiming to affect designers' perceptions of design tasks is usually also captured and utilized in these sessions. Even though differences between verbal and written design briefs were not anticipated in this study, this observation suggests that different forms of language use can facilitate different kinds of creative activities. Written and verbal design briefs represent two practical forms of design brief formulations corresponding to different needs in the professional context.

The use of verbal and written design briefs can also be explained by the notion of a product release cycle. Verbal design briefs are necessary for the fuzziness of developing new products. Group discussion sessions emphasize the importance of a collective decision-making process and social interactions in design communications. Verbal language is a suitable form of communications. After

successful launches of new products, customers' feedback is available for products' refinements. Written design briefs focus on using a systematic approach to refine products' specifications by adding or subtracting features. Design briefs at this stage of the cycle are often perceived as unchallenging by many subjects. The role of design briefs becomes a reference document shared by various parties involving in products' implementations and manufacturing. When existing products become mature and saturate existing markets, the cycle starts over again. Design briefs evolve from product release to product release and both forms of design briefs should not be treated as independent entities. Developed based on characteristics of designers, the designer-centered guidelines may still be applicable to formulate verbal design briefs in the professional context. In addition, the situation involving verbal design briefs or verbal form of communications seems to be crucial for innovative product development and should be further explored in future studies.

6.4. Future work

In this study, card-sorting exercises and semi-structured interviews were used to solicit designers' perceptions of design briefs. The sort results suggest that professional designers' cognitive processes are often intertwined with affective and conative qualities. Design brief formulations affect designers' initial perceptions to different extents depending on expertise levels (section 5.8). The results also suggest that designers' emotional states (based on their respective protocols) may be affected when they first perceive the design tasks. Previous design studies (Wieth & Burns, 2000; Fricke, 1999) already noticed the significance of these affective and conative factors and had taken precautious to account for these non-cognitive factors when studying design performance. Designers were assessed for their emotional states using questionnaires before participating in

experiments that focused on investigating designers' performance. Even though it was uncertain whether these psychological factors were causes or effects of design cognition, the observed phenomenon seemed to be intricate and directly affected the understanding of designers' performance.

Researchers from other disciplines have noticed the importance of emotional and motivational factors on cognition. Simon (1967) first incorporated emotional and motivational controls as subroutines to influence cognition. He intended to improve the human-information processing model by calling on these subroutines to mimic human abilities to serve multiple goals and direct attention for immediate needs in actual situations. Nonetheless, the incorporation only reassured the importance of both aspects in theoretical discussions. There were few studies that informed educators on how emotional and motivational development can be used to support design cognition and enhance designers' performance. One of the earlier studies is conducted by Jonassen (2000), an education theorist, who has been in the process of identifying appropriate affective and conative conditions to support solving of various kinds of problems since 2000. He analyzes and classifies problems into various categories and suggested how non-cognitive elements can be developed to assist performance correspondingly. His findings suggest that affective and conative supports are not unique to tackling design problems. However, he considers "design problems" amongst the hardest type of problem that require an individual perseverance. The challenge of developing proper supports for design problems is ongoing and seems to be tremendous because design problems come from various domains and have different contexts. Since there are no optimal solutions for any design problems, designers must challenge existing conditions to arrive at more preferred solutions at different time, place and context. Nonetheless, expert designers seem to require different kinds

of supports from novice designers. The efforts seem incomplete without taking expertise explicitly into consideration.

After proposing the designer-centered guidelines for design brief formulations, the thesis lays a foundation for understanding design brief perceptions based on the contextual factor and the expertise factor. Both factors were shown to be influential in affecting design brief perception and interpretation. In addition, new directions for research have also been revealed in the explicit design brief production-reception cycle. This section provides a few steps to systematically investigate these potential directions for future studies. Since the interviews with design managers revealed that many implicit assumptions are embedded in common purposes in the professional context by convention, the lack of a common understanding of these meanings among stakeholders often leads to designers' frustration. The first step is to make these embedded meanings and conventions assumed in the professional context explicit so that various stakeholders can share a common understanding in design communications. The step can be considered a communication approach to study design management. The second step is to explore the newly re-discovered personal/individual factor in the framework of design brief reception since the affective and conative factors seem to be dominant in influencing designers' performance rather than the pure cognitive factor. If researchers still focus on expressing design expertise at the cognitive or behavioural level, the integral nature of expertise may be neglected. Design researchers should also take design expertise in a broader sense since these non-cognitive qualities are shown to be influential in achieving superior performance in many creative professions (Csikszentmihalyi, 1990; Latham, 2006; Thomas, 2000; Amabile, 1998). Motivational research in management and other non-design disciplines may shed some light on the direction of motivating designers regardless

of expertise. Researchers can also focus on understanding certain innate human characteristics including the notion of self-fulfilment and curiosity to seek out commonalities and differences among individuals. The next step would require empirical studies to validate findings to develop generalisable conditions for supporting designers with various expertise levels. Besides, existing practice in the professional context such as using subjective modifiers and descriptors to describe the quality of an artefact or using multi-modal stimulus to inspire designers can be considered a form of practical wisdom that can be further investigated. The goal is to synthesize these existing findings from practice and other disciplines related to the personal/individual factor into the tentative framework of design brief production in order to iteratively improve the design brief production-reception cycle.

Based on the simplified models of design brief reception, some potential hypotheses for future studies are listed below.

- Specification formulations are likely to be perceived negatively by professional designers. Designers may become unmotivated to perform in such cases.

- Verifications of these implicit assumptions and meanings associated with design brief presentations in other design disciplines and contexts.

- Lengthy or wordy design briefs seem to be counter-productive to students' performance since they may reduce students' interests.

- The heuristic method of using functional requirements instead of naming the artifact to enhance creative outcomes is the most effective on novice designers.

- A bullet-point form presentation seems to provide a false sense of security to novice designers about potential design requirements.
- Scenario formulations providing softer design requirements are preferred by designers regardless of expertise.
- Movie-script like techniques on design brief formulations may be able to arouse designers' emotion and motivation.

In addition, this study only accounts for individual designers' perceptions of design briefs but has not investigated perceptions of design briefs in design teams. Designers with similar or mixed levels of expertise may work together in a design team which adds an extra layer of communication to the complex phenomenon. The effect of communication on individual design brief perceptions and the possibility of a team's perception of design briefs should be investigated in future studies.

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APPENDIX A

EDUCATIONAL INTERVIEW QUESTIONS AND TRANSCRIPTS

Samples of educational interview questions and transcripts

Title: Semi-structured interview regarding formulation of project briefs in an educational setting Rev.3
Doc ID: (SSI_FPBES_r3)

Personal Information:
Please circle your information

Highest educational level achieved in design:	Diploma	High Diploma	Bachelor's degree	Master's Degree	PhD
Years of teaching experience in design:	<3	3-6	7-10	>10	
Area of expertise:	Environmental design	Visual Comm. / Advertising	Product design	other _____	

Part A direction: Please access the following statements by circling the appropriate box from SA = Strongly Agree, A = Agree, N = Neither, D = Disagree, SD = Strongly Disagree. If you are not sure about the statement, please circle "Don't know".

	What makes a good project brief in design?	SA	A	N	D	SD	Don't know
1	A project brief should reflect learning objectives.	□	□	□	□	□	□
2	Formulating a good project brief is a challenging task.	□	□	□	□	□	□
3	A project brief should contain all the necessary information for the project.	□	□	□	□	□	□
4	There is no need to clarify the project to the students by means other than the brief document.	□	□	□	□	□	□
5	Students should understand the assessment criteria from the project brief.	□	□	□	□	□	□
6	I encourage students to discuss the project brief together.	□	□	□	□	□	□
7	Students should be able to identify design requirements from the project brief.	□	□	□	□	□	□
8	Students should ask questions about the project brief. (And do they actually do?)	□	□	□	□	□	□
9	A project brief should be precise and concise.	□	□	□	□	□	□
10	Students should be able to identify design constraints from the project brief.	□	□	□	□	□	□
11	Students tend to misunderstand or misinterpret project briefs.	□	□	□	□	□	□
12	Evaluation criteria should be clearly stated in a project brief.	□	□	□	□	□	□
13	Design requirements are clearly stated in a project brief.	□	□	□	□	□	□
14	A project brief should promote creative and original solutions.	□	□	□	□	□	□
15	A project brief should be a written document.	□	□	□	□	□	□
16	A project brief should be shorter than four A4 pages.	□	□	□	□	□	□
17	Students should find enough information from the brief to start designing.	□	□	□	□	□	□
18	I need to explain the design brief before students fully understand the project.	□	□	□	□	□	□
19	Students often don't spend enough time thinking about project briefs.	□	□	□	□	□	□
20	Discussion of the project brief among students clarifies design requirements.	□	□	□	□	□	□
21	It is easy to formulate different project briefs for different students.	□	□	□	□	□	□
	How do I formulate project briefs?	SA	A	N	D	SD	Don't know
22	I have learning objectives in mind before formulating a project brief.	□	□	□	□	□	□
23	I give hints in the project brief to help students understand the assignment.	□	□	□	□	□	□
24	I revise my project brief a few times before giving it out to students.	□	□	□	□	□	□
25	Formulating a project brief is time-consuming.	□	□	□	□	□	□
26	I use personal experience when formulating the project brief.	□	□	□	□	□	□
27	Students' learning is affected by the project brief.	□	□	□	□	□	□
28	I let my colleagues' comments on my project briefs before giving them out to students.	□	□	□	□	□	□
29	I use textbook examples to formulate project briefs.	□	□	□	□	□	□

30	I refer to printed materials (books, magazines, brochures, etc) to formulate project briefs.	☐	☐	☐	☐	☐	☐
31	I use my environment to stimulate ideas for tasks expressed in project briefs.	☐	☐	☐	☐	☐	☐
32	I sometimes collaborate with industrial partners to formulate project briefs.	☐	☐	☐	☐	☐	☐
33	I spend more than one day to formulate project briefs.	☐	☐	☐	☐	☐	☐
34	I use different methods to formulate my project briefs.	☐	☐	☐	☐	☐	☐
35	I formulate different project briefs according to students' abilities.	☐	☐	☐	☐	☐	☐
36	I judge the effectiveness of my project brief based on students' outcome.	☐	☐	☐	☐	☐	☐
37	I judge the effectiveness of my project brief based on students' process.	☐	☐	☐	☐	☐	☐
38	Effective student learning in design requires strong design process.	☐	☐	☐	☐	☐	☐
39	Effective student learning in design requires strong design outcome.	☐	☐	☐	☐	☐	☐

END OF PART A

APPENDIX A - EDUCATIONAL INTERVIEW QUESTIONS AND TRANSCRIPTS

Part B: Interview questions:

The nature of a project brief:

1. What is a project brief and how is it different from a problem statement?
2. What is the function or goal of a project brief in an educational setting?
3. How do you formulate a project brief for students?
4. Where do you get inspiration for formulating project briefs?
5. What kinds of learning objectives do you have in mind when formulating briefs?
6. What kind of information is included in a project brief?
7. How much time do you spend formulating a project brief?
8. What is the usual length of a project brief (in terms of A4 pages)?
9. How often do you modify your project brief and under what circumstances?

Different kinds of project briefs:

10. Are you aware of different kinds of project briefs?
11. Are you aware of any methods to formulate different design briefs? If so, what are these methods?
12. Do you try to formulate multiple project briefs for a given project?
13. Do you make different project briefs according to the students' ability? If so, how?

Evaluation criteria and students' understanding of the brief:

14. Do you get requests from students to clarify the project brief? Is this good or bad?
15. Do you think asking questions are necessary for students to identify design requirements and constraints from the project brief?
16. What kind of questions about the brief is considered relevant?
17. What kind of evaluation criteria is included in a project brief?
18. How can you make sure students find sufficient information to start designing?
19. Do you think there is a relation between students getting stuck and the project brief?
20. How do you judge the effectiveness of your project brief? (based on students' design outcome/process?)

Students and the brief:

21. Do you know if there is a relationship between a project brief and students' performance?
22. In what way does a project brief affect the students? Any examples?
23. How can a project brief promote students' creativity? Any examples?
24. What makes a good project brief in an educational setting?

25. Do you have any comments about questions given in the interview? Are the questions appropriate?

END OF PART B

Educational interview transcripts of design educator E5 and E6 are included in the appendices

// Educational interview transcript of design educator E5
// (The interview was conducted in Cantonese)
// start at 00:45
// Educator E5 really likes to use metaphor to explain his ideas, using playing soccer, swimming, kayaking, etc.
// completed version, do not change.
//W: interviewer

W: How do you define a project brief?

E5: First of all, subject brief, design brief and project brief. The adjective that you put in front of the word brief is irrelevant. There is only one important keyword that is "the brief". //1:17

Briefing is about information dissemination. Project is an outcome, design is a discipline. After the briefing, a designer makes a product. That is why it is called a design brief. //1:40

The adjective only identifies an outcome. Project is a format stating that it is not a workshop brief. Using the format of a project to make a design outcome. Keyword is the word brief the adjective in front of it does not affect it as much. //2:07

W: Does the brief have to be a document? //2:13

E5: In a subject brief and in a design context, in an academic environment, it is documentation. It is a written brief. //2:21

However, in a commercial setting, a client may give you a verbal brief instead of a written brief. //2:29

The briefing is nothing more than a problem statement. Firstly, as a tutor, I need to identify the problem from a client standpoint and determine that the problem can be solved by means of design. Then, I will ask the designers or design students to work on a design project. //3:00

The brief is essentially a presentation of a problem statement and explains what is the problem that I am facing. E.g. I need to set certain goals, to increase sales of a particular product through promotion. //3:22

Or I want to make certain products to help a particular group of people in the market. All of these are elements of a brief. //3:26

First, you need to identify a problem, otherwise, you cannot propose solutions to solve it. A brief is a problem statement. //3:44

W: What are the common learning objectives? //4:05

E5: In an educational setting, a brief cannot be too tight; a tight brief already dictates the outcomes. //4:15

The process is more important than the outcome in an educational setting whereas in a commercial world, the client will demand an outcome. //4:30

At our school, we emphasize a brief to give rooms for students to develop their design process. The students largely learn from the process, the process of working through the project, and rarely through the outcome. //4:46

W: How do you formulate a design brief? Do you put all the materials together with your experience? //4:57

APPENDIX A - EDUCATIONAL INTERVIEW QUESTIONS AND TRANSCRIPTS

E5: In an educational context, we try to set the brief so that it simulates those in the real world environment, to tackle actual, commercial, or community needs. //5:16

They should be real-world problems. The only difference is in the educational arena. Because of this, we need to identify real problems for the students. //5:36

W: What is a good brief in your opinion? //5:38

E5: In terms of a brief structure, it needs to have an introduction; lays out the background, the background can be historical, cultural, financial, and technological. //5:57

In this environment, we setup, very often based on the market, we need to establish a phenomenon. What is happening in the real world?
What are the product design needs of certain groups of people? You need to introduce these elements to the students. //6:14

The second section is related to the manufacturers, the clients, his manufacturing goals, or their manufacturing philosophy and the reasons why they need new designs aimed at a pre-identified market //6:32

The designers may not know this information because the client is the market expert. //6:38

The brief must clearly state the boundaries of the ballpark. If the boundary is not known, how is it possible to play the ball game? //6:46

The third part, the client must identify their expectations, design goals, design outcomes to solve what kinds of problem. How big is the market? How big is the problem? It must be very clear. //7:03

However, a brief's clarity does not mean tightness. The clients should not dictate everything, eg. A client should not dictate pe se to design a poster, where to post it, how many people will see it. This will limit the space for designers to exercise their creativity. //7:21

The clients may be a manufacturing experts or marketing expert. They are not a design expert. They may not know the best form of media (e.g. poster) to deliver their messages. So, the client should let the students/designers to discover and explore new methods to solve their problems. //7:46

W: How do you know when the brief is too tight? //7:50

E5: I think we should be careful about the language use(wordings) in a brief to minimize the hints of the expected outcome. A brief should emphasize on the problem being solved. //8:10

The brief should also emphasize on the process but not on the outcome. //8:20

To solve a real world problems, you also need some real world parameters. For example, a budget, a manufacturing limt or a technological limit. //8:32

A designer cannot expect the client to throw out all the existing equipment and purchase new equipment for the new design solution. So this is a boundary condition, the design goals must be written clearly, what should be achieved? //8:56

W: How do you know when a good brief is written? Often times, it shows up only in the outcomes. //9:12

E5: For example, what is a tight and what is a loose brief? Back to Alices talk, a client asks for the design of a chair or a client asks you to design for a tired person, a comfortable sitting place. //9:33

We have done some research, if you ask a designer to design a chair, the designer

will automatically can think of four legs and a square board. //9:45

However, that is not necessarily a good solution because one can practically sit on anything. //9:47

So, firstly, the brief should have goals for the designers. Secondly, it needs to have boundaries, but don't emphasize on the expected outcome. This is a recurring emphasis. //10:05

We don't call it a loose brief but an open brief. //10:8

A tight brief is a straitjacket. Someone already closes all the doors except one and asks the designer to go through only from that door. //10:20

An open brief has many openable doors, letting the designer discovers what is behind each door and take away with whatever they think is useful for the project. //10:36

W: How do you classify different design briefs? //10:43

E5: Very easy, there should be two kinds of brief: a good brief and a not so good brief. //10:49

This has nothing to do with the design disciplines. A good brief can communicate the design requirements to the designers what should be achieved but not dictate the outcome. //11:10

The brief may states that we are currently at position A and what should the future position B looks like. However, the path from position A to position has not been determined. A designer can seek out his own path. //11:22

At least, the brief should leave rooms for designers to try out different paths. //11:31

This is not so much concerned with the format or structure of a brief but a brief formulation should be concerned with the content. //11:41

The answer is very simple, a good brief or a bad brief. //11:47

This can also applied to a good client and a not so good client. A good client leaves various kinds of weapons (tools) for the designers but the client wont teach the designers how to operate/fight in a battle. //12:04

A designer cannot work/fight without any weapons. However, if you only provide one kind of tools. A designer might not be suitable to use that particular tool in that particular project. //12:23

The client and the designer need to work together and communicate together to understand their target (enemy). Where should they hit, what areas (hands or the heart)? You don't need to kill the target at every battle. //12:37

W: How can you formulate different design briefs for a given project? (will that depend on the students abilities or the different learning objectives?) //12:51

E5: The brief will remain the same because it is a reference for boundaries. // 12:59

Students with different abilities. I will use a metaphor as playing soccer. The rules for soccer are clear, each side has 11 people and the goal is to put a goal in the enemy field. The field, the playing formats, the rules, are all known. //13:21

The problem is that different designers may want to play different roles: a mid-fielder, a forward, a goal keeper, or a guard, and other positions. During the design process, if the rules are not too tight, the students can find out what positions they like/choose to play in the game. //13:45

W: What do you think about students asking questions about the briefs? // 13:58

E5: Thats a good thing indeed. If the students have no questions about the brief, it means your brief is too clear, too direct, the expected outcome already presented to the students. Eg. A poster of specific sizes, with a specific logos, fonts, and pictures. Then, they wont have any questions. //14:20

It is a good thing if they have questions because that shows that the students have given some thoughts on the brief. Otherwise, they wont have any questions. //14:32

If a brief is too tight and direct, the students think they understand the project and will quickly dive into the doing/execution part. Then they won't have any questions. //14:39

The more questions they have about a given brief, the better it is. When the students do not understand the brief, they need to use their brains to assess the project. //14:44

However, when the students come to ask tutors questions, tutors should not give out all the answers. The more answers a tutor gives to the students, the tighter become the brief. A tutor must carefully select and answer the questions raised by the students. //14:59

Another metaphor, I put a student at the center of the ocean and tell the students they need to swim to a safe place, or you will die, the students might ask whether he should go. //15:19

A tutor can tell the students which is closer to the coast, east or west. A tutor needs to help the students analyze the situation. Once, the student made a decision about the direction, a tutor then needs to help the student understand his own decision. //15:34

Furthermore, a student may need to decide what swim strokes, breast stroke or sidestroke or dog paddle, he should use for reaching the shore. He needs to analyze again the situation, the swimming distance, his energy . //15:46

The student needs to make a decision based on his ability, the efficiency (being the fastest or being the most endurance), staying alive for a long journey, which make up the process. //16:03

As a tutor, the brief should not give the students the answer. A tutor should not give out answers during tutorials or in any formal guidance. The answer should be sought out by the student. //16:17

When a student brings you an answer, you even have to ask the students whether his answer is the best answer to the question. You need to challenge their answers. //16:28

W: In this case, the students are very likely to get stuck, dont you agree? //16:34

E5: You are right; the students often complain that they are in the middle of an ocean. They just paddle around in a circle and do not go anywhere. 16:50

The students think there is no answer. First of all, it depends on the different viewpoints. As a tutor, I need to develop their independent thinking, problem solving. I have no reason to give them answers. //17:04

The students often come over bringing two colors and ask you to pick one color for them. If I tell them the color I like, the students are going to be very happy because they know they receive their tutors' approval. //17:19

They finish the subject and there is not need to think about the project. However, the students do not understand the rationales behind the tutor's decision. If I explain my decision to the students, they are not going to learn anything. //17:28

The students will come back to ask you the next time. After they graduate from school, a designer can no longer ask the same question to the client, because the client

may say that he is paying for their services, to make decisions. //17:42

You need to stand firm and not bending to the students' wishes. The students often said in the SFQ that there is no feedback from tutors. From an educational perspective, we have to make sure the students can seek out answers on their own. //17:58

However, at some emergency situations, I will give them some suggestions to try out different things. Some hints, a small push. I will not give out explicit answers. //18:28

I will not hold their hands to pull them to the shore. I may say to the students to try going east or west and ask them to report what they see in that direction the next day. //18:40

W: How do you judge or evaluate your own brief writing? //18:58

E5: Our brief has a section of aims and objectives. It describes what the students should learn or can do (pick up skills) during the design process. //19:17

The knowledge, related information they pick up. During the problem-solving or design process, what are the tutor's expectations for the students. //19:28

The aims and objectives must be written clearly. In that case, the students will understand what kind of experience they should learn from the project.
The students can cooperate with the tutors. //19:44

If the objectives are not clear, the students will complain that the brief only asks for a poster. Even if they have handed in two or three posters, the tutor is still not satisfied. That's why the students always complain to the tutor. //19:54

If the students know the learning objectives, e.g. learning by doing and learning from mistake, the students will know what is wrong with their works and the tutor disapproval is part of the learning experience. //20:08

As long as the students know what is inadequate in their works. The students can improve on the area next time around. //20:15

A good brief must have clear aims and objectives, it is difficult to write and we spend a great deal of time and effort even though this part contains only a few button points. //20:28

On the contrary, the expected outcomes are less difficult but not easy. How can a brief be close but not too close to the expected outcome? //20:39

The brief should indicate certain directions but not so much to dictate the destination, like a treasure map, it contains some clues that can arise the students interest but not explicit about how deep one should dig, how many treasure boxes, how much treasures inside each box. //20:59

You still need students to find out for themselves. I think the most important part of a brief is aims and objectives. //21:08

W: In an educational setting, what are the roles of design briefs and tutorials, which one is more important? //21:20

E5: A brief is a learning contract, project contract, subject contract. The most important thing is the learning process. //21:37

The students enroll in our school to study design. We got their tuition to provide a design education. The whole program is a leaning contract but an individual subject brief is part of a larger learning contract. It is the same thing. //21:55

In this learning contract, learning is the most important but not the outcome. A tutorial is walking a path together with a student. //22:10

Tutors and students tackle the problem together, discover, and analyze what is good and what is bad. I would like to stress the keyword is together. //22:20

The reason that is a joint activity because it should not be led or dictated by the tutor even the schedule, materials for tutorials, decisions made during the tutorials should not be dictated by the tutor. //22:39

The tutor should guide the student on the side. A tutorial should be led by a student. A student should come to a tutorial when he thinks there is a need, otherwise, he should not come to a tutorial, it is a waste of tutorial. If there is a genuine need, a student should be well-prepared; a tutor should act as a mentor/guide. //23:04

The second role of a tutor is a challenger to a student's decision. Challenging the student's decision should be very tactful, a tutor should not reject everything from the student. Otherwise, the student will be very disillusion, disappointed, disinterested. The student may simply give up or turn in a marginal work. //23:24

A tutor should use certain methods to motivate the students' interest to find new paths. //23:41

This is not an easy task because in the outside world. In the industry, if you are a supervisor or a boss, their version of tutorial is very simple. When a designer brings his works for your opinion, you only have to say which one is good and which one is bad. You then ask the designer to go back to work and don't waste your time. //23:54

A boss pays a salary for the designer to design for him. A boss does not take a tuition and is not obligate to teach a design student. A boss often just said to continue with certain works without explicit reasons. In that case, a designer does not learn anything from the boss decision. As tutors, we should not act like that. //24:21

We must consider various methods to let the student look at design from an end-user perspective, from a market perspective, and ask the student to decide whether his works is good or not. //24:39

This is especially true for my colleagues who just came from the industry. The industry operates in a "yes" or "no" fashion. At the school, a tutor should not just say a definite yes or no to the students. Tutors should use response in a vague language: maybe, possibly, not quite enough. //25:10

W: Do you think the design project has any influence on the students performance? //25:17

Absolutely. As I said before, even though it may not be very important, we will have an expected outcome. The expected outcome is not the finished piece of design work but rather is the student learning or achievement.

We will state very clearly in the assessment criteria that after the project or the subject, what the students should expect to learn from the project and the level of achievement in design. //25:50

As I said, the brief is a learning contract. A tutor should know the brief so that he can evaluate and grade the students. The students should know what is needed to achieve a high score in the project. //26:05

Otherwise, a student might complain that he has done a good job but receiving such a low grade. //26:08

W: In a brief, how can you promote a creative outcome? Any specific methods? //26:25

If you want the students to design something new. You need to stress in a brief. You first need to find an interesting problem to solve. //26:42

A new problem for the students to solve. Even if it is an old problem, a tutor can

write and present the problem in a more interesting way. //26:53

E.g. You may say that there are many solutions in the market. There is nothing new under the sun. There are not many new problems. A new problem rarely arises. //27:03

All are old problems. However, there might be a new market, new environment, new technology which slightly change the problem. //27:12

So, we have to make the problem interesting and stress to give enough room for the students to develop new ideas and innovations. //27:19

During the tutorials, the students need to research thoroughly for the problem.

E.g. My juicer exercise, I let the students try out all the juicers that are available on the market. They try and evaluate all of them. They get to know the merits and drawbacks of the competitors. //27:37

When it is time for the students to design a new juicer, they knew they have to put in some new elements in order to attract the customers and sales. The customers will determine to buy their designs instead of the other 99 competitors. //27:51

The experience of using a product is important. Definitely, we can add this element in our brief or exercise to provide such an experience.//28:05

We expect the students to get individual experience by going through the exercise. There are 90+ juicers, each person will get a different experience from the same product. //28:18

This experience may be able to spark off some additional functions for the students to design a unique product or a product with unique features. //28:27

We expect 30 students to tackle the same brief, because the brief is open-ended, we will have 30 different solutions. //28:41

If a brief is too tight, 30 students will arrive at the same solution. //28:51

W: Since you show the students so many juicers, do you expect some similarity from the sample juicers.

Sure, that is referencing. Unavoidably, there will be certain influence on the students from the samples. That's a juicer by Philips Starck. The students will be influenced by the guru. //29:14

That's not so relevant. Many new innovations are based on existing products. The innovation is an improvement. //29:18

Evolution but not revolution. It does not matter. If the student can improve the exisiting product by adding extra functions which also solve some extra problems of the customers, then why not? //29:36

For example, the cake-baking rice cooker, this product provides an additional function of baking cake, the customer does not need to buy an extra oven. That is a 2-in-1 solution and save the room for the oven. Now, they even have a 3-in-1 model for cooking congee. //29:58

W: What kind of brief is more difficult to students? An open brief? //30:09

I can be certain that from a student's perspective, an open brief is more difficult. So, students prefer a very tight brief; they will be very clear of what is needed to be done for the brief. //30:20

However, as an educator, I often stress that we should not provide a comfort zone or a pattern for the students. The students will feel that is an easy project and will do the same thing according to their experience, producing the same artifact, then there will not be any new ideas. //30:41

APPENDIX A - EDUCATIONAL INTERVIEW QUESTIONS AND TRANSCRIPTS

You should give the student a new ballpark figure [boundary] each time in each project. You may change the number of players this time, say 10 instead of 11. The strategy for a 10-person team must be changed. //30:55

If a student gets use to the 10-person format, you should change to a different game, maybe from soccer to ruby. //31:08
[training the student the ability to handle multiple situations]

When you train a design student, you need him to adapt to various situations; this is what we call transferable skills. The student can apply his experience and strategy of playing soccer to play basketball or any other sports. //31:24
[this can be an across domain skills of expertise??]

W: What is a complex brief? //31:36

Students think the brief is complex, not because the brief sets a high standard/expectation or requires the students to do lots of work or research. Complex to the students simply mean "not clear". There is a clarity issue. There is no clear identification of the problem. //31:58

First of all, the why is missing in the problem and there is no clear or trivial design goals. //32:13

A clear brief is very systematic, sections after sections, tells the whole story. The student will not find it difficult. At that point, the student needs to do a thorough research for the whole story. //32:40

W: Any methods that can help narrow down the brief without harming the creativity of the outcomes? //32:54

Very simple, you do not tell the students what artifact is expected as the outcome. This already makes the students to think. //33:06

If you tell the students to design a chair, they will proceed to design a chair. However, if you tell the students to design a sitting place, the students will start to think. //33:14
[withholding the expected outcome!!]

The students might think what the best sitting object is, and ask "why" the client wants to sit, sitting for how long and what is the sitting position? so on and so forth. Then, according to the functional requirements, the students will decide on the forms and materials. They also need to study the end-users. //33:34
[prompting the students to ask questions is a good thing, to find out more!!]

How heavy is the user? What does the user like? The weight of the user or the cloth of the user may affect the material selection. //33:49

E.g. the end-user likes to wear leather/plastic pants, if a designer chooses to use leather/plastic for the sitting place, both of them may stick together/slide apart. Even if I know the answer, I must leave it for the students to explore or discover by themselves. //33:58
[Do not answer all the questions asked by the students even if you know them, let them find out for themselves.]

Even if students show you their designs, I will ask them whether they have done any pilot tests for the artifact. I won't tell them the answers to their designs even if I knew the answers. They will find out eventually that the materials do not work together and produce static charges. //34:18

For a good design, the tutor should not put his solutions or the expected solutions into the brief. A good brief contains enough elements for the students to exercise their creativity and design freedom. That's the best brief. //34:40

After finished writing the brief, you should read it and ask yourself what will I do for that brief. //34:51

Our ultimate goal is for the students to design something/a solution that is better than their tutors. //35:00

//35:21 interview done
****
****

A fine arts teacher may tell you a different story depending on which brain (left or right) they used to answer your questions. //36:03

I feel some of the questions are repeated during the interview. //36:17

This questionnaire is also a brief, you can ask more detailed questions to the educators and try to avoid the yes/no kind of questions. //37:08

APPENDIX A - EDUCATIONAL INTERVIEW QUESTIONS AND TRANSCRIPTS

// Educational interview transcript of design educator E6
// (The interview was conducted in English)
// this is a completed version, do not change //
****************************** Start of interview (52 mins 30 secs)
****
//W: interviewer

W: What do you think is a project brief? //00:59

E6: In the context of education, I think a project brief performs a slightly different function in education than in the office. Although it is considered sort of a simulation, the sort of briefs that you would have gotten in an office. //1:22

So, it does lay out the parameters of a project. It does by examples show the students what must be considered in a project. //1:38

The categories of information you have to considered look at a project. It also outlines a project that is a reasonable type of projects that the students will be running into in a professional context. //1:53

By the same token, we don't try to reproduce exactly what you would find in a professional context. We try to build in educational experience into that. //2:05

Often in a school context, each studio will focus on a specific issue. //2:11

For instance, if it is a subject about sustainability, you would intentionally build in requirements into the brief that forces students to consider, to make solutions in terms of sustainability. //2:30

Briefs for students, are sort of a preparation and simulation of the future office environment. We try to do it in the form that they would receive it from the clients or from the boss at the office. //2:45

But also, We intentionally build in an educational experience and a focus for a specific issue. //2:52

W: what kinds of learning objectives are usually build in the project brief? //3:01

E6: I will speak directly from my field, architecture or environmental design. Each studio, we introduce certain skills to the students and certain typologies. //3:18

Meaning a certain types of space they would be confronted with. One example, one studio may be about residential typology. One studio maybe about shops on the street. One maybe about restaurants, one may be about hotel, etc. //3:25

So, one thing a brief does is that it demonstrate to the students when they look into the topology. We layout a space plan, doing a home for an instance. //3:49
The requirements for the home are, these rooms, these functions, they should have these characteristics. Perhaps, even sizes of them. //4:00

It demonstrates to the students what are the kinds of spaces involved in this kind of typology, also what kind of considerations. //4:09

In case of a residential typology, you have to know the client, so the brief would include some background on the family who are going to inhabit the place. //4:18

It also possibly includes budget consideration but that is not so strong in the educational context. That is one thing that will be included in a brief. A brief is a vehicle to introduce the typology. //4:36

Also, skills, usually has to do with the kind of deliverables that we required. An important part of the brief, is the list of deliverables in the end. //4:50

The brief will have the starting point, and sort of the goals. The starting point for environmental design will often be a space floor plan. //5:06

What kind of space you need to fulfill, what the size of it, what function does it need to fulfill. //5:21

The outcomes are not necessarily the outcome of the final built project but the outcome of the studio. So, we tell the students what drawings do they need to produce, so many plans at this scale, a model at this scale, a model should communicate this. So we often will layout in quite a lot of details what media the students should use to communicate the design. //5:43

W: The brief document seems to contain a lot of materials. //5:52

E6: Yes, but often very concise, it contains sort of the beginning and the end. The students have to decide the middle. It contains a problem statement. It contains an outline of what the students should have at the end in terms of the format. You will in the end have two floor plans, at this scale. //6:13

W: The students are clear about the evaluation process? //6:21

E6: Actually what accompany the brief is a very clear articulation of two things that are very important to the students to assess and actually are part of the contractual obligation. //6:37

One is the assessment criteria, very clear, after this, I can give you example from final year projects. We have a sheet of assessment criteria telling exactly what criteria will account for how much percent of your final grade. //6:52

So, for instance, for the final year projects, we have three components of assessment, concepts, design development, professionalism. //7:06

And each of these has sub-components. and part of the briefing we give to the students is exactly what these components mean. how you will be judged and what percentage will mean for your final grade. //7:21

The second part of the subject brief is very important is the schedule. Especially the key point, when students must present and when they will be assessed. //7:32

So, final year projects are actually relatively simple in this because it is largely individual. So there are only four date in common, the starting date, the date they have their project proposal finalized, the middle term presentation and the final presentation. //7:55

W:How would the information included in a brief be called a subject brief or a project brief? //8:11

We call it a subject brief. In an educational context, the subject brief and the design brief goes into each other very often. //8:33

They do have points of contact. Let’s me see if I can very clearly articulate. Maybe the assessment criteria and schedule are more to do with the subject brief. Although in the students mind, they are closely related. //8:52

I think probably the space floor plan, specifications, requirements and deliverables probably belong more to the design brief. //9:05

W: What is a good brief in an educational? what are the criteria? //9:17

E6: A good brief is a brief that asks good questions in a way that doesnt pre-determine the answers. //9:27

A good brief in essence is a good question asked in a good way. That also provides guidance to the students. The necessary amount of guidance. It doesnt constrain students or pre-determined their answers. //9:46

A brief that is too rigid. I am talking in a professional context as well as educational context. If it is too rigid, you are almost predetermining the answers by the way you are asking the questions. //10:00

And that is not a good thing in any contexts. What you want to do, especially in an educational context, is you want the students to exercise their creative muscles. //10:14

So you want to create a context. You want to build in a lot of problems (to be honest) then, you want to ask a question or several questions that lead to many many more questions in the students minds. //10:31

And it forces the students to formulate their own questions. //10:35

So, a good brief will guarantee that all students are working within the bounds you want them to. If you want them to look at shops design. Every student should be designing a shop. Someone shouldnt be designing a park. //10:56

In an ideal class, students will be looking at many different concepts of how a shop should be designed. They will questions what is a shop? //11:11

Some may want to go in a conventional way. But some may in terms ask questions of why does a shop have to be inside a building? Why does a shop have to have a physical location? Why does a shop have to display things in this way? etc. //11:30

A skillfully written brief will fix the things that you want to have fixed, the boundary, but inside of these boundaries encourage the students to ask questions, force them to ask questions. //11:51

If you give them too many answers in the brief already, they are not encouraged to be creative, they see it as an instruction following exercise rather than a K //12:06

In design, I think it is more important to teach students how to ask questions than to how answer questions actually. //12:18

Then they come up with answers to their own questions. Obviously, it is more difficult. //12:37

Good students are always used to answering questions. They are used to having a question asked and answering that question because they are trained to. //12:45

They are trained that education is about knowing the answer. Yes, but education is also about knowing what questions to ask. //12:56

For instance, if I tell students they are going to design a shop, the first thing I want to know from the student is, if you are going to design a shop, what are the questions that you need to ask in order to design a shop. //13:14

What do you want to know from your clients and what do you want to know from yourself in order to design it. //13:21

W: What is the usual length of a design brief? //13:25

E6: You mean in terms of pages, It varies, It can be anywhere from a single page to up to 5 pages in the educational context. In a competition, it could be 50 or 100 pages. That’s more complicated. //13:44

Typically ,from 1-5 pages, it depends on how long, how complex, and also how open you want it to be, //13:57

The general brief of a final year project even though it is a very complex project. The subject brief is 2 pages long; the individual subject brief is 1 page. //14:09

Because in a final year project, we expect the student to determine themselves the project. So, it is often the case that the more we expect from the students, the shorter the brief will be. //14:20

W: Have you tried to formulate different design briefs for different projects?

//14:29

E6: Yes, I think every design studio needs different kinds of briefs. It depends on what your educational issues are. //14:41

If it is a multi-disciplinary studio that has many different kinds of disciplines, it is going to be a different kinds of briefs. //14:47

In my first year here, I taught in the DS4, sustainability, ecology by design. That time the team was multi-disciplinary, meaning I couldn't tell the students that they are going to design a shop, they are going to design something else. //15:10

the students have to work in teams, where they had to come together, interior designers will come together with a visual communication students will come together with a product designer. //15:23

And would have to together to find a context to cooperate, so that the brief actually started out with a question: you need to find us a context that where you as a team can insert yourselves and work in this. //15:43

W: So, they are essentially making their own brief?

But the brief in that case was introducing them to an issue, introducing to them the issue of ecology, sustainability in design, what are the different functions? //16:03

That is quite wide open. That brief consisted just sort of trying to plant the seed of what are the questions you could ask. Admittedly that was very difficult to students. //16:18

They have to define their own problems, they have to define it in a multi-disciplinary team and they have to work in that team. //16:37

It is quite open-ended and quite difficult to students and to tutors in that way. //16:45

The other subject, we tend to (if it is just an environmental student), we tend to have certain things we need the student to be learning at this point of their education. //17:04

At some points, you need to have in your portfolio a shop design, retail design, because that something you probably are going to have to show to your potential employers, so we know we have to build it somewhere in the curriculum. //17:21

From a pedagogical point of view. Thats one reason why every studio brief will be focus on a typology. Thats just the way portfolio has to be put together. Thats quite practical. //17:37

But we tried to pair that with an issue. In DS5, design study 5, one of the added complications is that they had to collaborate with an overseas team. They were working with students in Korea and in Austria. //18:00

That requires a brief where communication is a large part of the brief and that is not something you have to explicitly address in other briefs, how you communicate because communication is not very complicated. //18:17

But in that case, the brief was almost more about the communication process than the final outcome itself, it's about how you organize the process of designing. //18:30

Because what we were teaching the students, they were doing residential building, small pretty simple project because the complication of that project had to do not with the product that they were designing but the process they went through. //18:45

So, the design brief has a lot to do with how you interact, how you record, how you exchange information back and forth between the team. //19:01

You mention cooperate workshops, that is a special case again. Because, in that case, a brief is developed with a client. It is similar to a professional brief, a brief in a professional context. //19:22

because usually, the client will come with some ideas of what the client thinks he want. //19:30

Now what we encourage our students to do is something that we called a return brief, meaning they take the clients requirements and they in turn write a brief using their experience as a designer to formulate what the client actually needs. //19:49

W: Usually, what are included in a return brief? //19:54

E6: In a return brief is generally the same as I explained at the beginning, describing the project, you need to design the public spaces of your own complex. //20:15

You need to include these functions in these, and we want to address these targeted groups, and these requirements, they may include a budget or they may include a timeframe as well. //20:34

Speaking the language of the professional brief, the return brief is pretty much trying to communicate with the clients describe a project in a way the client will understand. Because what am I getting? Who it is for? How much is it going to cost? And how long will it take? //20:54

W: Is a return brief a common practice in the professional world? //20:58

E6: In some context, yes, we never called it a return brief, in the professional world the way you do it is, in essence, you sit down with a client. The client will not bring you a brief. //21:27

It is rarely a case, I have never experienced a case where the client comes to you with a brief, the only case that has been, in competition where you participate in a competition, you receive a brief. //21:41

It [The returned brief] happens in conversations. You sit down with a client and say what do you want. They client might say that Ive opened a shop, I have a contract to rent this place, I need to redecorate and renovate the space to the need of my shop and I have this much money to do it. That’s it. //22:05

A client comes knowing what he needs in these very vague terms and they dont speak the language of design. Thats why they come to a designer. //22:17

The first job of a designer is to tell the client what he wants, tell the client in design terms and a lot of that will happen verbally at first. //22:36

Will happen in terms of programmable space, to sort of lay out you probably need to spend about this much on it K that goes into further and further articulation. If they accept that brief, you then start doing sketches and showing them actual design. //22:58

But the brief is almost always in the invention of the designer, so, you call it a returned brief but often it is not the returned brief. Actually, it is the first brief that is formulated with the clients. //23:16

You will meet with the client one or two times, if it is a simple project, then maybe only one meeting, you come and draft it. Often in simple projects, the brief is something that is never committed to papers either. //223:35

It is something sort of an on-going conversation between the designer and the client, quite informal. For a simple project, like a family home. //23:49

The more complicated, yes, you need a brief for contractual reasons. A brief is a contract so that you know and the designer knows what is expected to do and if

the scope of what changes can add the change of context and the client also know what is expected. //24:08

First and foremost, the brief is a contractual thing. Communication of course as well. But a brief will change throughout the process. //24:26

W: How do you judge the effectiveness of the briefs you have written, through the students, the process or outcome? //24:40

E6: First I think through the process. If I noticed that the students are lost, then I know the brief is not specific enough. //24:58

If I notice the students are all getting very similar not exploring, then I know maybe the brief is too narrow or tend to lead them in a certain direction. //25:13

Or the brief doesn't give them enough inspiration. So, you judge it first, you can start to judge it the first time the students come back to you. //25:24

W: They ask questions?

It is different in different context, because Hong Kong students; they are very keen to know what is expected. What they feel comfortable with is that if they have an extremely clear description of what is expected of them. Then, they know this is what I have to do and I will do it. //25:52

The challenge of writing a brief is to avoid that in a way. To avoid giving out something that tends to show a safe way forward and encourage students to ask and to feel comfortable with asking and looking for different directions as well. //26:18

I think you spot a good brief more toward the beginning of the process. I think the brief is more important at the beginning, because it is sort of a basis from which a student goes to work from. //26:37

Actually I think a brief can often do more harm than good at the later stage. Because, you almost want to start changing, or questioning or asking for alternatives to the brief as the process goes on. Very soon in the process, you want to look at things that were not anticipated in the brief. //27:04

I think the brief is a starting point. The best value of a brief is viewed as a very good seed from which a project can grow but it is bad if, two months into the project, you still find the brief is too constraining. //27:28

So, in my own practice, I almost want to be able to forget about most of the brief as soon as possible as just to check up from time to time. //27:41

W: Do you think the role of tutorials is more important than the brief itself? //27:50

E6: Yea, because you cant anticipate everything in the brief. It is impossible, and if you can, then that means you got very boring projects throwing to the students. //28:02

Much more in tutorial, the brief should give you guidelines you can refer to if the students get completely lost or wandering outside of the territory that is relevant. Then, you can use it to bring them back in and say, you know you are dealing with something which is not part of what you are dealing with. //28:26

But it also gives students a chance to keep checking and referring back to the brief. In tutorial, it is often useful as a point of reference to point out the students, not that you have to follow this but to say ok what you are doing, how does that related to the question that was questioned in the beginning. //28:49

A bad brief should have, you can always refer back to it, it could be that there are some questions in the brief that dont make sense at the beginning. There could be some questions that don't make sense starting the project, a month later, you

look back, and it is relevant. //29:13

W: How can a project brief promote creativity, as in the outcome that you can observe? //29:28

E6: I think this goes back to the beginning in the way of encouraging students to ask questions, but also asking the right questions. At the beginning, encourage students to look at things in different ways. //29:57

W: Do you have any examples? //30:03

E6: In design studies 6, which deal with the future of design and it was about future transportation. [Thinking about the actual topic ...] //30:36

Anyway, we gave the brief in addition to that, we required each student to come with an issue that would interest them about the future of Hong Kong, actually before we even gave them the brief. //30:50

This is wild open, we were asking you to think about the future of your city, think about what issues are important or interesting to you when thinking about the future of your city. //31:06

Some had political issues, some had environmental issues, some had issues with aging, there are going to be a lot of old people, some had pollution, water shortages and aesthetic, developing a HK identity of aesthetic, but all of them came with something. //31:25

And then we forced them to look at that and did some research into this, and then held them accountable for bringing this issue into the project. //31:37

So, before they knew what they would be working on, before they even knew the object that they would be working on, they were asked to think about an issue. They werent given this issue. They were asked to draw them out of their personal experience and what they are interested about and care about. //31:53

And that sort of forced to bringing two things together. Avoid the students of going into the very easy solutions. //32:03

Say that we are designing a boutique hotel for future HK, first thing they obviously do is, they look at, what a hotel looks like, OK, then I am doing this and doing that. //32:19

By holding them accountable for coming to the subject with a commitment already, having made a commitment in research to an issue. If this is important to you, you got to find a way to bring that into your design. You said that is important to you about the future of HK, show us now. //32:42

It is sort of a forced association that often comes. Forcing and bringing things, force them to fit something in that doesnt quite fit. Like cognitive dissonance, is one of the key things for creativity because it gets you out of your comfort zone. //33:09

You are forced to bring two things together. Both of which you probably are interested in, but you never thought of them together before. You got to force a connection, you got to make leap, you got to make jump. You got to think of things being connected that arent connected now. //33:29

All of these techniques help and anything that can bring, doesnt allow a straight obvious path that make students accountable. //33:44

Things that I dont even know the answer for, that I as a tutor, maybe that an important point, that also forces me as a tutor not to take the easy way out either. //33:58

Now each of the students will have a problem that I don’t know the answer either. It maybe something that I never thought of bringing together either. //34:13

As a tutor in my tutorial, I am not tempted to give students the answers. I know how to do them and I designed that before. So, I am not in a danger of forcing students to an answer that I already know because I have more experience. //34:36

You talk about this from students point of view. I think it is equally interesting from the tutor point of view. That there are so many traps that tutor can fall into. //34:48

You want to help the students, you want to tell them how things are done in the world, yet thats part of our job, but that is not the most important part. //35:00

The most important part is allowing them to develop themselves so they themselves can have positions and they themselves can go through experiencing the creative process, experiencing finding out the answers, rather than have the answers packaged and given to them by me. //35:20

W: What kind of briefs will students find more difficult? Too open/too restricted/ too complex? //35:31

E6: At the beginning, I think the students will find a very open brief very challenging because at the beginning, they try to imagine the process. //35:46

They are sitting there at the beginning of the semester, they are trying to get their head around, what do I have to do to get to the goals. //36:55

During the process though, I think they start, get beyond just want to get to the goals, they want the satisfaction of seeing the fulfillment, they are doing something unique, they are bringing something of themselves to it. //36:16

I think that if something is too rigid, and they see what they are doing is being very similar to the person sitting next to them is doing, and they dont see a way out of it. I think this actually leads to dissatisfaction. //36:37

I have had students who see a way to do it, they are quite confident to see their way through, and either I tell them there is nothing interesting about this project. //36:54

Or they themselves complaining that I know how to do this project but I am just not satisfied with it. I dont see any special that I am doing. //37:05

W: Do you think this kind of getting stuck, non-satisfied outcome, is related to the brief formulation? //37:20

E6: It can be, but not completely but it can be. I think there are something in the brief that can do it. //37:28

If a brief is too vague, I think it can also lead to students getting stuck. It doesn’t give them any clues where they can seek inspirations. //37:39

It doesn’t give them any fuel to go back to it. I mentioned before that a good brief is something you can go back to and find something relevant that you didnt find at the beginning. Not necessarily constraints but inspirations. //37:58

I think a brief is too vague can lead to this [students getting stuck], but also a brief that is too rigid. //38:08

I have seen competition brief that are horrible, because they are too rigid, they build the design into the brief. They are asking architect to provide their design but in essential, they know what they want already. //38:23

They give you the list of rooms, the sizes, the heights. What can I do, I can arrange the rooms and choose the colors. It is not asking for contest, it is not asking, //38:38

I have even seen competition brief where that have sort of an organizational diagram,

how the room should relate to each other which is. They see architecture as adding a style to it. //38:56

They dont see architecture as asking fundamental questions about how space should be organized, what relations and functions should have, or even questioning the very functions themselves. //39:09

I think a brief for students is the same. If you have a very clear of the space relations to each other, it gives the students a wrong idea of what design is for one thing. And it leads to dissatisfaction or false satisfaction on the part of the students. //39:30

But equally, if it is completely open, you are not doing your job as a tutor if you dont build your experience into asking the right questions and giving the right clues as to where the students could go to. //39:51

W: When you are narrowing down the brief, how can you make sure it doesnt hurt the creativity part? //40:00

E6: You narrow it down in terms of drawing the boundaries rather then structuring what is inside the boundaries. For instance, the typology is one way, and also you introduce students to certain ideas. //40:28

Going back to the example of a hotel. Either you show how a hotel is done but what about these questions, what about the question of tourism being different than in the past, what about the question of hotel doing more than just helping people to have a night stay. What about issue of hotel blending in, becoming a hybrid with other typologies. //41:01

Asking a lot of what about, what about, what about to students and forcing them, they dont have to answer all these. but if they just go back to the normal way that you see a normal hotel being done. Then how are you not interested at all in any of these what about question that we are asking. You dont have a position at all on any of these. //41:33

W: But these are the explicit questions that you will put on the brief? //41:37

E6: In some cases, we explicitly put them on the brief, in some cases; they will arrive, not in a brief as a document, but in the briefing session. //41:58

I think that in educational context, I would not necessarily separate one from another. Because the brief and the briefing are two parts of the same thing. The brief is something you can refer back to, the briefing is explaining what it meant, like illustrating it with examples. //42:17

It also depends on the level of the students as well. In their first year, you have to give some very fundamental information, asking very fundamental questions about design and force students to very fundamentally look at what it means to be a designer. //42:45

By the time to their final year, you dont have to ask these, you need pushing them to ask higher levels questions, then it becomes a matter of critical approach to design. //42:56

At all levels; a brief should encourage a critical approach to design. It should, in the educational context, force students to take a stance. Not fill in everything where we ask the students what to do this, like the brief said I should do this, that’s why I am doing this. //43:26

Within certain boundaries again, here is an areas that you are asked to look at, now here is what is being done in that region, here are some questions, look at it in a critical way, bring your interest to it. //43:43

I am not going to judge you whether you are right or wrong. I am going to judging you whether you apply a critical eye to it and whether you have reason to approach it the way you are. You want to do something different or because you see an issue

you want to address. //44:02

W: Have you change the language use / wordings when formulating a brief to promote creativity? //44:28

E6: yea, even in my education in the 80s. Definitely even earlier from my professor who were taught in the 60's and 70's. There were a trend even then to, if you are designing a kitchen, you dont in the brief you dont call it a kitchen; you call it a food preparation area. //44:50

And the living room will be the common area, a sleeping area, Thats actually quite common. Thats you don't want to build in preconception about a bedroom is a bedroom meaning it has a bed in it and it is a room. //45:13

But put it as an area that you sometimes sleep in and you sometimes do other things, do we need a bed in a bedroom? I think it is very useful not to build in pre-conception. //45:27

We often try that as well, but then you got another set of pre-conceptions built in, for instance a food preparation area, that you prepare food in your apartment and you have an area for that. //45:42

W: So, there is no way out? //45:44

E6: It is at the level that you want to build in your preconception, we do exist in certain cultural context that is one way of giving the students clues where they can be asking questions, and where they might be open-ended to define something and where we don't necessarily want them to question. //46:06

In the hotel, I think we called it an accommodation or something like that, before that, we did something on transport nodes which is has to do with, we look at an area where different transports came together. What happen there? //46:28

An airport is some place where airplanes come down, buses come in and ferry come in, what happens there? What kind of space happened there? You know a MTR station is something different where you go from train, to bus, to foot. //46:50

OK. Thats a description of a node, but we dont define what happens there. We know what generally happens at a seven-eleven. In that case, we define not by the function at all but just a situation, we define a situation. //47:08

What could happen in the situation where people are moving from one kind of transportation to another. And people had thing like art gallery, student supposed like an art gallery should be there, It could be a place where people can take short rest, it could be a place where political action happens. This is the place where people cross each other path. //47:33

That led to a wide range of proposals from the students but they werent just free flowing, it has to make sense within the context of what happens where people change from one mode of transport to another. //47:54

W: You mention that there are couple different ways to present the brief. (Hotels vs accommodations) What kind of results do you see when you present the different briefs? //48:13

E6: I don't know if I have any one to one example, let me think. I dont know if there is a case where I very strictly differentiated the brief for them.

W:Maybe using the situated example and the hotel accommodation place. //48:37

I think that, of course, in the case of the transportation node, we dont give the students any clues what could happen there and that is for them to invent. They dont have anything and all they know is what happen there apparently. //49:01

So, of course, what comes out of that is very diverse. So, in that case, the location is fixed, you have to tell them, you have to situated a place where a transportation

node. But the opportunities for making spaces are completely up to them. //49:27

The other one is exactly the opposite; you didnt tell the students the location. They had to look for the location; we told them what they are going to do a small scale accommodation. //49:38

They chose different types of accommodation, then they become focused on who they are accommodating. Someone's doing a youth hostel; someone's doing specifically to bring people from different cultures together. Some were doing for high end people. 49:56

But, in that case, we didnt tell the students where it has to be, so they know what it has to be, but they have to use their critical assessment for, ok where should I put this, what kind of building should be, we told them they have to chose an existing building. //50:14

We are not going to build a new building. They have to choose a building and renovated. So they would chose a building and would think about the correct location, correct character of the building as well. //50:29

So, you always got to have to fix something, you pin down one end, you got the students to run around with the other end. //50:41

In one case, we pin down the location and the situation. Here is a location, take a look at what happens there, and tells us what the opportunities are. //50:54

The other we told them more specifically a topology, you are providing a space for out-of-towners, not even out-of-town, someone wanted to do short term accommodation for young people, getting their first new flat, before they can afford a whole flat, to have some sort of communal living, where they can be free from their family home, before they can afford to start a family. //51:21

But to look at it as a secondary accommodation, it is a home away from home. And then they were given that, they have to think about where does that happen, who would I address to, what kind of building would be appropriate for this ,what kind of alterations would be appropriate? //51:43

E6: So, I think the best brief properly gives a student a landmark; they have one fixed point, so that from that fixed point, they have a focus within which to exercise their creativity. //52:03

They know it is a transport node, certain things are sure, certain things happened there, so the situation is given, they can go there and they can observe the condition. //52:15

I think within the three years, we try to constitute this in different ways. Sometimes, the situation may be fixed; sometimes the typology might be more or less fixed. //52:30

In the cooperative workshop, the clients is fixed but the clients might not even know what the project is. The clients is fixed, you know you are working with porter and gamble, Nike, the HK housing authority and they may have a general idea of what they are looking for. //52:48

But, in that case, you got to update the client or you need to draw out the client what you can do for them. Often, in the cooperative workshop, a client just have a vague notion that they want to work with the school of design because design is good. //53:07

The students then have to in a way show them, telling me designers what you can do for me. That's a higher level of thinking, thinking about their role in society as designers. //53:30

********** End of interview
****

54:03 onward used for evaluating the two assessment tools.

Summary: fix a point for design to begin, meaningful questions, different topologies (necessary skills for future employment),
Introduce issues or context (scenario), forced associations (create different problems for students), asking students to take responsibility for their issues, dont know the answers for the questions. Rather has more openness than too constraint. Brief is something you go back to, can discover new issues overtime, might not make senses at the beginning. Higher levels role of design in society.

APPENDIX B

QUESTIONNAIRES USED IN THE PILOT STUDY

Samples of questionnaires in the pilot study.

Title: Questionnaire for understanding abstraction levels in project briefs Rev.7
Doc ID: (QLA_r7a)

Personal Information:

Please circle your information

Age:	< 20	20-24	25-30	> 30	
Previous design education level:	Form 7	Diploma	High Diploma	Assoc. Degree	Bachelor's degree
Years of working experience in design:	<3	3-6	7-10	>10	
Area of studies (year):	Environmental design (1 2 3)	Visual Comm. / Advertising (1 2 3)	Product design (1 2 3)	Other _____	

Directions:
This study approximately lasts for ONE hour. It consists of TWO design assignments and FOUR questionnaires. Please spend approximate 25 minutes for each assignment and the remaining time for the questionnaires. Thank you for your participation.

Part B direction: Please assess the following statements by circling/ticking the appropriate box from (very abstract(抽象)) to (very concrete(具體)) based on your understandings of abstraction. If you are not sure about the statement, please circle/tick "Don't know".

	Please estimate the abstractions (抽象性) of the following design tasks	Very abstract	Abstract	Neutral	Concrete	Very concrete	Don't know
1	Design a table	□	□	□	✓	□	□
2	Design a new game board for the game "Monopoly" (大富翁)	□	□	✓	□	□	□
3	Design a talking alarm clock	□	□	□	✓	□	□
4	Design a vehicle (運載工具)	□	□	✓	□	□	□
5	Design a kitchen table	□	□	□	✓	□	□
6	Design a dress shirt (禮服襯衫)	□	✓	□	□	□	□
7	Design a children sitting sofa set	□	□	✓	□	□	□
8	Design a sport coupe (二人雙門轎跑車)	□	✓	□	□	□	□
9	Design a desktop lamp	□	□	□	✓	□	□
10	Design the front door for a busy department store	□	□	□	✓	□	□
11	Design a flash memory-based portable music player	□	□	□	✓	□	□
12	Design an automatic door	□	□	□	✓	□	□
13	Design an exhaust fan outlet (排氣口) for a kitchen	□	□	□	□	✓	□
14	Design a music player that will let a jogger enjoy listening to music when jogging (跑步者)	□	□	✓	□	□	□
15	Design a wearable time-telling device	□	□	✓	□	□	□
16	Design a new board game that friends and family can enjoy playing together	✓	□	□	□	□	□
17	Design a lighting device that enables books reading at night	□	□	✓	□	□	□
18	Design a kids' toy for learning the English alphabet	□	□	✓	□	□	□
19	Design a furniture set	□	□	✓	□	□	□
20	Design an English alphabet playing set	□	□	□	✓	□	□
21	Design a diamond watch	□	✓	□	□	□	□
22	Design a piece of clothing	□	✓	□	□	□	□
23	Design a bedside lamp for people who like to read at night before going to bed	□	□	✓	□	□	□
24	Design a device to remind important day and time for the visually impaired (弱視人士)	□	□	✓	□	□	□
25	Design a ventilation system (通風設備) for a kitchen	□	□	✓	□	□	□

Please assess the following statements by circling/ticking the appropriate box from (very complex(複雜)) to (very simple(簡單)) based on your understandings of complexity. If you are not sure about the statement, please circle/tick "Don't know".

	Please estimate the complexity (複雜性) of the following design tasks	Very complex	complex	Neutral	Simple	Very simple	Don't know
1	Design a table	□	□	□	✓	□	□
2	Design a new game board for the game "Monopoly" (大富翁)	□	□	□	✓	□	□
3	Design a talking alarm clock	□	□	□	✓	□	□
4	Design a vehicle (運載工具)	✓	□	□	□	□	□
5	Design a kitchen table	□	✓	□	□	□	□
6	Design a dress shirt (禮服襯衫)	□	✓	□	□	□	□
7	Design a children sitting sofa set	□	□	✓	□	□	□
8	Design a sport coupe (二人雙門跑車)	✓	□	□	□	□	□
9	Design a desktop lamp	□	□	□	✓	□	□
10	Design the front door for a busy department store	□	□	□	✓	□	□
11	Design a flash memory-based portable music player	□	□	✓	□	□	□
12	Design an automatic door	□	✓	□	□	□	□
13	Design an exhaust fan outlet (排氣口) for a kitchen	□	✓	□	□	□	□
14	Design a music player that will let a jogger enjoy listening to music when jogging (慢步跑)	□	□	✓	□	□	□
15	Design a wearable time-telling device	□	□	✓	□	□	□
16	Design a new board game that friends and family can enjoy playing together	□	□	✓	□	□	□
17	Design a lighting device that enables books reading at night	□	□	✓	□	□	□
18	Design a kids' toy for learning the English alphabet	□	□	✓	□	□	□
19	Design a furniture set	□	□	✓	□	□	□
20	Design an English alphabet playing set	□	□	✓	□	□	□
21	Design a diamond watch	□	□	✓	□	□	□
22	Design a piece of clothing	□	□	✓	□	□	□
23	Design a bedside lamp for people who like to read at night before going to bed	□	□	□	✓	□	□
24	Design a device to remind important day and time for the visually impaired (弱視人仕)	□	✓	□	□	□	□
25	Design a ventilation system (通風設備) for a kitchen	□	□	□	✓	□	□

APPENDIX C

THINK-ALOUD EXERCISE AND CARD-SORTING INSTRUCTION

The think-aloud warm-up exercise and card-sorting instruction used in empirical study II.

Think Aloud Warm-up Exercise

In this experiment we are interested in what you think about when you find answers to some questions that I am going to ask you to answer. In order to do this I am going to ask you to THINK ALOUD as you work on the problem given. What I mean by think aloud is that I want you to tell me EVERYTHING you are thinking from the time you first see the question until you give an answer. I would like you to talk aloud CONSTANTLY from the time I present each problem until you have given your final answer to the question. I don't want you to try to plan out what you say or try to explain to me what you are saying. Just act as if you are alone in the room speaking to yourself. It is most important that you keep talking. If you are silent for any long period of time I will ask you to talk. Do you understand what I want you to do?

Good, now we will begin with some practice problems. First, I want you to multiply these two numbers in your head and tell me what you are thinking as you get an answer.

"What is the result of multiplying 24 x 36"

Good, now I want to see how much you can remember about what you were thinking from the time you read the question until you gave the answer. We are interested in what you actually can REMEMBER rather than what you think you must have thought. If possible I would like you to tell about your memories in the sequence in which they occurred while working on the question. Please tell me if you are uncertain about any of your memories. I don't want you to work on solving the problem again, just report all that you can remember thinking about when answering the question. Now tell me what you remember.

Good. Now I will give you two more practice problems before we proceed with the main experiment. I want you to do the same thing for each of these problems. I want you to think aloud as before as you think about the question, and after you have answered it I will ask you to report all that you can remember about your thinking. Any questions? Here is your next problem.

"How many windows are there in your parent's house?"

Now tell me all that you can remember about your thinking.

Good, now here is another practice problem. Please think aloud as you try to answer it. There is no need to keep count, I will keep track for you.

"Name 20 animals."

Now tell me all that you can remember about your thinking.

Card Sorting Instructions

Purpose:
To see how you, the designer, perceive different design briefs/tasks.
Results will help understand how designers structure their knowledge.

Directions:
1. Scatter the cards around the table in random order.

2. Sit down at the table and sort the cards into groups that you feel are appropriate and then describe each group.

    a. Do not produce stacks that are too large or too small, but if a card deserves its own section, then, so be it.

    b. Stacks do not need to be even.

    c. Take your time.

    d. If a card could fit in multiple piles, pick one of the piles that you feel makes more sense.

3. After the cards are sorted into piles, use a post-it note and label the piles with a word or set of words that best describes the pile. Place the post-it note on the top card of the pile.

4. Prioritize the stacks in order of your importance if possible but is not necessary.

5. Please answer the following question.

Was this card sorting exercise difficult for you? Why or Why not?

APPENDIX D

CARD-SORTING VERBAL PROTOCOL TRANSCRIPTS

Card-sorting verbal protocol transcripts of subject B(Yr1), G(Yr3), H(Prof), H(Mgr), and G(Edu) are included in the appendices. One subject is selected per expertise level.

```
// Subject B (Yr1) card-sorting verbal protocol transcript
// (The card-sorting exercise was conducted in Cantonese)
//    -- indicates the subject's responses to the given design task on the card
// () --indicates reiterations of the task description from the subject
// [] -- describing the subject's activities and the transcribers
reflections/interpretations
// <> -- indicates the card which is attended by the subject at the moment
//

//1st sort 00:10

<21 Heart rate monitor, specifications, composition>
Design a heart rate monitor, very direct, design something which needs precise.

<8 Diamond watch, subordinate, single>
Design a diamond watch, this is related to fashion and beauty. //00:48

This stack is about precision, monitor, time-telling device, requires accuracy and
precision. //00:56

This stack is related to situations, maybe related to lifestyles. //00:58

<5 Garden chair, structures, point>
*Garden chair, I don't know how to sort it now becasue it states some material
requirements. *
//1:09

This is related to food, eating.

<13 Ventilation system, functions, single>
Ventilation system should be grouped under interior design. //1:18

<6 Coin-operated payphone, subordinate, single>
*This is a payphone, I will put tasks which are relative simple and have only a
single requirement into one stack.* //1:38

<4 Window cleaner, specifications, composition>
Design a window cleaner, the requirements are ergonomic, and lots of
functionalities. //1:59

[subject starts labeling group names because they are quite a few design tasks
already.]

This stack is related to functional requirements. //2:10

This stack is related to accuracy. //2:20

<1 Coffee maker, specifications, point>
*Design a coffee maker, some specific requirements, 10-cup size, which looks
similar to the chair task.* //2:45

<3 Beverage vending machine, structures, composition>
Design a vending machine, some requirements, I think this looks like an electrical
appliance, don't know how to sort this yet. //3:04

(Restaurant, design a trash can, many people are smoking. Design something for
throwing away cigarettes.) //3:23
```

<23 Flower vase, structures, point>
This task is a flower case, it has a color requirement, related to lifestyles. //3:30

<10 Card game, functions, composition>
This is a card game, don't know how to sort it yet, it should be similar to toy design. //3:39

This is a dress shirt, should be grouped with the fashion task. Actually, I don't know how to sort this fashion stack and just leave it there for the moment. //3:47

<11 Footwear, superordinate, single>
This is footwear, the task is too general and there are few requirements, So, I don't know how to sort it.//3:52

<16 Clothing, superordinate, single>
This is to design a piece of clothing is too general again. //3:55

<24 Office ladies shoes, scenarios, composition>
(This is office ladies, have to work long hours, need to design a shoes for them.) This is related to design for people. //4:10

<15 Dashboard, specifications, point>
(This is to design a car dashboard, it requires of speedometer, odometer etc.) This task requires high precisions. //4:25

<7 Bedside lamp, scenarios, sinlge>
(This is a bedside lamp, for people reading,) should be lifestyle. //4:38

I will carefully resort these two uncertain stacks, design for people and fashion, later. //4:40

<18 Can opener, specifications, point>
(This is a can-opener, easy for griping, dishwasher safe.) Perhaps this is design for people, I need to reconsider it in details at a later stage. //4:58

<19 Sofa set, scenarios, composition>
This is children sit in front of a TV, blocking the adults, Can you design a sofa set to improve a situation. This is situational. //5:12

Now I have two fine-sorted stacks while the other group is more coarse. //5:26

This coarse stack, only stated like design a footwear, with no requirements, which seems to give [a designer] more design freedom. //5:31

You can approach these design tasks from various directions because the cards only ask you to design an artifact and there are no specific requirements. So, I think these tasks can be approached from multiple directions. //5:54

The other coarse stack is, functions, design for people, contains can-opener, bed lamp is more lifestyle, office ladies have some functions, flower vase is lifestyle, restaurant trash can is functional. //7:11

Coffee maker and garden chair may not belong to functional group. //7:18

<14 Food preparation area, functions, point>
(To design a food preparation area for cooking Chinese dinner, area for cutting raw meat,) this is about an area, Chinese kitchen is about interior design, need a strong spatial sense. //7:43

[The remaining cards are more difficult to sort.] //7:57

Some of the cards are difficult to sort, bedside lamp, could be related to lifestyle, children watching TV, could be related to functional.
//8:13

APPENDIX D - CARD-SORTING VERBAL PROTOCOL TRANSCRIPTS

(To design a new card game, play together, interesting, challenging), this is playful. //8:35

A new card game is toy.

A garden chair but it stated the use of specific materials; it should be related to lifestyle. //9:00

Coffee mug is very personal, for college students.

The other one is coffee maker with specific requirements. //9:18

Bedside lamp is more lifestyle.

[difficult cards: card game, garden chair, because of the material requirements?, coffee mug, for college students, coffee maker with specific requirements, beside lamp, ventilation system]
//9:50

[still pondering a new card game, interesting and challenging] //9:48

This side is about lifestyle, these products allow more design variations. //10:01

*I will use the pink post it note to mark these two difficult cards, the other cards are easier to sort, I will single out the two cards. //10:18

This card has specific requirements but did not specify any end-users*
//finish @ 10:55

The pink group is difficult to categorize, but the other cards show similar attributes. //11:30

//another recording episode starts (b)**********
//Explanations for the sorting results.

I primarily sorted the cards into 6 categories and based my sorting on the nature of the tasks. //b00:14

For instance, the first group has more design freedom, it only stated to design a footwear, or to design a diamond watch. //b00:18

For this kind of tasks, you can design what you like. It let you to have a big room for imagination, like footwear, no material requirements, no specific requirements, you can design what you like, a designer can start from any directions. This stack gives more design freedom. //b00:38

The second group is accuracy; these design tasks require certain engineering background, for instance, to design a card dashboard, even though it may be a 2D layout design. //b00:57

However, when working on this task, it will inevitably involves engineering. When you are driving, how can it make you see more comfortable or more convenient, whether buttons should be of bigger size? //b00:16

Time-telling device, a clock, storage device may need accurate measurements, heart-rate monitor will require high precision, these tasks are related to human machine communication and require accuracy. //b01:42

The third group is functional design for people. The task specified that you need to design an artifact which has some constraints; however, the constraints are originated from a user-perspective. //b01:55

E.g. the can-opener stated that it should not have sharp-edges, easy to grip and easy to turn, are human-centered requirements. I think that character signifies this group. //b2:13

This one stated that you need to design a Chinese kitchen ventilation system, but why does it have to be a Chinese kitchen but not a Japanese kitchen? and to design an area for cooking, are related to space, how to organize the different use of space. //b2:40

The 5th group has specific requirements, e.g. you need to design a coffee maker with a 10-cup capacity, with removable basket, this is similar to the other group but this has more requirements. But these requirements are not from a user-centered perspective, it only tell you a situation. //b3:03

*This task only tells you to design an artifact with all the mentioned specifications, you then need to decide how to design the artifact. This is similar to a freelance job in the commercial world. You only need to give the client a mediocre solution. * //b3:12

The last one is lifestyle design, design a flower vase, a garden chair, has some constraints, like materials, but there is no requirements for color, you can still add your own style into the design. //b3:47

E.g. the chair task limited the use of material, but there are no constraints on the shape, a round chair or a square chair. There are rooms for design to exercise their own imagination. These are my sorting reasons. //b3:59

****
****
//Second sort b4:45

(Design an automatic revolving door) //b5:09

(Design a piece of clothing) //b5:16

Can I sort the cards from a different viewpoint?

This time I will layout all the card first. //b5:30
[layout all the cards on the table]

I will use a different approach to layout all the cards first.
//5:35

Design a card dashboard is related to mechanical hardware, I will put this into on stack. //b5:55

Now looking from above, lots of the cards seem mechanical. //b5:58

Heart rate monitor belongs to this group.

Wearable time telling device actually is a watch. //b6:10

Let me be playful, I don’t want to give you the same stable result as I did in the 1st sort. //b6:17

Office ladies belong to design for people group. //b6:21

This is a coffee maker; I will leave it alone first. //b6:25

Ventilation system, system should be related to spatial arrangements. //b6:33

(Design a margarine storage device that can be reused), this should be related to food, why did I put this into the accuracy stack?
[misread the information or made a mistake last time?] //b6:42

To design a footwear, this is too simple. //b6:48

To design a dress-shirt, piece of clothing, coin-operated payphone, *All these [single statement] tasks are very ambiguous* //b7:17

APPENDIX D - CARD-SORTING VERBAL PROTOCOL TRANSCRIPTS

I need to think about how to sort the revolving door card; I do not know whether the door's requirements will involve engineering knowledge. //b7:33

This is related to kitchen.

Window cleaner belongs to the design for people stack. Can-opener is also design for people. //b7:45

Garden chair is more about style.

Bedside lamp and garden chair are a pair because I can exercise my design freedom. //b8:04

(Busy restaurant, cigarettes light buds on the ground, design a trash can to improve it), improvement is related to people. //b8:17

Flower vase is paired with the garden chair because they give a designer lots of design freedom. //b8:30

Payment receiver.

To design a sofa, this is to improve a situation. //b8:49

These are the remaining one. Design a storage device, which can hold some margarine. This can be related to coffee maker, this sort result is different from last time. [Misread information] //b9:06

A new card game, you can design any kinds of card games, you can add lots of your own imagination. //b9:20

<3 Beverage vending machine, structures, composition>
This is a beverage machine, looks similar to a design task in the professional world. //b9:30

A food preparation area is spatial arrangements. //b9:38
[Subject pays special attention to certain keywords, "area"]

<12 Coffee mug, scenarios, composition>
(This task is to make college students, two cups of coffee to bring into their car, a coffee mug) This has some constraints but ask you to design something for drinking coffee. //b9:56
[this is a scenario card, design constraints vs. design requirements]

This time, I put the revolving door into the accuracy stack because I think it is related to engineering. //b10:07
[I will use some new labels for naming the groups]

Time-telling card is a watch right? You are trying to trick me? It is a watch. I did not look at it carefully last time. I saw the keyword, time-telling device and thought it should be related to accurate device.
//b11:05

Can I change the group now? Because of the card wordings, I think it should still belong to the accuracy group.
[Moving the time-telling device card from design freedom group to accuracy group] //b11:10

//finish 2nd sort
11:11**********
[writing labels for each group]

This group is design for people again, a human-centered design. //b11:27

This group is a spatial. //b11:40

This group is to design a product with certain conditions.

This group is more lifestyle, more design freedom. //b12:18

[Explaining the difference made for the 2nd sort] //12:40

I used a different way to sort the card this time. Last time, I sort the card individually. This time, I layout all the cards before sorting them. //b12:48

I think it is easier to sort the cards when they are layout on the table. I also notice a few new information but it doesn't change too much of my perception. //b13:02

Especially when the cards are layout on the table, I can see them more clearly and pay more attention to the wordings on the cards. //b13:10

However, I am still using my own principles to sort the cards about the nature of the tasks. //b13:21

I think I misread the storage device card because I miss out some information and put it in the accuracy group. //b13:35

Now I see that card as design something to store a small amount of margarine. So, I put it into product with certain conditions. //b13:53

The rest is generally the same. //b14:03

****
****

//3rd sort 15:20
[layout all the cards on the table]

At the second sort, I pay more attentions to the card descriptions. //b16:22

I might not be sure about my first sort results. At the second sort, I am more confident about my sorting results. //b16:31

I am thinking if there is another way that I may not have thought of before. //17:14

[Standing and thinking without verbalizations] //b17:05
I am thinking whether they are any hidden relationships between the cards which I am not aware of because everyone has a different viewpoint and I can imagine other's viewpoint. //b17:25

[Arrange the cards very quickly and very efficient, using a different perspective, no verbalization at all]
//18:21

Sometimes, I will adopt this kind of quick scanning method.

// finish 3rd sort
18:43**********
****

If I were to work for an outside project, this time I only have 3 groups.
The first group has lots of texts, explain many things, provide you with lots of texts and you will need to pay attention to details. You may need to do lots of research. I think these tasks are annoying. I will not do this kind of tasks first if I have a choice. //b19:25
[These cards have many words, long descriptions; designers do not like to read texts??]

The second group points to design an artifact which states all the design requirements clearly in bullet-point form. These tasks look like design works in

the real world. These tasks are very boring. //b19:46
[Looking at the bullet-point form cards]

The last group is very free, only asks you to design an artifact, you can design what you want. You need to find out the situations and the target users on your own. These tasks give you lots of freedom and you can do lots of interesting research. You are free to design anything; I will choose these tasks because there is not much constraints. //b20:07
[Looking at the single statement tasks]

On the surface, the tasks with lots of texts seem to give you situations but actually it has lots of constraints. The single statement has few constraints. //b20:23
[When reading the design tasks, subject(Yr 1) can make a lot of assumptions and infer about design constraints and design freedom.]

The first [lots of texts] and third [single statement] groups contain tasks that are school design projects. The middle [bullet-point form] group contains tasks from the real world design projects. The first group may be is for senior year design projects. But I still prefer to work on the single statement design tasks. //b20:32

W: Are you satisfied with your sort results this time?

Sure, at least, I can quickly scan out the design tasks that I like to do and those that I don't. //b21:17

This 3rd sort has a very clear objective [personal preference]. //b21:40

This 3rd sort approach is for exploration only and I will use the earlier approach which is more rational and I can sort the cards carefully to see what I really like. //b22:05

// Subject G (Yr3) card-sorting verbal protocol transcript
// (The card-sorting exercise was conducted in Cantonese)
//-0:10 start sorting
// [] -- describing the subject's activities and the transcribers reflections/interpretations
// <> -- indicates the card which is attended by the subject at the moment

[read one card at a time]

(Dress shirt, to design a ventilation system for a Chinese restaurant) //0:15

<19 Sofa set, scenarios, composition>
<17 Trash can, scenarios, composition>
There are problem-solving. These seem like problem tasks. //0:25

(Design a window cleaner, ...)

Design a footwear is very free. //0:55

(Design a wearable time-telling device, Design a piece of clothing) //1:06

(Design a coffee maker,) this seems to have given you something for you to design. //1:19

(Design a garden chair,) this seems like the coffee maker. //1:23

These are bullet point-forms but they are similar. //1:32

Design a new card game, this seems to provide you with a situation/phenomenon and ask you to design an artifact for it. //1:59

(8 am in the morning, ...freshly brewed coffee to drink inside a car, design a coffee mug.) This pile describes an event happened at a specific time, you need to design something for some target users at this specific time. //2:38

[reading the card description, some groups already emerged]

Some cards have given you a event happened at a specific time, some cards are very generic phenomenon. //2:51

<23 Flower vase, structures, point>
This is in point-forms and specifies what you need to do. //3:00

[5-6 groups already emerged]

(Office ladies ...promote healthy living and exercises) This seems like a problem and ask you to solve it. //3:24

(Design a heart rate monitor is ... display ECG,...) This becomes another group. This group is .. //3:57

*One group has very specific requirements and specifies what you need to do, are in point-forms. These are more forceful requirements. * //4:14

This group (the ECG) tells you a general idea of what is expected, but they are not rigid requirements. These are softer requirements. //4:26

(Design a food preparation area for cooking Chinese dinner,) //4:42
[put this with the window cleaner card]

(Design a dashboard, ...) //4:53

(Design a beverage vending machine ...) //5:05

*(No sharp edges, no contact, ...) This task has very specific requirements, the edges, it looks like the product has been designed for me, I only need to make a

sketch for it practically.* //5:25
[impression perceived is that the subject only needs to visualize the outcome???]

(Design a bedside lamp for people who like to read ...) //5:40

(Coin-operated payphone, a diamond watch ...) //5:57

I am done.

//finish 1st sort
6:00**********
****

[reviewing the card descriptions] //6:40

[start labeling the groups] //7:00

...
[start looking at these two cards] //9:33

[Looking at the window cleaner card and the food preparation area card and decided to switch into existing groups.] //9:55

[settled the two cards, but then changed 1 card again.]

[probably needs to add some time (2 mins) back to the 1st sorting because after //9:33, the subject focuses on reviewing the cards rather than giving the group names.] //10:34

//11:40 [finished labeling and start explaining the sort results]

*In this first group, e.g. one card asks you to design a coffee maker, has 10-cups, removable basket, auto start/top, basically you are looking at a product or the product specifications but without knowing the target users. * //12:04

All these cards stated the key features of the product. It focuses on the product itself. //12:18

This second pile focuses more on outcomes, e.g. card game, focuses more on users. When I design for that task, I will think how to make the players to have fun. Or how to measure heart rate and calorie. I will start from a user's perspective. //12:51

I will focus on the target users first for this (users) group. For the previous group, the task asks you to design an artifact; I will start by thinking where to arrange the cups, or the layout of the buttons. The spec. group makes me focus on the product. //13:10

[specifications focus on product such as buttons layout, users group focus on users (similar to the sketch results from the design exercise)]

This pile(time-users) states a specific time or situation, such as a busy restaurant, 8am in the morning. Although the product can be used at any time, the given situation may inform me when I am designing, what are the specific things people will do at that time or what may be the specific needs? //13:35

I will start designing by considering the time-situation. E.g. design a coffee mug which can be used at anytime. I will think maybe college students will have specific needs in that situation for the coffee mug. //13:54

This pile is similar to the earlier (users) group, however, there are some differences. This is very situational such as children watching TV and blocking adults design a sofa to improve this situation; this is like a problem-solving task. //14:20

This seems to have given you a problem and ask you to solve it. The users group

did not give me that impression. The task descriptions were presented in such ways that want me to focus on the users benefits. //14:37

The final two groups, task descriptions are very short, give you lots of design freedom. //14:50

Compared to the rest of the groups which have given you time and other constraints. These tasks contain one or two sentences. //14:58

I think one pile is more technical, automatic revolving door, ventilation system, coin-operated payphone are more technical. When looking at these tasks, these are more technical designs. //15:20

You still have lots of design freedom but you need to take the technical aspects into consideration. There are some implicit limitations due to available technology. E.g. Ventilation system, you may need to consider air inlets and outlets, coin-operated is a constraint already, so these have one or two constraints. //15:50

They also have some target users/customers, for payphone users, for kitchen staff. //16:13

*The last pile doesn't have any users/customers. A dress shirt, a piece of clothing, essentially you can find these products easily on the street. There is lots of design freedom. My first question is who my target users are. * //16:40
[lots of design freedom, but need to know the target users]

The target users are unknown. Whether it is designed for a senior or a teenager or children? //16:50

//2nd sort begins 18:26
****
**

I will use a different method this time. //18:29

[reading individual card one at a time, layout all the card on the table first]

Last time, I sort the cards based on the information given on the cards. //19:34

I already know the information, I want to know if some of the cards naturally belong to a category. //19:47

At this moment, this is kind of confusing. //20:00

(Office ladies,...) this should be footwear. //20:15

Garden chair and sofa set can be together. //20:24

(Busy restaurant,) it seems like I am working in interior design. //20:41

(Payphone, ...)

(8am in the morning, coffee mug) This should be related to food.//20:58

(piece of clothing, dress shirt, ...)

Some cards seem to be related to measurements. //21:20

(Design a window cleaner, design a new card game) //21:33

(Coin-operated phone ....) //21:40

What is this device (payphone)? //22:31

*I am thinking if these cards can form similar categories, even though their descriptions are different, maybe, the design artifacts can be put into used at

the same place or actually can be the same category. E.g. office ladies can be footwear. So, I put them together into a group. * //23:11

Garden chair belongs to the sofa set as in the furniture group.//23:19
[psychological natural categories??]

Card game can be a toy. These three cards. Should I put them together or separate them?
[Uncertainty??]

This group is related to home electronics. //23:41

This group is very specific, about measurements. //23:46

Design a wearable device, dress shirt, clothing, etc. are related to accessories and fashion. They should belong to the same group as in footwear. //24:06

Revolving door, food preparation area, trash can, and ventilation system look to me like interior design tasks. More on interior design. //24:22

Let see if I need to change anything. //24:37

(flower vase, ...black color)

That is my results. //24:50

//finish 2nd sort 24:50
****
*

This group is electronics. //26:39

This group is, garden chair, furniture. //25:35

Both groups are electronics, however, one group requires very precise measurements. It relies on the numbers to determine its functions. //26:20

The other group is more related to outcomes, enjoyable experience, but not numbers. //26:36

This one is a toy by itself. Is that going to be too small a group? //26:48

This group seems like urban fixtures (payphone). //27:05

This is a piece of art (flower vase). //27:16

These are fashion and accessories. //27:33

These are interior design.

W: Can you explain why you change your sorting? //28:18

Because I already read the information on the cards and have a general idea about the cards. Previously, I know some of them are rather technical. I knew some of them can be grouped together. //28:30

My 1st sort results are based on the information given on the cards, I feel what the task want me to do, what kind of information was given and what I can do for the tasks. That was my thought. //28:48
[1st sorting based on information]

For the 2nd sort, the sort is based on the kinds of artifacts being designed. //29:00

Some cards have little information, e.g. footwear, you can sketch whatever you like. //29:05

However, this one (office ladies) is based on a problem but the expected outcome is still a footwear. So, I put them together. //29:14

*I don’t know how to sort some of the cards. E.g. Flower vase is more like a piece of art, it is quite different from the rest of the groups. Flower vase can be treated as a home product; however, the descriptions did not say the area of use. * //29:30
[special interest in art? does the same reason apply to footwear?]

Where you put the flower vase can make a big difference for your design. You may change your perspective. I regard this as an art piece. //29:38
[not enough contextual information?]

Card game is not related to any other cards but I think it looks like a toy to me. It should have a playful element. //29:48

Coin-operated payphone. You probably will have this at your house. This should be a product on the street for public use. The rest of the cards also do not contain any urban fixtures. //30:02

The electronics group should be one pile but I made a finer judgment to separate the group. //30:09

These look like interior design, these tasks can be part of a bigger project. If you need a revolving door, the place is going to be big, maybe for a mall or restaurant unless your house is very big. I think it can be part of a restaurant //30:36
[a good assumption??]
// start 3rd sort -00:30
****
**

[putting cards into groups, one at a time according to the 2nd sort results]

[realized that the beverage vending machine can be grouped with the public fixtures group] //1:18
Both can be for public use.

//finished sorting 1:44

APPENDIX D - CARD-SORTING VERBAL PROTOCOL TRANSCRIPTS

// Subject H (Prof.) card-sorting verbal protocol transcript
// (The card-sorting exercise was conducted in Cantonese)
// [] -- describing the subject's activities and the transcribers reflections/interpretations
// W: Interviewer,

[Subject H: start 1st sort //00:02, 1st sort time = 13:12 mins, initially showing a certain amount of frustration toward the tasks with no requirements, 2nd sort time 2:13 mins]

W: You can start whenever you are ready.

I: To design a wearable time-telling device, design a coffee maker, lost of household products, to design a new card game. //00:28

[Subject H to put all the cards on the table]

Design a footwear. // 1:06

H: too many cigarette light buds on the ground ... [reading the card descriptions and summarised with certain phrases] // 1:14

To design a bedside lamp for whom likes to read books. //1:19

H: need to design a flower vase, have materials requirements, color requirements, weight requirements, //1:37

?<99064>H: some of the tasks are simpler, some tasks are more detailed?<101688> //1:44

H: To design a storage device, ..., need to do some measurements, store margarine ok, //2:07

?<135936>H: it is related to system design, it is rather difficult?<137477> //2:19

H: to design a food preparation area for cooking Chinese dinner, ?<145007>it is related to kitchen ?<146992>

H: cutting materials, cooking rice, ?<152876>this task is out of the blue to make a shirt,

H: this task is to design a piece of clothing?<161473> //2:42

H: I am sorting out all the tasks that have no descriptions first, //2:50 to design a revolving door, to design a diamond watch, these tasks do not contain any requirements or information.

H: To design a wearable-time telling machine, it is a kind of watch? //3:06

H: Under careful considerations, this way of categorising the tasks is meaningless?<193938> [rejected using the amount of information appears on the cards as the sorting principle and ungroup the pile.] //3:13

H: Office ladies usually have long working hours and they don't have time to exercise. This looks familiar, I recalled reading " to a design a footwear" card earlier. Both should be grouped together. //3:30

To design a vending machine, this machine is very veratile. why are there so many components? the task already contains everything. this is insane. //3:53

H: To design a coffee marker, it contains some design requirements. //3:59

H: To design a dashboard is the most difficult no matter what is mentioned on the card. //4:06

H: To design a garden chair using stainless steel, modular design, requires easy

assembly,
It seems that there are some differences among the tasks.?<258122> //4:18

H: To design a new card game for friends, enjoy, can cooperate or against , should be interesting and challenging, *I just finished a similar project at my own company.* //4:24

H: to design a hear rate monitor, ECG, very powerful, the tasks requirements are so powerful, this should belong to medical or health-related products. //4:46

H: Can opener is good, the reuqirement states that it should not hurt the hands. //4:55

H: It is 8 am in the morning students need two cups of coffee at the cars, coffee mug, there was a coffee maker, both should be related and grouped together?<311817> //5:13

H: Children watching, they always sit, ... adults from viewing the show, the sofa needs to have two different ends, it is another interesting project.?<327725>//5:30 [may be there are more room for the designers to imagine the project and relate to the project more readily???]

H: I think these tasks are related to everyday living.?<336845>

H: to design a coin-operated payphone, to design a window cleaner ... , to effectively clean windows, a versatile window cleaning machine. //5:54

H: It seems to be a difficult task to organize these tasks. The categories will get to be very small, there can be twenty different task categories ?<360517> //6:05

H: To design a dashboard, my main obstacle is what direction should I take to categorise these tasks.?<383162> //6:25

H: Should I use their levels of details to categorise? or however some of them are closely related or similar, //6:35

H: For example, the task footwear, if there is no requirements, I cannot start designing, what does it mean to design a footwear??<401603> [asking for more information ??] //6:40

H: Frankly, my supervisor will have their own preferences, to design a footwear can mean anything. //6:47
Maybe this is all the information I can have already. It will be better only if I can have the additional design requirements.?<420933>//6:59

H: Maybe not, actually, there is nothing I can do with these single statement tasks. [a moment showing frustration and confusion] //7:07

H: Should these tasks only be considered as an open-ended desgin tasks? Maybe it doesn't require anything special for the task. If my boss asks me to design for these tasks, I will try to predict the current trend and his preferences. OK. That's should be the direction. //7:26

H: *For these single statement tasks, the boss is only having a vague idea of what to do, he doesn't know what he wants to do.?<454444> [throwing a stack of cards on the table with contempt]* //7:34

H: The longer statements seem to be problem-solving statements, these are simpler and easier to do. //7:42

H: Very obvious, some of them have lots of requirements, some requirements are so specific and to the extreme.?<477707> //7:59

H: garden chair and coffee maker, the requirments are so specific. but some other tasks requirements are so open-ended. //8:19

APPENDIX D - CARD-SORTING VERBAL PROTOCOL TRANSCRIPTS

H: 8am ,need to make two cups of coffee, it is still-problem-solving, it's some kinds of phenonomen?<503738> //8:28

H: *The task said it needs a coffee mug, however, it may not be necessary for to use a mug as long as you solve the problem. I can suggest to use other solutions. *//8:43

H: A new card task is the most strange task and does not belong to anywhere. //8:50

H: Storage device, has all the design requiements, magarine, seem very specific but also like problem-solving again. //9:09

H: Design a coin-operated payphone, I can design a pretty one [no requirements] //9:20

to design a heart-rate monitor, ECG, ... very specific. //9:27

I can start with the dashboard and Chinese dinner cards can be put together. //9:37

H: Design task, Office ladies, window cleaner is a problem again, ergonomic handle, [put down the card already and pick up another card] ... //9:53

To design a beverage vending machine, this is to design a system, this is difficult to say because I don't know what are the existing problems [again some reflect for solving problems] //10:04

To design a new card game, I think this is a nature task for a toy designer. //10:16

There is no importance within the tasks. I originally thought there are some importance of different tasks. //10:25

Coffee maker, can opener, [reviewing individual cards with every groups] // 10:36

H: Basically, I already made a preliminary selection. One group has no descriptions, //10:40

H: One group is not pointing to one solution, the task only states the symtoms of the problems/situations. The tasks state phenonomen and try to improve the existing conditions?<652590> //10:57

H: Another group is already getting into very functional, I can relate to one of my project, it is all about functions and is not subjected to any changes. //11:13

H: office ladies, watching TV, ...

H: *storage device is very specific too. It already states all the basic requirements.* // 11:41

Window cleaner and office ladies, even though they ask you to design one specific product, There is no reason that I can't handle this task. //12:06

H: On the surface, some of the tasks are very similar. //12:18

What am I thinking, to design a lamp (scenario task), (trying to visualize a scenario of switching off the night before going to bed.) Turning off the light is very tediou. This is what is needed.?<766824> //12:49

H: Vending machine, seems to be different, is it a descibing a problem or trying to manufacture a vending machine?<776688> However, the requirements are very vague. Ok. This group is something uncertain. //13:06

H: I am finished, no need to give order within the group ?<795283> (approx. 14 mins to finish the sorting) //13:15

[laying out the cards and labelling the cards //15:10]

H: There are four groups.

H: *The first group is called, the concrete, confirm group (affirmative, definitive) because it has specific conditions/requirements need to fulfill, very details, these are very strong constraints, it seems to have a lot of information to support the tasks. * //15:51

H: For example, the number of cups for the coffee maker, no sharp edges, The tasks spell out all the requirements. All the requirements are pretty definitive. //16:39

Sometimes, even the colors are pre-determined and it is likely, these requirements are based on my boss past experience. These colors sell better. You need to trust your boss, for example, the coffee maker states 10-cup capacity, I could ask why not make a 12-cup capacity, maybe there is not much of a difference. These requirements should be taken as granted because they are not arguable. //17:10

Everyone knows larger is better, however, there may be some other factors like cost to affect the requirements. //17:15

H: For the can opener, it should not leave sharp edges, that is just commonsense. These requirements should not be questioned, are firm requirements. //17:36

H: There are tasks, you don't need to question, you only need to follow the orders. Another example is the removable filter basket, the function makes the coffee maker easy to clean. ?<1056006>//17:40

H: You cannot argue for this kind of trivial or obvious requirements. //17:40 (It is difficult to question something that is widely considered to be true.)

H: Dashboard is another task required experience and you only need to follow what should be included. //17:45

For the hear rate monitor, all the stated functions seem to reflect that someone else has design it before and considered essential for the product.?<1074883> //17:56

H: Since I am not a doctor, if your boss gets this job, your boss must have a related background and you need to listen to his advice. These requirements cannot be argued. [reasoning the stated requirements as from authoritative sources] //18:09

H: For the garden chair, it wants to use plastic and steel, maybe becasue all the wooden chair got damaged easier from past expereince. //18:23

This can be another advice based on past experience. These requirements are very specific and is a must and cannot be changed. These requirements do not seem to be personal preferences. ?<1125323>//18:52

H: For the garden chair, it wants to use plastic and steel, maybe because all the wooden chair got damaged easier from past experience. //18:23

This can be another advice based on past experience. These requirements are very specific and are a must and cannot be changed. These requirements do not seem to be personal preferences. ?<1125323>//18:52

H: For the storage device, it is about measurement, it seems to be a task similar to a measuring cup. (a justification !) //19:24

H: These requirements seem to come from some kinds of research or experience or learn from the market that why you need to design the product following the requiremets. You can be very sure what to design. //19:31

H: To design a food preparation area, maybe it is a rather systematic design, even though it is not a single piece, the task will tell you something very specific, cutting raw meat, and rice cooking area,

You can still elaborate on your interpretations and design for the cooking area for cutting raw meat and fish. ?<1214463> [cooking area is open for interpretation ??] //20:08

H: This is similar to the coffee maker card. Even though the task stated as a 10-cup maker, a designer can determine the shape of the cup which can be round, rectangular or others. //20:17

Besides the above design freedom, there is a large part of the project that has been specified for you already.

These tasks are very definitive and these are basic requirements that must be satisfied. //20:32

H: The second group has no information, "out of the blue" group, becasue it requires imagination. //20:55

If your boss gave you a task like that, you need to make a best guess at what he wants. //21:04

H: My feeling is that these tasks are form or aethestics related, very abstract tasks. //21:16

H: The ventilation system for a Chinese restaurant can have a lot of variations. //21:34

I know it requires ventilation, however, where should I start to design? ... //21:45

H: OK. these tasks require the designers to start from scratch, to understand the tasks and to look at the tasks from a macro perspectives.?<1314101> [reflection for the single statement tasks] //21:54

H: For example, the piece of clothing, I will need more information, need to do more research using the internet, books, magazines.?<1327803> //22:08

H: To see what are the existing products in the market and extract all the elements/characteristics that you think are useful for this particular task. [maybe only naming a product can help designers look for existing product in the market] // 22:10

H: You search for interesting features. You collected all the information. Then, you may find a case that is interesting, a handle of a phone that is very interesting, a keypad that is innovative or a coin-loading mechanism interesting, then you need to add your imagination, integrate everything together then you come up with something new. //22:29

H: However, these may not be something that your boss want, your boss may simply need a normal phone booth. That could be the case, you never know. //22:41

H: The revolving door has an axial and is revolving, your boss may want something innovative, a special operating mechanism, you don’t know what your boss want, you need to make a guess or use a trial and error method. [only an object name leave lots of design freedom but also need to make lots of guessing for the boss preference, a designer needs to make a lot of assumptions and as we know from literature that novice designers are not very good at using or lacking domain specific knowledge] //23:03

H: This kind of trial and error is different from the first group, the first group is based on many specific requirements, this group has no requirements and you need to negostiate the requirements together with your boss. [negotiation to narrow down the design requirements with multiple parties??] //23:14

H: Your boss may decide to design a diamond watch just because he has never done it before. However, the trends and directions are not determined yet. //23:31

H: For the coffee maker, the boss may determine the directions, if it is going for

an office setting, we may go for 10-cup size, if we are going for a home setting (4-cup size) which will determine the cup-size requirements. A certain direction has been decided. [some options are closed already] //23:45

H: For the second group, there is no even a general direction, what is footwear? everthing is footwear, you need to decide whether it is sports shoes ? The boss may not know what the direction should be, very hip or very cheap? [a sense of uncertainty] //24:01

H: If you recevie this kinds of tasks, you need to talk with your boss for further information.
You need to know what he wants otherwise, there is no ending to the project.?<1458367> //24:49

H: Children watching TV, this is a problem-solving group. //24:22

H: Why do they belong to the problem-solving group?

H: These tasks seem to post a problem?<1486810>//24:43

H: Children blocking the TV screen, office ladies ... ,it seems the situations have been investigated. //24:56

H: To design a sofa, this seems to be a conclusion arrived/solution after discussing the problem situation. //25:01

H: If someone has done the research, as a designer, you need to examine the research data or other relevant information before you can decide what to do next. ?<1517635> //25:11

H: If no research was done, the designer needs to perform his own research for the problem/situation before doing anything else. There exists a general direction, however, the product can vary within the general direction. //25:20

H: Somehow, "unless your company is making shoes", [you can provide numerous solutions to the given situation/problem.] //25:30

The problem is not having enough time for exercises, the solution does not need to be a pair of walking shoes. A designer needs to dig out the background information about the situation. //25:47

This is not the best example for the category. There is one very obvious example. //25:53 [There can be multiple solutions. Some tasks are not as obvious of having multiple solutions.]

H: The 8 am coffee scenario, the task need a coffee mug, however, I can argue that a very efficient alarm can solve this problem, you can eat breakfast at home. //26:07

There is a helicopter alarm clock I have seen before, it requires the user to put to helicopter to stop the alarm. //26:24

H: One can wake up early at home to enjoy the coffee. There is no final solution, any solutions can be interesting. //26:34

H: Even though the task tells you to make a coffee mug, the task has provided you with a situation which lead you to consider any relevant information together. [desinger looking at the design context???] //26:40

In constrast to the first group which does not provide any situations. That group only provides you with a name of the object. You only need to find the task. //26:45

The designer now understand/comprehend the cause and effect of the design task. [empowering the designers???] //26:52

Once that is established, a designer can negotiate with the design task. //26:56 ?<1596987>

APPENDIX D - CARD-SORTING VERBAL PROTOCOL TRANSCRIPTS

H: the other 2 groups have no situations, the tasks only states an artefact, however, this group has provided a reason. You can always argue for any tentative solutions that alleviate the situations. You can negostiate with the clients. [challenge the current solutions] //26:58

H: One also needs to consider the company business, if they manufacture shoes, then the product designed should not be a toy. //27:10

H: For the window cleaner, I can design a versatile cleaner that can effectively clean windows. I can also design a water spraying gun that can clean everything. //27:31

H: Game design is very special to me, I considered it to be very very difficult. You need to have many people to try out and have feedback to be able to arrive a good card. //28:02

H: You can study all the other tasks individually , but the card game task is very interactive. //28:09

H: Everyone on the market wants to do a card game right but very few people succeed.

H: There are so many fail example of bad card game, you need to invest a lot of time and money to develop an interesting game. [personal preference] //28:23

H: This card is unique in the whole stacks of cards. //28:40

For sleeping kind of activity, a large group of people (50% or 30%) have similar experience or exercise, these are common problems. However, the reactions to card game are very individual. //29:15

H: becasue the task still needs the designer to study and follow up the design.

H: Technically, the card game is a sub-category of the problem-solving group.?<1811276> //29:26

The card game still requires a lot of studying and follow-up. //29:35

[Resorting takes place, 2nd sorting start //31:37, 2:13 mins]

[reading individual cards and put them back to the 1st sorting groups.]

[finished sorting //33:50]

I think there is no problem with the single task statments group. I might have switched some cards between the problem-solving and the definitive group. //34:52

H: I want to supplement some information for the vending machine task?<2113987> //35:12

H: Although the vending machine has these fixed components, I will ask why and reason for the requirements, maybe partly becasue I am not familiar with the task. [familiarity of the task affects sorting results] //35:39

However, I will not ask the reasons for tasks in group 1 (definitive).

W: Is there any order in the sorting results?

I don’t think there is any additional order. //36:08

H: E.g. in a design house or a research lab, I received all the tasks at once, Then, I will do the most familiar tasks, unfamiliar tasks will be the last thing to do or until the boss ask me to do. It is my personal preference. [doing the familiar tasks first] //36:33

// Subject H (Mgr.) card-sorting verbal protocol transcript
// (The card-sorting exercise was conducted in Cantonese)
// [] -- describing the subject's activities and the transcribers reflections/interpretations
// <> -- indicates the card which is attended by the subject at the moment

[protocol training, 1st sort 7:30mins, 2nd sort 4:36 mins]

[card sorting starts //5:54]

Preparation area for cutting raw fish, rice cooking area [reading directly from the card] //6:23

[Trying to understand individual cards and reading along the process...]

I will put the cards that are related to food into one pile first. //7:35

Office ladies, ... another pile is wearables. //7:51

Diamond watch, footwear, garden chair, ... piece of clothing, coffee maker, flower vase ... related to household products. //8:55

Can-opener is related to household products. //9:05

[What is ECG?]

Health, restaurant, [already finish reading all the cards] //10:06

I can see a few big groups, some cards are difficult to put into specific groups. //10:10

Maybe, I will put the difficult cards into the other group. //10:11

There are many restaurants and food-related cards, I will put them into the same group. //10:23

5 cards follow into this category. This device can be used in a restaurant. //10:40

These cards are wearable items, diamond watch is a different category but is still an in-between item.
[using/connecting the keywords given in the card descriptions], Fashionable items. //10:56

[phone rings, 30 sec] //10:56

Back //11:21

Window cleaner related to household.

Automatic door is different and I will decide later. //11:28

More household products, can-opener can be related household or kitchen. [primarily look at the application area] //11:41

10 Cup-capacity, I don't drink coffee, can be related to restaurant. //12:03

8 am in the morning, coffee mug can be household products.

I put the garden chair into household first, even though it is a little bit of a stretch. //12:20

Design a dashboard for a car, don't know how to sort it. [dashboard, ECG, card game] //12:24

Heart rate monitor is an equipment. //12:26

APPENDIX D - CARD-SORTING VERBAL PROTOCOL TRANSCRIPTS

More household products.

Board game, automatic door (don't know if it can be used at a restaurant?), I will put it there. //12:51

Dashboard, heart rate, health-concerned consumer products are difficult to sort. //13:06

Don't know how to sort the last 3 cards.

For these cards, customers are related to home, family, products used at a house or room. //13:20

Those are the target customers.

These cards are fashion related products. Wearables, footwear, clothing, diamond watch.. trendy and wearables, different kind of customers. //13:39

This group is something (products) you will need/be interested in if you are opening a restaurant. //13:53

I don't know how to sort the last three cards. //13:56

[finished sorting 13:56]

[naming the cards]
1. Catering
2. Fashions
3. Household
4. Others

//14:52
[reading cards under groups]
...noticing that he has put the payphone under the household group and would like to switch it to others. //16:31

[finish reading cards] //17:05
[detail explaining his reasons]

If it were my intention to open up a restaurant, it gives me a focus, it drives my interest. //17:33

For teenagers, that group contains items that they will be interested in and spend money on. //17:41

[Phone rang again ...]
[back //18:28]

Household products are stuff from IKEA and alike. //18:37

*If you sort it this way, it can attract the flow of people, people who are looking for the similar kind of products. *
[similar to how supermarket arrange their products in the store] //18:46

[1sr sort done //18:54]

Don't know the other group.

[2nd sort begins //19:41]
[without saying anything!!]

I am reading the cards again to see whether I can sort the cards in a different way. //20:38

....

10 cup capacity should not be in a restaurant, probably should use at home. [rethinking some previous made decisions] //21:53

Greasy fingers ...

Trying to see if there are more cards that are related to food. //22:36

... public area ... [a new keyword was generated, trying to zoom out even more?] //23:28

However, area is not related to product, that does not seem to be the way to go. [also focus on products] //23:43

There are two categories remaining the same. I think I have done a worse job than before. [done 2nd sort] //24:17

Unchanged:
1. Household
2. Fashion

3. food-related
4. public area
5. others

I only tried a slightly different way of sorting, maybe I was just doing trial and error, cannot always get it right the first time. //25:27

[3rd sorting starts //26:16]

I think it will be the same result as my 1st sort. //27:31

.... [seem frustrated ...] //29:18

[same as the 1st sort] //29:33

2nd sort seems to be very distributed, the 1st sort is more focus.

[card-sorting done]

// Subject G (Edu) card-sorting verbal protocol transcript
// (The card-sorting exercise was conducted in English)
// [] -- describing the subject's activities and the transcribers reflections/interpretations
// <> -- indicates the card which is attended by the subject at the moment

// 1st sort time: 10:45 minutes
//# of groups: groups
//
//

This is a very practical task. //00:05

To design a food preparation area. //00:18

To design a margarine storage device. //00:36

Walking shoes for office ladies. Well, we would have to rewrite that design task. [?] //01:00

To design a dress shirt. It is very unspecific. //01:08

To design a wearable time telling device. That sounds nicer. //01:14

To design a piece of clothing. //01:21

APPENDIX D - CARD-SORTING VERBAL PROTOCOL TRANSCRIPTS

To design a coin-operated payphone. //01:25

To design a garden chair. That is a very nice design brief because that leads us actually to be able to design. //01:43

To design an automatic revolving door. We need to, again, identify a whole lot of things that will make us able to design. //01:58

To design a heart rate monitor. That seems to be fairly specific. //02:21

To design a dashboard for a car. An odometer? That's something to smell. //02:31

To design a beverage vending machine. //03:08

To design a trash can. That is quite well described. //03:31

[Facilitator: It seems that you have some preliminary categories already. //03:35]

Yea. Some are much better defined than others. So it's a matter of defining the task. //03:45

So this one has already a location. It has a context which I put something whereas the coin-operated payphone, I have no idea where that is gonna go, if it is outdoors or indoors, so I do not know. //04:11

Some are more specific in enabling you to design something. //04:16

Can opener. This one is very well defined like this one here. //04:32

This gonna take a while. To design a window cleaner. Very well defined. //04:49

A diamond watch. This is like this here. //05:09

To design a footwear. 05:15

Bedside lamp. A bit more specific but not very much. //05:27

New card game. //05:44

To design a sofa set. Why do they give me a solution? This is really the killer. This belongs to this one. //06:09

It's a killer. I mean it's like it is not a design brief. It is kind of like an order to exercise something. //06:16

Flower vase. //06:29

To design a coffee mug. Why do you need two coffee mugs? That's somebody who does have ... //07:0

To design a coffee maker. //07:09

I need to go through this again. //07:12

Basically, I think these are design tasks that evoke more or less creativity. Then these are very ambiguous ones like design a piece of clothing. That is extremely ambiguous. You can do anything. You do not know for whom. You do not know who is going to manufacture it. //07:40

I think we have more of this. To design a footwear. To design a diamond watch. To design a dress shirt. To design an automatic revolving door. //07:52

And a wearable time telling device. That is not too bad. It is a nice one. //08:08

Dashboard. And a coffee maker. A coffee maker should do these. //08:19

Food preparation area. Area for you do not know where it goes. How much space. //08:30

Coin operated payphone is like an automatic revolving door. //08:40

It does not matter how many stacks it comes up with, does it? //09:55

I think I have my stacks. //10:45

[Finished 1st sort.] //10:45

So maybe I go from the left side to the right. //11:13

I think my criteria for selection are how specific and unspecific is the brief,
how many questions are left open to answer before I can start designing something. //11:40

So I think good briefs that allow industrial designers to start right away
are these three here. //11:52

To design a window cleaner that is used to wash and dry windows. That is very specific.
The task is mapped out. The windows we know where they are. And that can be designed.
So we don't have many questions open. //12:07

How should I call that? I don't know. //12:12

I make a "+". There are three in this category. //12:22

"+" means they are good ones. //12:30

Good for immediate design action. //12:58

It still leaves questions open. I think none of them is specific enough to not
have any questions left open. //13:22

I think that's like how many criteria do you get and how many do you still have
to find out. //14:01

The next category is this one here who gives me more requirements.
I think this has the best defined requirements for practical function. //14:16

Some talk about use that is different. Here this has more specific requirements.
//14:30

There are two distinct differences. One has a specific requirement in terms of materials.
And the other one in term of the context and the user. //15:00

Few specific requirements ... //15:12

I think really a design brief should map out a goal and an aim. //15:25

And it should map out requirements. And the requirements can be functional
specific requirements but the requirements also in terms of user. //15:35

The user is the functional requirements, the aesthetic requirements and the
symbolic requirements. //15:45

Some are really missing if you need to define them before you can start designing. //16:14

Few specific requirements not enough for immediate design. //16:24

For general ideas but they go all over the place. //16:32

Not enough for directed ideas. //16:39

That would be these five. //16:52

This one is a category for itself. //16:55

Probably these belong there as well. //17:06

I am just seeing if these belong somewhere else. //17:33

These also have some requirements very clearly mapped out but it is not easy to see a reason why these requirements are taken so it's a bit like this one but it's even more [???]. //18:03

Too few and seemingly arbitrary. //18:16

Not logical requirements. //18:30

Now these here. They really do not have enough information. //19:18

Not enough information to foster creativity. //19:49

I think a lot of creativity can come out of constraints and requirements so here this is too open. //20:02

As oppose to this, this one is also not enough information really but enough information to spark creativity. //20:31

Open enough and understandable, at least to the western world, in context and requirements. //21:17

Well, it is not really true. I think I just like the task. //21:22

I think it belongs in here. //21:28

This is really outrageous. This is not a design brief but a solution actually. //21:56

I just say it is not a design brief. //22:03

If you want me to explain, I can explain. //22:06

Ok. I did the task. What do I get now? //22:28

[Facilitator: Can you explain a bit for the last one?] //22:33

[Walking shoes] It is providing a solution to a very badly stated problem, to a really non-defined problem. And it may not really be the solution. //23:10

[Sofa set] the suggestion of the design as a solution for something but not really the problem that is outlined. //23:34

That would be my idea about it. //23:38

[Collecting labels] //23:55

//[starting the 2nd sort at 24:35]
//2nd sort time: 8:33 minutes
//# of groups: groups
//
//

I can re-sort this stack. //24:38

[Facilitator: You have to let us know why you to re-sort and the reason for re-sorting.] //24:54

I can re-sort by only do it when not so much by content any more, but more by appearance. //25:11

I think these are the ones that go better together. //25:24

I can become more specific. These few are requirement for materials that are probably done by a manufacturer that can only manufacture. And these materials, then it has a [???]. //25:56

It's then manufacturing-based. //26:00

This one here is people-based. It's like people have these and these habits and design something for their habits. //26:06

That would be that. //26:11

This has also habit but in a professional setting. //26:18

These here have clearly... They are similar things so I will move these over here. So they have like some functional criteria or some environment defined where they are being used. So that could be here. //26:47

These are very brief that we can only ask whether it is an office building or a residential building or do they have something... //27:0

Heart rate monitor. That's probably for an exercising thing that can be used in the home. It already gives some indication as to where it is going to be marketed. //27:20

This is a very functional one. So maybe the functional one could go here. //27:29

So maybe we shuffle this way. //27:32

These already suggest where they are being used or who the manufacturer is or both. //27:39

This is the people thing. //27:42

This is the solution thing. I will not touch that. //27:48

These are probably good indicators for like saying this is not a design brief yet. What do you need to know in order to make it a design brief? //28:10

[Finished 2nd sort. Start writing labels.] //28:20

[Facilitator: What makes you change your mind and rearrange the cards?] //28:27

I changed my mind because you can look at it from different angles. So now I know a little bit more about what the tasks are or what the descriptions of the tasks are, so I have a little bit more insight. At first they were all new. So now I know a little bit more then thinking about it, and I can regroup but it is not a very big regrouping. //29:09

It still is ...I mean my underlining method or way of working or understanding of designing is still the one that you need to know the aim, the target, the people using it, what context and you need to know something who you are designing for, probably also what kind of manufacture is there, what kind of price range maybe, and what are the possibilities as well as looking at the functional aspects which are practical function or aesthetic function or semiotic functional, symbolic function. //30:05

Well defined so it indicates user and its use. //30:23

People-specific behaviour or intend. //30:51

You can design for specific behaviours of people but still you need to know all the other requirements so it is kind of like this one. //31:08

Some specific requirements not enough. //31:24

These two also have some specifics but the specifics there are for materials which get to the manufacturer where these here can be the retailer, the marketer or the restaurant owner or something like that giving you a brief. //32:02

So they may not manufacture it. They may have it manufactured somewhere.
So it has a different source. //32:10

Some specifics and materials. //32:16

This is not a design brief yet. //32:46

This is not a design brief. //33:08

[Finished 2nd sort.] //33:08

[Card-sorting session ends]

APPENDIX E

CARD-SORTING INTERVIEW QUESTIONS AND TRANSCRIPTS

Samples of card-sorting interview questions and transcripts.

Title: Semi-structured interview regarding formulation of project briefs in a commercial setting Rev.1
Doc ID: (SSI_C1)

Objectives: To find out how design briefs are formulated for a commercial project.

In this context, projects briefs and design briefs are used interchangeably and refer to documents used for communicating relevant information about a design project to a team of designers.

Part A) Interview questions:
Can you briefly describe your background relating to product/industrial design and design management? (both educational and professional experience)

<u>The nature of a project brief:</u>

1. How would you define a project brief?
2. Who are usually involved in formulating a project brief? (e.g. Stakeholders such as the clients, marketing department, design team?)
3. How long does it take to formulate a project brief and what are the procedures?
4. What kind of information is included in a project brief? (e.g. in terms of different sections of a brief?)
5. What makes a good project brief (as opposed to a bad one) in a commercial setting and based on what criteria?

<u>Project brief formulation:</u>

6. How do business strategies affect the project brief?
7. How do you define the clients' needs and translate the needs into design specifications?
8. Do you know of any specific/effective methods to formulate a project brief (or the design tasks given in a brief)?
9. Have you tried to formulate multiple project briefs for a given project? If so, what are the results?
10. How often do you change a project brief and under what circumstances?

<u>Evaluation criteria and designers' understanding of the brief:</u>

11. What kinds of deliverables are included in a project brief and why?
12. Who is responsible for interpreting the project brief when there are disagreements between designers
13. What kind of project briefs do designers find more difficult? (e.g. too open / too restricted brief / complex brief / precise brief / others ?)
14. How do you judge the successfulness of your project brief? (e.g. design outcomes, sales, clients' satisfaction?)

<u>Project brief, innovation and more:</u>

15. How can a project brief promote creativity or innovation in the design outcome? Any examples? (creative outcome is defined as being unique and original)
16. Do you use any other methods to promote design criteria such as usability, functionality, reliability in the project brief? (e.g. writing guidelines?)
17. Do you have any comments about questions given in the interview? Are the questions appropriate?

END OF PART A

Part B) Personal Information:

Please circle all that apply

Highest educational level achieved in design:	Diploma	High Diploma	Bachelor's degree	Master's Degree	PhD
Years of experience in design:	<3	3-6	7-10	>10	
Domains:	Toys	Consumer electronics	Small appliances	Furniture	
	Gifts/premiums/ accessories	other _____			
Area of expertise:	Human factors /Ergonomics	Interaction design	Information design	Usability	
	Accessibility /Universal design	Aesthetics/ Emotional design	Market/ User research	Eco-design / Sustainable design	
	other _____				
Number of projects encountered:					

END OF PART B

Card-sorting interview transcripts of subject B(Yr1) and H(Prof.) are included in the appendices.

```
//Subject B(Yr1) card-sorting interview transcript
//(The interview was conducted in Cantonese)
//Final version
//Q: Interviewer

Q: What do you think about the card-sorting exercises? //00:11

The exercise was interesting and I had experience about sorting but I won't have
so much confident in myself. //00:21

I do not have much confident the first time but I have more confident for the second
sort. //00:24

I think I have more time to understand the cards' materials and I believed the second
sort is the best. //00:35

The third sort is resulted from my belief that there are no strict rules in sorting
the cards. So, I try to explore new ways of sorting. //0:39

The third results seem to reflect how I will encounter these tasks in the real world,
at my job, or at school. //00:48

Q: Can you introduce yourself a little bit? //00:55

I studied product design (POLYU assoc. degree] for 2 years, then go into Yr1 degree
program. //1:09

I am very inquisitive and I stayed in the US for awhile when I was young. //1:18

You will pay attentions to things around you only if you very curious. //1:25

I also like to know what other people opinions about the same subject. //1:30

e.g. If a person has an opposite personality than mine, I would like to know the
reasons for his/her actions. //1:40

Q: What is a design brief? //2:06

I think an assignment brief that tells the designers all the procedural steps is
very rigid and boring. It provides too many constraints. //2:43

A good design brief reminds the designer a certain direction to follow, where to
find relevant information, show you examples, but not to restrict the artifact to
be a lifestyle product. //3:04

It should dictate that the artifact requires the use of two materials. //3:06

I think design tasks can be very free, only describe the task in one sentence. That
is all it needs. The designer can explore the project at his/her own way. //3:19

Q:What are included in a design brief? //3:25

Usually, a brief contains lots of information. Recalling a previous project about
a chopstick stand, the brief has lots of "you should" statements
use two materials, need to fulfill the requirements of certain users, etc. //3:44

A bad brief can limit the designer thinking. For instance, it can limit the designer
by stating a specific theme such as listing the project as a lifestyle project or
giving specific user groups. //3:58
```

Q: How many briefs have you seen? //4:14

I know a few friends who study deign overseas, their briefs do not contain the "you should" statements. //4:24

Their briefs provide a lot of information for the project and they can start from an artistic viewpoint or a user viewpoint for the project. //4:40

They have to pick their own viewpoint for a design project. //4:44

I don’t know what kind of briefs are used in IVY, but their outcome artifacts are easily recognizable. //5:02

Foldable pair of glasses as an example, all of their outcomes are different but seem to contain the same element. There is no variation at all. //5:20

I think it may be due to their design briefs. //5:31

Q:How long is a brief (A4 size)? //5:41

Usually 1 or 2 A4 pages, I think longer brief is less useful, I prefer shorter one with larger fonts. //5:56

Q:How much time do you spend reading the brief? //6:00

I don’t read a design brief. I like to ask other people opinions about the brief. I usually put the brief aside. //6:23

I will listen to the briefing session and I begin to find information and do it my way. //6:31

Q: What catch your attention in a brief? //6:36

I don’t like to read brief nor listen to briefing but I will change this attitude in the coming yr2. //6:56

I will ask the tutors or colleagues for any uncertain parts of the brief and I will start doing in my own way. //7:12

I rarely go back to a brief. I will read the brief eventually. I don’t find the brief until the end. Friends told me that I am not good at understanding the brief. //7:43

I have troubles catching the key points of the brief. I usually ask my friends and begin my initial associations. //8:00

Q: How do you know if you have enough materials to start the design process? //8:07

I will write down in a separate paper what I needed to research for the project and it also depends on the tutors, //8:26

Some tutors only require you to finish the project and produce an expected outcome, some tutors will follow you along all the steps in the design process. In that case, you don’t have to read a brief because the tutor will guide you closely. //8:42

W: That may not be the case if you work in the real world. No one will follow you around.

When I am working in the real world, there is no brief, I will ask lots of question and write down the answers as my own brief. //8:53

I will have an interpreted version of the brief. It contains materials about rationales, my initial ideas and feedback from clients. Then it will generate some criteria. //9:20

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The client may not satisfy with the outcomes but I will use the recorded materials as my defense. //9:24

The brief is for negotiation. //9:33

Q: What are the deliverables? //9:37

Sketches are important for the process. Mock-ups, research materials. //10:08

Q: What other way do you categorize the brief (besides easy/difficult)? //10:15

Lifestyle brief is the easiest because for accurate (technical) brief, it will require a large amount of data and research. e.g. a workout machine requires physiological data. //10:28

A lifestyle (aesthetics) project may dictate the materials but you can choose your own colors. You can still do things that are close to your own style. //10:41

Design concept is very important to me. What are the conceptual connections between the artifacts? E.g. A flower vase won a muji award because it communicate meanings through form and shapes. //11:35

These projects with aesthetic elements are easier. //11:35

Q: How important is a design brief? //11:43

I don't understand a design brief. It seems vague to me. *The briefs are written in plain English but I do not understand them.* //12:00

I think there is always hidden meanings in a brief but I cannot interpret it. //12:07

The brief requirements are too general. E.g. "your product should reflect .... whatever " //12:50

There are lots of traps in a brief. E.g. I handmade a prototype but the tutor rejects the idea. //13:30

Q: Do you think guidelines or instructions are useful? //13:35

They are not useful and that's why I always ask others for their opinions. //13:50

The brief makes me insecure. I feel ok if you just tell me in verbal form what you want me to do. //14:00

When there are lots of texts, they seem to imply lots of design requirements and make me insecure. //14:10
[interview ended //14:10]

//Subject H(Prof.) card-sorting interview transcript
//(The interview was conducted in Cantonese)
[interview started]

[feedback on card-sorting]
The difficulty basically depends on your sorting principles. //00:42

If you see two footwear, you will immediately link them up together. However, the situations might be totally different and make them into two separate products. //00:53

Sometimes, design is very much about personal preferences. //00:58

If you boss has certain preferences, you need to find out/understand what your boss wants. //1:03

You will be very happy if your boss tells you a lot of details about a project because there will be a small chance for disapproval. //1:08

However, when there is no direction from the boss, you need to think and create your own direction.
[touching on how a personal preference or personal attitude can affect the design directions in a business setting]//1:09

I will classify two kinds of projects. One kind of projects is those that have been given an explicit direction from my boss and I will finish these projects first. //1:13

Otherwise, I will put off the no direction projects for a later time which probably will require some time for research and investigation. //1:20

This is related to my personal working preference. I don’t like to pile up the works and leave the easy tasks at last. //1:32

In many cases, a designer needs to handle multiple projects and I will try to put closure to a project as soon as possible. //1:40
[again reflecting designer has personal working preferences and attitudes(closure to a project)]

I will put projects with a direction and with explicit requirements into one group and projects with no direction into another group. //1:46

This is mainly reminiscent to how I handle projects given by my boss. //1:53

For the explicit group, you don’t have to think much for that group because your boss is very explicit about the project. //1:57

For the no direction group, you need to discuss with your boss regardless of your experience. There is no point of working alone in a project. //2:08

If you are a junior designer, you certainly should discuss with your boss for this kind of project. //2:08

This is not about being a talented designer and making your own calls. A designer needs to negotiate with others and to be more realistic about the project. //2:26
[reality about creativity and the design environment, striking a balance between self-expression and business reality.]

I will start with the group with all the explicit requirements but also put the design footwear task in between. //2:46

The reason that I will put the "out-of-the blue" tasks in between the definitive tasks because definitive tasks are very boring and tedious. //2:50

So, in between various tasks, I can do some simple research and look for a general

direction. //3:03
[the concept of boring and tedious tasks come up again. Subject I approach to mediate the routine design tasks is to switch to some research and direction-seeking activities]

For the definitive group, the coffee maker task is simple and direct. You can easier find more information about the task because there are many competitors on the market. //3:20

Even though there are lots of requirements, you still have some freedom to add your own requirements. //3:27
[a designer still looks for further information]

This kind of tasks are the easiest because you can get the points of the projects immediately. //3:30

For example, I am not familiar with a "kitchen", you need to study more and I will put it off a little bit latter. //3:40
[familiarity of the task domains or artifacts (domain specific knowledge) can affect the working order]

My principle is to finish a project as soon as possible and to relieve the load off my head. //3:45

The reason why I would like to switch between the definitive and the out-of-the-blue tasks is that

The definitive tasks are very practical, it is like in and out, in and out kind of work flow. //4:00

The out of the blue tasks can be more creative/imaginative, require more thinking. //4:06

In reality, you need to do all tasks that have been given to you whether easy or difficult tasks. //4:14

It will be very boring if you have to do these tasks continuously. As a designer, I am very afraid of being bored, repeating the same activity all the time. //4:29
[switching of activity which may be based on some reasons other than the design tasks?? More likely, design tasks affect/cultivate working habits than the other way around!!]

The last group, problem-solving group is very difficult because you may need to read a lot of research data to be familiar with the task. //4:37

There are two approaches in this case depending whether you want to do a good job or just finishing the task. //4:45
[indication of a personal attitude toward a given task? Whether there is a motivation to do a good job]

E.g. to design a bedside lamp, you can just imagine the scenario and start designing using only common sense. // 4:49

If you want to do a good job, you need to spend more time on the task. //4:52

It is likely that through your research, the out-of-the-blue task can transform into a situation task that you need to fulfill certain requirements. //5:04
[possible task transition between groups]

There is also a chance that after your research, you find out what your boss’s preferences, then you can transform the task into a definitive task. // 5:12
[problem-solving tasks can be transformed into definitive tasks.]

I think the various groups only indicate design tasks at different stages. //5:16

Out-of-the-blue tasks can become problem-solving tasks through research and those

tasks will eventually become definitive tasks because after the problem-solving process, you will have certain concrete design criteria. //5:30

I think the definitive tasks are at the final stage of the design project. //5:37
[this can be a one interpretation/impression of abstract to concrete formulations of design tasks]

W: What is a project brief?

Don't bother me. Just tell me what you want for the project. //6:04

I like to work on the out-of-the-blue tasks because I think it is a first stage of a project. //6:15

I don't like to work on the final stage of a project but sometimes it is unavoidable. E.g. you need to design a helicopter which can fly and look nice. //6:21

Your boss might tell you that he wants a nice-looking form but there are so many directions, nice as in hip-hop or nice as in Jazz or Ballet, etc. //6:34

So, I don't know what does my boss mean when he said "nice" but I like to take on the challenge to investigate the meaning myself. //6:36

I like design briefs that give a general direction but no too concrete. Don't tell me requirements as concrete as a 10-cups size. //6:45

Maybe these requirements are very intuitive or based on experience which I cannot really argue against. //6:52

However, these limitations can affect my thoughts and opinions about the project. If my opinions are very different from my boss, there is a chance of disagreement and unhappiness between both parties. //7:01

My boss is also human, it will create certain kinds of uneasiness if you do not follow a bit to his given design direction. //7:09
[a very concrete brief may not leave enough rooms for negotiation and your ideas may put on too much leverage to challenge your boss authority]

A designer also needs to take his boss's pride into account when discussing a design project. //7:07

Your communication skill often times is more important than your innovative ideas. //7:14
[certain conflicts may arise due to power and authority??]

W: Who is responsible for formulating the design brief?

My boss is the person in my current small-sized company. //7:26

In larger companies, usually are top management people with a heavy marketing-oriented mindset. //7:33

However, there are different kinds of mindset even in marketing.

Some bosses have a copy-cat mentality, if a helicopter is selling good, they will make the same helicopter. //7:51

The brief will be a copy-cat brief such as "to make the same helicopter but in smaller size." //8:09

My current boss inclines towards more innovation. For a radio-controlled car with certain features, we begin with lots of discussions. //8:29

The initial design brief does not come in a concrete sheet of paper. The process of formulating the brief begins with group discussion and follows by research and information-seeking for a few days and lead to a consensus. //8:42

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It may start from tasks in the out-of-the-blue group. E.g. To design a RC vehicle, but my boss will not use "car", he will use "vehicle". //8:51
[emphasize on using vehicle instead of car]

We will then discuss how to design the RC vehicle. Maybe, the wheels can transform to a propellers when flying. //8:55
[involve multiple parties, designers and marketing]

We may agree on the value for a design and look for competing features on the market. //9:04

We don't like to be a copy-cat. E.g. our latest project involves an all terrain vehicle, our competitors look ridiculous because of inconsistent form and operation (propellers are still moving even the vehicle is on the ground). //9:30

Our products are much more consistent in operations when transforming from the land to sea operation (describing how it transforms). //9:48

As a designer, you are happy to look at the final project and to try out some new features that no one has it yet. However, there are certain risks associated with the new features. //9:57 [A designer's satisfaction from the final product.]

W: How long is the brief writing process?

That previous project is very difficult and took us much time to soul-search for the project.

For the common consensus, the concrete brief came out in 2-3 weeks even a month. //10:27

W: Can you explain the soul-searching process?

All I can say is that you need to think about the project day and night. Continuously looking at the competitors. //10:36
[incubation period??]

We want to be innovative and don't want to make the same features as others. //10:49

Our approach is continual innovations, so we are not afraid of copy-cat competitors. //10:52

Even when you speak of new features, there are many new directions. //11:01

If we come up with certain new ideas and we will imagine how it will look in an actual setting and the value of the design. //11:11

There is no best solution in design. There are always better solutions. //11:14

We usually look for the best direction with our ability in mind. //11:20

There are a lot of trial and error. We have thought of many unsatisfied solutions and come up with the one that is feasible in marketing, engineering and designer perspective. // 11:34
[when formulating a brief, there is a lot of reminiscent of the design process, ideas and projects, projects and ideas. Trial and error and iteration]

W: What is included in a design brief?

There may not be a written document but it is more of a consensus collecting all the key points from our conversations. //12:33

E.g. Transform vehicles (title), land and sea, features, selling points, directions (both can be a boat and a car).

The content is very point-form and serves as my design brief. //12:37

W: How do you communicate with others if there is not a written brief?

Yes, in a smaller company, I only need to remember the brief at heart and discuss with others. //13:35

In larger companies, junior designers will rarely see a design brief. A brief will be stopped when it is passed to senior designers. //13:09

Senior designers will tell junior designers what to do. Sometimes, senior designers will try to tell something different from the brief to the juniors because seniors may be looking for innovative ideas and want to present some new ideas to the management. //13:15
[withholding information of the brief from seniors to juniors or telling an interpreted version]

Seniors want to see whether the ideas will work before management. However, the new idea usually only partially fulfill the original brief. This often leads to disaster. //13:21

Actually, I also agree that it may not be a good thing to let juniors see a such clear picture of a project. //13:29

Because in design, everyone will have a different interpretation/understanding of the same conversation/language. //13:34

If everything is written in text(black and white), people might be afraid to break the boundary. //13:42

Even if you tell a designer what to do in a conversation, because of the nature of verbal communication, a designer's understanding of the conversation may also change over time. //13:55

This can be a good thing because it may lead to new ideas.

If your boss is not a designer, he may come from a sales and marketing background. //14:07

For safety reasons, the brief probably will be very similar to that of the competitors. //14:17

Your boss may also blame the designers for poor sales. //14:23

Innovative products pose lots of risks. However, misunderstanding can be a very creative force in the risk-averse/disinclined/non-innovation environment. //14:29
[describing the usefulness of misunderstanding and ambiguity in a business setting?? so innovation is an accident more than an intention??]

There are markets for very innovative products. This is my personal view on marketing and design. //14:38

If I were a senior in the future, I probably will do the same thing, hiding the actual design brief after reading it, and tell the juniors my interpreted version of the brief. //14:47 [to try out new ideas of junior designers with lower risks.]

W: If there are many designers involved in a project, do you need a consensus design brief?

At a certain stage, there will be an integration of everybody version but this should not happen in the first stage of a project. //15:10

From my experience, many designers will constraint themselves in the very first stage. e.g. A toy car project is a toy car, do not want to do any explorations as long as the product satisfies the boss and the project is considered to be done. //15:17

It is almost as if treating the design project only as a job duty/responsibility. //15:19

I do not like this kind of working attitude. //16:20

I understand that there are times that a designer need to compromise in a project but at least a designer should not compromise at the very beginning of a project. //15:28

You will never know whether your boss will like the idea or not if you do not show it to him even for very rough sketch.
[a designer needs to be bold to show his idea even facing adversary??] //15:35

An out of the ordinary idea can also work really well. A good example is the Disney character, Jack, a skeleton, which is quite different from the other cute characters, Donald duck, Mickey mouse etc. //15:47

Some people might not like the character, however, Jack created a brand new market in that particular segment. //15:55

I always keep in mind that there will not be any success if there is no failure. //16:12

At the very beginning if no one ever tryouts the Jack idea, there will not be the success of Jack. //16:14
[Design is about break traditions, and brave to face uncertainty and possibly failures]

Q: How does marketing affects the writing of a project brief?

Very simple, the two things marketing cared for projects are profit-making and playing safe. (low risk) [maximize profits and minimize risks??] //16:23

They don't care much about research or the product. They have a certain amount of profit in mind, then they will make that kind of products. //16:31

Q: Isn't this difficult to translate profit making into the brief?

They do put that[making money] as a criteria into the brief and that's why marketing often puts out a brief that is a collection of other products/competitors on the market. //16:42

For example, the competitor has a mid-range product with these specifications, styles and features, and now our company needs to make a product that gives a similar feeling but at a higher class and within the specific cost. //16:55

Very often that is exactly the brief that a designer is looking at. You may ask yourself "what does that mean?" //17:00

Q: So, this kind of briefs is no useful for you?

This kind of brief has limited value to me. //17:14

I do not like to do this kind of design projects. I should clarify my comment that I do not like to do that kind of projects but I will still do it. //17:19

They [marketing] do not care about the quality or style of the product. They care only because there are existing products which happened to create a big market. So, we need to make similar products. //17:31

E.g. Everyone has dived into the LCD TV market to make LCD products. However, some products are really ugly and low quality. //17:41

Everyone saw that as a big market so everyone goes to make LCD TVs. //17:45

Q: There is nothing wrong with a marketing-driven business strategies?

However, the problem is that there is no clear direction and wrong reasoning. The worst reason for a product is that "everyone makes that product, so we will have the same product." // 17:53

Using Philips as an example, I don't think Philips is very innovative. Its business strategy is to follow competitor products after their launch. //17:58

However, Philips products still have its own market and make good sales. Their products have decent appearances. They also excel in functionality. //18:06

Being late in the market is no a problem, their qualities still influence consumers to buy their products. //23:48

That can be a good design strategy, more on the mechanical side. That is also the company direction. //18:23

The worst thing is that if the company has a wrong business strategy [design direction], all the briefs leading from that strategy will also be wrong. //18:26

"Everyone makes that product, so we will have the same product." is definitely a wrong business strategy. //18:32

Q: What does the strategy eventually lead the company to?

Then, such a company will stay at the same position forever [a stalwart]. I don't like to work for a stalwart company. //18:41

For a toy manufacturers, even if you have a good sales this year with a particular product, it doesn't guarantee the same result next year with the same product. //18:56
[That's the reason why a company needs to keep innovating new products.]

Q: Do you have different teams tryout different methods for the new project?

It happens but it is not cost-effective, usually this approach is not taken, only under special circumstances. //19:37

Q: Any special methods to translate customers' needs into product features?

I will give the customers a few extreme solutions, you need to test their reactions. //20:05
[trial and error, testing their reactions with extreme solutions]

However, if you have worked with the client before, the longer the better, then you don't need to test their reactions that much. //20:10
[no need to test much once you establish a trustful relationship with your client]

When I was working for a design consultancy, you know the client's direction, you don't need to test their products. //20:16

Even for my own freelance, you need to test the water, tell them you are creative, they will trust you but you have to go a little bit over the edge, you will be able to get your message across. //20:31

If they show "wowowow", that's their real reaction and you can use it as the basis for your other ideas and response correspondingly. //20:40

Q:

I judge the person that I am working with. I see Design as a service. You should not view the project from an artist perspective. //21:06

You need to have some business perspectives but not as a copy-cat. You need to work within the client's acceptable boundaries. //21:14
[connecting business to design]

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Q: What are the brief deliverables?

You cannot guarantee sales because I am not a salesperson. //21:33

Usually, the design outcome will be a little bit different from what is stated in the original design brief. What is stated in the brief is an ideal case. //21:48

Q: If you state a particular market for the product, do you test that requirement after the project?

We will test the product in the designated market, however, most of the requirements will be different but the general direction stays the same. //22:03

E.g. A client may state that he wants to have a specific part of the outcome to look like some other brands. However, the outcome will likely to be something different from what he wanted. //22:10

The outcome will be my own insistence, I will make the client feel that there is no difficulty to copy a feature, but I don't want to be a copy-cat, I will use my own method to satisfy the client's needs. //22:25 [a designer showing his own attitude toward design, rather not be a copy-cat]

If I knew the client will be satisfied with similar products on the market, I would not let the client see that copy-cat idea but I would rather do something different but still fulfill the client's requirements. //22:32 [looking for a different answer]

This is how I see a design brief, you don't need to follow all the requirements. //22:38

For a very marketing-oriented brief, if you follow everything from the brief, you will only produce your version of an exact copy-cat product. I don't want to make the 2nd version of someone else product. //22:41
[A designer will always be a designer, not only fulfilling client's needs but also design something unique!!]

Q: Which kind of brief is easier or harder for you?

The easy ones are with all the design requirements given. You only need to follow the requirements and there is no need to think. //23:07
[in terms of routine design/repeating a skill-based operation, and something require design thinking kind of searching process/trial and error]

The difficult ones are "also" "more interesting", the out-of-the-blue group, you can exercise your imagination, there is no right or wrong answer. //23:20
[this trait can be traced back to a craftsman in the 19th century, the job requires certain skills to meet certain challenges.]
[also in terms of "flow", how one can attain the flow state when task challenge = skill level which is a universal human character.]

A 11-cup size will be wrong for a 10-cup size specification of a coffee maker. //23:21

At the beginning stage of a project, there is no right or wrong. I like to do that kind of project. //23:25

Somehow, if you only follow orders and do whatever that has been given to you, you will stay at the same position as an illustrator. //23:42

I don't want to be an illustrator. //23:46

There is also a concern for being paid as an illustrator for the same position. //23:52

If you don't want to have the same pay, you need to create your value. //23:54

Actually, the job market is very competitive even if your sketch is very good and creative. //24:00

I want to get ahead of others, I will be happy to discuss with others. I want to know more and to learn more. I want to add value to myself and don't let myself stay at the same stage. [A junior designer showing the passion for lifelong learning. Personal motivation and external motivation (money,job position, job security) both play a role] //24:17

Q: How do you judge the successfulness of your project?

Very simple, the outcome is good-looking and makes profits. //24:37

400K sales figure is very successful. Design is no doubt a business but it is also very important that you need to be true to yourself in the business. //24:53

Being true to yourself doesn't mean you should not compromise with your boss in some circumstances. //24:59

It means you should not be a copy-cat. There needs to be a bottom line in every compromise. //25:08

You should listen to other people opinions if a situation does not come with a right or wrong decision. You can try to take a few more steps. //25:10

If you can follow the above rules and the product produces good sales, the project is a success. //25:19

Q: Any specific methods to enhance creativity in products?

Market acceptance should ask the marketing department. My task is to create a good product. //25:44

Sometimes exceptional sales depends very much on marketing skills especially with mediocre products. //25:55

A product quality is essential, but advertisements and brand images are also critical to a product success. //26:01

Ipod has its own uniqueness but it is marketing that makes it a high-selling product with a good position at the market. //26:14

Innovative products. I will start with an image and the current trend of a particular product. //26:56

I will not follow the trend, I will try to lead the trend. You need to find out the trend and predict future trend. //27:10

Q: How do you predict future trends?

That really depends on your senses. Everyone got certain senses but some people have bad tastes. //25:25

You need to determine what senses you can trust and people with related experience can tell you alot. //27:43

Ipod is leading the current trend.

You can find out the current trend by looking at sales and competitors products. When everyone is doing it, it is the current trend. //28:16

The current trend will have its deficiency and drawbacks. You need to make a product that improves the existing situation. //28:46

...

APPENDIX E - CARD-SORTING INTERVIEW QUESTIONS AND TRANSCRIPTS

RC vehicle now is boring, we will make it transformable and make it very stylish. //29:23

You need to move forward and think one-step ahead of others. //29:38

...

If you are only concerned with innovation, you probably should be an artist because design has a strong business component. //30:10

As a designer, I think the minimal moral conduct is not to be a copy-cat. Besides that, profit-making probably is the 2nd priority. //30:21

You need to be more realistic. You can make a very innovative product but the company can go into bankruptcy the next day. There are numerous examples like that. //30:29
[balance between innovations and business balance sheet]

That can not be called a successful product.

Ipod has an innovative interface, MP3 is no innovative, the success comes also from an excellent marketing campaign. //30:52

....

Q: Any methods to enhance certain criteria of a product, usability, functionality?

For many people, toy is still for children but to me, toy can be for everyone. Currently, I am looking at adult products from the children perspective. //32:13

For example, a toy helicopter doesn't has to use foam as the body material, I can use other materials which can be better than foam. //32:36
[material innovation, to replace existing/conventional materials]

Not only on functions, you also need a killer appearance for a good product. //32:54

I will emphasize on functions, materials and forms. //33:14

How can you make your product pop out from the rest of the products with a 2 second attention from the consumer? //33:24

You can write all the selling points on the carton/packaging but no one is going to notice. //30:30

An eye-catching form can stir curiosity and impulse to purchase the product. //33:38

My success depends on sales and I have to make the product eye-catching. //33:44

You need to first catch a consumer's attention. //33:57

....

[bridging to other design areas that may affect sales and marketing, about sony/ipod packaging, and color scheme, very creative packaging and attractive/unconventional colors for products]

[design can be very details, even to individual color schemes and packaging methods]

...

[interview done] //34:54

Design should not be separated from business. That's my opinion. //33:20

APPENDIX F

A TABLE SUMMARY OF SUBJECTS' INITIAL SORT RESULTS

APPENDIX F - A SUMMARY TABLE OF SUBJECTS' INITIAL SORT RESULTS

Card no	Card name	Subject Yr1_A	Subject Yr1_B	Subject Yr1_C	Subject Yr1_D
1	Coffee maker, specifications, point	System and mechanical design Task (Yr1_A)	Lifestyle (Yr1_B)	Specific requirements, no specific users (more difficult) (Yr1_C)	Indoor / Home -- Kitchen/Eat (Yr1_D)
2	Margarine storage device, functions, point	Home use tasks (Yr1_A)	System (Yr1_B)	Accuracy (Engineering) (Yr1_C)	Indoor / Home -- Kitchen/Eat (Yr1_D)
3	Beverage vending machine, structures, composition	System and mechanical design Task (Yr1_A)	System (Yr1_B)	Specific requirements, no specific users (more difficult) (Yr1_C)	Street (Yr1_D)
4	Window cleaner, specifications, composition	Home use tasks (Yr1_A)	Household (Yr1_B)	Function – design for people (Yr1_C)	Indoor / Home -- Small objects (Yr1_D)
5	Garden chair, structures, point	Home use tasks (Yr1_A)	Household (Yr1_B)	Lifestyle (allow variations/interpretations, more difficult) (Yr1_C)	Indoor / Home -- Furniture (Yr1_D)
6	Coin-operated payphone, subordinate, single	System and mechanical design Task (Yr1_A)	Public use (Yr1_B)	Lots of design freedom (Yr1_C)	Street (Yr1_D)
7	Bedside lamp, scenarios, single	Home use tasks (Yr1_A)	Electronics (Yr1_B)	Lifestyle (allow variations/interpretations, more difficult) (Yr1_C)	Indoor / Home -- Small objects (Yr1_D)
8	Diamond watch, subordinate, single	Fashion tasks (Yr1_A)	Fashion (Yr1_B)	Lots of design freedom (Yr1_C)	Wearables (Yr1_D)
9	Revolving door, subordinate, single	System and mechanical design Task (Yr1_A)	Public use (Yr1_B)	Lots of design freedom (Yr1_C)	Indoor / Home -- Space (Yr1_D)
10	Card game, functions, composition	Card game task (Yr1_A)	Lifestyle (Yr1_B)	Lifestyle (allow variations/interpretations, more difficult) (Yr1_C)	Indoor / Home -- Activity (Yr1_D)
11	Footwear, superordinate, single	Fashion tasks (Yr1_A)	Fashion (Yr1_B)	Lots of design freedom (Yr1_C)	Wearables (Yr1_D)
12	Coffee mug, scenarios, composition	Home use tasks (Yr1_A)	Lifestyle (Yr1_B)	Specific requirements, no specific users (more difficult) (Yr1_C)	Indoor / Home -- Kitchen/Eat (Yr1_D)
13	Ventilation system, functions, single	System and mechanical design Task (Yr1_A)	System (Yr1_B)	Interior design (spatial) (Yr1_C)	Street (Yr1_D)
14	Food preparation area, functions, point	Home use tasks (Yr1_A)	Interior design (Yr1_B)	Interior design (spatial) (Yr1_C)	Indoor / Home -- Kitchen/Eat (Yr1_D)
15	Dashboard, specifications, point	System and mechanical design Task (Yr1_A)	Household (Yr1_B)	Accuracy (Engineering) (Yr1_C)	Street (Yr1_D)
16	Clothing, superordinate, single	Fashion tasks (Yr1_A)	Fashion (Yr1_B)	Lots of design freedom (Yr1_C)	Wearables (Yr1_D)
17	Trash can, scenarios, composition	Problem-solving / situations tasks (Yr1_A)	Problem-solve (Yr1_B)	Function – design for people (Yr1_C)	Street (Yr1_D)
18	Can opener, specifications, point	System and mechanical design Task (Yr1_A)	Public use (Yr1_B)	Function – design for people (Yr1_C)	Indoor / Home -- Kitchen/Eat (Yr1_D)
19	Sofa set, scenarios, composition	Problem-solving / situations tasks (Yr1_A)	Problem-solve (Yr1_B)	Function – design for people (Yr1_C)	Indoor / Home -- Furniture (Yr1_D)
20	Time-telling device, functions, single	Fashion tasks (Yr1_A)	Fashion (Yr1_B)	Accuracy (Engineering) (Yr1_C)	Wearables (Yr1_D)
21	Heart rate monitor, specifications, composition	System and mechanical design Task (Yr1_A)	Health (Yr1_B)	Accuracy (Engineering) (Yr1_C)	Indoor / Home -- Health (Yr1_D)
22	Dress shirt, subordinate, single	Fashion tasks (Yr1_A)	Fashion (Yr1_B)	Lots of design freedom (Yr1_C)	Wearables (Yr1_D)
23	Flower vase, structures, point	Home use tasks (Yr1_A)	Lifestyle (Yr1_B)	Lifestyle (allow variations/interpretations, more difficult) (Yr1_C)	Indoor / Home -- Small objects (Yr1_D)
24	Office ladies shoes, scenarios, composition	Problem-solving / situations tasks (Yr1_A)	Problem-solve (Yr1_B)	Function – design for people (Yr1_C)	Wearables (Yr1_D)

Card no	Card name	Subject Yr1_E	Subject Yr1_F	Subject Yr1_G	Subject Yr1_H
1	Coffee maker, specifications, point	Existing products, conditions (Yr1_E)	Bullet point-form, with design requirements (Yr1_F)	Commercial use with specific requirements (Yr1_G)	Kitchenwares (Yr1_H)
2	Margarine storage device, functions, point	Existing products, conditions (Yr1_E)	Bullet point-form, with design requirements (Yr1_F)	For public users with special functions (Yr1_G)	Kitchenwares (Yr1_H)
3	Beverage vending machine, structures, composition	Existing products, conditions (Yr1_E)	Paragraph, with design requirements (Yr1_F)	For public users (Yr1_G)	Mechanical (Yr1_H)
4	Window cleaner, specifications, composition	Household products (Yr1_E)	Paragraph, with design requirements (Yr1_F)	For public users (Yr1_G)	Everyday life (Yr1_H)
5	Garden chair, structures, point	Existing products, conditions (Yr1_E)	Bullet point-form, with design requirements (Yr1_F)	For public users with special functions (Yr1_G)	Everyday life (Yr1_H)
6	Coin-operated payphone, subordinate, single	Public facilities (Yr1_E)	Simple descriptions, no constraints (Yr1_F)	For public users (Yr1_G)	Everyday life (Yr1_H)
7	Bedside lamp, scenarios, single	Household products (Yr1_E)	Simple descriptions, target users, no constraints (Yr1_F)	For public users (Yr1_G)	Everyday life (Yr1_H)
8	Diamond watch, subordinate, single	Fashion related (Yr1_E)	Simple descriptions, no constraints (Yr1_F)	Luxury products (Yr1_G)	Time (Yr1_H)
9	Revolving door, subordinate, single	Public facilities (Yr1_E)	Simple descriptions, no constraints (Yr1_F)	Commercial use (Yr1_G)	Everyday life (Yr1_H)
10	Card game, functions, composition	Improve situations (Yr1_E)	Paragraph, no bullet points (Yr1_F)	Luxury products with requirements (Yr1_G)	Fun (Yr1_H)
11	Footwear, superordinate, single	Fashion related (Yr1_E)	Simple descriptions, no constraints (Yr1_F)	Luxury products (Yr1_G)	consumer goods (luxury) (Yr1_H)
12	Coffee mug, scenarios, composition	Improve situations (Yr1_E)	Concrete situations, with design requirements (Yr1_F)	Special needs (Yr1_G)	Everyday life (Yr1_H)
13	Ventilation system, functions, single	Household products (Yr1_E)	Simple descriptions, target users, no constraints (Yr1_F)	Commercial use (Yr1_G)	Kitchenwares (Yr1_H)
14	Food preparation area, functions, point	Interior design (Yr1_E)	Bullet point-form, with design requirements (Yr1_F)	Commercial use with specific requirements (Yr1_G)	Kitchenwares (Yr1_H)
15	Dashboard, specifications, point	Existing products, conditions (Yr1_E)	Bullet point-form, with design requirements (Yr1_F)	For public and commercial use (Yr1_G)	Time (Yr1_H)
16	Clothing, superordinate, single	Fashion related (Yr1_E)	Simple descriptions, no constraints (Yr1_F)	Luxury products (Yr1_G)	consumer goods (luxury) (Yr1_H)
17	Trash can, scenarios, composition	Improve situations (Yr1_E)	Concrete situations, with design requirements (Yr1_F)	For public and commercial use (Yr1_G)	Everyday life (Yr1_H)
18	Can opener, specifications, point	Existing products, conditions (Yr1_E)	Bullet point-form, with design requirements (Yr1_F)	For public users with special functions (Yr1_G)	Kitchenwares (Yr1_H)
19	Sofa set, scenarios, composition	Improve situations (Yr1_E)	Concrete situations, with design requirements (Yr1_F)	For public users (Yr1_G)	Everyday life (Yr1_H)
20	Time-telling device, functions, single	Daily use, wearable (Yr1_E)	Simple descriptions, no constraints (Yr1_F)	Special needs (Yr1_G)	Time (Yr1_H)
21	Heart rate monitor, specifications, composition	Daily use, wearable (Yr1_E)	Paragraph, with design requirements (Yr1_F)	For public users (Yr1_G)	Time (Yr1_H)
22	Dress shirt, subordinate, single	Fashion related (Yr1_E)	Simple descriptions, no constraints (Yr1_F)	Luxury products (Yr1_G)	consumer goods (luxury) (Yr1_H)
23	Flower vase, structures, point	Existing products, conditions (Yr1_E)	Bullet point-form, with design requirements (Yr1_F)	Luxury products with requirements (Yr1_G)	consumer goods (luxury) (Yr1_H)
24	Office ladies shoes, scenarios, composition	Improve situations (Yr1_E)	Concrete situations, with design requirements (Yr1_F)	Special needs (Yr1_G)	Everyday life (Yr1_H)

APPENDIX F - A SUMMARY TABLE OF SUBJECTS' INITIAL SORT RESULTS

Card no	Card name	Subject Yr3_A	Subject Yr3_B	Subject Yr3_C	Subject Yr3_D
1	Coffee maker, specifications, point	mechanical / functional (Yr3_A)	Design with special needs, structure requirements (Yr3_B)	Household (Yr3_K)	Home wares - electronics (Yr3_D)
2	Margarine storage device, functions, point	mechanical / functional (Yr3_A)	Design with special needs, structure requirements (Yr3_B)	restaurant / food (Yr3_K)	Home wares - electronics (Yr3_D)
3	Beverage vending machine, structures, composition	Interface (Yr3_A)	Design with basic needs, structure requirements (Yr3_B)	Public ware (Yr3_K)	Public facility (non-home) (Yr3_D)
4	Window cleaner, specifications, composition	mechanical / functional (Yr3_A)	Design with special needs, structure requirements (Yr3_B)	others (no ideas) (Yr3_K)	Health care (Yr3_D)
5	Garden chair, structures, point	stylish (represent oneself / one's status) (Yr3_A)	Design with special needs, structure requirements (Yr3_B)	others (no ideas) (Yr3_K)	Public facility (non-home) (Yr3_D)
6	Coin-operated payphone, subordinate, single	Interface (Yr3_A)	Direct target (Yr3_B)	Public ware (Yr3_K)	Public facility (non-home) (Yr3_D)
7	Bedside lamp, scenarios, single	stylish (represent oneself / one's status) (Yr3_A)	Statement + situations (Yr3_B)	Household (Yr3_K)	Home wares - electronics (Yr3_D)
8	Diamond watch, subordinate, single	stylish (represent oneself / one's status) (Yr3_A)	Direct target (Yr3_B)	Electronic modern interactive (Yr3_K)	Wearable (Home - Outdoor) (Yr3_D)
9	Revolving door, subordinate, single	environment / system (Yr3_A)	Direct target (Yr3_B)	Public ware (Yr3_K)	Commercial (Indoor) (Yr3_D)
10	Card game, functions, composition	more creative space (Yr3_A)	Design with basic needs, structure requirements (Yr3_B)	children (not interested) (Yr3_K)	Toy, Design (Yr3_D)
11	Footwear, superordinate, single	stylish (represent oneself / one's status) (Yr3_A)	Direct target (Yr3_B)	soft goods (need other experts) (Yr3_K)	Fashion (Yr3_D)
12	Coffee mug, scenarios, composition	more creative space (Yr3_A)	Story-telling / introduction (Yr3_B)	Household (Yr3_K)	Wearable (Home - Outdoor) (Yr3_D)
13	Ventilation system, functions, single	environment / system (Yr3_A)	Direct target (Yr3_B)	restaurant / food (Yr3_K)	Commercial (Indoor) (Yr3_D)
14	Food preparation area, functions, point	environment / system (Yr3_A)	Design with special needs, structure requirements (Yr3_B)	restaurant / food (Yr3_K)	Commercial (Indoor) (Yr3_D)
15	Dashboard, specifications, point	Interface (Yr3_A)	Design with basic needs, structure requirements (Yr3_B)	Electronic modern interactive (Yr3_K)	Car (Yr3_D)
16	Clothing, superordinate, single	stylish (represent oneself / one's status) (Yr3_A)	Direct target (Yr3_B)	soft goods (need other experts) (Yr3_K)	Fashion (Yr3_D)
17	Trash can, scenarios, composition	environment / system (Yr3_A)	Story-telling / introduction (Yr3_B)	Form: semantic (Yr3_K)	Public facility (non-home) (Yr3_D)
18	Can opener, specifications, point	mechanical / functional (Yr3_A)	Design with special needs, structure requirements (Yr3_B)	Household (Yr3_K)	Home wares - electronics (Yr3_D)
19	Sofa set, scenarios, composition	more creative space (Yr3_A)	Story-telling / introduction (Yr3_B)	children (not interested) (Yr3_K)	Furniture (Yr3_D)
20	Time-telling device, functions, single	more creative space (Yr3_A)	Direct target (Yr3_B)	Electronic modern interactive (Yr3_K)	Wearable (Home - Outdoor) (Yr3_D)
21	Heart rate monitor, specifications, composition	Interface (Yr3_A)	Design with special needs, structure requirements (Yr3_B)	Electronic modern interactive (Yr3_K)	Health care (Yr3_D)
22	Dress shirt, subordinate, single	stylish (represent oneself / one's status) (Yr3_A)	Direct target (Yr3_B)	soft goods (need other experts) (Yr3_K)	Fashion (Yr3_D)
23	Flower vase, structures, point	stylish (represent oneself / one's status) (Yr3_A)	Design with special needs, structure requirements (Yr3_B)	Form: semantic (Yr3_K)	Home wares - electronics (Yr3_D)
24	Office ladies shoes, scenarios, composition	more creative space (Yr3_A)	Story-telling / introduction (Yr3_B)	soft goods (need other experts) (Yr3_K)	Fashion (Yr3_D)

Card no	Card name	Subject Yr3_E	Subject Yr3_F	Subject Yr3_G	Subject Yr3_H
1	Coffee maker, specifications, point	Design criteria: function + constraints (Yr3_E)	Home - functions (Yr3_F)	Have technical figure, instructions (focus on products) (Yr3_G)	Coffee (Yr3_H)
2	Margarine storage device, functions, point	Design criteria: function + constraints (Yr3_E)	Others - functions (Yr3_F)	Have technical figure, instructions (focus on products) (Yr3_G)	Home products (Yr3_H)
3	Beverage vending machine, structures, composition	Design criteria: function (Yr3_E)	Public (Yr3_F)	More on outcome (focus on users) (Yr3_G)	Redesign existing products (Yr3_H)
4	Window cleaner, specifications, composition	Design criteria: function (Yr3_E)	Home - functions (Yr3_F)	More on outcome (focus on users) (Yr3_G)	Home products (Yr3_H)
5	Garden chair, structures, point	Design criteria: concrete constraints, materials, color, size (Yr3_E)	Home - styles (Yr3_F)	Have technical figure, instructions (focus on products) (Yr3_G)	Home products (Yr3_H)
6	Coin-operated payphone, subordinate, single	No special criteria: technology (Yr3_E)	Public (Yr3_F)	Very technical but quite free (but have target customers) (Yr3_G)	Redesign existing products (Yr3_H)
7	Bedside lamp, scenarios, single	Story-telling (creating a situation) (Yr3_E)	Home - functions (Yr3_F)	Very technical but quite free (but have target customers) (Yr3_G)	Home products (Yr3_H)
8	Diamond watch, subordinate, single	No special criteria: fashion (Yr3_E)	Fashion (Yr3_F)	Very free (can design for any target users) (Yr3_G)	Fashion/ Hobbies (Yr3_H)
9	Revolving door, subordinate, single	No special criteria: technology (Yr3_E)	Public (Yr3_F)	Very technical but quite free (but have target customers) (Yr3_G)	Redesign existing products (Yr3_H)
10	Card game, functions, composition	Design criteria: function (Yr3_E)	Home - target users (Yr3_F)	More on outcome (focus on users) (Yr3_G)	Fun and Games (Yr3_H)
11	Footwear, superordinate, single	No special criteria: fashion (Yr3_E)	Fashion (Yr3_F)	Very free (can design for any target users) (Yr3_G)	Footwear on health (Yr3_H)
12	Coffee mug, scenarios, composition	Story-telling (creating a situation) (Yr3_E)	Others - functions (Yr3_F)	Design something for specific time users (Yr3_G)	Coffee (Yr3_H)
13	Ventilation system, functions, single	Design area provided (not clear, loose) (Yr3_E)	Public (Yr3_F)	Very technical but quite free (but have target customers) (Yr3_G)	Chinese dinner, food preparation area (Yr3_H)
14	Food preparation area, functions, point	Design area provided (not clear, loose) (Yr3_E)	Interior - functions (Yr3_F)	Very technical but quite free (but have target customers) (Yr3_G)	Chinese dinner, food preparation area (Yr3_H)
15	Dashboard, specifications, point	Design criteria: function (Yr3_E)	Others - functions (Yr3_F)	Have technical figure, instructions (focus on products) (Yr3_G)	Redesign existing products (Yr3_H)
16	Clothing, superordinate, single	No special criteria: fashion (Yr3_E)	Fashion (Yr3_F)	Very free (can design for any target users) (Yr3_G)	Fashion/ Hobbies (Yr3_H)
17	Trash can, scenarios, composition	Problem solving (Yr3_E)	Public (Yr3_F)	Design something for specific time users (Yr3_G)	Chinese dinner, food preparation area (Yr3_H)
18	Can opener, specifications, point	Design criteria: function (Yr3_E)	Home - functions (Yr3_F)	Have technical figure, instructions (focus on products) (Yr3_G)	Home products (Yr3_H)
19	Sofa set, scenarios, composition	Problem solving (Yr3_E)	Home - functions (Yr3_F)	Design from a situation (problem-solving) (Yr3_G)	Fun and Games (Yr3_H)
20	Time-telling device, functions, single	No special criteria: technology (Yr3_E)	Fashion (Yr3_F)	Very free (can design for any target users) (Yr3_G)	Redesign existing products (Yr3_H)
21	Heart rate monitor, specifications, composition	Design criteria: function (Yr3_E)	Others - functions (Yr3_F)	More on outcome (focus on users) (Yr3_G)	Footwear on health (Yr3_H)
22	Dress shirt, subordinate, single	No special criteria: fashion (Yr3_E)	Fashion (Yr3_F)	Very free (can design for any target users) (Yr3_G)	Fashion/ Hobbies (Yr3_H)
23	Flower vase, structures, point	Design criteria: concrete constraints, materials, color, size (Yr3_E)	Home - styles (Yr3_F)	Have technical figure, instructions (focus on products) (Yr3_G)	Chinese dinner, food preparation area (Yr3_H)
24	Office ladies shoes, scenarios, composition	Problem solving (Yr3_E)	Fashion (Yr3_F)	Design from a situation (problem-solving) (Yr3_G)	Footwear on health (Yr3_H)

APPENDIX F - A SUMMARY TABLE OF SUBJECTS' INITIAL SORT RESULTS

Card no	Card name	Subject Prof_A	Subject Prof_B	Subject Prof_C	Subject Prof_D
1	Coffee maker, specifications, point	specific requirements, specific product (Prof_A)	Product Features (Prof_B)	Re-design with requirements (non-household) (Prof_C)	Stand-alone devices, improve user experience (Prof_D)
2	Margarine storage device, functions, point	specific requirements, specific product (Prof_A)	Product Features (Prof_B)	Bring out issues [problem-solving] (Prof_C)	Stand-alone devices, improve user experience (Prof_D)
3	Beverage vending machine, structures, composition	Specific task, paragraph (Prof_A)	Product Features (Prof_B)	Re-design with requirements (non-household) (Prof_C)	Process-oriented activities (Prof_D)
4	Window cleaner, specifications, composition	Specific task, paragraph (Prof_A)	Product Features (Prof_B)	Re-design with requirements (non-household) (Prof_C)	Stand-alone devices, improve user experience (Prof_D)
5	Garden chair, structures, point	specific requirements, specific product (Prof_A)	Product Features (Prof_B)	Re-design with requirements (household) (Prof_C)	Home settings, study people habits (Prof_D)
6	Coin-operated payphone, subordinate, single	straight forward, specific product needs (Prof_A)	Vague / Freedom (with certain info) (Prof_B)	Re-design (Prof_C)	Process-oriented activities (Prof_D)
7	Bedside lamp, scenarios, single	specific situation, open product (Prof_A)	Scenario / User / Environment (Prof_B)	Re-design with requirements (household) (Prof_C)	Home settings, study people habits (Prof_D)
8	Diamond watch, subordinate, single	straight forward, specific product needs (Prof_A)	Vague / Freedom (with certain info) (Prof_B)	Re-design (Prof_C)	Wearable pretty things (Prof_D)
9	Revolving door, subordinate, single	straight forward, specific product needs (Prof_A)	Vague / Freedom (with certain info) (Prof_B)	Re-design (Prof_C)	Part of a building/room (Prof_D)
10	Card game, functions, composition	specific situation, open product (Prof_A)	Require other experts (Prof_B)	Re-design with requirements (household) (Prof_C)	Fun (Prof_D)
11	Footwear, superordinate, single	specific product type, open product (Prof_A)	Vague / Freedom (Prof_B)	Re-design (Prof_C)	Wearable pretty things (Prof_D)
12	Coffee mug, scenarios, composition	specific situation, open product (Prof_A)	Scenario / User / Environment (Prof_B)	Re-design with requirements (household) (Prof_C)	Stand-alone devices, improve user experience (Prof_D)
13	Ventilation system, functions, single	straight forward, specific product needs (Prof_A)	Vague / Freedom (with certain info) (Prof_B)	Re-design (Prof_C)	System/Environment consideration (Prof_D)
14	Food preparation area, functions, point	specific requirements, specific product (Prof_A)	Scenario / User / Environment (Prof_B)	Re-design with requirements (non-household) (Prof_C)	System/Environment consideration (Prof_D)
15	Dashboard, specifications, point	specific requirements, specific product (Prof_A)	Product Features (Prof_B)	Re-design with requirements (non-household) (Prof_C)	Complicated display (Prof_D)
16	Clothing, superordinate, single	specific product type, open product (Prof_A)	Vague / Freedom (Prof_B)	Re-design (Prof_C)	Wearable pretty things (Prof_D)
17	Trash can, scenarios, composition	specific situation, open product (Prof_A)	Scenario / User / Environment (Prof_B)	Bring out issues [problem-solving] (Prof_C)	System/Environment consideration (Prof_D)
18	Can opener, specifications, point	specific requirements, specific product (Prof_A)	Product Features (Prof_B)	Re-design with requirements (household) (Prof_C)	Stand-alone devices, improve user experience (Prof_D)
19	Sofa set, scenarios, composition	specific situation, open product (Prof_A)	Scenario / User / Environment (Prof_B)	Bring out issues [problem-solving] (Prof_C)	Home settings, study people habits (Prof_D)
20	Time-telling device, functions, single	specific product type, open product (Prof_A)	Vague / Freedom (Prof_B)	Re-design (Prof_C)	Wearable pretty things (Prof_D)
21	Heart rate monitor, specifications, composition	Specific task, paragraph (Prof_A)	Product Features (Prof_B)	Re-design with requirements (non-household) (Prof_C)	Health and well-being (Prof_D)
22	Dress shirt, subordinate, single	straight forward, specific product needs (Prof_A)	Vague / Freedom (Prof_B)	Re-design (Prof_C)	Wearable pretty things (Prof_D)
23	Flower vase, structures, point	specific requirements, specific product (Prof_A)	Product Features (Prof_B)	Re-design with requirements (household) (Prof_C)	Aesthetics/Art (Prof_D)
24	Office ladies shoes, scenarios, composition	specific situation, open product (Prof_A)	Scenario / User / Environment (Prof_B)	Bring out issues [problem-solving] (Prof_C)	Health and well-being (Prof_D)

Card no	Card name	Subject Prof_E	Subject Prof_F	Subject Prof_G	Subject Prof_H
1	Coffee maker, specifications, point	Detailed design specifications - potential budget/cost (Prof_E)	Product design (Prof_F)	Kitchen (Prof_G)	Definitive (Prof_H)
2	Margarine storage device, functions, point	Detailed design specifications - potential budget/cost (Prof_E)	Product design (Prof_F)	Kitchen (Prof_G)	Definitive (Prof_H)
3	Beverage vending machine, structures, composition	Detailed design specifications - users and situations (Prof_E)	Product design (Prof_F)	Vending machine (Prof_G)	Problem-solving (Prof_H)
4	Window cleaner, specifications, composition	Detailed design specifications - users and situations (Prof_E)	Product design (Prof_F)	Household (Prof_G)	Problem-solving (Prof_H)
5	Garden chair, structures, point	Detailed design specifications - potential budget/cost (Prof_E)	Product design (Prof_F)	Household (Prof_G)	Definitive (Prof_H)
6	Coin-operated payphone, subordinate, single	No specifications (budget? Environment? Who?) (Prof_E)	Free [Design freedom] (Prof_F)	Vending machine (Prof_G)	Out of the blue (Prof_H)
7	Bedside lamp, scenarios, single	Detailed design specifications - users and situations (Prof_E)	Life target [users] (Prof_F)	Household (Prof_G)	Problem-solving (Prof_H)
8	Diamond watch, subordinate, single	No specifications (budget? Environment? Who?) (Prof_E)	Free [Design freedom] (Prof_F)	Personal: timepiece (Prof_G)	Out of the blue (Prof_H)
9	Revolving door, subordinate, single	No specifications (budget? Environment? Who?) (Prof_E)	Free [Design freedom] (Prof_F)	Restaurant: interior (Prof_G)	Out of the blue (Prof_H)
10	Card game, functions, composition	Detailed design specifications - users and situations (Prof_E)	Life target [users] (Prof_F)	Family (Prof_G)	Card game (Prof_H)
11	Footwear, superordinate, single	No specifications (budget? Environment? Who?) (Prof_E)	Free [Design freedom] (Prof_F)	Personal: Fashion and accessories (Prof_G)	Out of the blue (Prof_H)
12	Coffee mug, scenarios, composition	Detailed design specifications - users and situations (Prof_E)	Life target [users] (Prof_F)	Car interior (Prof_G)	Problem-solving (Prof_H)
13	Ventilation system, functions, single	No specifications (budget? Environment? Who?) (Prof_E)	Free [Design freedom] (Prof_F)	Restaurant: Chinese style (Prof_G)	Out of the blue (Prof_H)
14	Food preparation area, functions, point	Detailed design specifications - interface (Prof_E)	Product design (Prof_F)	Restaurant: Chinese style (Prof_G)	Definitive (Prof_H)
15	Dashboard, specifications, point	Detailed design specifications - interface (Prof_E)	Product design (Prof_F)	Car interior (Prof_G)	Definitive (Prof_H)
16	Clothing, superordinate, single	No specifications (budget? Environment? Who?) (Prof_E)	Free [Design freedom] (Prof_F)	Personal: Fashion and accessories (Prof_G)	Out of the blue (Prof_H)
17	Trash can, scenarios, composition	Problem-solving / with users and situations (Prof_E)	Life target [users] (Prof_F)	Restaurant: interior (Prof_G)	Problem-solving (Prof_H)
18	Can opener, specifications, point	Detailed design specifications - potential budget/cost (Prof_E)	Product design (Prof_F)	Kitchen (Prof_G)	Definitive (Prof_H)
19	Sofa set, scenarios, composition	Problem-solving / with users and situations (Prof_E)	Life target [users] (Prof_F)	Family (Prof_G)	Problem-solving (Prof_H)
20	Time-telling device, functions, single	No specifications (budget? Environment? Who?) (Prof_E)	Free [Design freedom] (Prof_F)	Personal: timepiece (Prof_G)	Out of the blue (Prof_H)
21	Heart rate monitor, specifications, composition	Detailed design specifications - users and situations (Prof_E)	Product design (Prof_F)	Personal: health-care (Prof_G)	Definitive (Prof_H)
22	Dress shirt, subordinate, single	No specifications (budget? Environment? Who?) (Prof_E)	Free [Design freedom] (Prof_F)	Personal: Fashion and accessories (Prof_G)	Out of the blue (Prof_H)
23	Flower vase, structures, point	Detailed design specifications - potential budget/cost (Prof_E)	Product design (Prof_F)	Household (Prof_G)	Definitive (Prof_H)
24	Office ladies shoes, scenarios, composition	Problem-solving / with users and situations (Prof_E)	Life target [users] (Prof_F)	Personal: health-care (Prof_G)	Problem-solving (Prof_H)

APPENDIX F - A SUMMARY TABLE OF SUBJECTS' INITIAL SORT RESULTS

Card no	Card name	Subject Mgr_A	Subject Mgr_B	Subject Mgr_C	Subject Mgr_D
1	Coffee maker, specifications, point	Design tasks with requirements (Mgr_A)	Devices / products -- use in home environment (Mgr_B)	Emphasize on functions of products (Mgr_C)	Design task statements (Mgr_D)
2	Margarine storage device, functions, point	Basic background info to a problem (Mgr_A)	Devices / products -- use in home environment (Mgr_B)	Emphasize on functions of products (Mgr_C)	Design task statements (Mgr_D)
3	Beverage vending machine, structures, composition	Design tasks with specific requirements (Mgr_A)	Public use - devices / machines (Mgr_B)	Emphasize on functions of products (Mgr_C)	Tasks with background information (Mgr_D)
4	Window cleaner, specifications, composition	Design tasks with specific requirements (Mgr_A)	Devices / products -- use in home environment (Mgr_B)	Requirements involve technology (Mgr_C)	Tasks with background information (Mgr_D)
5	Garden chair, structures, point	Design tasks with requirements (Mgr_A)	Public use - devices / machines (Mgr_B)	Straight forward, form and material (Mgr_C)	Design task statements (Mgr_D)
6	Coin-operated payphone, subordinate, single	Just do it design task (Mgr_A)	Public use - devices / machines (Mgr_B)	No specifications at all (Mgr_C)	Tasks in point-forms (Mgr_D)
7	Bedside lamp, scenarios, single	Basic background info to a problem (Mgr_A)	Devices / products -- use in home environment (Mgr_B)	People and environment (Mgr_C)	Tasks with background information (Mgr_D)
8	Diamond watch, subordinate, single	Just do it design task (Mgr_A)	Personal wearable items (Mgr_B)	No specifications at all (Mgr_C)	Tasks in point-forms (Mgr_D)
9	Revolving door, subordinate, single	Design tasks with non-specific requirements (Mgr_A)	Public use - devices / machines (Mgr_B)	No specifications at all (Mgr_C)	Tasks in point-forms (Mgr_D)
10	Card game, functions, composition	Design tasks with specific requirements (Mgr_A)	For kids / Game (Target users) (Mgr_B)	Product with entertainment value (Mgr_C)	Tasks with background information (Mgr_D)
11	Footwear, superordinate, single	Design tasks with non-specific requirements (Mgr_A)	Personal wearable items (Mgr_B)	No specifications at all (Mgr_C)	Tasks in point-forms (Mgr_D)
12	Coffee mug, scenarios, composition	Basic background info to a problem (Mgr_A)	Devices / products -- use in home environment (Mgr_B)	People and environment (Mgr_C)	Tasks with background information (Mgr_D)
13	Ventilation system, functions, single	Design tasks with non-specific requirements (Mgr_A)	Not product - food cooking / Chinese restaurant (Mgr_B)	No specifications at all (Mgr_C)	Tasks in point-forms (Mgr_D)
14	Food preparation area, functions, point	Basic background info to a problem (Mgr_A)	Not product - food cooking / Chinese restaurant (Mgr_B)	Emphasize on functions of products (Mgr_C)	Design task statements (Mgr_D)
15	Dashboard, specifications, point	Design tasks with requirements (Mgr_A)	Information board - car (Mgr_B)	Emphasize on functions of products (Mgr_C)	Design task statements (Mgr_D)
16	Clothing, superordinate, single	Design tasks with non-specific requirements (Mgr_A)	Personal wearable items (Mgr_B)	No specifications at all (Mgr_C)	Tasks in point-forms (Mgr_D)
17	Trash can, scenarios, composition	Basic background info to a problem (Mgr_A)	Public use - devices / machines (Mgr_B)	People and environment (Mgr_C)	Tasks with background information (Mgr_D)
18	Can opener, specifications, point	Basic background info to a problem (Mgr_A)	Devices / products -- use in home environment (Mgr_B)	Emphasize on functions of products (Mgr_C)	Design task statements (Mgr_D)
19	Sofa set, scenarios, composition	Basic background info to a problem (Mgr_A)	For kids / Game (Target users) (Mgr_B)	People and environment (Mgr_C)	Tasks with background information (Mgr_D)
20	Time-telling device, functions, single	Design tasks with non-specific requirements (Mgr_A)	Personal wearable items (Mgr_B)	No specifications at all (Mgr_C)	Tasks in point-forms (Mgr_D)
21	Heart rate monitor, specifications, composition	Design tasks with specific requirements (Mgr_A)	Personal health products (Mgr_B)	Requirements involve technology (Mgr_C)	Tasks with background information (Mgr_D)
22	Dress shirt, subordinate, single	Design tasks with non-specific requirements (Mgr_A)	Personal wearable items (Mgr_B)	No specifications at all (Mgr_C)	Tasks in point-forms (Mgr_D)
23	Flower vase, structures, point	Design tasks with requirements (Mgr_A)	Devices / products -- use in home environment (Mgr_B)	Straight forward, form and material (Mgr_C)	Design task statements (Mgr_D)
24	Office ladies shoes, scenarios, composition	Basic background info to a problem (Mgr_A)	Personal health products (Mgr_B)	People and environment (Mgr_C)	Tasks with background information (Mgr_D)

Card no	Card name	Subject Mgr_E	Subject Mgr_F	Subject Mgr_G	Subject Mgr_H
1	Coffee maker, specifications, point	Production-production (Mgr_E)	Styling approach, Ergonomics (Mgr_F)	Product / Industrial design (Mgr_G)	Catering (Mgr_H)
2	Margarine storage device, functions, point	User-Ergonomics (Mgr_E)	Functional approach (Mgr_F)	Product / Industrial design (Mgr_G)	Catering (Mgr_H)
3	Beverage vending machine, structures, composition	Production-production (Mgr_E)	System design approach, environmental (Mgr_F)	Environmental / Space design (Mgr_G)	Catering (Mgr_H)
4	Window cleaner, specifications, composition	User-Ergonomics (Mgr_E)	Functional approach (Mgr_F)	ODM (tailor-made product design) (Mgr_G)	Household (products) (Mgr_H)
5	Garden chair, structures, point	Production-production (Mgr_E)	Styling approach, Ergonomics (Mgr_F)	Environmental / Space design (Mgr_G)	Household (products) (Mgr_H)
6	Coin-operated payphone, subordinate, single	Production-production (Mgr_E)	Conceptual, Ergonomics, open topic (Mgr_F)	Product / Industrial design (Mgr_G)	Others (Mgr_H)
7	Bedside lamp, scenarios, single	User-Ergonomics (Mgr_E)	Styling approach, Ergonomics (Mgr_F)	Product / Industrial design (Mgr_G)	Household (products) (Mgr_H)
8	Diamond watch, subordinate, single	Production-production (Mgr_E)	Styling approach, Ergonomics (Mgr_F)	Fashion / Jewelery design (Mgr_G)	Fashion (Mgr_H)
9	Revolving door, subordinate, single	Production-production (Mgr_E)	Conceptual, Ergonomics, open topic (Mgr_F)	Environmental / Space design (Mgr_G)	Catering (Mgr_H)
10	Card game, functions, composition	User-Family (Mgr_E)	Game logic design approach (Mgr_F)	ODM (tailor-made product design) (Mgr_G)	Others (Mgr_H)
11	Footwear, superordinate, single	User-Fashion (Mgr_E)	Styling approach, Ergonomics (Mgr_F)	Fashion / Jewelery design (Mgr_G)	Fashion (Mgr_H)
12	Coffee mug, scenarios, composition	User-Ergonomics (Mgr_E)	Problem solving (Mgr_F)	ODM (tailor-made product design) (Mgr_G)	Household (products) (Mgr_H)
13	Ventilation system, functions, single	Production-production (Mgr_E)	Functional approach (Mgr_F)	Environmental / Space design (Mgr_G)	Catering (Mgr_H)
14	Food preparation area, functions, point	User-Ergonomics (Mgr_E)	System design approach, environmental (Mgr_F)	Environmental / Space design (Mgr_G)	Catering (Mgr_H)
15	Dashboard, specifications, point	Production-production (Mgr_E)	Ergonomic design approach (Mgr_F)	Product / Industrial design (Mgr_G)	Others (Mgr_H)
16	Clothing, superordinate, single	User-Fashion (Mgr_E)	Styling approach, Ergonomics (Mgr_F)	Fashion / Jewelery design (Mgr_G)	Fashion (Mgr_H)
17	Trash can, scenarios, composition	Production-environment (Mgr_E)	Problem solving (Mgr_F)	Environmental / Space design (Mgr_G)	Catering (Mgr_H)
18	Can opener, specifications, point	User-Ergonomics (Mgr_E)	Functional approach (Mgr_F)	Product / Industrial design (Mgr_G)	Household (products) (Mgr_H)
19	Sofa set, scenarios, composition	User-Family (Mgr_E)	Problem solving (Mgr_F)	ODM (tailor-made product design) (Mgr_G)	Household (products) (Mgr_H)
20	Time-telling device, functions, single	Production-production (Mgr_E)	Conceptual, Ergonomics, open topic (Mgr_F)	Product / Industrial design (Mgr_G)	Fashion (Mgr_H)
21	Heart rate monitor, specifications, composition	User-Healthy (Mgr_E)	Styling approach, Ergonomics (Mgr_F)	ODM (tailor-made product design) (Mgr_G)	Others (Mgr_H)
22	Dress shirt, subordinate, single	User-Fashion (Mgr_E)	Styling approach, Ergonomics (Mgr_F)	Fashion / Jewelery design (Mgr_G)	Fashion (Mgr_H)
23	Flower vase, structures, point	Production-production (Mgr_E)	Styling approach, Ergonomics (Mgr_F)	Product / Industrial design (Mgr_G)	Household (products) (Mgr_H)
24	Office ladies shoes, scenarios, composition	User-Healthy (Mgr_E)	Functional approach (Mgr_F)	ODM (tailor-made product design) (Mgr_G)	Fashion (Mgr_H)

APPENDIX F - A SUMMARY TABLE OF SUBJECTS' INITIAL SORT RESULTS

Card no	Card name	Subject Edu_A	Subject Edu_B	Subject Edu_C	Subject Edu_D
1	Coffee maker, specifications, point	Physical quality specified (Physical focus) (Edu_A)	Food industry (domestic / commercial products) (Edu_B)	Tools [specific objects] (Edu_C)	Functions (product / space / system) (Edu_D)
2	Margarine storage device, functions, point	Physical quality specified (Physical focus) (Edu_A)	Food industry (domestic / commercial products) (Edu_B)	Eat (Edu_C)	Functions (product / space / system) (Edu_D)
3	Beverage vending machine, structures, composition	Technical quality specified (Tech focus) (Edu_A)	Food industry (domestic / commercial products) (Edu_B)	Eat (Edu_C)	Design features / well-defined problems (Edu_D)
4	Window cleaner, specifications, composition	Technical quality specified (Tech focus) (Edu_A)	Domestic market [daily use] (Edu_B)	Tools [specific objects] (Edu_C)	Design features / well-defined problems (Edu_D)
5	Garden chair, structures, point	Physical quality specified (Physical focus) (Edu_A)	Domestic market [daily use] (Edu_B)	Wear [able and accessories] (Edu_C)	Functions (product / space / system) (Edu_D)
6	Coin-operated payphone, subordinate, single	Relatively straight forward design task (simple) (Edu_A)	Others (Edu_B)	Outdated [boring] (Edu_C)	Open-ended (Edu_D)
7	Bedside lamp, scenarios, single	Use scenario design task (Edu_A)	Domestic market [daily use] (Edu_B)	Tools [specific objects] (Edu_C)	Open-ended (Edu_D)
8	Diamond watch, subordinate, single	Relatively straight forward design task (simple) (Edu_A)	Bodyware / bodycare (consumer products) (Edu_B)	Wear [able and accessories] (Edu_C)	Open-ended (Edu_D)
9	Revolving door, subordinate, single	Relatively straight forward design task (simple) (Edu_A)	Others (Edu_B)	Tools [specific objects] (Edu_C)	Open-ended (Edu_D)
10	Card game, functions, composition	Use scenario design task (Edu_A)	Domestic market [daily use] (Edu_B)	Play [design can be playful] (Edu_C)	Design features / well-defined problems (Edu_D)
11	Footwear, superordinate, single	Relatively straight forward design task (simple) (Edu_A)	Bodyware / bodycare (consumer products) (Edu_B)	Wear [able and accessories] (Edu_C)	Open-ended (Edu_D)
12	Coffee mug, scenarios, composition	Use scenario design task (Edu_A)	Food industry (domestic / commercial products) (Edu_B)	Tools [specific objects] (Edu_C)	Introduction / background / brief description / situation (Edu_D)
13	Ventilation system, functions, single	Relatively straight forward design task (simple) (Edu_A)	Food industry (domestic / commercial products) (Edu_B)	Eat (Edu_C)	Open-ended (Edu_D)
14	Food preparation area, functions, point	Physical quality specified (Physical focus) (Edu_A)	Food industry (domestic / commercial products) (Edu_B)	Eat (Edu_C)	Functions (product / space / system) (Edu_D)
15	Dashboard, specifications, point	Physical quality specified (Physical focus) (Edu_A)	Others (Edu_B)	Tools [specific objects] (Edu_C)	Design features / well-defined problems (Edu_D)
16	Clothing, superordinate, single	Relatively straight forward design task (simple) (Edu_A)	Bodyware / bodycare (consumer products) (Edu_B)	Wear [able and accessories] (Edu_C)	Open-ended (Edu_D)
17	Trash can, scenarios, composition	Use scenario design task (Edu_A)	Food industry (domestic / commercial products) (Edu_B)	Eat (Edu_C)	Introduction / background / brief description / situation (Edu_D)
18	Can opener, specifications, point	Physical quality specified (Physical focus) (Edu_A)	Food industry (domestic / commercial products) (Edu_B)	Tools [specific objects] (Edu_C)	Design features / well-defined problems (Edu_D)
19	Sofa set, scenarios, composition	Use scenario design task (Edu_A)	Domestic market [daily use] (Edu_B)	Play [design can be playful] (Edu_C)	Introduction / background / brief description / situation (Edu_D)
20	Time-telling device, functions, single	Relatively straight forward design task (simple) (Edu_A)	Bodyware / bodycare (consumer products) (Edu_B)	Wear [able and accessories] (Edu_C)	Open-ended (Edu_D)
21	Heart rate monitor, specifications, composition	Technical quality specified (Tech focus) (Edu_A)	Bodyware / bodycare (consumer products) (Edu_B)	Tools [requires domain knowledge] (Edu_C)	Design features / well-defined problems (Edu_D)
22	Dress shirt, subordinate, single	Relatively straight forward design task (simple) (Edu_A)	Bodyware / bodycare (consumer products) (Edu_B)	Wear [able and accessories] (Edu_C)	Open-ended (Edu_D)
23	Flower vase, structures, point	Physical quality specified (Physical focus) (Edu_A)	Domestic market [daily use] (Edu_B)	Wear [able and accessories] (Edu_C)	Design features / well-defined problems (Edu_D)
24	Office ladies shoes, scenarios, composition	Use scenario design task (Edu_A)	Bodyware / bodycare (consumer products) (Edu_B)	Tools [requires domain knowledge] (Edu_C)	Introduction / background / brief description / situation (Edu_D)

Card no	Card name	Subject Edu_E	Subject Edu_F	Subject Edu_G	Subject Edu_H
1	Coffee maker, specifications, point	Requirements oriented brief (Edu_E)	Eating and drinking (Edu_F)	Too few and seemingly arbitrary (not logical) requirements (Edu_G)	Structured design brief (Edu_H)
2	Margarine storage device, functions, point	Performance oriented brief [functions] (Edu_E)	Bullet points (Edu_F)	Few specific requirements (Edu_G)	Structured design brief, open-ended (Edu_H)
3	Beverage vending machine, structures, composition	Features oriented brief [components] (Edu_E)	Eating and drinking (Edu_F)	Too few and seemingly arbitrary (not logical) requirements (Edu_G)	Design task statement (Edu_H)
4	Window cleaner, specifications, composition	Performance oriented brief [functions] (Edu_E)	One paragraph (Edu_F)	Good for immeidate design action (Edu_G)	Design task statement (Edu_H)
5	Garden chair, structures, point	Requirements oriented brief (Edu_E)	One-liners (Edu_F)	Few specific requirements (Edu_G)	Structured design brief (Edu_H)
6	Coin-operated payphone, subordinate, single	Object-mechanism oriented brief (Edu_E)	One-liners (Edu_F)	Not enough information for designing (Edu_G)	Command [Design] (Edu_H)
7	Bedside lamp, scenarios, single	Needs oriented brief [user needs] (Edu_E)	One-liners (Edu_F)	Few specific requirements (Edu_G)	Design task statement (Edu_H)
8	Diamond watch, subordinate, single	Object / product oriented brief (Edu_E)	One-liners (Edu_F)	Not enough information for designing (Edu_G)	Command [Design] (Edu_H)
9	Revolving door, subordinate, single	Object-mechanism oriented brief (Edu_E)	One-liners (Edu_F)	Not enough information for designing (Edu_G)	Command [Design] (Edu_H)
10	Card game, functions, composition	Needs oriented brief [user needs] (Edu_E)	Eating and drinking (Edu_F)	Few specific requirements (Edu_G)	Design task statement (Edu_H)
11	Footwear, superordinate, single	Object / product oriented brief (Edu_E)	One-liners (Edu_F)	Not enough information for designing (Edu_G)	Command [Design] (Edu_H)
12	Coffee mug, scenarios, composition	Problem-scenario brief (Edu_E)	Scenario-based (Edu_F)	Too few and seemingly arbitrary (not logical) requirements (Edu_G)	Design scenario (Edu_H)
13	Ventilation system, functions, single	Object-mechanism oriented brief (Edu_E)	One-liners (Edu_F)	Few specific requirements (Edu_G)	Design task statement (Edu_H)
14	Food preparation area, functions, point	Features oriented brief [components] (Edu_E)	Eating and drinking (Edu_F)	Too few and seemingly arbitrary (not logical) requirements (Edu_G)	Structured design brief (Edu_H)
15	Dashboard, specifications, point	Features oriented brief [components] (Edu_E)	Bullet points (Edu_F)	Too few and seemingly arbitrary (not logical) requirements (Edu_G)	Structured design brief (Edu_H)
16	Clothing, superordinate, single	Object / product oriented brief (Edu_E)	One-liners (Edu_F)	Not enough information for designing (Edu_G)	Command [Design] (Edu_H)
17	Trash can, scenarios, composition	Problem-scenario brief (Edu_E)	Scenario-based (Edu_F)	Few specific requirements (Edu_G)	Design scenario (Edu_H)
18	Can opener, specifications, point	Requirements oriented brief (Edu_E)	Bullet points (Edu_F)	Good for immeidate design action (Edu_G)	Structured design brief (Edu_H)
19	Sofa set, scenarios, composition	Problem-scenario brief (Edu_E)	Scenario-based (Edu_F)	Not a design brief (Edu_G)	Design scenario (Edu_H)
20	Time-telling device, functions, single	Object-mechanism oriented brief (Edu_E)	One-liners (Edu_F)	Open + Understandable in context + requirement (Edu_G)	Command [Design] (Edu_H)
21	Heart rate monitor, specifications, composition	Performance oriented brief [functions] (Edu_E)	One paragraph (Edu_F)	Good for immeidate design action (Edu_G)	Design task statement (Edu_H)
22	Dress shirt, subordinate, single	Object / product oriented brief (Edu_E)	One-liners (Edu_F)	Not enough information for designing (Edu_G)	Command [Design] (Edu_H)
23	Flower vase, structures, point	Requirements oriented brief (Edu_E)	Bullet points (Edu_F)	Few specific requirements (Edu_G)	Structured design brief (Edu_H)
24	Office ladies shoes, scenarios, composition	Problem-scenario brief (Edu_E)	Scenario-based (Edu_F)	Not a design brief (Edu_G)	Design scenario (Edu_H)

APPENDIX F - A SUMMARY TABLE OF SUBJECTS' INITIAL SORT RESULTS