工作分配:翻譯3跟4章節

3 Discussion and implication (討論與啟示)

3.1 Role change (角色變更)

Industrial designers’ contribution is dominant in the concept design phase and fterward, engineering designers take over their major role. This can beregarded as the general characteristics of the four types of design processes. With the exception of Type 3, all the design processes started with design con- cepts developed by industrial designers. In the case of Type 1 and Type 2, in- dustrial designers independently define the design concept in terms of shape and use. Type 4 is integrative in the concept design phase, but starts with the industrial designer’s initial design concept. Unlike the other three types, Type 3 cases, where the scheduled modification of existing products happens, start with the layout design by engineering designers. It appears that their roles are divided as concept developers and concept implementers. Interestingly, as a company pursues new concept products or emphasizes emotional feeling and usability even in re-design cases, the role of industrial designers seems to be sig- nificant. This is a different phenomenon from the idea that a new concept product is developed through the development of new principles and technol- ogy. They rather devised new uses or the meaning of existing ones. Therefore, this can be viewed as evidence that new design also starts with existing technol- ogies and principles.

工業設計師的貢獻在概念設計階段占主導地位，之後，工程設計師將接管他們的主要角色。這可以忽略作為四種類型設計過程的一般特徵。除類型3外，所有設計流程均始於設計約束由工業設計師開發的概念。對於類型1和類型2，工業設計師根據形狀獨立定義設計概念和使用。 Type 4在概念設計階段是集成的，但從工業設計師的最初設計理念。與其他三種類型不同，在第3類情況下，發生了對現有產品的預定修改的情況，

首先由工程設計師進行佈局設計。看來他們的角色分為概念開發者和概念實現者。有趣的是公司追求新概念的產品或強調情感和即使在重新設計的情況下也具有可用性，工業設計師的作用似乎很明顯。很棒。這與新概念不同。產品是通過開發新原理和技術而開發的ogy。他們寧願設計新用途或現有用途的含義。因此，這可以被視為新設計也從現有技術開始的證據，原則和原則。

Regarding industrial designers’ knowledge, counter to our belief that they would rarely consider inside parts, they seem to have enough knowledge to read and handle the inside functional components and carry out the outside design. Except for Type 1, defining the outside shape always happens through considering and rearranging the inside functional parts by industrial designers. Type 2 is an unexpected case. Industrial designers develop the outer shape by arranging the related inside components at the same time. However, their work on the inside parts was probably limited to major parts that directly affect the outside shape. Although, they were not fully involved in designing the details of inside parts, it is apparent that their role was extended to the area of engineering design. It is attributed to the top management's strong sup- port to industrial design and the shared CAD tools between both groups.

關於工業設計師的知識，請反對我們認為他們很少考慮內部零件，他們似乎有足夠的知識來閱讀和處理內部功能組件並執行外部功能設計。 除類型1外，定義外部形狀總是通過由工業設計師考慮並重新佈置內部功能部件。類型2是意外情況。 工業設計師通過以下方式開發外形同時安排相關的內部組件。 但是，他們的內部零件的工作可能僅限於直接進行的主要零件影響外形。 雖然，他們沒有完全參與設計內部零件的細節，很明顯，它們的作用擴展到了工程設計領域。 這歸因於最高管理層的強大支持，移植到工業設計以及兩組之間共享的CAD工具。

3.2 Selection of design approach (選擇設計方法)

Theoretically 'inside-out' and 'outside-in' approaches happen and are caused by the combination of different working tendencies of engineering designers and industrial designers (Hubka & Eder, 2012; Kim & Lee, 2010). The four types of collaborative design processes can be seen as extended versions of the two approaches. This section discusses the relationship between the four types and the two approaches, conditions for applying each type successfully, and applying them in consultant and client partnership settings.

從理論上講，"由內而外"和"由外而內"的方法會發生並引起結合工程設計師不同的工作傾向和工業設計師（Hubka和Eder，2012； Kim＆Lee，2010）。 四個協作設計過程的類型可以看作是兩種方法。 本節討論這四個之間的關係類型和兩種方法，成功應用每種類型的條件，並將其應用於顧問和客戶合作夥伴設置。

For consumer products whose contexts of use are emphasized, industrial de- signers are supposed to firstly define the exterior in relation to usability and appearance, and then engineering designers decide the interior functional parts linked with the exterior to support the usability and appearance. Thi is an outside-in approach where Type 1 is suitable and Type 2 is nearly appropriate in such contexts. If we define inside-out process as deciding preliminary layout first and then using it for developing the suing outside form and definitive layout together, Type 3 is a case. Considering the two approaches, Type 4 is considered as a mixed process, because both exterior and interior are defined simultaneously. If we define inside-out process as deciding the exterior after completing interior definitive layout, there is no such process across the com- panies studied here. It is less suitable for use with consumer products. It is

rather suitable for industrial durable goods. For example, if we design an in- dustrial motor, the capacity determines the winding number of electric wires and the size of magnetic cores. We should calculate the layouts and sizes of interior rotors and stators scientifically to achieve optimal performance. Thus, the interior parts must be fully decided first, and then the exterior form is defined to overlay. If we develop the interior parts of a motor based on a pre-set exterior form, it will not operate properly.

對於強調使用環境的消費產品，工業簽名者應該首先定義與可用性相關的外觀，

外觀，然後由工程設計師確定內部功能部件與外部鏈接以支持可用性和外觀。這是一

從外到內的方法，其中類型1適用，類型2幾乎適用在這種情況下。如果我們將內外流程定義為決定初步佈局首先，然後將其用於開發隨後的外部形式和確定性一起佈置，類型3就是一個案例。考慮到兩種方法，類型4為被視為混合過程，因為外部和內部均已定義同時。如果我們將“由內而外”的過程定義為在完成內部確定的佈局，整個公司都沒有這樣的流程內褲在這裡學習。它不太適合與消費產品一起使用。它是相當適合工業耐用品。例如，如果我們設計一個電機，容量決定電線的纏繞數量以及磁芯的尺寸。我們應該計算出的佈局和大小內部轉子和定子科學地達到最佳性能。因此，必須首先完全確定內部零件，然後再確定外部零件表單定義為疊加。如果我們開發基於馬達的內部零件在預設的外觀上，它將無法正常運行。

When using Type 1, industrial designers can come up with innovative design ideas freely. Nevertheless, the approach will lead to two problems. First, it will be difficult to gain technological performance in engineering. To achieve optimal performance, the internal functional parts may clash with the exterior shape. Second, to solve the first problem the design team is likely to compro- mise the original design concept through trading off between functions and appearance. To manage this approach successfully, top management’s strong support to keep the innovativeness of the design will be necessary when a compromise is to take place. Type 2 could be an alternative olution to the problems as we observed in Company B. Its strategy was that ndustrial de- signers decide the exterior form while moving or placing the related interior parts. This avoids critical interference between exterior and interior parts. Yet, it is arguable whether industrial designers should execute the interior layout design in addition to the exterior form development at the expense of the freedom of imagination. It is probable that they compromise innovative- ness within their knowledge. To apply Type 2 successfully, designers should be highly knowledgeable about both industrial design and engineering design.

使用Type 1時，工業設計師可以提出創新設計自由的想法。然而，該方法將導致兩個問題。首先，將難以獲得工程技術性能。達到最佳性能，內部功能部件可能與外部發

生衝突形狀。其次，要解決第一個問題，設計團隊可能會通過在功能和出現。為了成功管理此方法，高層管理人員的能力很強如果需要妥協將發生。類型2可以替代

正如我們在公司B中觀察到的那樣。它的策略是簽名者在移動或放置相關內部時決定外部形式部分。這避免了內部和外部之間的嚴重干擾。然而，工業設計師是否應該執行室內設計是有爭議的佈局設計以及外觀設計開發，但要付出代價想像力的自由。他們可能會折衷創新-在他們的知識範圍內。要成功應用Type 2，設計師應對工業設計和工程設計有很高的了解。

To attain the feasibility of a superior design concept in the early phase, Type 4 is worth noting as industrial designers' concepts and engineering designers' technical support enable new product development. Given this process is effi- cient and likely to develop innovative products, companies need for it proper conditions to employ. Dyson Company can be a role model. It is known that designers and engineers share a workspace as members of a department for the integrated implementation of design (Dyson & Coren, 1997). To facilitate this process, companies need to have an integrated team where two groups share a working space and absorb each discipline's culture as expected. More impor- tant is the organizational culture that stimulates designers to be challenging and open to work together. If designers are worried about company's penalty for a failure, they will be more conservative. Without this situational change, Type 4 even as a well-documented process in a company will not effectively work.

為了在早期階段實現高級設計概念的可行性，類型4值得注意的是，工業設計師的概念和工程設計師的技術支持可以進行新產品開發。鑑於此過程很有效-強大且有可能開發創新產品的公司需要適當的產品僱用條件。戴森公司可以成為榜樣。眾所周知設計師和工程師作為一個部門的成員共享一個工作區設計的集成實施（Dyson和Coren，1997年）。為了方便在此過程中，公司需要有一個由兩個小組共享一個工作空間，並按預期吸收每個學科的文化。更重要tant是激發設計師挑戰性的組織文化並願意一起工作。如果設計師擔心公司的罰款對於失敗，他們將更加保守。沒有這種情況的改變，即使在公司中有據可查的流程也無法有效地處理第4類工作。

In industry, many engineering companies collaborate with external industrial designers. Although, we did not investigate this type of collaboration, discus- sion about possible process scenarios in reference to our findings will be bene- ficial. When manufacturers work with design consulting firms, they can receive complementary support to complete the project on time or generate fresh ideas (Bruce & Morris, 1994). In consultant and client partnerships, there are two modes of process couplings: passive coupling where consultants develop solu- tions independently while they contact the client to get additional information or review their outcomes, and active coupling where the collaborative team of consultants and clients designers work closely to generate solution (Gericke & Maier, 2011). In passive coupling, as the external designers work indepen- dently, its design process will be similar to Type 1 or 2. Type 1 will be useful when clients want to collect creative ideas as many as possible by utilizing the specific specialities they missing. This case will be helpful when client com- panies are highly technology-oriented and have enough capability to imple- ment good concepts with strong engineering pports. Type 2 will be appropriate when clients have less capability than in the bove-mentioned case and are required to utilize external industrial designers to lead their prod- uct development at the initial stage. The active coupling mode will have similar processes to Type 3 and 4. Type 3 will be appropriate when clients already have good design direction and related technology, and want to improve the aesthetic ppearance of the product. Type 4 will be reasonably impossible un- less the integrated team of client and consultant companies work in the same space during project time. There should be other factors to consider in collab- orative design processes in consultant and client partnership. In many cases, information provided by clients for consultants is restricted to some extent. Therefore, the same types of collaborative processes happening in a consultant and client partnership and inside of a company will not be the same in terms of contents. Nevertheless, our research results and discussion could provide clues for selecting a better design approach in the consumer electronics domain.

在工業界，許多工程公司與外部工業界合作設計師。雖然我們沒有調查這種類型的合作，但是參照我們的發現對可能的過程方案進行討論將是有益的-官方的。當製造商與設計諮詢公司合作時，他們可以收到補充支持以按時完成項目或產生新想法（Bruce＆Morris，1994）。在顧問和客戶夥伴關係中，有兩個過程耦合的模式：顧問開發解決方案的被動耦合與客戶聯繫以獲取更多信息時，或查看他們的結果，並在協作團隊

顧問和客戶設計師緊密合作以生成解決方案（Gericke和Maier，2011年）。在無源耦合中，隨著外部設計師的獨立工作，請注意，其設計過程將類似於類型1或2。類型1將很有用當客戶想要通過利用來收集盡可能多的創意時他們缺少的特定專業。這種情況在客戶投訴時會很有幫助。內褲高度以技術為導向，並具有足夠的能力來實現在強大的工程支持下，指導好的概念。類型2將是當客戶的能力低於上述能力時，則適用並需要聘請外部工業設計師來領導他們的產品初期的uct開發。主動耦合模式將具有相似的

到類型3和類型4的過程。當客戶端已經具有類型3時，類型3是合適的良好的設計方向和相關技術，並希望提高產品的美學外觀。如果沒有-減少客戶和顧問公司的整合團隊在同一工作項目期間的空間。合作時應考慮其他因素-顧問和客戶合作夥伴中的演說設計過程。在很多情況下客戶為顧問提供的信息在一定程度上受到限制。因此，顧問中發生的相同類型的協作過程客戶合作夥伴關係和公司內部在以下方面將有所不同內容。儘管如此，我們的研究結果和討論仍可提供線索在消費電子領域選擇更好的設計方法。

3.3 Implication of the types of design processes(設計過程類型的含義)

Industrial designers and engineering designers are different in their design ap- proaches, and perspectives about product development (Eder, 2013; Pahl et al., 2007

; Ulrich & Eppinger, 2012). Industrial designers generate user- centred solution concepts, and engineering designers solve design problems based on technical perspectives. The process exposed to these two groups’ spe- cialities can be the basis for developing competitive and innovative products. Moreover, the coupling process of systematic engineering design and user- centred design thinking is beneficial for generating user-centred solutions in consultanteclient relationships (Gericke & Maier, 2011). The coupling process is the best option for a company to take, and achieve competitiveness in the market. For example, consumer electronics companies use the four types of collaborative design processes to achieve their market goals. Industrial de- signers’ role in the early phase of the four types is noticeable and the way of adopting industrial designers’ specialities is an influential factor in adopting an appropriate type of collaborative design process. The possibility of obtain- ing innovative design concepts can be increased by giving freedom to industrial designers as in Type 1. Then, how can such freedom drive industrial designers to create innovative design concepts? In fact, architectural and industrial de- signers start with the solution image firstly and finalize by following repetitive

trials (Lawson, 2006; Roozenburg & Cross, 1991). This is consistent with a model where designers firstly engage in conjecture based on presuppositions and then perform analysis (Hillier et al., 1972). It implies that industrial de- signers rely on envisioning the future to create innovative concepts rather than thick design research about market and customers. Press and Cooper (2003) added that industrial design approach is value-driven. Therefore, indus- trial designers in Type 1 are given freedom from constraints to generate crea- tive ideas through envisioning the desired future.

工業設計師和工程設計師的設計方式不同產品開發的方法和觀點（Eder，2013； Pahl等，2007）; Ulrich＆Eppinger，2012年）。工業設計師產生用戶集中解決方案概念，工程設計師解決設計問題基於技術觀點。這兩類人的經歷道德可以成為開發具有競爭力的創新產品的基礎。此外，系統工程設計與用戶的耦合過程-集中的設計思維有利於生成以用戶為中心的解決方案顧問客戶關係（Gericke＆Maier，2011年）。耦合過程

是公司採取並在競爭中獲得競爭力的最佳選擇市場。例如，消費電子公司使用四種類型的協作設計過程以實現其市場目標。工業設計簽名者在這四種類型的早期階段中的作用是顯而易見的，採用工業設計師的專業是採用的影響因素適當類型的協作設計過程。獲得的可能性-通過賦予工業自由度可以增加創新的設計理念就像類型1中的設計師。那麼，這種自由如何驅動工業設計師創造創新的設計理念？實際上，建築和工業設計簽名者首先從解決方案圖像開始，然後通過重複進行最終確定試驗（Lawson，2006; Roozenburg＆Cross，1991）。這與設計者首先基於預設進行猜想的模型然後

進行分析（Hillier等，1972）。這意味著工業簽名者依靠對未來的展望來創造創新的概念，而不是而不是關於市場和客戶的深入設計研究。新聞和庫珀（2003）補充說，工業設計方法是價值驅動的。因此，工業類型1的試驗設計人員可以不受約束地產生crea-

通過構想理想的未來來實現富有創意的想法。

Norman and Verganti (2014) argued that innovative product development takes place with technology or meaning change rather than serious design research with human-centred approach. They added that human-centred design methods are more suitable for the incremental improvement of existing products. In the current product development environment in the consumer electronics domain, product-planning experts play a pivotal role in research on market and customers. Thus, the input from the product planning team to industrial designers will be restricted to their creativity. This explains why companies utilize Type 1 in a reverse way; developing concepts first and then defining the market next rather than the other way around. Typically

in product design concept, designers consider function concept that is highly related to technology, and styling concepts that give new meaning to the users (Baxter, 1995). Thus, the design concept produced by industrial designers should be innovative, because of the function and/or styling concepts. When it relates to the technology, engineering designers should develop new technol- ogies or search appropriate technologies to implement the concept. This typeof process can lead to new technology development if not rejected in the prod- uct development planning stage.

Norman和Verganti（2014）認為創新產品開發發生於技術或意義的改變而不是認真的設計以人為本的研究。他們補充說，以人為本設計方法更適合現有產品的增量改進

產品。在當前消費者的產品開發環境中在電子領域，產品規劃專家在研究中起著關鍵作用市場和客戶。因此，產品規劃團隊的意見工業設計師的創作將受到限制。這解釋了為什麼公司以相反的方式使用類型1；首先開發概念然後定義市場，而不是反過來。通常在產品設計概念中，設計師認為功能概念非常重要與技術有關的樣式和為用戶賦予新含義的樣式概念（Baxter，1995）。因此，工業設計師產生的設計理念由於功能和/或樣式概念的原因，應該創新。什麼時候與技術有關，工程設計師應開發新技術，

或搜索適當的技術來實施該概念。這種類型如果不被產品所拒絕，流程的發展會導致新技術的發展。uct發展規劃階段。

In Type 2, the company imposes various roles and responsibilities on indus- trial designers. As engineering designers do not interrupt, they may have a certain level of freedom. Industrial designers' approach is solution-oriented. They do not usually follow systematic process. They rather come up with new ideas and repeated them. However, Type 2 probably interrupts industrial designers approach by imposing another role in which they handle inside layout design with the exterior design. Industrial designers adopting problem oriented and systematic approaches will definitely restrict them from imagina- tion in concept development. This will make them more realistic when consid- ering the feasibility of their design concepts. As such, the design outcome of Type 2 will be less innovative than that of Type 1. Otherwise, Type 2 will be better fit for redesign than new design. If industrial designers do not consider the inside parts in Type 2 for redesign, they can face difficulties, and the design concept can be rejected (Kim & Lee, 2014).

在類型2中，公司對工業界承擔各種角色和責任，試用設計師。由於工程設計師不會打擾，他們可能會有一定程度的自由。工業設計師的方法是面向解決方案的。他們通常不遵循系統的過程。他們寧願想出新的想法，並重複他們。但是，類型2可能會中斷工業設計師通過強加他們在內部處理的其他角色來實現版面設計與外觀設計。工業設計師採用問題面向系統的方法肯定會限制他們的想像力-概念開發中的位置。當考慮以下情況時，這將使它們更加逼真：他們的設計概念的可行性。因此，設計結果類型2的創新性不如類型1。否則，類型2將是比新設計更適合重新設計。如果工業設計師不考慮

Type 2的內部零件需要重新設計，它們可能會遇到困難，因此設計這個概念可以被拒絕（Kim＆Lee，2014）。

If we consider applying Type 2 and Type 3 for redesign, when does Type 2 bet- ter than Type 3? The characteristics of Type 3 are in accordance with most design processes shown in engineering design. Industrial design has been considered as an afterthought in the engineering design field (e.g. Andreasen & Hein, 2000; Hubka & Eder, 1987; Pahl et al., 2007). As per their viewpoints, industrial design's function is related to the aspects of product appearance, such as styling, form and colour after a product's technical features are deter- mined. Type 3 is the process where engineering designers have technological solutions to the design concept. They request industrial designers to develop exterior appearance. Thus, Type 3 uses only part of industrial designers' exper- tise in creating aesthetic appearance. In this perspective, Type 2 can offer more ways for industrial designers to show their expertise than Type 3. Considering the fact that Type 3 is the most frequently used process, it can be more efficient in terms of process management. Probably, the uncertainty in the early phase in Type 3 is the least among the four types. Most of the technical solutions for the design concept are set by engineering designers in the early phase, and in- dustrial designers are only limited to create aesthetic appearance.

如果我們考慮將類型2和類型3用於重新設計，那麼類型2在什麼時候下注-比3型更強？類型3的特性符合大多數工程設計中顯示的設計過程。工業設計已經被視為工程設計領域的事後想法（例如Andreasen＆Hein，2000；Hubka＆Eder，1987年；Pahl等，2007）。根據他們的觀點，工業品外觀設計的功能與產品外觀，產品的技術特徵確定後的樣式，形式和顏色等開採第三類是工程設計師掌握技術的過程設計概念的解決方

案。他們要求工業設計師進行開發外觀。因此，類型3僅使用了工業設計師的部分經驗
-

創造美觀的外觀。從這個角度來看，類型2可以提供更多工業設計師展示其專業知識而不是類型3的方法Type 3是最常用的過程，因此它可以更有效率在過程管理方面。可能是初期的不確定性類型3中的“類型”在四種類型中最少。的大多數技術解決方案設計概念是由工程設計師在早期階段確定的，工業設計師只能創造美觀的外觀。

The one process we could not discover would be Type 5: ED-led Technology- driven process. This could be contrasted to Type 1: ID-led Concept-driven Process. In Type 5, engineering designers would develop a new technology at first without consideration product development plan, and test its perfor- mance with testing prototypes. Next, industrial designers generate new prod- uct design concepts for the technology. Then, the visualized design concepts and the prototypes could be used to decide product development. Applying Type 5, a company could create a new category product that increases the pos- sibility to open a new market. One of the reasons that we could not find this type would be the rareness of innovative technology development, and a rare chance for new technology to meet a new concept. In addition, a company is unlikely to wait for engineering designers and industrial designers with great uncertainty until the product development is decided. To make this process better, we need engineering designers to develop new technologies, and indus- trial designers to create new concepts using technology with mutual coopera- tion. From this argument, Type 4 can be useful in applying officially for innovative product design. It can also enable the technology developed by en- gineering designers to be integrated with new concepts generated by industrial designers.

我們無法發現的一個流程將是Type 5：ED主導的技術-驅動過程。這可以與類型1：由ID主導的概念驅動型進行對比處理。在類型5中，工程設計師將開發一種新技術

首先，不考慮產品開發計劃，並測試其性能-配備測試原型。接下來，工業設計師產生新產品uct技術的設計概念。然後，可視化的設計概念原型可用於決定產品開發。正在申請第5類，公司可以創建新類別的產品，以增加開拓新市場的能力。我們找不到這個的原因之一類型將是創新技術開發的稀缺性，新技術滿足新概念的難得機會。另外，一家公司不太可能等著工程設計師和工業設計師在確定產品開發之前不確定。要進行此過程更好的是，我們需要工程設計師來開發新技術，試用設計師使用相互合作的技術創建新概念tion。根據這一論點，類型4可以在正式申請創新的產品設計。它還可以啟用由en-工程設計師將與工業產生的新概念整合設計師。

4 Conclusion(結論)

We aimed to determine the existence of the types of collaborative design pro- cesses, and the conditions of adopting a particular type in a company. We established collaborative design processes from in-depth interview data of industrial designers and engineering designers. As a result, we found four types of collaborative design processes. They were categorized according to the dif- ference of the early phases of the design process. The four types of processes are used for different purposes in different contexts. At times, they are applied strategically to develop new design or redesign, and at other times they are applied organically due to internal and external forces. We also found that the role of industrial designers is influential and extended.

我們旨在確定協作設計專業的類型是否存在。必要，以及在公司中採用特定類型的條件。 我們是根據以下人員的深入訪談數據建立的協作設計流程工業設計師和工程設計師。 結果，我們發現了四種類型設計流程。 他們是根據不同的分類-設計過程的早期階段的參考。 四種流程在不同的上下文中用於不同的目的。 有時，它們會被應用

戰略性地開發新設計或重新設計，而在其他時候由於內外力而有機地施加。 我們還發現工業設計師的作用具有影響力並得到擴展。

The abstract character of design process models and the mono-disciplinary ap- proaches in research are not well-matched to actual practice and are identified as the causes of this problematic situation (Brooks Jr, 2010; Eckert & Clarkson, 2005). In this regard, there has been a request to combine different design process models (Albers, 2010; Dorst, 2008). The four types of processes are combined processes of a solution-oriented approach driven by industrial designers and a problem-oriented approach by engineering designers. They show the actual design process is not represented with a single model even in a single domain, i.e. consumer electronics. To improve the applicability of design processes and to receive the suitable support of design methodologies in design practice, more concrete process models that consider the specific context of a company and project are needed (Finkelstein & Finkelstein, 1983; Gericke & Blessing, 2011). We specifically focused on the consumer elec- tronics domain where industrial designers and engineering designers impor- tantly collaborate in product development. We found the four types of design processes and identified their purposes and contexts. Thus, our findings with the contextual detail will provide useful information for companies plan- ning efficient design process management for new product development, espe- cially in the consumer electronics domain.

設計過程模型的抽象特徵和一門學科的應用研究中的方法與實際不符，無法確定

造成這種問題的原因（Brooks Jr，2010; Eckert＆克拉克森（2005）。在這方面，有人要求將不同的設計過程模型（Albers，2010； Dorst，2008）。四種流程是由工業驅動的解決方案導向方法的組合過程設計師和工程設計師以問題為導向的方法。他們顯示實際的設計過程甚至無法用單個模型表示單一領域，即消費類電子產品。為了提

高適用性設計過程並獲得設計方法的適當支持設計實踐，考慮具體的更具體的過程模型

公司和項目的背景是必要的（Finkelstein和Finkelstein，1983年； Gericke＆Blessing，2011年）。我們特別專注於消費電子產品工業設計師和工程設計師在電子學領域的重要地位-緊密合作進行產品開發。我們發現了四種類型的設計流程並確定其目的和環境。因此，我們的發現內容相關的詳細信息將為公司的計劃提供有用的信息，

針對新產品開發的高效設計流程管理，特別是特別是在消費電子領域。

In light of the research methodology, we have shown how collaborative design processes can be established from in-depth interview data of designers. We identified process elements, constructed partial processes with them, and built detailed collaborative design processes with our mosaic method. We also introduced ‘process chunk’ and defined a chunk or two interacting chunks as a phase. We argue that this approach is beneficial to determine actual design process at best level. We think this method is applicable to the discovery of other design processes. The form of our process models is comparable to other phase-based models (e.g. French, 1998; Pahl et al., 2007). We found from our models that reverse iteration or feedback rarely happens between phases. This is different from the description of existing phase-based engineering design process models. In an ideal situation, we think bidirectional iteration is possible, but practically because of severe market competition, we conclude that it seldom happens.

根據研究方法，我們已經展示瞭如何進行協同設計可以根據設計師的深入訪談數據來建立流程。我們確定過程元素，用它們構建局部過程，並建立使用我們的鑲嵌方法進行詳細的協作設計過程。我們也引入了“流程塊”並定義了一個或兩個交互塊作為一個階段。我們認為這種方法有助於確定實際設計處於最佳狀態。我們認為這種方法適用於發現其他設計過程。我們的流程模型的形式可與其他基於階段的模型（例如French，1998； Pahl等，2007）。我們從我們的發現在階段之間很少發生反向迭代或反饋的模型。這個與現有的基於階段的工程設計的描述不同過程模型。在理想情況下，我們認為雙向迭代是可能，但實際上由於激烈的市場競爭，我們得出結論很少發生。

Further studies with this method are required especially toward other project cases in other product domains. The companies in this study were all manufac- turers of electronic products. Therefore, the result is limited to this product category. We need to test how the four collaborative design processes are applied in other companies. Conversely, it is worth studying cases of innova- tive product development and the processes applied.

需要對該方法進行進一步研究，尤其是對其他項目其他產品領域的案例。 本研究中的公司均為製造電子產品的製造者。 因此，結果僅限於該產品類別。 我們需要測試四個協作設計過程如何應用於其他公司。 相反，值得研究創新案例產品開發和應用過程。

References(參考文獻)

About GD (2011). Retrieved from http://gd.kidp.or.kr/eng/intro/eng_about.asp.

Ackroyd, S., & Hughes, J. A. (1981). Data Collection in Context. London: Longman.

Ahmed, S. (2007). Empirical research in engineering practice. Journal of Design Research, 6, 359e380.

Albers, A. (2010). The integrated product engineering model (iPeM) and its central hypotheses. In Proceedings of the TMCE (pp. 12e16).

Andreasen, M. M., & Hein, L. (2000). Integrated Product Development. IPU.

Baxter, M. (1995). Product Design. CRC Press.

Berends, H., Reymen, I., Stultiens, R. G., & Peutz, M. (2011). External designers in product design processes of small manufacturing firms. Design Studies, 32, 86e108.

Berg, S. (1988). Snowball SamplingdI. In: Encyclopedia of Statistical Sciences.

Brooks, F. P., Jr. (2010). The Design of Design: Essays from a Computer Scientist. Pearson Education.

Browning, T. R., Fricke, E., & Negele, H. (2006). Key concepts in modeling product development processes. Systems Engineering, 9, 104e128.

Browning, T. R., & Ramasesh, R. V. (2007). A survey of activity network-based process models for managing product development projects. Production and Operations Management, 16, 217e240.

Bruce, M., & Morris, B. (1994). Managing external design professionals in the product development process. Technovation, 14, 585e599.

Burns, T. E., & Stalker, G. M. (1961). The management of innovation. University of Illinois at Urbana-Champaign’s Academy for Entrepreneurial Leadership Historical Research Reference in Entrepreneurship.

Cagan, J., & Vogel, C. M. (2002). Creating Breakthrough Products: Innovation from Product Planning to Program Approval. Ft Press.

Charmaz, K. (2006). Constructing Grounded Theory: A Practical Guide through Qualitative Analysis. Pine Forge Press.

Clark, K. B. (1991). Product Development Performance: Strategy, Organization, and Management in the World Auto Industry. Harvard Business Press.

Cross, N. (2008). Engineering design methods: Strategies for product design.

Darke, J. (1979). The primary generator and the design process. Design Studies, 1, 36e44.

Dorst, K. (2008). Design research: A revolution-waiting-to-happen. Design Studies, 29, 4e11.

Dym, C. L. (1994). Engineering Design: A Synthesis of Views. Cambridge University Press.

Dyson, J., & Coren, G. (1997). Against the odds: An autobiography. Orion Business Books.

Eckert, C., & Clarkson, J. (2005). The reality of design. In Design Process Improvement (pp. 1e29). Springer.

Eder, W. E. (2013). Engineering design vs. artistic design: some educational consequences. US-China Education Review A, 3, 259e280.

Finkelstein, L., & Finkelstein, A. (1983). Review of design methodology. IEE Proceedings A (Physical Science, Measurement and Instrumentation, Management

and Education, Reviews), 130, 213e222.
French, M. (1998). Conceptual Design for Engineers. Springer Science & Business Media.
Gericke, K., & Blessing, L. (2011). Comparisons of design methodologies and process models across domains: A literature review. In DS 68-1: Proceedings of the 18th International Conference on Engineering Design (ICED 11), Impacting Society through Engineering Design. Vol. 1: Design Processes, Lyngby/Copenhagen, Denmark, 15.-19.08.2011.
Gericke, K., & Blessing, L. (2012). An analysis of design process models across disciplines. InProceedings of the 12th International Design Conference DESIGN, Vol 1 (pp. 171e180).
Gericke, K., & Maier, A. (2011). Scenarios for coupling design thinking with systematic engineering design in NPD. In 1st Cambridge Academic Design Management Conference-CADMC. University of Cambridge.
Glaser, B. G., & Strauss, A. L. (2009). The Discovery of Grounded Theory: Strategies for Qualitative Research. Transaction Publishers.
Haik, Y., & Shahin, T. (2010). Engineering Design Process. CengageBrain.com.
Hillier, B., Musgrove, J., & O'Sullivan, P. (1972). Knowledge and design. Environmental Design: Research and Practice, 2, 1e14.
Hosnedl, S., Srp, Z., & Dvorak, J. (2008). Cooperation of engineering & industrial designers on industrial projects. In Proceedings of the DESIGN 2008, 10th International Design Conference, Dubrovnik, Croatia (pp. 1227e1234).
Hubka, V., & Eder, W. E. (1987). Principles of Engineering Design. Heurista Zurich.

Hubka, V., & Eder, W. E. (2012). Design Science: Introduction to the Needs, Scope and Organization of Engineering Design Knowledge. Springer Science & Business Media.

J€ansch, J., & Birkhofer, H. (2006). The development of the guideline VDI 2221-the change of direction. In DS 36: Proceedings DESIGN 2006, the 9th International Design Conference, Dubrovnik, Croatia.

Kim, K., & Lee, K.-p. (2014). Don't make art, do industrial design: A voice from industry. DMI Review.

Kim, K. M., & Lee, K. P. (2010). Two types of design approaches regarding industrial design and engineering design in product design. In11th International Design Conference (Design 2010), Vols 1e3 (pp. 1795e1805).

Kleinsmann, M., & Valkenburg, R. (2003). Barriers to shared understanding in collaborative design projects. In DS 31: Proceedings of ICED 03, the 14th International Conference on Engineering Design, Stockholm.

Kroll, E., Condoor, S. S., & Jansson, D. G. (2001). Innovative Conceptual Design: Theory and Application of Parameter Analysis. Cambridge University Press.

Kvale, S., & Brinkmann, S. (2009). Interviews: Learning the Craft of Qualitative Research Interviewing. Sage Publications, Incorporated.

Lawson, B. (1994). Design in Mind. London: Butterworth Architecture.

Lawson, B. (2006). How Designers Think: The Design Process Demystified. Architectural Press.

Lee, K. C., & Cassidy, T. (2007). Principles of design leadership for industrial design teams in Taiwan. Design Studies, 28, 437e462.

Leedy, P. D., & Ormrod, J. E. (2012). Practical Research: Planning and Design

(10th ed.). Pearson.

Lindemann, U. (2003). Methods are networks of methods. In DS 31: Proceedings of ICED 03, the 14th International Conference on Engineering Design, Stockholm.

Maffin, D. (1998). Engineering design models: Context, theory and practice. Journal of Engineering Design, 9, 315e327.

March, L. (1984). The logic of design. Developments in Design Methodology, John Wiley & Sons, Chichester 265e276.

Merriam, S. B. (1998). Qualitative Research and Case Study Applications in Education. Revised and Expanded from “Case Study Research in Education”. ERIC.

Miller, C. C., Cardinal, L. B., & Glick, W. H. (1997). Retrospective reports in organizational research: A reexamination of recent evidence. Academy of Management Journal, 40, 189e204.

Norman, D. A., & Verganti, R. (2014). Incremental and radical innovation: Design research vs. technology and meaning change. Design Issues, 30, 78e96.

Ogot, M., & Okudan-Kremer, G. (2004). Engineering Design: A Practical Guide. Trafford Publishing.

Pahl, G., Wallace, K., & Blessing, L. (2007)Engineering design: A systematic approach, Vol. 157. Springer.

Pei, E. (2009). Building a common language of design representations for industrial designers & engineering designers.

Persson, S., & Warell, A. (2003). Relational modes between industrial design and engineering design a conceptual model for interdisciplinary design work. In Proceedings of the 6th Asian Design International Conference.

Persson, S., & Wickman, C. (2004). Effects of industrial design and engineering design interplay: An empirical study on tolerance management in the automotive industry. InDesign 2004: Proceedings of the 8th International Design Conference, Vols 1e3 (pp. 1151e1160).

Press, M., & Cooper, R. (2003). The Design Experience: The Role of Design and Designers in the Twenty-first Century. Ashgate Publishing, Ltd.

Reymen, I. (2001). Improving Design Processes through Structured Reflection: A Domain-independent Approach. Technische Universiteit Eindhoven.

Roozenburg, N., & Cross, N. (1991). Models of the design process: Integrating across the disciplines. Design Studies, 12, 215e220.

Roozenburg, N. F., & Eekels, J. (1995)Product design: Fundamentals and methods, Vol. 2. Chichester: Wiley.

Seidman, I. (2012). Interviewing as Qualitative Research: A Guide for Researchers in Education and the Social Sciences. Teachers College Press.

Takeda, H., Veerkamp, P., & Yoshikawa, H. (1990). Modeling design process. AI Magazine, 11, 37.

Tomiyama, T., & Yoshikawa, H. (1986). Extended general design theory. Department of Computer Science [CS] 1e29.

Tovey, M., & Harris, G. (1999). Concept design and sketch mapping. The Design Journal, 2, 32e42.

Ullman, D. G. (2009) (4th ed.).The Mechanical Design Process, Vol. 2 New York: McGraw-Hill.

Ulrich, K. T., & Eppinger, S. D. (2012). Product Design and Development (5th ed.). McGraw-Hill/Irwin.

Vasic, V. S., & Lazarevic, M. P. (2008). Standard industrial guideline for mechatronic product design. FME Transactions, 36, 103e108.

Vergidis, K., Tiwari, A., & Majeed, B. (2008). Business process analysis and optimization: Beyond reengineering. IEEE Transactions on Systems, Man, and Cybernetics, Part C: Applications and Reviews, 38, 69e82.

Vredenburg, K., Isensee, S., Righi, C., & Design, U.-C. (2001). An Integrated Approach. Prentice Hall.

Wong, J. F. (2010). The text of free-form architecture: Qualitative study of the discourse of four architects. Design Studies, 31, 237e267.

Wynn, D., & Clarkson, J. (2005). Models of designing. In Design Process Improvement (pp. 34e59). Springer.

關於GD（2011）。取自http://gd.kidp.or.kr/eng/intro/eng_about.asp。

Ackroyd， S.和Hughes， J. A.（1981）。上下文中的數據收集。倫敦：

朗文

Ahmed， S.（2007年）。工程實踐中的實證研究。設計雜誌

研究，6，359e380。

Albers， A.（2010年）。集成產品工程模型（iPeM）及其中心

特拉假說。在《 TMCE會議錄》（第12e16頁）中。

Andreasen， M.M.和Hein， L.（2000年）。集成產品開發。 IPU。

Baxter， M。（1995）。產品設計。 CRC出版社。

Berends， H.， Reymen， I.， Stultiens， R.G.， &Peutz， M.（2011年）。外部設計師

在小型製造公司的產品設計過程中。設計研究，32，

86e108。

Berg, S。（1988）。雪球採樣在：統計科學百科全書。

小布魯克斯（2010）。設計設計：計算機科學家的隨筆。

培生教育。

Browning, T.R., Fricke, E。和Negele, H。（2006）。產品建模的關鍵概念

uct開發流程。系統工程，9，104e128。

Browning, T.R.和Ramasesh, R.V.（2007）。基於活動網絡的調查

用於管理產品開發項目的流程模型。生產和

運營管理，16，217e240。

Bruce, M。和Morris, B。（1994）。管理外部設計專業人員

產品開發過程。 Technovation，14，585e599。

伯恩斯（T. E.）和斯托克（Stalker），G。M.（1961）。創新管理。大學

伊利諾伊大學厄本那-香檳分校的領導力學院

創業精神研究參考。

Cagan, J。和Vogel, C.M。（2002）。創造突破性產品：創新

從產品計劃到計劃批准。英尺新聞。

Charmaz, K。（2006）。建構紮根理論：實踐指南

定性分析。松木鍛造出版社。

Clark, K.B.（1991年）。產品開發績效：策略，組織，

和汽車行業的管理。哈佛商業出版社。

克羅斯（2008）。工程設計方法：產品設計策略。

Darke, J.（1979年）。主生成器和設計過程。設計研究，1

36e44。

Dorst, K.（2008年）。設計研究：一場等待革命的革命。設計

研究，29，4e11。

Dym，C.L。（1994）。工程設計：觀點的綜合。劍橋大學

市新聞。

Dyson，J。，＆Coren，G。（1997）。反對的可能性：自傳。獵戶座

尼斯書籍。

Eckert，C。和Clarkson，J。（2005）。設計的現實。在設計過程中

改進（第1e29頁）。施普林格。

Eder，W.E.（2013）。工程設計與藝術設計：一些教育意義

序列。美中教育評論A，3，259e280。

Finkelstein，L.＆Finkelstein，A.（1983）。審查設計方法。 IEE Pro-

證書A（物理科學，測量與儀器，管理

與教育》，第130卷，第213e222頁。

French，M。（1998）。工程師的概念設計。施普林格科學與商業

媒體。

Gericke，K.，＆Blessing，L.（2011年）。設計方法的比較

跨領域的流程模型：文獻綜述。在DS 68-1中：會議記錄

第18屆國際工程設計會議（ICED 11）的影響-

通過工程設計學會。卷1：設計過程，Lyngby / Co-

丹麥彭哈根，2011年9月15日至19日。

Gericke，K.，＆Blessing，L.（2012年）。整個設計過程模型的分析

學科。第十二屆國際設計大會論文集

設計，第1卷（第171e180頁）。

Gericke，K.，＆Maier，A.（2011年）。將設計思維與系統耦合的方案

NPD中的遠程工程設計。在第一屆劍橋學術設計人獎中

年齡會議-CADMC。劍橋大學。

Glaser，B. G.和Strauss，A. L.（2009）。紮根理論的發現：策略

定性研究技術。交易發布者。

Haik，Y.和Shahin，T.（2010）。工程設計過程。 CengageBrain.com。

希里爾（B.）Hillier，B. Musgrove，J.， &O'Sullivan，P.（1972）。知識和設計。環境-

心理設計：研究與實踐，2，1e14。

Hosnedl，S.，Srp，Z.， &Dvorak，J.（2008年）。工程與工業合作

工業項目的設計師。在《 2008年設計》會議論文集中，第十屆

跨國設計會議，克羅地亞杜布羅夫尼克（第1227e1234頁）。

Hubka，V。， &Eder，W.E。（1987）。工程設計原理。赫里斯塔

蘇黎世。

Hubka，V.和Eder，W. E.（2012）。設計科學：需求介紹，範圍

和組織工程設計知識。施普林格科學與商業

ness Media。

J.ansch，J。和Birkhofer，H。（2006）。 VDI 2221-指南的製定

方向的改變。在DS 36：《會議錄設計》（2006年）中，第9個國際

國家設計會議，克羅地亞杜布羅夫尼克。

Kim，K.&Lee，K.-p.（2014）。不做藝術，做工業設計：來自

行業。 DMI審查。

Kim，K.M.和Lee，K.P.（2010）。關於內部的兩種設計方法

產品設計中的工業設計和工程設計。第11屆國際

設計會議（Design 2010），第1e3卷（第1795e1805頁）。

Kleinsmann，M.和Valkenburg，

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