ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL OF SCIENCE ENGINEERING AND TECHNOLOGY

TEXTUAL EXAMPLES IN IDEA GENERATION PHASE OF DESIGN PROCESS: CREATIVITY AND FIXATION

M.Sc. THESIS

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Department of Architecture

Architectural Design Programme

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To my dear father, rest in peace…

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January 2020

Serkan Can HATIPOĞLU
(Architect and Academician)

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TEXTUAL EXAMPLES IN IDEA GENERATION PHASE OF DESIGN PROCESS: CREATIVITY AND FIXATION

SUMMARY

During the idea generation phase of the design process, designers often search for inspirations in external sources of information, such as photographs, written descriptions and physical examples. These sources have potential to enhance creative performance. However, they sometimes become too attached to particular ideas of external precedents or various examples. It refers to *fixation* which is identified as inadequate adoption of features from existing examples. Influence of the existing examples on creativity and fixation, specifically textual examples, have been discussed in this research.

For the nature of design, researchers highlighted the restructuring process of design problem by new sources because the capabilities and boundaries of design problems are not defined very well. Further, the design problem is not knowable at any specific point. Design knowledge identifies itself by its ambiguity. Many models have been developed for design process. The various numbers of divided phases of the models can be seen as having two main areas: (1) idea generation phase (or "ideation"); (2) later phase for details. Idea generation plays an important role in the design process. It is the area of new and creative configurations on design.

Creativity is an integral part of the design process. Designers purpose to achieve original ideas to demonstrate their ability and unique designs. External stimuli or inspirational inputs play important roles to increase creativity. They can support moments of stimulation. Associations between information from memory and external stimuli can contribute to the creation of new meanings. Designers are widely influenced by their surroundings in daily lives. However, each stimulus may not be the part of a more creative result Even if designers want to utilize stimulus as an inspirational source, somehow it may fixate their mind to its surface features and they may lose potential creative contributions of the source. It is called fixation. There is much research that shows significant evidence of conformity effects across the design problems.

The given examples to designers may cause higher-level fixation and lower-level creativity or vice versa. Fixation may occur when example solutions are introduced, on the other hand, the designers may create more original ideas as well. There is a need for research to find ways to avoid fixation traps or reduce their adverse impact. Thus, this research focuses on variables of the given example.

The following claims show some research areas remained unclear: (1) Some researchers investigated textual examples as - one of the modalities of representation - but did not focus on forms of textual examples. (2) Much research has been conducted with examples which are selected by the researcher. Nevertheless, designers can also choose or produce their own stimuli. There is not much research on this possibility. In this context, my research focuses on the following two variables through two studies (Study 1 and 2): (1) forms of textual examples; (2) self-construction of textual examples.

First, most of the studies in the literature have focused on visual presentation and there is not enough research on the content and form of the text. The study of textual

examples has still not been awarded enough attention especially as various forms of text. Some forms of text are as follows: keyword, paragraph, sentence, poem. These observations lead me to the following research question: Which forms of textual example increase creativity and reduce fixation more? (Study 1).

Second, most of the studies regarding textual examples have used prose or keywords. The poems have been ignored. However, poems imply more meaning with fewer words. The structure of the poems enables more creative narratives than structure of prose. Because unusual organization of words stimulates the readers and draws their attention. This activates the creative performance of the reader. The surrealist poem is the extreme form of this activation. It is random assemblies with headlines and sentences which is cut from newspapers. Thus, novel meaning networks are formed. The method of creating a surrealist poem offers a new way of getting inspiration. It is termed as *self-construction practice* by this research. Through this method, designers create their own example from the given one. Reconstruction of the text may increase the creative process and prevent fixations from the given text. This suggestion led me to the following research question: If the designers write their own poem instead of a given poem (as a self-construction practice), can they internalize the textual example? In addition, does it produce more creative and less fixated designs? (Study 2).

Two experimental studies were planned to partially answer the research questions, in which novice students of architecture were asked to solve two different design problems, under different conditions. All of the experimental sessions were conducted in a design education studio. The participants produced sketches and added a written explanation relating to their designs. Fluency, flexibility and repetition of key attributes were calculated by the researcher. Originality, practicality, understanding of the task and quality were ranked by judges.

Study 1 shows us tendencies of using various textual forms. Distinctions of keywords and of poems have appeared among them. This emphasizes the role of keyword and poem in the design process as inspirational sources and provides many tips for their potential use. The keyword also leads to a high degree of fixation. However, a low degree of fixation is observed when poems are presented as inspirational examples.

In Study 2, the self-constructed poem seems to support develop more successful design ideas from many perspectives. In the context of the surrealist poem, writing and reading the surrealist poem trigger the designers' imagination. At first, the words and lines of poems seem unrelated to each other and designers try to relate them and solve the puzzle of meaning. Hence, novel meaning networks are formed. It indicates that surrealist poems are able to activate the creative performance of the designers. Writing their own surrealist poems ,as a self-construction practice, motivated designers to begin to produce by having fun. Motivated designers have stimulated themselves to produce creative ideas. In other words, the self-construction process may be added to the design process models in the earlier part of the idea generation phase which is called as pre-design and warm-up phase. This earlier phase makes designers highly motivated and they internalized the given examples.

Following the conclusions, several implications and recommendations for the design process and education are discussed.

TASARIMIN SÜRECİNİN FİKİR ÜRETİM AŞAMASINDA METİNSEL ÖRNEKLER: YARATICILIK VE FİKSASYON

ÖZET

Tasarım sürecinin fikir üretme aşamasında tasarımcılar çoğunlukla esin kaynağı olarak fotoğraf, metin ve fiziksel objeler gibi dışsal kaynakların arayışına girerler. Bu tür esin kaynakları yaratıcı performansı arttırma potansiyelleri taşır. Bununla birlikte, bazen dışsal kaynakların belirli fikirlerine çok fazla bağlanırlar. Bu durum mevcut örneklerin özelliklerinin yetersiz bir biçimde benimsenmesi olarak tanımlanan *fiksasyon* (*fixation*) kavramına işaret eder. Mevcut örneklerin, özellikle de metin örneklerinin, yaratıcılığa ve fiksasyona etkisi bu araştırmanın tartışma konusudur.

Tasarımın doğasına bakıldığında, yapılan araştırmalarda tasarım problemini yeni kaynaklar aracılığıyla yeniden yapılandırma süreci vurgulanmaktadır. Çünkü tasarım problemlerinin sınırları iyi yapılandırılmış (*well-structured*) problemler kadar net bir şekilde tanımlı değildir. Ayrıca, tasarım sürecinin doğası belirli bir tasarım probleminin belirli bir yöntemle çözülebilmesine imkan tanımaz. Tasarım bilgisi kendini *belirsizliği* ile tanımlar. Tasarım faaliyetinin doğası belirsiz ve keşfetmeye açıktır. Tasarım süreci çeşitli aşamalara bölünerek tanımlanmıştır. Bu aşamaların ilişkileri üzerine birçok model geliştirilmiştir. Modellerin çeşitli sayıdaki bölünmüş aşamaları iki ana alana sahiptir: (1) fikir üretme aşaması, (2) sonraki aşama (detayların geliştirilmesi için). Fikir oluşturma, tasarım sürecinde önemli bir rol oynar. Tasarımdaki yeni ve yaratıcı çözümlemelerin alanıdır.

Yaratıcılık, tasarım sürecinin ayrılmaz bir parçasıdır. Tasarımcılar yeteneklerini ve özgünlüklerini göstermek için yaratıcı fikirler üretmeyi amaçlarlar. Dış uyaranlar veya ilham verici girdiler yaratıcılığı artırmak için önemli roller oynamaktadır. Bunlar uyarılma anlarını destekleyebilir. Hafızadan gelen bilgiler ile dış uyaranlar arasındaki ilişkiler, yeni anlamların yaratılmasına katkıda bulunabilir. Bu nedenle, her bir uyarıcı olası bir ilham kaynağı olabilir. Tasarımcılar, günlük yaşamlarında çevrelerinden geniş ölçüde etkilenir. Bu etki, tasarımcılar aktif olarak ilham ararken sistematik bir şekilde gerçekleşebileceği gibi bilinçsizce de gerçekleşebilir. Öte yandan her bir uyarıcının daha yaratıcı bir tasarım geliştirmeyi destekleyeceğini iddia etmek zordur. Tasarımcılar uyarıcıyı ilham verici bir kaynak olarak kullanmak isteseler bile, bir şekilde zihinlerini uyaranın yüzeysel özelliklerine sabitleyebilir ve kaynağın potansiyel yaratıcı katkılarını kaybedebilir. Bu duruma fiksasyon denilmektedir. Tasarım sürecinde kaynağın özelliklerine takılıp kalma eğilimine dair önemli kanıtlar sunan birçok araştırma vardır.

Tasarımcılara verilen örnekler, daha yüksek seviyede fiksasyona ve daha düşük seviyede yaratıcılığa neden olabilir veya bunun tersi de olabilir. Örnek tasarımlar sunulduğunda fiksasyon oluşabilir, diğer taraftan tasarımcılar daha özgün fikirler de geliştirebilir. Fiksasyon tuzaklarından kaçınmanın ya da olumsuz etkilerini azaltmanın yollarını bulmak için araştırmalara ihtiyaç vardır. Aşırı derece sabitlenmiş bir zihin olmadan daha iyi kalitede çözümler geliştirilebilir. Bu nedenle, bu araştırma

karşılaşılan örneğin değişkenlerine odaklanmaktadır. Fiksasyon ve yaratıcılıkla ilgili değişkenler literatürde şu başlıklar altında toplanabilir: (1) Dış uyaranın değişkenleri; (2) manipüle edilen tasarım süreci değişkenleri; (3) sistematik olarak manipüle edilmemiş tasarım süreci değişkenleri; (4) deneysel değişkenler. Bu değişkenleri araştırırken bazı araştırmacılar verilen örneklerin yaratıcılığı artırabildiğini, bazıları ise verilen örneklerin fiksasyona neden olduğunu savunmuştur. Bu muğlaklık yaratıcılık ve fiksasyon arasındaki çift yönlü (*double-edge*) durumu gösterir.

Netlik kazanmamış olan bazı araştırma alanları şu şekildedir: (1) Bazı araştırmacılar, metin örneklerini - temsil yöntemlerinden biri olarak - araştırdılar ancak metin örneklerinin biçimlerine odaklanmadılar. (2) Birçok araştırmada, araştırmacı tarafından seçilen örneklerin sunulduğu bir gözlem süreci kurgulanmıştır. Ancak, tasarımcılar kendi uyarıcılarını da seçebilir veya üretebilirler. Bu olasılık hakkında çok fazla araştırma yapılmamıştır.

İlk araştırma alanı, metinsel / görsel / fiziksel vb. temsil yöntemlerinin bir alt dalı olarak mevcut literatüre eklenebilir. Ancak ikinci araştırma alanı için literatürde tanınmış herhangi bir parametre henüz yer almamaktadır. "Tasarımcının örnekle etkileşimi" olarak adlandırılan bir parametre, bu araştırma aracılığı ile literatüre eklenmektedir. Bu parametrenin potansiyel alt başlıkları şu şekildedir: (2.1) örnek gösterilmesi ve daha sonra tasarım sürecinin başlaması; (2.2) örnek verilmesi ve örneğin tasarımcıya ilham verecek şekilde yeniden inşa edilmesi. İkinci alt başlık (2.2), bu araştırmanın yazarı tarafından kendinden-inşa (self-construction) olarak adlandırılmıştır. Dış uyaranların çeşitli parametrelerinin olumlu ve olumsuz etkilerini anlamak, tasarımcıların fiksasyon için önlem almalarına ve yaratıcı yanlarını arttırmalarına yardımcı olabilir. Bu olasılık, beni dış uyaranların parametrelerini incelemek ve onları test etmek için deneyler kurgulamaya teşvik etmektedir. Bu bağlamda araştırmam aşağıdaki iki çalışma aracılığı ile (Çalışma 1 ve 2) iki değişkene odaklanıyor: (1) metinsel örnek biçimleri; (2) metin örneklerinin kendinden-inşası.

Bu araştırmanın amacı, fikir üretirken kullanılan örneklerin tasarımcı ile etkileşimini araştırmak ve desteklemektir. Dolayısıyla, bu araştırmayı yönlendiren temel araştırma sorusu aşağıdaki gibidir: Tasarımcıların metinsel örneklerle etkileşime girerken tasarım sürecindeki bir fikre takılıp kalmalarını hafifletmenin yanı sıra yaratıcı performansları nasıl arttırılabilir?

İlk olarak, literatürdeki çalışmaların çoğu görsel sunuma odaklanmıştır ve metnin içeriği ve şekli hakkında yeterli araştırma yoktur. İlham kaynağı olarak okutulabilecek, tasarım problemi ile ilişkili veya ilişkisiz metin örnekleri üzerinde yapılan çalışmalarda, özellikle çeşitli metin türlerinin yaratıcı sürece etkileri yeterince araştırılmamıştır. Ayrıca, tasarıma olan katkısı tam olarak değerlendirilmemiştir. Anahtar kelime, paragraf, cümle, şiir metin biçimlerine örnek olarak verilebilir. Bu gözlemler beni şu araştırma sorusuna yönlendiriyor: Hangi örnek metin biçimleri yaratıcılığı arttırır ve fiksasyonu azaltır? (Çalışma 1).

İkinci olarak, metin örnekleri ile ilgili çalışmaların çoğunda düz yazı ya da anahtar kelimeler kullanılmıştır. Şiirler göz ardı edilmiştir. Ancak şiirler, daha az sözcükle daha fazla anlam ifade edebilme gücüne sahiptir. Şiirin strüktürü, düz yazılara kıyasla daha yaratıcı anlatılar sağlayabilir. Çünkü ilişkisiz görünen kelimelerin bir araya getirilmesi okuyucuları teşvik eder ve onların dikkatini çeker. Bu, okuyucunun yaratıcı performansını harekete geçirir. Sürrealist şiir ise bu harekete geçişin uç noktası olarak görülebilir. Sürrealistler sanatın herhangi bir fayda sağlamadan icra edilebileceğini savunurlar. Sınırsız hayal gücü, sürrealizmin önemli bir ilkesidir. Sürrealist sanatçılar

kolaj ve sanat eserleri üzerine yazılar gibi manifestolarını uygulayabilecekleri sürrealist yöntemler ve araçlar geliştirmişlerdir. Diğer bir örnek, gazetelerden kesilen başlıkları ve cümleleri rastgele bir araya getirme pratiğidir. Bu pratik sürrealist şiir olarak adlandırılabilir. Bu şiirler okunduğunda, hayal gücünü tetikler. Sözcükler birbiri ile ilişkisiz gibi göründüğünden okuyucu onları ilişkilendirmeye ve çözümlemeye çalışır. Böylece yeni anlam ağları kurulur.

Ek olarak, tasarım sürecinde esin kaynakları ile ilgili yapılan çalışmalar çoğunlukla esin kaynağını arama aktivitesi üzerine kuruludur. Sürrealist şiir üretme yöntemi yeni bir esinlenme yolu sunmaktadır. Bu metoda bu araştırmada kendinden-inşa adı verilmiştir. Bu yöntemle, tasarımcılar verilenlerden örneklerden kendi örneklerini yaratırlar. Böylelikle, kişisel örneklerini ilham verici bir kaynak olarak oluştururlar. Metnin tasarım sürecinde yeniden oluşturulması, yaratıcı süreci artırabilir. Ayrıca verilen metine bağlı yaşanan fiksasyonlara engel olabilir. Bu öneri beni şu araştırma sorusuna yöneltti: Tasarımcılar verilen bir şiir yerine (kendinden-inşa yöntemiyle) kendi şiirlerini yazarlarsa, metinsel örneği içselleştirebilirler mi? Ek olarak, daha yaratıcı ve daha az sabitlenmiş (*fixated*) tasarımlar üretebilirler mi? (Çalışma 2).

Araştırma sorularının cevabını aramak için birinci sınıf mimarlık öğrencilerinin katıldığı iki deneysel çalışma planlandı. Bu çalışmalarda öğrencilere farklı metin türleri verilerek iki farklı tasarım problemini bireysel olarak çözmeleri istendi. Bu araştırmadaki değişkenleri en aza indirmek için, verilen örneğe ilişkin şu değişkenler sabitlenmiştir: soyutluk-somutluk (soyut olarak), anlam uzaklığı (optimal mesafe olarak), alışılmış-yeni (yeni), dijitallik (basılı olarak), miktar (birden çok, fakat birbiriyle ilişkili olarak), verilen süre (altmış dakika), zamanlama (tasarım problemi ile birlikte). Deneylerin tümü tasarım eğitimi stüdyolarında gerçekleştirildi. Katılımcılar eskizler hazırladılar ve tasarımlarıyla ilgili yazılı bir açıklama eklediler. Eskizler ve açıklama yazıları, verilen örneklerin nasıl etkilediğini analiz etmek için kullanılan temel kaynaklardır. Bu araştırma, farklı yöntemler arasındaki sonuçları gözlemlemek için nicel ve nitel deney yöntemlerini birlikte kullanmaktadır. Araştırmacı bazı metrikleri nicel olarak hesaplarken, diğer metrikler niteliksel olarak jüriler tarafından puanlandı. Akıcılık, esneklik ve önemli özelliklerin tekrarı araştırmacı tarafından hesaplandı. Özgünlük, pratiklik, problemin anlaşılması ve kalite jüriler tarafından puanlandı.

Çalışma 1 bize çeşitli metin formlarını kullanmaya dair eğilimleri göstermektedir. Anahtar kelimeler ve şiirler diğer metin formlarından ayrışmışlardır. Bu, anahtar kelime ve şiirin tasarım sürecinde ilham verici kaynaklar olarak rolünü vurgulamakta ve potansiyel kullanımları için birçok ipucu sağlamaktadır. Her ne kadar anahtar kelime, özgünlük ve esneklik gibi birçok metrikte üstün olsa da, aynı zamanda yüksek derecede fiksasyona da yol açar. Anahtar kelimeye benzer şekilde, şiir de yaratıcı tasarım çözümleri sunar. Ayrıca, ilham verici örnekler olarak şiirler sunulduğunda düşük derecede fiksasyon gözlemlenmektedir. Bu durumda (1) yaratıcı bir süreçte (anahtar kelime gibi) fiksasyonu azaltmaya çalışılabilir veya (2) zaten düşük fiksasyon olan bir süreçte (şiir gibi) daha yaratıcı tasarımlar geliştirmeye çalışılabilir. Araştırmacılar her iki yolu da takip edebilir. Anahtar kelime için fiksasyonu azaltmak biraz daha zor görünmektedir. Çünkü tasarımcılar fiksasyonu azaltırken fikirlerin yaratıcı tarafını kaybedebilir. Bununla birlikte, şiirin yüksek yaratıcı ve az sabitlenmiş formatını geliştirmek daha kolay gözükmektedir. Neredeyse hiçbir fiksasyon eğilimi olmadığından, daha yaratıcı yollar ararken fiksasyonu arttırma olasılığı pek görülmemektedir. Tüm bu nedenlerden dolayı, Çalışma 2 için ikinci seçenek tercih edilmiştir ve sürrealist şiirdeki yaratıcılığı artırmanın yolları araştırılmıştır.

Çalışma 2'de değerlendirme ölçütlerine göre öne çıkan şiir türleri ortaya konmuştur. Kendinden-inşa edilen şiir birçok açıdan daha başarılı tasarım fikirleri geliştirmeyi desteklemektedir. Sürrealist şiir bağlamında, sürrealist şiirin yazılması ve okunması tasarımcıların hayal gücünü tetiklemektedir. İlk başta, şiirlerin sözcükleri ve satırları birbiriyle alakasız görünüyor ve tasarımcılar bunları ilişkilendirmeye ve anlam bulmacasını çözmeye çalışmaktadır. Bu nedenle, yeni anlam ağları oluşmaktadır. Bu durum sürrealist şiirlerin tasarımcıların yaratıcı performansını harekete geçirebildiğini gösterir. Kendinden-inşa bağlamında, kendi sürrealist şiirlerini yazmak, tasarımcıları eğlenerek üretmeye başlamak açısından motive etmiştir. Motive edilmiş tasarımcılar yaratıcı fikirler üretmek için kendilerini teşvik etmiştir. Başka bir deyişle, kendinden-inşa pratiği, *tasarım öncesi ve ısınma aşaması* olarak adlandırılabilir ve fikir üretme aşamasının öncül bir aşaması olarak tasarım süreci modellerine eklenebilir. Bu öncül aşama tasarımcıları motive eder ve verilen örnekleri içselleştirmesini sağlar.

Anahtar kelimeler ve şiirler eğitimde sıkça kullanılabilir, ne kadar çok kullanılır ve fiksasyon farkındalığı yaratılırsa, tasarımcı adayları o kadar fazla alışkanlık kazanır. Bu alışkanlık, verilen metin örneklerini fiksasyona bağlı kalmadan yüksek yaratıcılıkla kullanma yeteneğini geliştirir. Bu, birinci sınıf öğrenciliğinden profesyonel tasarımcılara dönüşüm sürecinde önemli bir uzmanlık parametresinin geliştirilmesi olarak görülebilir. Bu uzmanlık parametresi ile profesyonelleştikçe artan fiksasyon sorunu ve birinci sınıf öğrencilerine kıyasla daha az yaratıcı çözümler geliştirme eğilimi önlenebilir.

Rastlantısallık tasarımda gözden kaçan olası yaklaşımları ortaya çıkarma potansiyeli taşır. Ancak, yalnızca rastlantısallık var ise, yaratıcı fikirler ortaya çıksa bile tasarım süreci başarı ile tamamlanmayabilir. Tasarım sürecinin akışında rastlantısallığın minimumda olsa bile strüktüre edilmesinde fayda vardır. Rastlantısallık tasarım sürecinin doğasında olan belirsizlik halini arttırabilir. Dahası strüktüre edilmiş rastlantı hali tasarımcının kaybolma ve kaygı hissini önler ve tasarım fikrini güçlendirebilir. Rastlantısallık sürrealist şiirler ile yakalanabilir. Kendinden-inşa ile oluşturulan şiirin yakınsak yapısı tasarımcılar tarafından yapılmış olur. Bu da kişisel rastgeleliklere işaret eder. Sonuç olarak, inşa etme süreci de rastgeledir ve tasarımcılar arasında farklılaşır. Ham örnek aynı olsa da, birbirinden farklı kendinden-inşa süreçleri ortaya çıkmaktadır.

Kendinden-inşa, sürrealist şiire ek olarak araştırmanın üzerinde durduğu bir diğer konudur. Bu kavram bu araştırma ile üretilmiştir. Bu araştırma, kendinden-inşa pratiği ile tasarım sürecindeki örneklerin kullanımı üzerine alternatif bir bakış açısı sunar. Fikir üretme sürecinde, tasarımcı kendinden-inşa pratiğini herhangi bir şekilde uygulayabilir. Böylece, kendinden-inşa alışkanlık haline gelebilir ve tasarımcılar verilen örneklere bağımlı kalmaz, yaratıcı yönlerini besler.

Yaratıcılık ve fiksasyon tasarım sürecinin literatüründe çift yönlü bir karaktere sahip gibi görünmektedir. Yani, yaratıcılığın arttığı birçok durumda, dolaylı olarak fiksasyon da artmaktadır. Yaratıcılığa paralel olarak fiksasyondaki artış eğilimi, kendinden-inşa pratiği ile önlenebilir. Kendinden-inşa pratiği fiksasyonu önleyebilir. Çünkü oluşturulan her örnek, kaynakları aynı örnek olsa bile farklı şekillerde yeniden strüktüre edilir. Ayrıca, tasarımcının yaratıcılığını da önemli ölçüde artırabilir. Kendinden-inşa pratiğinin tasarım sürecine birçok katkısı olduğu görülmektedir. Bu nedenle, bu pratik farklı içerik ve temsillerde birçok örnek üzerinde kullanılabilir, denenebilir ve literatürdeki yeri genişletilebilir.

Gelecekte yapılabilecek çalışmalar için bazı fikirler ortaya çıkmıştır. (1) Bu araştırma, tasarım sürecinin fikir üretme aşamasına odaklandı. Ancak, verilen örneğin etkisi daha sonraki aşamalarda da incelenebilir. (2) Çalışma 1'de metin örneklerinin farklı formları incelenmiştir. Aynı şekilde fotoğraf, fiziksel obje vb. diğer örneklerin de kendi içinde farklı formları ayrıntılı olarak incelenebilir. Böylece, anahtar kelimeler ve şiirler gibi davranan formlar diğer örnek türlerinde de keşfedilebilir. (3) Çalışma 2, kendinden-inşa kavramına giriş niteliğinde bir içeriğe sahiptir. Örneklerin tasarım sürecine etkisini anlamak için birçok parametre olduğundan daha önce bahsedilmişti (soyutluk-somutluk, disiplin, zamanlama vb.). İlerleyen çalışmalarda kendinden-inşa pratiğinin diğer parametrelere nasıl tepki verdiği ve onlarla nasıl ilişki kurduğu araştırılabilir. (4) Analojik akıl yürütme ile ilgili araştırmaların çoğu bilgisayar destekli sistemlerin geliştirilmesine katkıda bulunmayı amaçlamaktadır. Araştırmacıların, tasarım sürecinin doğasını araştırırken amacı, çoğunlukla onu anlamak ve yapay zekâyı geliştirmektir. Benzer şekilde, sürrealist şiir hakkında daha ayrıntılı bir araştırma yapıldığında ve bu tür örneklerin üretilmesinin yararlı olduğu diğer çalışmalar tarafından desteklenirse, tasarım problemini anlayan ve sınırsız olasılıklarda şiirler üreten bir "sürrealist şiir üreteci" geliştirilebilir.

1. INTRODUCTION

Interactions between mind and information refer to cognition. Memory, language, imagery, problem-solving, reasoning and decision are some types of mental activities related to cognition. The cognitive approach is one of the most frequent methods used to understand designers' thinking process. It is crucial to figure out the nature of the design process and develop better design practices.

For the nature of design, several terms are developed, such as ill-/well-structured problems (Simon, 1973), ill-behaved aspects of design attitude (Eastman, 1970) and wicked problems (Buchanan, 1992; Rittel & Webber, 1973). Researchers highlighted restructuring process by new sources because capabilities and boundaries of design problems are not defined very well as well-structured problems. In addition, they underlined the feature of indeterminacy of design problems. Because the design has no special subject matter except the designer's conception. Further, the design problem is not knowable at any specific point. Design knowledge identifies itself by its ambiguity. There are several reasoning types of design thinking, such as inductive, deductive and abductive. Design is more prone to abductive reasoning and it does not mean that it cannot include others. Different reasonings may be appropriate in different moments of the design process. Goals, constraints, alternatives, representations and solutions are five crucial elements of design that are intertwined with the cognitive process of designers in problem-solving theory. The identification of goals in problem-solving has a complex structure. Goals may be incomplete, partially unknown or multiple. It is consistent with the ambiguous nature of design knowledge.

Redefinition of the problem and constant reflection between phases are common operations of investigations regarding the nature of the design process. These movements make each design process unique and uncertain. The design process is defined by dividing it into various phases. The various numbers of divided phases of the models can be seen as having two main areas: (1) idea generation (or "ideation") phase (an area where problem definitions are made and initial ideas are developed); (2) later phase for details (an area where tests for ideas are performed and details are

applied). It is necessary to keep the idea generation phase as effective as possible from the beginning to the end. Because it affects the entire process and design output predominantly. In other words, the idea generation plays an important role in the design process. On the other hand, inclination of obtaining fully understood system, as divided phases, is contrary to the ambiguous nature of the design. However, it still provides some suggestions to get an idea of how to perceive the process as different and relational phases. Following that, the process can be understood in a holistic way again.

Creativity is a crucial influence in the design process. It can be seen as an integral part of the design process. Originality and appropriateness are the two main elements of creativity. External stimuli or inspirational inputs play important roles to increase creativity. They can support moments of stimulation. The nature of design contains a continuous switch between information from memory and stimuli. There are internal and external stimuli. Internal indicates representations that are inside the head, external refers representation which is outside of the head as opposed to internal sources. Associations between information from memory and external stimuli can contribute to the creation of new meanings. In any case, inspiration may be a motivation to strive for new meanings and possibilities. However, anyone cannot assure designers that each stimulus concludes with a more creative result. Even if designers want to utilize stimulus as an inspirational source, somehow it may fixate their mind to its surface features and they may lose potential creative contributions of the source. It is called fixation. The most common influence of fixation is the obstruction of the creative process. As a result, the given examples, as external inspirational sources, have the potential to increase creativity as well as the threat of having a fixated mind.

1.1 Statement of the Problem

The given examples to designers may cause higher-level fixation and lower-level creativity or vice versa. Therefore, features of the given examples need to be reviewed. Fixation may occur when example solutions are introduced, on the other hand, the designers may create higher quality solutions as well. There is a need for research to find ways to avoid fixation traps or reduce their adverse impact. It may provide ways to develop better quality solutions without much-fixated mind. In fact, many variables may shape the moment of fixation and creativity in the process, such as given

examples, written instructions, the profile of designers, physical conditions of practice area and so on. Examples seem to be much more compelling than written instructions Thus, this research focuses on variables of the given example.

In parallel to the increasing interest in creativity and fixation, several studies have been conducted. The literature regarding fixation and creativity are in the following headings: (1) External stimuli variables; (2) Design process variables (that have been manipulated); (3) Design process variables (that have not been systematically manipulated); (4) Experimental variables (Vasconcelos & Crilly, 2016). Some researcher supported that given examples are able to increase the creativity, while others advocated that given examples cause the fixation. It indicates the double-edge situation between creativity and fixation.

Many parameters were collected and initial discussions were made about their influence on creativity and fixation. However, the relationships between the given example and idea generation in design still need to be investigated further.

Having a visual example may seem positive in terms of its quick readability. Nonetheless, this situation also has detrimental effects on the design process. A quick grasp of visual examples leads to a tendency to leave the analytical examination. It may, therefore, remain a superficial acquisition from the given example. It refers to uncreative outcomes and fixation to surface features of example. On the other hand, Textual examples may be more difficult to analyze and grasp than visual examples, but they may be the impulsive force for potential creative designs as well. Furthermore, textual examples results from the way of production of mental images. Even the most abstract image still presents the visual as a ready-image. Thus, the visual example is a modality of representation that is more likely to conclude with fixation. However, there are only narratives in the texts, it is possible for each designer to visualize the given example in different ways. This may contribute not being fixated on particular things. For these reasons, studies were developed with textual examples. Following claims show some research areas remained unclear: (1) Mostly, the foci of research were not the forms of textual examples, but just one form of representation. (2) Although selecting the presented examples by researchers is a common procedure, designers can also choose or produce their own example.

For the first research area, “forms of textual/visual/physical… example” can be added as a sub-branch of the modality of representation. For the latter research area, there is not any recognized parameter in the literature. I will add a parameter which is called “the interaction of designer with the example”. Potential sub-titles of this parameter are as follows:

(2.1) to be exposed with example and then designing,

(2.2) to be given example and re-construct them to inspire oneself.

It will be called as **self-construction** for the second move in the design process. Understanding the role that positive and negative impact on various parameters of external stimuli may help designers to develop suitable precautions for fixation and to enhance the creativity of design solutions. It motivates me to review the parameters of external stimuli and set up experiments to test them. In this context, my research focuses on the following two variables:

(1) forms of textual examples;

(2) self-construction of textual examples.

1.2 Aims and Research Questions

The aim of this research is to investigate and support the influence of interacting with the existing textual examples while producing ideas. Thus, the research question that guides this investigation is the following:

– *How are designers inspired or fixated by the surrounding examples, especially the texts?*

To make it more specific, the expectation of the studies is added to the research question as a reflection:

– *How do designers enhance their creative performance as well as mitigate fixation while interacting with textual examples?*

To answer the main question of the thesis, a number of sub-research questions were formulated. Firstly, most of the studies in the literature have focused on visual examples and there is not enough research on the content and form of the text. The study of textual examples has still not been awarded enough attention especially as various forms of text. Further, its contribution to design has not been fully assessed.

Some forms of text are as follows: keyword, paragraph, sentence, poem. These observations lead me to the following research question (Study 1):

– *Which forms of textual example increase creativity and reduce fixation more?*

Secondly, most of the studies regarding textual examples have used prose or keywords. The poems have been ignored. However, poems imply more meaning with fewer words. The structure of the poems enables more creative narratives than structure of prose. Because unusual organization of words stimulates the readers and draws their attention. This activates the creative performance of the reader. The surrealist poem is the extreme form of this activation. Surrealists argue that art can be practiced without any concern of usefulness. Infinite imagination is an important principle of surrealism. Surrealist methods and tools have been developed to implement their manifestos, such as collage and papers on artworks. Another example is random assemblies with headlines and sentences which is cut from newspapers. They can be called as the **surrealist poems**. When these poems are read, they trigger the imagination. Because of the words that seem to be unrelated to each other, the reader tries to relate them and solve the puzzle of meaning. Thus, novel meaning networks are formed.

In addition, studies for inspiration in the design process mostly focus on searching activity for inspiration. The method of creating a surrealist poem offers a new way of getting inspiration. It is called **self-construction** practice by this research. Through this method, designers create their own example from the given one. Following the searching for the example, they constructed their personal example as an inspirational source. Reconstruction of the text in the design process may increase the creative process. It can also prevent fixations from the given text. This suggestion led me to the following research question (Study 2):

– *If the designers write their own poem instead of a given poem (as a self-construction practice), can they internalize the textual example? In addition, does it produce more creative and less fixated designs?*

Each study presented in this thesis aims to answer one sub-question.

1.3 Research Method

The method used in this research is developed by focusing on designers and their thinking process for creative performance. Designers are the sources that inform this

investigation as the subjects of the studies. Two experimental studies were planned to partially answer the research questions, in which students of architecture were asked to solve two different design problems in sixty minutes, under different conditions.

Since fixation is an unconscious activity, the designers may have a harmful habit that they don't realize unless they have the ability to aware of fixation. If fixation becomes a habit, it may become an ordinary activity and increasingly difficult to get rid of the habit and reduce the state of fixation. If it is taken precautions for fixation by educators and students in the early years of education, the students can refrain from having the habit of fixation. For these reasons, participants performed individually as novice students from architecture disciplinary.

In order to minimize the variables in this research, the following variables regarding the given example have been fixed: fidelity (as abstract), expansion (as optimal distance), commonality (as novel), digitality (as printed), quantity (as multiple but inter-related), given time (as sixty minutes), timing (as along with design brief). Conditional groups were adjusted according to the aims and questions of the studies. For Study 1, five conditions have been arranged: (1) control, (2) keyword, (3) sentence, (4) paragraph, (5) poem. For Study 2, three conditions have been organized: (1) control, (2) ready poem, (3) self-constructed poem.

All of the experimental sessions were conducted in a design education studio. The participants produced sketches and added a written explanation relating to their designs. The sketches and written descriptions of participants were the main sources of analysis on the influence of the given examples. This research combines quantitative and qualitative empirical methods to make it possible to observe convergence between results across the different research techniques. While the researcher calculated some metrics quantitatively, other metrics were scored by two judges qualitatively. Fluency, flexibility and repetition of key attributes were calculated by the researcher. Originality, practicality, understanding of the task and quality were ranked by judges. The judges are research assistants in design school and who also have professional design experience.

The process of evaluation has several steps. First, the assignment was read and some of the relevant information was shown to judges in an abbreviated form. The judges could ask questions for further clarification. Second, slides of all the concepts were

shown in random order for 15 seconds, accompanied by a one-sentence summary to explain the way each of them works. Third, the first scoring category was briefly introduced, and all the design solutions were again presented for 15 seconds. Each judge graded the ideas individually in the introduced category. Then, the similar sessions were held for other categories repeatedly.

1.4 Outline of the Thesis

The research has been organized into five chapters. The first chapter "Introduction" offers an overview of the context that encompasses the main research problem and a description of the research methodology used in this research. The main research question and sub-questions are presented here. Further, problem, aim and scope, methodology and outline of the thesis are explained.

In the second chapter "Theoretical Framework", it has been discussed the essential themes that underlie this research project, which define its context. This chapter offers an overview of the essential literature that supports the studies carried out in this research. It begins with an introduction to the topic of design thinking and process. First, cognition and cognitive approaches are introduced. Second, various approaches for design thinking and process are explained in five themes: (1) Nature of design, (2) Knowledge / Attitude of design, (3) The reasoning types of design, (4) Goals of design, (5) Nature of design process. Then, fundamental paradigms of design process are compared. Design process models are reviewed in detail. It is followed by literature on creativity. Various paradigms on creativity and creative output in design process are discussed. Later, stimulation and inspiration are explained with their definitions, background and mechanism. Subsequently, a section on fixation literature is presented. It includes a short history of fixation, its various definitions in design, related terms to fixation, the fundamental reasons for fixation and how fixation may affect designers. Later, it has been presented a detailed review of the studies related to the main concerns of this research. Many parameters regarding designers, given examples and procedure in design process have been introduced. Text as the given example for inspiration are discussed. Finally, self-Construction of textual examples are discussed.

In the third chapter "Research Design", the parameters that are fixed or kept as variables are presented here. Research questions and focus of Study 1 are developed. Later, research questions and focus of Study 2 are developed. For experimental setup;

participants, design tasks, conditional groups and data analysis are explained. Some examples are provided for a clear understanding of the procedure.

In the fourth chapter “Results”, it has been presented the results from Study 1 and Study 2. Both are experimental studies with several conditions. Study 1 illustrates which forms of texts stimulate designers in terms of creativity and fixation. This indicates potential research areas for future investigations. Study 2 explores the usefulness of self-construction practices which is constructing personalized inspirations, as an additional process of searching inspirational sources.

In the last chapter “Conclusions”, the research has been concluded presenting a review of the empirical findings revealed by the aforementioned studies. It culminates several suggestions as an introduction to new perspectives for the design process with creativity and fixation. For Study 1, pros and cons of keywords and poems are discussed. For Study 2, power of self-construction practice is highlighted. The following possible implications for design education and practice are offered: (1) Frequent use of keywords and poems, (2) Constructed randomness, (3) Self-construction as a method, (4) Self-construction in the context of creativity and fixation. As a final step, it discusses the limitations of this research as well as indicating recommendations for future investigations.

2. THEORETICAL FRAMEWORK

2.1 Design Thinking and Design Process

Since the aim of the research includes to examine the design process, cognition is important to understand design thinking. However, cognition has a wide range of research areas. Therefore, I will briefly introduce cognition and cognitive approaches. Then its relation with the design will be examined.

It is common to define the design as negotiations between problem and solution. Therefore, what is meant by "problem" will be explained. Next, various approaches for design thinking and process will be reviewed. Such approaches have following themes:

- First theme: Nature of design
- Second theme: Knowledge / Attitude of design
- Third theme: The reasoning types of design
- Fourth theme: Goals of design
- Final theme: Nature of design process

Finally, fundamental paradigms of design process will be compared. These paradigms are (1) problem-solving theory and (2) reflection-in-action theory. Distinctive propositions of both theories will be introduced. Thus, it can be understood that it is not possible to grasp the design process from a single perspective. Each theory presents some propositions that characterize the design thinking and design process.

2.1.1 Introduction to Cognition and Problem

What cognition is and importance of it

Information is a data with context, that carries meaning (Hicks et al., 2002; Howard, 2008). Meaningful data are like butterflies which fly independently without purpose. The mind is a hunter who desires to catch them by butterfly net, in order to domesticate and educate them for various purpose in different contexts. Along with this metaphor, interactions between hunter (mind) and butterflies (information) refers to cognition. Cognition is a mental activity regarding knowledge and the process of understanding

(Matlin, 2012). Such mental activities involve how people obtain and store or leave out the knowledge and transform some of them as a response to various circumstances (see, Figure 2.1 :). Memory, language, imagery, problem-solving, reasoning and decision are some types of mental activities. Therefore, the cognitive approach refers to theories of knowledge and thought processes.

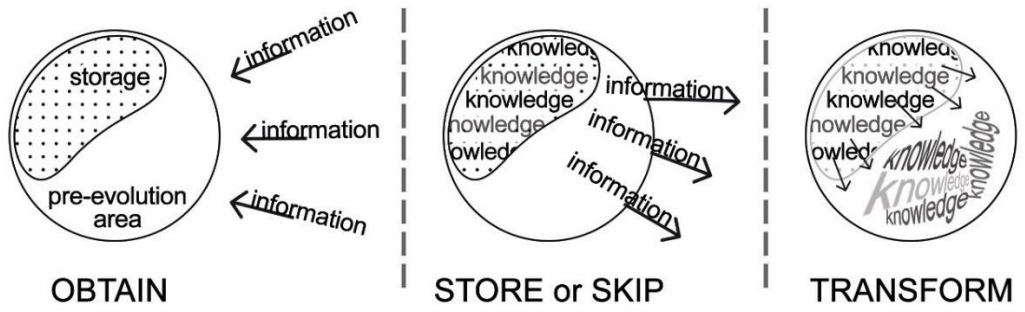


Figure 2.1 : General Observation Areas of Any Cognitive Science.

Importance of cognition can be illustrated with four rationales:

1) Perception, remembrance, and thinking are major events of daily life. Hence, exploration of cognitive activities provides basic inferences concerning the human being. However, even in psychology classes, many students have difficulties to explain what cognition is (Maynard et al., 2004). To understand the design process, designers need to be aware of the importance of cognition.

(2) Cognitive approach has an impact on many research areas of design. For instance, memory retrieval of design knowledge, inspiration from external stimuli, acquisitions of expertise for designers, the structure of individual study and teamwork, inquiry of proper design methods and so forth.

(3) Because of the complexity of mind, it may be difficult to analyze what we do, throughout the design process. Thus, any contribution to the understanding of the mind's activities and its work strategies may facilitate to develop designer's performance.

(4) Moreover, managing information (i.e., searching and accessing them or storing and transforming them for current design task) usually takes up to 30% of the time of designing (Court, 1995; J. Marsh, 1997). It indicates that cognitive variables should be understood as clearly as possible, in order to overcome challenges one-third of the design process.

Position of design in cognitive science

Cognitive science, as an interdisciplinary study, inquiries any clue relating to the mind. Design cognition is a part of cognitive science that specifically interested in the design process. While attempting to resolve the mechanism of the designer's mind, we cannot detach design research from other cognitive-integrated fields, such as psychology, linguistics, philosophy, anthropology (see, Figure 2.2 :).

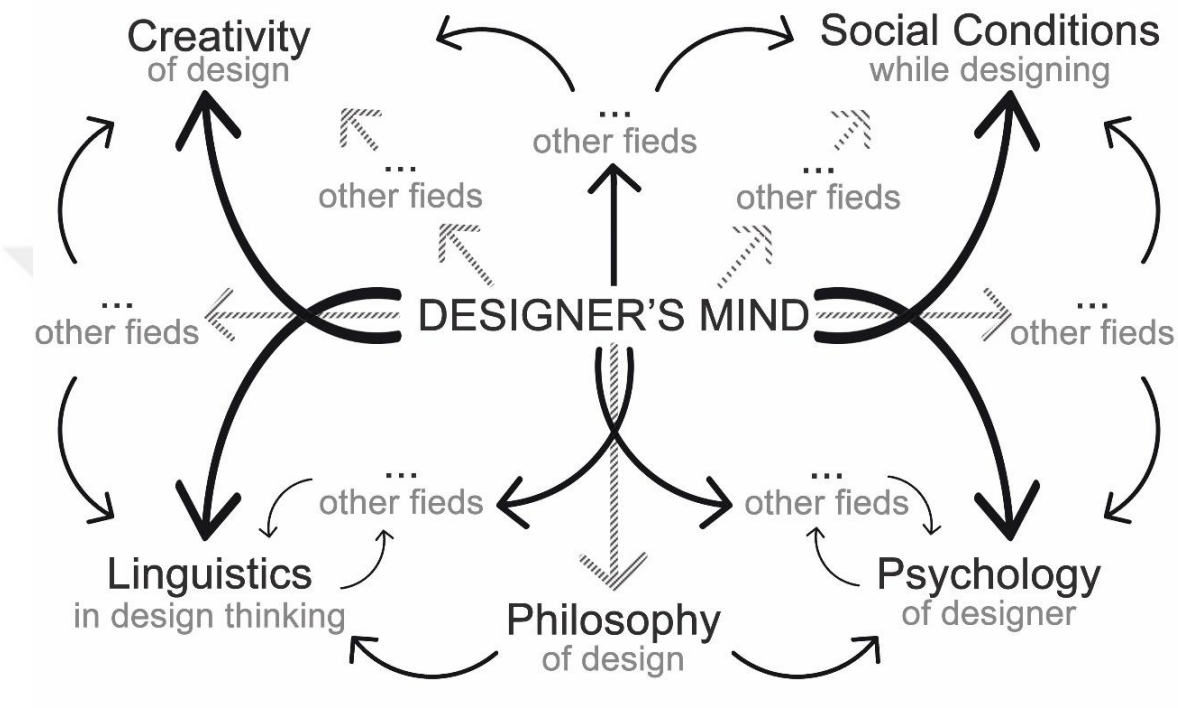


Figure 2.2 : Inseparable attribute of designer's mind from other fields.

Therefore, to acquire comprehensive insight into the mind, many fields are intertwined in cognitive science. The researcher should observe the views of various fields, in order to recognize the structure of information processing as a whole in design activity. This research has ambiguous boundaries with various fields such as creativity, linguistics, psychology and so on (see, Figure 2.3 :). Reviews of the design process may help to figure out a general framework of design thinking, so that introduces the mind's activity in design and provides a source for detailed research. Therefore, it is important to evaluate the design process within the cognitive area.

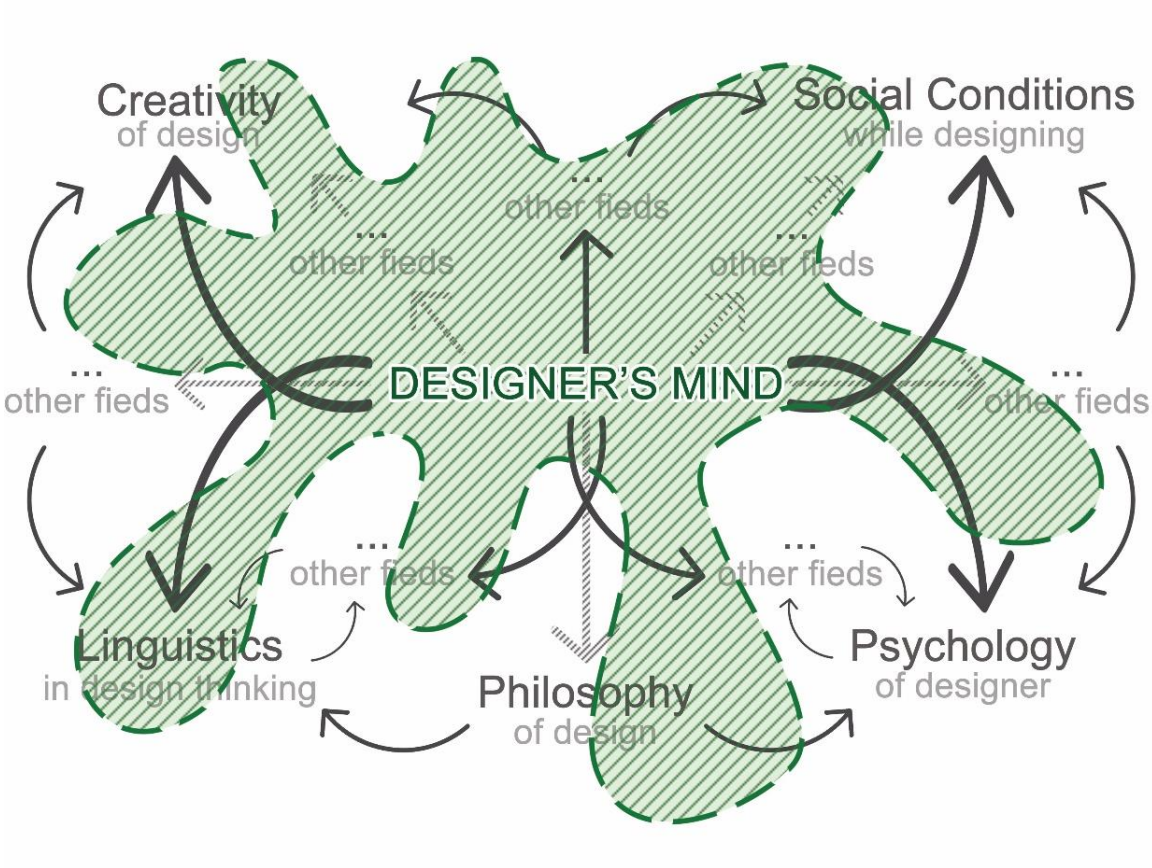


Figure 2.3 : Ambiguous boundaries of the designer's mind.

Definition of "problem"

The various approaches to design thinking and process are mainly based on the *design problem*. Therefore, it is useful to briefly discuss what is meant by *problem*. The problem can be considered as a gap between the goal of an object and its current situation (Taura & Nagai, 2013, Chapter 2). This description allows for many possibilities:

It allows many possible forms of ways to achieve a goal. The gap may be stretched or squeezed so that problem reshapes itself. Different forms of current situation and goal may affect the form of problem. The gap constitutes itself depending on the extent of attention among variables (see, Figure 2.4 :).

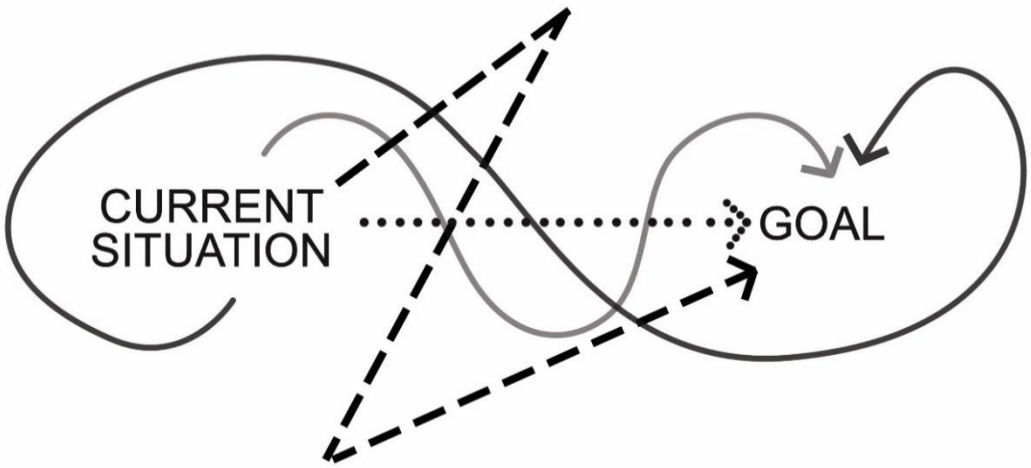


Figure 2.4 : Some possible forms of problem.

As can be seen from these examples, definitions of problem, solution and other variables affect each other simultaneously or consecutively. It is possible to generate more examples for the attribute of *problem* as *the metaphor of gap*. In essence, every variable of the process has active roles on others and the whole process. Furthermore, responses of the variables to each other are mostly unpredictable in design. This is a unique feature of the design problem. In the next section, the discourses developed on design thinking and process are examined through the notion of design problem.

2.1.2 Various approaches for design thinking and process

Design thinking is divided into many themes to understand different aspects of it. Sub-themes facilitate to grasp many features regarding design. However, it brings about a tendency for discerning design fragmentarily, rather than holistically. Regardless of which subtitle we study on; we need to be aware of the whole. Kimbell (2009) made an effort to organize various themes of design thinking and design process as a literature review. It helps to acquire an extensive view of design activity. However, the order of the themes doesn't seem proper to find out the relations explicitly. Here, I revised the order, to explain relations of the themes and facilitate to follow subtitles of design thinking anytime. In addition, some themes are left out to prevent a possible shift in the focus of the overview. Omitted themes are discussed meticulously in the following sections. In epitome, I re-organized her composition of design thinking themes and overviewed them in order.

Five themes are discussed in the next sections. The first theme is the nature of design to get an idea of what characteristics of the design. The second theme is knowledge of design to grasp what makes design knowledge unique. The third theme is reasoning types of design to consider the proper mode of thinking in design. The fourth theme is the goal of design to find out what designer achieve. The final theme is the nature of the design process to comprehend the ways of the combination of all themes. Together with these themes, many coexistences and thus abundant form of the design process can occur. It makes each design process special (see, Figure 2.5 :). However, it is still possible to construct a general framework for the nature of the design process.

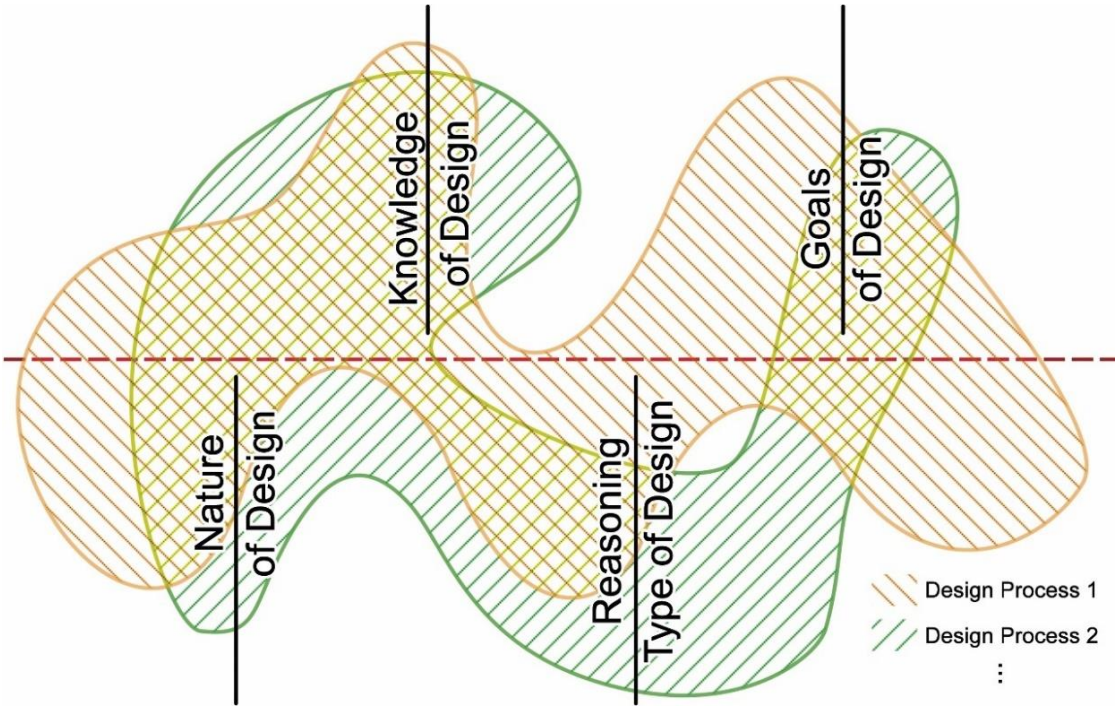


Figure 2.5 : Basic themes of design thinking and infinite possibility of the process .

2.1.2.1 First theme: Nature of design

There are some investigations regarding the nature of design, in order to get an idea of what design is. Simon (1973) mentioned two types of problem: well-structured and ill-structured. Simon lists the properties of well-structured problems: (1) definitive criterion (for testing solution); (2) at least one problem space (may include initial problem state, the goal state and other states); (3) changes of states (or legal moves) (in problem space, considerable moves are all transitions from one considerable state to another by operators); (4) any knowledge that the problem solver can acquire about the problem (which is in one or more problem spaces); (5) If the actual problem involves acting upon the external world, then the definition of state changes and it

affects any operator; (6) All of these conditions hold in the strong sense that the basic processes postulated require only practicable amounts of computation, and the information postulated is effectively available to the processes.

In the cases where all these rules apply, they allow such a well-structured problem to be solved by a *general problem solver*. It is a mechanism of computer programs. In this context, while the well-structured problem has mostly definitive movements, the ill-structured problem has more unpredictable nature. If the problem solver doesn't have permission for new resources during solution efforts, it is called well-structured. Because its capabilities and boundaries are defined very well (satisfied with its own problem space) and there is no need to restructure the problem itself. However, ill-structured problem confirms *the restructuring process* by new sources. It means that problem-solving effort involves learning which implies a redefinition of the problem. For characteristic of ill-defined problems (as a result of redefinitions), ends and the means of the solution are unknown at the outset of the problem-solving. Figure 2.6 : shows a schematic explanation of the system of ill-structured problem.

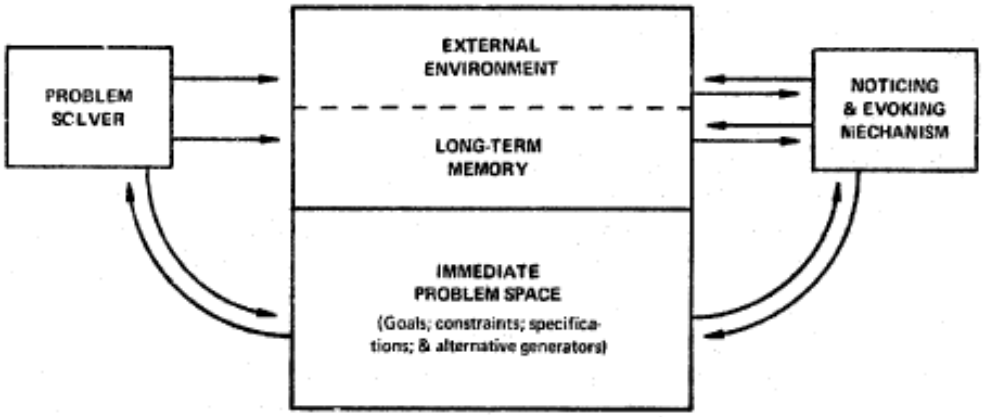


Figure 2.6 : Schematic diagram of a system for ill-structured problems (Simon, 1973, p. 192).

As can be seen, problem solver cannot work with problem space in an isolated way as a well-structured problem. It has interaction between a problem solver and external and internal environment which reshape problem space (by redefining problem constantly). External and internal environment serve as new sources which restructure process.

He gave an example of chess-playing for the well-defined problem, while an example of designing a house for the ill-defined problem. However, considering the entire chess

game instead of focusing on a single move, it has results that cannot be undone. Then, the condition of problem alters depending on each response by the competitor. It indicates continuous redefining of what the problem is. Hence, well-structured problems may turn into ill-structured problems and there is no real boundary between well-structured problems and ill-structured problems. This ill-behaved aspect of design behavior has been recognized even in the earliest formal studies. Eastman (1970) conducted the earliest recorded design protocol study of architectural design. Simon developed a structure for this ill behavior.

A similar term in the literature is *wicked problems*. Rittel and Webber (1973) developed this term and describes features of it. Some of them may be summarized as follows: have no definitive formulation; have no stopping rules; cannot be true or false, only good or bad; no exhaustive list of allowable operations; there is always more than one possible explanation; each of them is unique. These specifications inspired many designers and researchers who have design studies. Buchanan (1992) emphasized the feature of indeterminacy of wicked problem in design. Simon's theorization of the ill-structured problem is more definitive and systematic. However, indeterminacy is highlighted for the wicked problem. Buchanan asked *why design problems are indeterminate*. The reason is that design has no special subject matter except the designer's conception. Design thinking may encompass any area of human experience. Thus, the scope of the designer's conception is universal. Nonetheless, the designer needs to explore a particular subject of the problems in specific conditions. It makes the design discipline distinctive from other scientific disciplines which have efforts to understand principles, laws, rules for the embodiment of subject matters.

Should we necessarily choose either determinacy or indeterminacy feature for the nature of design? Determinacy can be considered as one of the different types of design, rather than being a feature that must be abandoned for the understanding of the nature of the design. Pandza and Thorpe (2010) identified three types of design based on differences in social artifacts. They are (1) deterministic, (2) path-dependent and (3) path-creation design. In *deterministic* design, decisions are able to determine the designed products and their behavior. It provides a reliable design for experts because this problem-solving activity leads to an optimal design solution. The function of the designed artifact is the basis of thinking process deterministically. Prescriptive knowledge by deterministic inference enables expert designers to foresee design

product accurately and reliably. Nonetheless, the *path-dependent* design is doubtful concerning the existence of prescriptions for guiding to designer. Evolutionary patterns by social artifacts are a significant part of the design. While the designer can still structure the basic rules of pattern in the path-dependent design, the *path-creation* design has more highly complex and uncertain patterns. In path-creation design, any knowledge can reshape the emergence of product. Rules which is resulted from previous experience cannot control path-creation design. Designers strive to create new paths by recent knowledge and challenge the common assumption which is a consequence of previous experience.

So far, design and problem-solving are understood as they are similar, even the same. Nevertheless, Hatchuel (2001) rethought about Simon's claims and attempted to distinguish these two terms. He exemplified the distinction between design and problem solving with two problem situations. First example is a group which is looking for a good movie in town, second example is a group which is planning have a party. First one is considered as *problem-solving*, the latter is *design project*. He concludes three remarkable distinctions: (1) Design project encompasses the unpredictable expansion of the initial situation which was first framed just as *a party*. This attribute makes it a project, not a problem. (2) Design project includes *learning devices* which stimulates designers to *learn about what should be learned*. (3) Design project requires social interactions as well. As a consequence, the design contains problem-solving, while cannot be reduced just components of problem-solving. However, problem-solving is still a significant (but not only) point to understand what design is. Feature of re-structuring process seems insufficient to explain the nature of the design. That is why subsequent researchers ventured to explore the nature of the design by *re-structuring* Simon's argument.

As can be seen, the confusion about the conception of design problem has become stronger gradually. Following that, Dorst (2006) drew attention to paradoxes between discourses. In order to point out the problems of the design problem, he made three main properties of it: (1) The *design problem* is not knowable at any specific point. (2) It is difficult to identify because it continuously evolves in the process (see, Dorst & Cross, 2001). (3) The connotations of the conception of design problem are shifting as a part of the design effort. These properties clarify reasons for confusion among discourses of the design problem.

2.1.2.2 Second theme: Knowledge / Attitude of design

There are some investigations regarding the knowledge of design, in order to understand the characteristics of it that make it unique and original. The relationship between science, which is the source of knowledge production, and design needs to be understood clearly. It is common to hear that design is a-scientific. Because the basic component of science (i.e., predictable, generalizable, stable results) doesn't have to fit in the characteristic of the design. Alexander (1977) attempted to adapt the design to the general nature of science by *pattern language*. It was a systematic set of rules for architecture but it was rejected by most professional designers and researchers. Designers have the motivation to find novelty in any case. Hence, they are inclined to refuse accepted norms and suggestions that have been tested and tried. As a result, the design is not a discipline that rejects the nature of science or completely opposite to science. Obviously, the design is fed from science, but there are points where it differs by nature. The distinction of design is not a problematic issue, it is, indeed, the richness for both.

There are various definitions for the notion of design. The variety provides multidimensional meanings. First, it is careful decision making and *alignment with predefined criteria* in the organization studies (Galbraith, 1973, 1995; Nadler et al., 1997). In contrast, in the culture of designers, it has the freedom to discover the *unexpected point*, without losing the overall vision of the project (Weick, 2004; Yoo et al., 2006). Following the increasing interest in design knowledge, the latter view is widely accepted. For instance, Michlewski (2008) drew attention to some features of the designer. Some of them are that they focus on a possible solution so that it is *assertion-based attitude* rather than evidence-based. Designers rely on the *limited extent of predetermined grounds* and prefer to novel and original forms. To sum up, these suggestions underline the following discourses: (1) inclination to refuse accepted norms (i.e., *non-alignment with predefined criteria*); (2) discovery of *unexpected points*); (3) reliance on the *limited extent of predetermined grounds*. In the light of these discourses, this conclusion can be drawn easily: Design knowledge identifies itself by its *ambiguity*. Nature of (especially conceptual) design activity is uncertain, ambiguous and exploratory (Cross, 2006; Lawson, 2005). The ambiguity both frustrate and enjoy designers while designing. They need to get the ability to deal with the ambiguous process. Further, they should learn to use it as an advantage in the process.

It may provide to generate and keep many alternative solutions open for as long as possible.

Ambiguity, as a significant aspect of design knowledge, can be explained by the ‘‘C-K theory’’, which supports the idea that the concepts are partly unknown. It was first introduced by Hatchuel and Weil (2003). Then, they announced an advanced model of it six years later (Hatchuel & Weil, 2009). The name ‘‘C-K theory’’ reflects the proposition that design can be modeled as the interaction between the space of *concepts* (C) and the space of *knowledge* (K). Knowledge space encompasses true (or established: recognized and generally accepted) propositions. Nevertheless, concept space involves undecidable propositions regarding partially unknown objects, which we may call “concept”. Existence of partially unknown objects is not certain in Knowledge. The objective of design activity is to transform concepts into knowledge. Therefore, design knowledge is expanded with the design concept reciprocally by the action of operators which have four different ways (C-K, K-C, C-C, K-K). Using of *learning device* (Hatchuel, 2001), as a characteristic of the design, is effective in describing design knowledge. Because designer may learn which concept she/he should learn and how she/he should transform some concepts into knowledge by using of learning device. Therefore, the designer requires designing its learning device.

2.1.2.3 Third theme: The reasoning types of design

There are some investigations regarding the reasoning types of design (or mode of thinking), in order to understand the way designers’ thinking and use of design knowledge. Inductive, deductive and abductive reasoning are basic reasoning types of design thinking (see, Figure 2.7 :). Inductive reasoning is an effort to find out general principles by using particular facts or instances. It is known as Aristotelian logic. Conversely, we can use knowledge regarding things that generally true in order to figure out particular situations. Thus, it is an inference from logical premises. It indicates deductive reasoning. In addition, abductive reasoning can be seen as the source of new ideas. It is a concept from the philosopher Peirce (quoted by March, 1976). It is the process of forming an informative hypothesis, in other words, the logic of conjecture. March (1976) prefers to use the term *productive reasoning*.

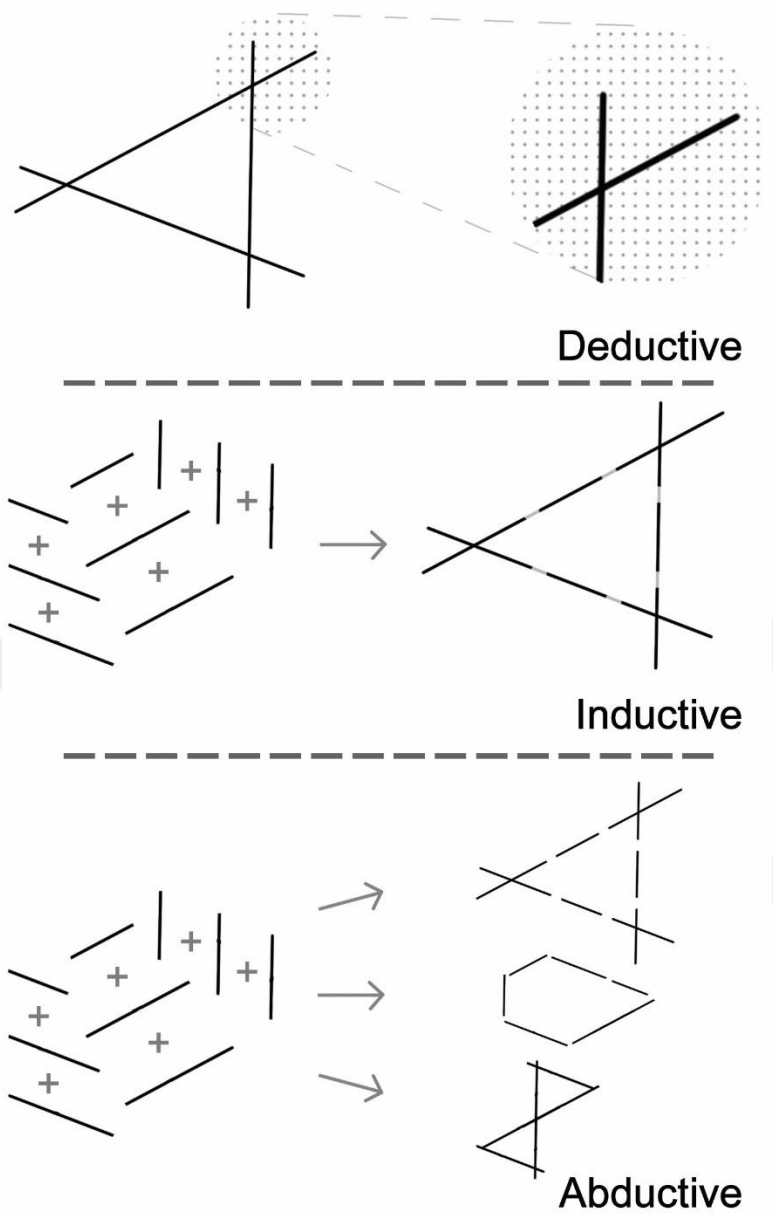


Figure 2.7 : Three types of reasoning.

The reasoning in design is depending on what feature of design knowledge has. Abductive reasoning has the logic of “what might be”, while inductive and deductive reasoning have the logic of “what should be”. The first logic is inclined to open to various and ambiguous possibilities. Hence, abductive reasoning is more likely to fit in the design. Because it refers to ambiguity which is a crucial component of design knowledge. The reasoning in design is shaped depending on how the nature of the problem is as well. The wickedness of design problem (which highlights indeterminacy) leads designers mostly to use abductive reasoning. According to Cross (2006), employing abductive thinking is one of the core features of the design.

The fact that design is more prone to abductive reasoning does not mean that it cannot include others (inductive and deductive). Different reasonings may be appropriate in different moments of the design process. Dunne and Martin (2006) suggested a combinational model of using reasoning types. It is a cyclic model. They assigned roles of reasoning for design as follows: (1) abduction is to generate many ideas; (2) induction is to generalize available results; (3) deduction is to follow logical consequences and foresee their results; (4) testing of the ideas in practice (see, Figure 2.8 :).

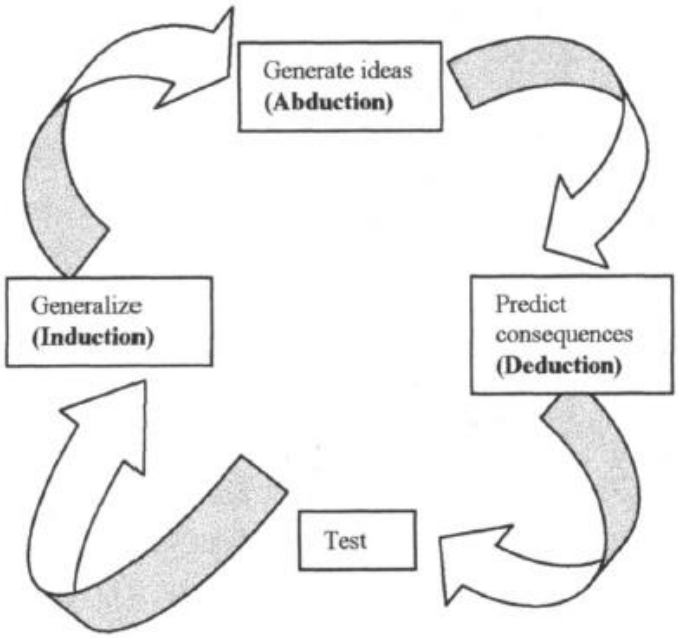


Figure 2.8 : The cycle of reasoning of design thinking (Dunne & Martin, 2006, p. 518).

2.1.2.4 Fourth theme: Goals of design

There are some investigations regarding goals of design, in order to understand the design process by using design knowledge to achieve a goal with particular reasoning. One of the opinions concerning the design goal is based on the idea of harmony. Alexander (1973) outlined a general way of stating the design problem by functional origins as a basis of a pattern to easily read. He claimed that the ultimate object of design is formed. Here, the form may connote *regularity*. However, he perceives the irregular world as it endeavors to compensate for its own irregularities by fitting itself to them. Thus, irregularity also refers to form. The goal of design is to achieve the fitness of two entities: (1) the form (as a solution to the problem) and (2) its context

(which defines the problem) (Henderson, 1913). Good fit is the *ensemble* comprising the form and its context. He illustrated in the various example of the ensemble. Some of them are as follows: biological ensemble (Darwinian fitness is compounded of a mutual relationship between organism and its environment) (Darwin, 1859); ensemble of a suit and tie (one tie goes well with a certain suit; another goes less well) (Köhler, 1938); ensemble of chess game (some moves are more appropriate than others because they fit the context of the previous moves) (Groot, 1965; Newell & Simon, 1972); ensemble of musical composition and phrases (perfect rightness when Mozart puts just this phrase at a certain point in a sonata) (Wertheimer, 1934, 1938). The degree to which form fits its contexts determines the accuracy of the goal.

In light of all pre-acceptance and examples, some points need to be discussed. Perceiving the form as *an ultimate object of design* gives rise to narrows the complexity of the design too much. In my opinion, the design goal does not require to have a generalizable definition. Further, as can be understood from Alexander's wide range of examples, the *goal* was interpreted in a general ground. Nonetheless, the design goal may have more specific definitions. On the other hand, he emphasized to parameters of solution and problem. This emphasis may be helpful to grasp the goal of the design.

At this point, the design goal may be analyzed by the viewpoint of problem-solving. As a foundation of *problem-solving theory*, the goal of the design may be to define a problem and solve it (Simon, 1996). Goals, constraints, alternatives, representations and solutions are five crucial elements of design that are intertwined with the cognitive process of designers (G. F. Smith & Browne, 1993). Identification of goals in problem-solving has a complex structure. Goals may be incomplete, partially unknown or multiple (and difficult to direct one of them). It is consistent with the ambiguous nature of design knowledge. There are many strategies for the definition and solution of design. The common goal of them is to identify and develop the problem and to develop solutions for defined problems.

In addition, the goal of design is understood as a generation of new concepts and new knowledge by Hatchuel and Weil (2009). Each new concept contributes to re-define the problem. Thus, re-search for solutions which are adapted to the redefined problem. It is consistent with the ill-behavior of the design problem. Generation of new concepts has a vital role in, especially the creative design process. If the designer aims to

generate new concepts (as a design goal), it may provide more creative design. Even if it does not reflect the final product, the designer may improve her discussion and design thinking skills. Hence, priority is for new concepts (and problems), rather than new solutions.

2.1.2.5 Final theme: Nature of design process

There are some investigations regarding the nature of the design process, in order to understand the combination of design thinking, knowledge, reasoning and goals as a whole. The design process is shaped by many variables, researchers tried to explore the general mechanism of the design process, considering the variables.

Negotiations between problem and solution

Design problems and design solutions are interdependent. It is not effective to study solutions without thinking problems or the reverse. Lawson (2005) has examined the design process as a sequence of activities and review suggested maps for the process (see, Figure 2.9 :).

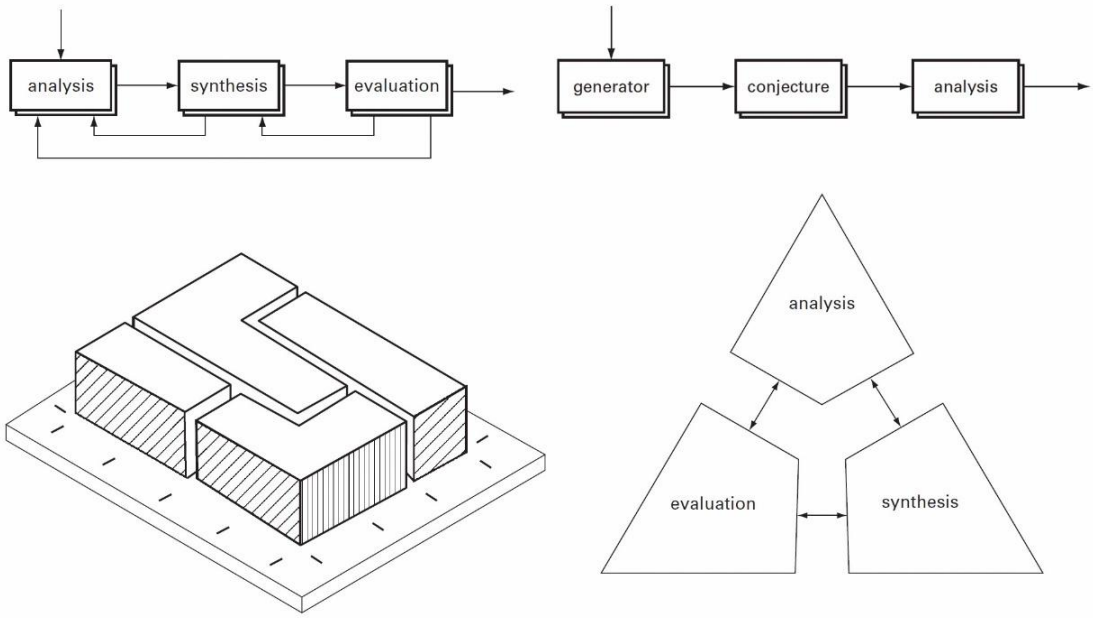


Figure 2.9 : Searching of graphical representation for design process during the discussion (Lawson, 2005, pp. 38-46).

Later, he developed a suggestion regarding the design process which identifies it as a negotiation of problem and solution (see, Figure 2.10 :). It involves three activities: analysis, synthesis and evaluation.

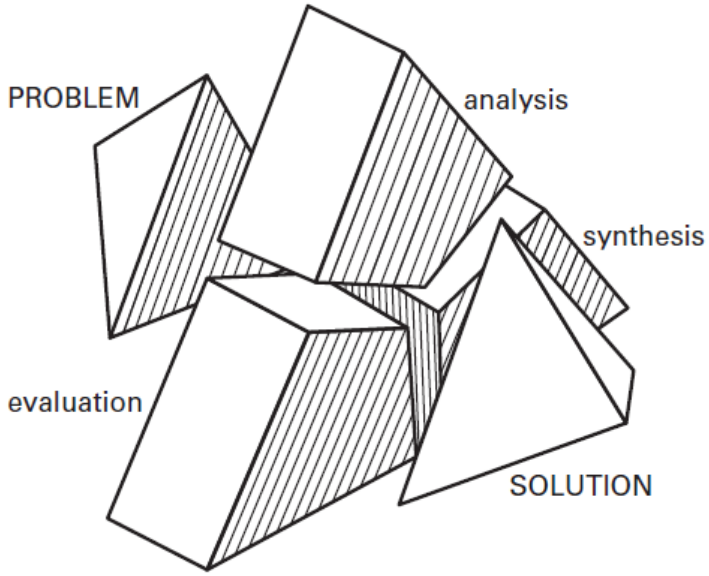


Figure 2.10 : The design process as a negotiation between problem and solution by three activities (Lawson, 2005, p. 49).

In the next chapters, Lawson (2005) continued to conduct his examinations. During the investigations, he examined the relationship between problem and solution and manifested lessons that can be learned about the design process. Following that, he claimed some direct features of the design process as well. His points can be seen as an overall picture of the nature of the design.

Regarding design problems: (1) "Design problems cannot be comprehensively stated" (Lawson, 2005, p. 120). It is difficult to compose a map of the design process. Because design problems are full of ambiguities regarding objectives. Objectives are inclined to change during the process. The process should be seen as dynamic rather than static. (2) "Design problems require subjective interpretation" (Lawson, 2005, p. 120). Designers from different fields generate a different solution to the same problem. This fact applies not only to the solution but also to the problem. Priorities of designers determine the way of interpretation. (3) "Design problems tend to be organized hierarchically" (Lawson, 2005, p. 121). For instance, redesigning a doorknob may emerge considerations of doors, walls, buildings. Furthermore, the designer arranges the considerations in his mind in order of importance. Their importance and hierarchical order depend on the character of the designer.

Regarding design solution: (1) "There are an inexhaustible number of different solutions" (Lawson, 2005, p. 121). The reason is that design problems cannot be comprehensively stated (see, the first feature of design problem). Because of the ill-

structure nature of the design problem, the researcher cannot make a list of all possible solution. (2) “There are no optimal solutions to design problems” (Lawson, 2005, p. 121). However, there are acceptable solutions. Different acceptable solutions satisfy designers, clients and users in different ways. There is not a perfect solution so that designers should not escape from recognizing the wrong parts of each alternative. (3) “Design solutions are often holistic responses” (Lawson, 2005, p. 122). Ideas of the powerful solution are integrated and holistic to some of the defined problems. As a consequence of these type of ideas, it is difficult to dissect a design solution. (4) “Design solutions are a contribution to knowledge” (Lawson, 2005, p. 122). Even if they are not built, left as just concept, each design progress in some way. Design solutions may not serve to the final product but they can still develop designer’s ideas, explicitly or implicitly. (5) “Design solutions are parts of other design problems” (Lawson, 2005, p. 122). When the designer applies her solution to the problem, new problems may appear. It is similar to a redefinition of the problem as a response to the solution, while this claim basically stresses new sub-problems which are resulted from the solution.

Besides these features, Lawson (2005) made direct observations regarding the design process: (1) “The process is endless” (Lawson, 2005, p. 123). As a consequence of limitless different solutions and no comprehensive formulation of problems, we cannot expect a finite design process. Designer's task cannot be completely done, there are probably better designs which the designer has not achieved yet. (2) “There is no infallibly correct process” (Lawson, 2005, p. 123). Despite attempts for design methods which would provide the best solution, there is no good way of designing which is valid for all design process. The designer should learn how to control and vary the design process, in order to explore and apply the design processes which fit in the current design situation. (3) “The process involves finding as well as solving problems” (Lawson, 2005, p. 124). İdentifying problem is a crucial part of the design process. Problems and solutions should be seen as emerging together, not consecutively. Therefore, designing is not a linear process. (4) “Design inevitably involves subjective value judgement” (Lawson, 2005, p. 124). Success is a subjective parameter for design and depends on judges. (5) “Design is a prescriptive activity” (Lawson, 2005, p. 125). Process of science and design are not similar. A fundamental

distinction is that design is prescriptive while science is descriptive. Basic questions of design include “what if, what might be” rather than “what, how, why”.

Co-evolution of problem and solution

Common feature of design process study is a thought that problems and solutions are seen as emerging together. They affect each other. However, how they can coexist was not clear. Investigations about creativity in design enabled to focus on the coexistence of problem and solution in detail. Creative design is seen as developing and refining together both problem formulation and solution ideas, through constant iteration of analysis, synthesis and evaluation process between problem and solution space. Maher et al. (1996) suggested that problem and solution space co-evolve together in the design process (see, Figure 2.11 :).

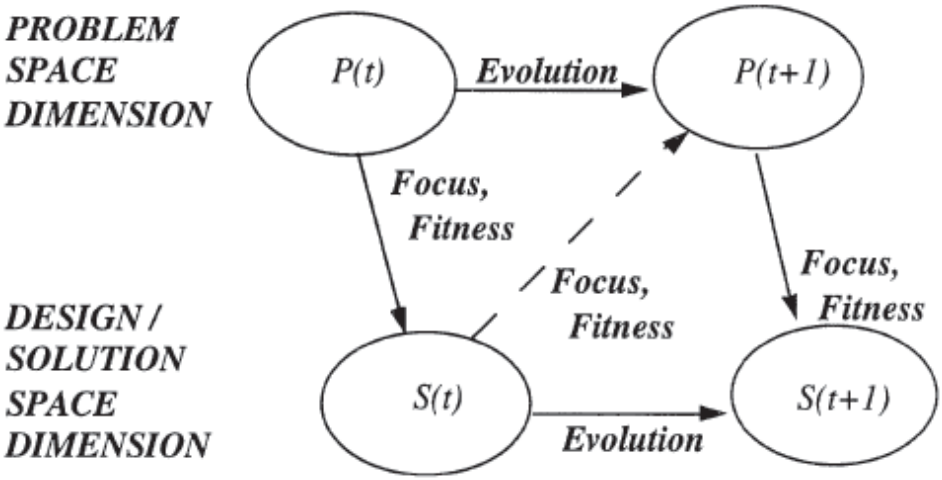


Figure 2.11 : Co-evolution model of Maher et al. (1996, p. 7).

The core solution idea changes the designer’s consideration regarding the problem. Then, designer redefines the problem and controls whether the redefined problem fits in earlier solution or not. Solution will be modified depending on fitness. This process of co-evolution will proceed along this line until the end. This co-evolution model inspired Dorst and Cross (2001) and they conducted an experiment to develop “co-evolution of problem-solution” (see, Figure 2.12 :).

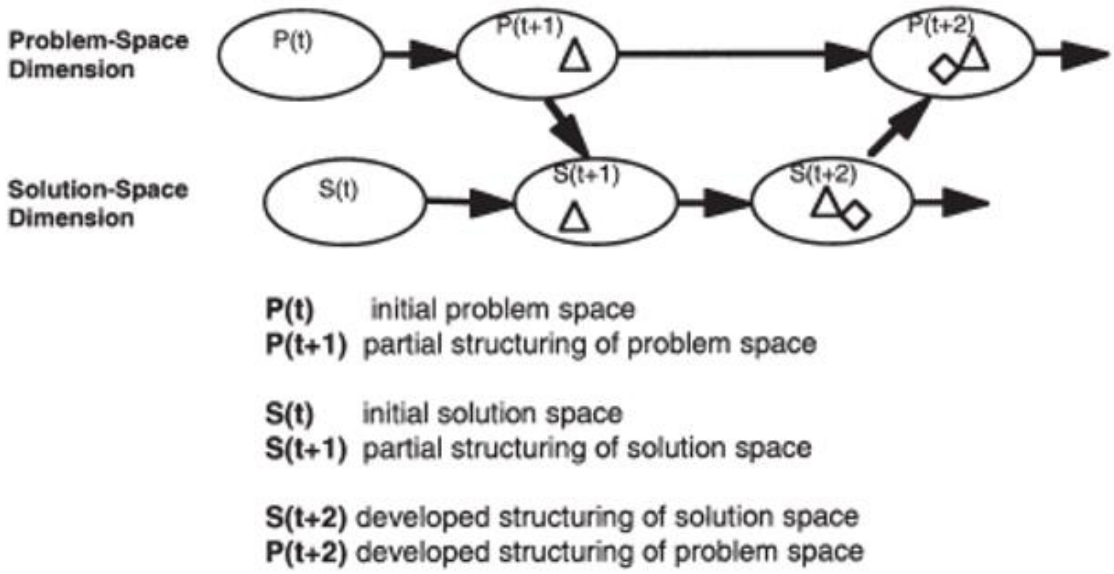


Figure 2.12 : Co-evolution of problem-solution by Dorst and Cross (2001, p. 435).

In this suggestion, designers explore the problem space first and recognize the partial structure of problem space (P(t+1)). This partial structure provides a partial structure of the solution space (S(t+1)). Designers use the partial structure of solution space to produce some initial ideas of design. It extends and develops the partial structure of the solution space again (S(t+2)). Designers transfer partial solution structure to the problem space (P(t+2)). These operations continue around this structured process.

Theory of reflective practice: Framing and reflecting the problem – in action

Theory of reflective practice is developed by Schön (1983, 1987). He introduced an alternative approach to design. This approach is suitable for the complexity of design and supplies interactions between the design process and design content and designer. He observed professionals at work (Schön, 1983). Later, he applied his concept in design, using examples from architectural design education (Schön, 1987, 1992). Schön's view regarding design is unique, uncertain. It is consistent with the ambiguous nature of the design. Professionals deal with these uncertainties. He figured designer as someone who transforms indeterminate situations to determinate ones. Schön was interested in how they do that. According to him, designers reflect on the current situation to construct their future decisions. It is termed as constant *reflection-in-action*. His observation demonstrates that unconscious activities and implicit knowledge used by practitioners. Schön gave an example of riding a bicycle for implicit knowledge. Although we know how to do it, it is difficult to explain our actions.

Schön's method to construct reflection-in-action is protocol study of conversation between a student (Petra) and her tutor (Quist) during a design process. His well-known case study is Petra's works of several weeks for designing an elementary school. She considered contours of the land, size and arrangement of the classroom units (see, Figure 2.13 :).

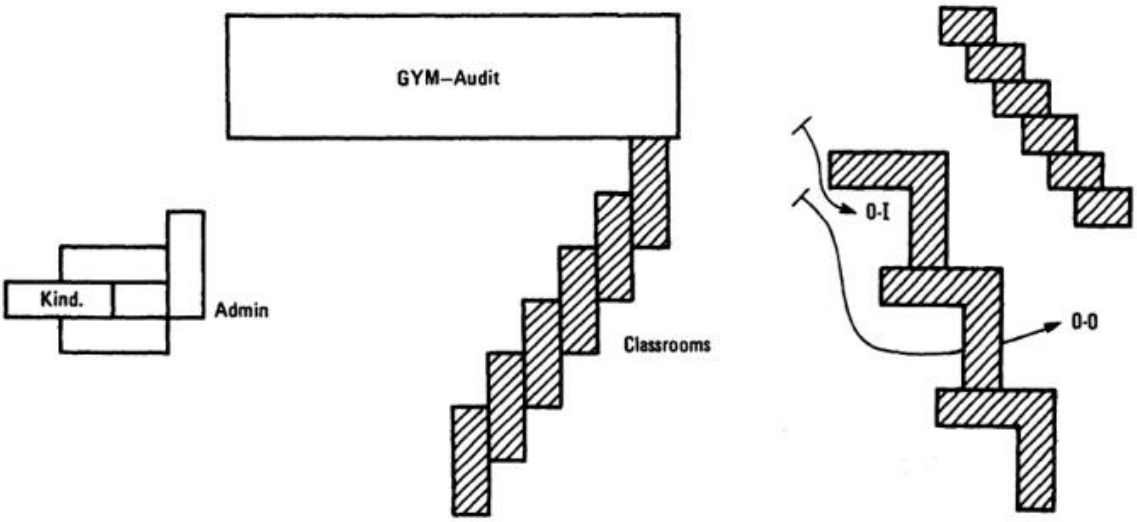


Figure 2.13 : Petra's (student) sketches for designing of an elementary school (Schön, 1987, p. 47).

Petra got stuck and presented her initial sketches to Quist. Quist criticized Petra's framing of the problem, signified incoherent decision concerning contours. He did not help for her design, introduced geometry which is parallel with the site, suggested L-shaped classroom. It was a *new frame* to generation *new moves* (they are next sketches following first plan drawing) (see, Figure 2.14 :).

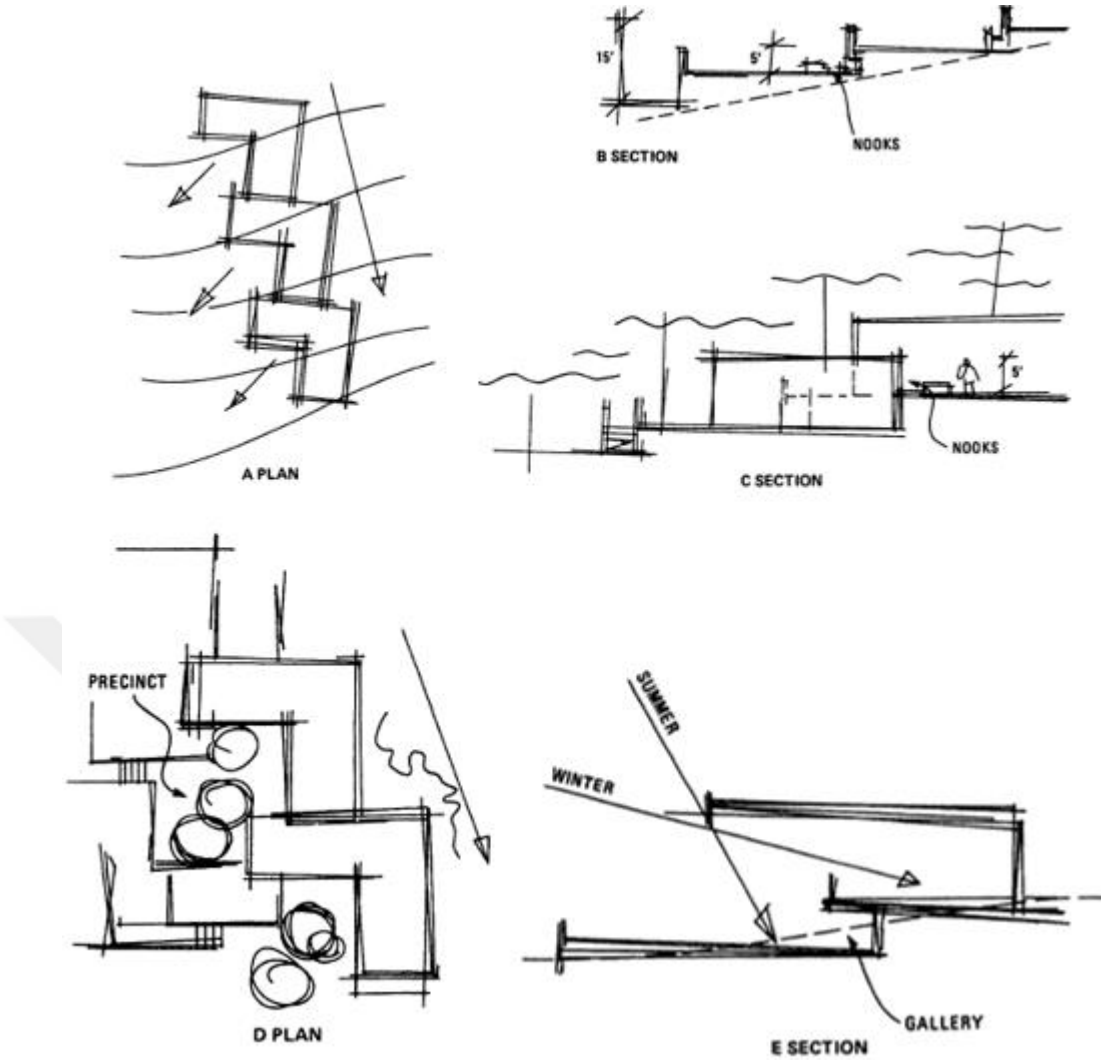


Figure 2.14 : Sketches Illustrating Quist's (teacher) Demonstration (Schön, 1987, p. 51).

Teacher *reframed* the student's framing of the problem by reshaping the situation. Then the teacher conducted an experiment to discover what consequences and implications can be seen. Discovery session was a web of moves. Furthermore, the teacher's *moves* caused unintended changes which were a source of new meanings. Thus, the new situation talked back to the teacher, he listened and appreciated what he heard. Each *framing* directed the teacher for the next *moves* and *reflection*.

It is easily read that there are basically four types of design actions: (1) naming, (2) moving, (3) framing, (4) reflecting. Valkenburg and Dorst (1998) developed a schematic representation of reflective practice with clear definitions of four design activities. It is a coding system (as an analysis method) to use Schön's reflection-in-

action theory. Even if they utilized it for analyzing design team communication, it is also proper to use for individuals (see, Figure 2.15 :).

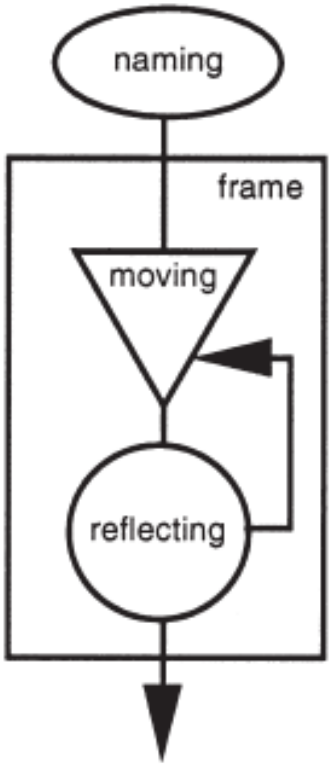


Figure 2.15 : The Mechanism of Reflective Practice; Four Design Actions (Valkenburg & Dorst, 1998, p. 254).

- *Naming* refers to pointing to parts of the design task as being important. It is a selection of things which may have potential significance for design.

- *Framing* refers to (sub)problem or (partial) solution to explore further on. The frame is a context for the next activities; something to hold on while designing. The constant existence of "framing" over the entire process makes it mostly only recognizable. Naming and framing are complementary acts. Selecting of things for attention indicates naming, organizing of selected things indicates framing.

- *Moving* refers to experimental actions such as generating ideas, sorting information, comparing concepts, combining ideas, looking at the consequences of design decisions and so on. Both solving the problem and exploration for new frames are within the scope of moving.

- *Reflecting* refers to reflection on earlier activities to know what designer is doing and what to do next.

In order to understand the notion of reflection more clearly, some issues need to be addressed. First, evaluating is not a reflection in terms of reflective practice, but moves (because evaluating is not pure reconsidering of moves, it is sort of judging earlier decisions). Second, Dewey (1933) is one of the founders of the notion of "reflection". He claimed that reflective thinking is initiated during a moment of doubt and uncertainty. Similarly, Schön's reflection-in-action (in reflective practice) emerges during the element of "surprise". Its goal-oriented tests are similar to Schön's moves (as testing experiments). Dewey's "established belief" is similar to Schön's frames. Therefore, Schön's reflective practice is not an entirely different view of the world. Nevertheless, Schön's effort is specifically for design discipline, while Dewey's view is general thought.

2.1.3 Fundamental paradigms of design process and their comparison

Many researchers have attempted to describe the design process by developing systems. The first methods in the 1960s had the positivist background under the conditions of technical systems. Criticism over the systems of design process increased interest in the design theory. Therefore, more attention to the field and more endeavor for detailed descriptions have been encouraged. Simon (1973) provided a framework by introducing problem-solving theories within the paradigm of technical rationality. This paradigm has been the dominant influence as a rational problem-solving process. Schön (1983) proposed a fundamentally different paradigm. He identified the design process as a reflection-in-action. This theory addressed blind spots of the prevalent methodologies. These two paradigms represent two different ways of looking at the world, positivism and constructionism. Dorst and Dijkhuis (1995) summarized the differences between the two paradigms (see, Figure 2.16 :).

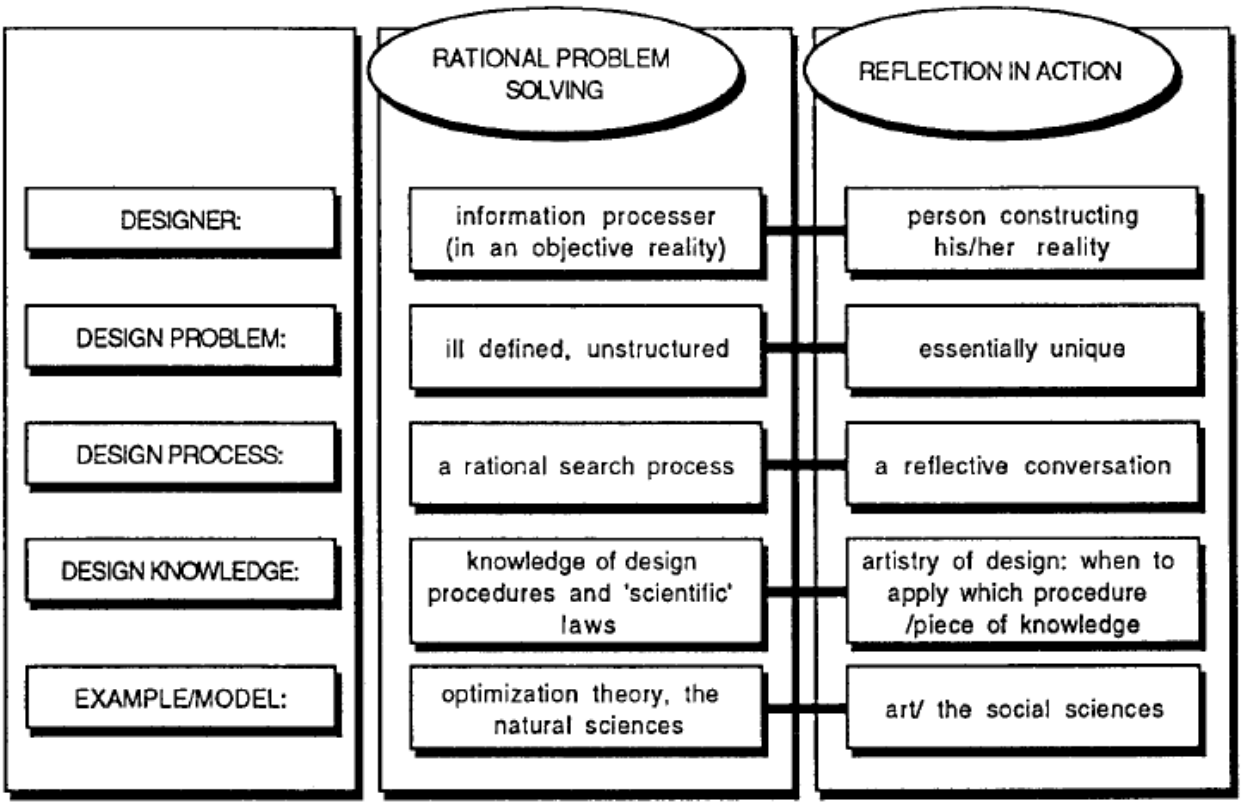


Figure 2.16 : Summary of problem-solving and reflection-in-action paradigms (Dorst & Dijkhuis, 1995, p. 263).

Then compared two paradigms by conducting protocol studies for two different data processing systems. They drew general and theoretical conclusions regarding the behavior of two paradigms as follows:

Process of rational problem solving:

1) The conceptual phase shows an irregular jumping between activities, not consecutive. Hence, it is difficult to detect any pattern at all.

2) It focuses on process-component of design decisions, not process-content, so that it does not provide a basis for problems and their structures.

3) It is useful in comparing the design process (because of its systematic approach). Further, the results of this analytical system are linked to the quality of final production. Hence, it is more solution-dependent.

4) It is appropriate where problem is clear enough.

5) It is appropriate when the designers have strategies that they can follow while solving them.

Process of reflection-in-action:

1) There are links between consecutive statements (as a basic component of structuring the problem by framing subsequent design statements).

2) It focuses on process-content. It describes design activity with a close link between the content and process components of design decisions.

3) It is difficult to draw general conclusions. Because the definition of the design process is problem-dependent. Another reason is that there is no basis for judging the appropriateness of frames. This feature limits the usefulness of this theory.

4) The process is not very well described. Clarity of process is weak, but it is consistent with the ambiguous character of design knowledge.

5) It works well in the conceptual stage where the designer has no standard strategies. Absence of strategy drives designers to try out problem and solution structures.

Extra features of the reflection-in-action process are as follow: (1) Designers are active in structuring the problem. (2) Designers do no evaluate concepts, but they evaluate their actions in structuring and solving the problem. (3) It is closer to describe the design as an experience than a rational problem-solving process.

2.1.4 Design process models

While constructing the logic of the design process, the process is defined by dividing it into various phases. Many models have been developed over the relations of these phases. Cross (2005) organized these models in three titles: a descriptive, prescriptive and integrative model. Further, Dubberly (2005) compiled these models in various titles, such as academic models, complex linear models, cyclic models, etc. I checked around 90 models from the literature and selected some of them to show a general perspective regarding the design process.

In the earlier section, the design process has been discussed via problem-solution theories. Here, I aimed to obtain an overview regarding the parts of the design process (if it can be read when it divides into parts). The design process can be thought of as a machine that somehow converts its inputs into outputs (Figure 2.17 :). However, this machine does not show us clearly how the input goes through the inside and transform to output. Thus, we cannot say whether this is a linear or cyclic process, which applies to every design activity. The discovery of this *process* machine is exciting so that

motivates us to do research on this subject. The more we understand how the machine works, the greater our awareness of designing.

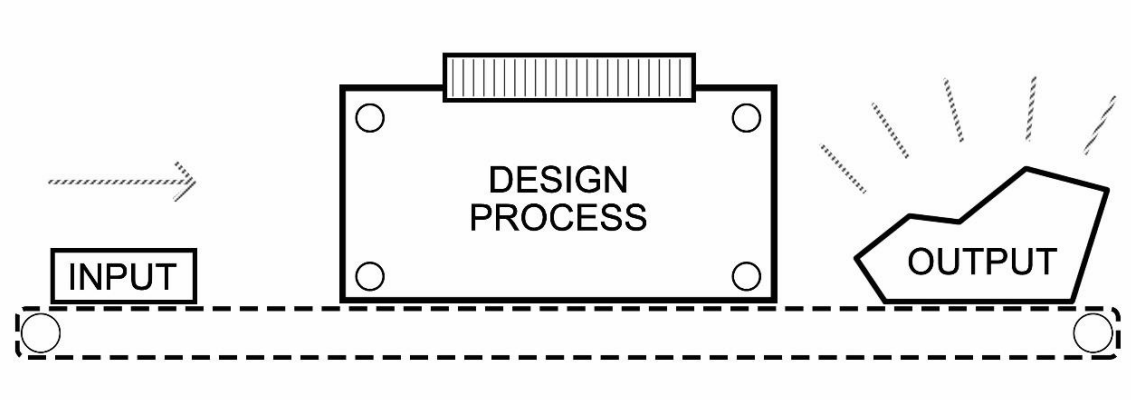


Figure 2.17 : Archetype of Design Process (input-process-output).

Researchers attempted to discern this transformation via steps and sub-steps (Figure 2.18 :). It makes easier to figure out partial mechanisms of the design process, then the overall process by associating partial mechanisms. We need to be careful while associating partial mechanisms because attempting to simply relate them may cause misinterpretation of the complex structure of the design (such as easy, step by step process). Relations between steps are very complex rather than sequential.

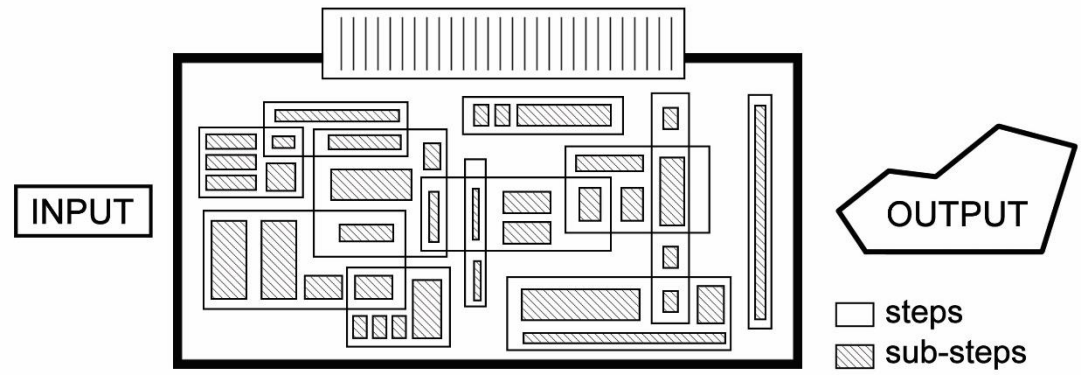


Figure 2.18 : Steps and Sub-Steps as a representation of design phases.

2.1.4.1 Descriptive models

The models for the design process may be organized in two basic categories: (1) Descriptive models (which describe the sequences of activities that typically occur in designing); (2) prescriptive models (which attempt to prescribe a better or more appropriate pattern of activities). “Descriptive models” are generally paradigm of solution-focused nature of design thinking. It underlines the significance of generating

a solution concept early in the process. Cross (2005) improved the simple four-stage model (Figure 2.19 :). They are essential activities that the designer performs. In this model, the evaluation stage leads both the final design and concept for more satisfactory concepts and solutions. It indicates a loop between evaluation and generation. In other words, the design proposal is evaluated by goals, constraints and criteria of a design brief. Subsequently, designers arrive communication stage which is end-point of the process as ready for manufacture. Communication, as a final stage of the model, is implicated as an explicit stage in the design process by Archer (1963).

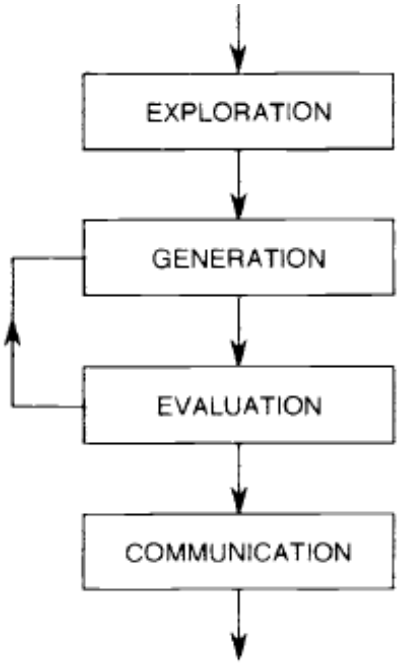


Figure 2.19 : Simple four-stage model of the design process (Cross, 2005, p. 30).

Earlier suggestions had just one-way models. However, loops as iterative returns to earlier stages of the process are part of the design activity. French (1985) has demonstrated a detailed model which includes analysis of the problem, conceptual design, embodiment of schemes, detailing (Figure 2.20 :). In this model, circles are stages of design, rectangles are activities between stages.

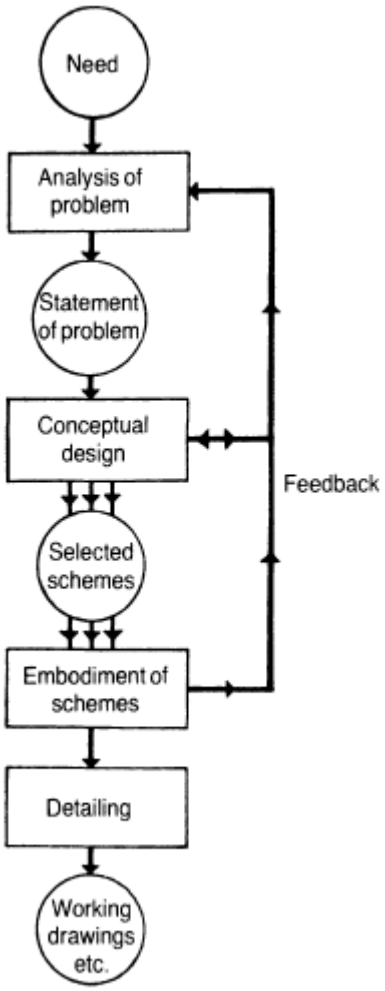


Figure 2.20 : Model of design process by French (1985, p. 2).

The *analysis of the problem* can be seen as a small part but it is important for the overall process. The output of the analysis is the statement of the problem and it has three elements: (1) a statement of the problem; (2) limitations for solutions (such as customer's standards, date of completion, etc.); (3) the criterion of excellence to be worked to. In other words, they can call as the goals, constraints and criteria of the design brief. The *conceptual design phase* is the generation of broad solutions as a scheme for the response of problem statements. It is the practice of idea generations. *The most scope for striking improvements* will place in this stage. Therefore, it is a determinative stage for the rest of the process. Some themes are selected to go to the next stage. In the third stage, which is called as *embodiment of schemes*, selected schemes are considered with more concrete aspects in detail. The designer decides the end product in this stage by many feedbacks among the first three stages. In *detailing phase*, the designer should decide many small but essential points of design.

2.1.4.2 Prescriptive models

After showing some descriptive models, I draw attention to “prescriptive models”. These models are for adopting improved ways of working. They offer a more systematic procedure to follow and provide a particular design methodology. There is a need for more analytical work before solution generations. The focus of earlier phases is worthwhile but the inclination of obtaining fully understood system is a controversial approach. This attitude is contrary to the ambiguous nature of the design. However, they still provide some suggestions to get an idea of how to perceive the process as different and relational phases.

Three basic stages are well-known in the design process: (1) analysis, (2) synthesis; (3) evaluation (Figure 2.21 :). I have mentioned the concept of analysis-synthesis-evaluation where I reviewed Lawson's suggestions while trying to understand the communication between problem-solution. In this section, I discussed these terms comprehensively in the context of prescriptive models. Jones (1984) defined these terms in his early example of a systematic design methodology. The analysis is the examinations of sub-problems of the main problem. Synthesis is reassembling of discovered sub-problems. In other words, the analysis stage refers to understanding and conception, synthesis stage is rebuilding by new analysis. Evaluation is an assessment of the last situation in the process. This structure is similar to descriptive models. However, prescriptive models underline generation of alternatives with best sub-solutions and making a rational choice of the best of the alternative designs.

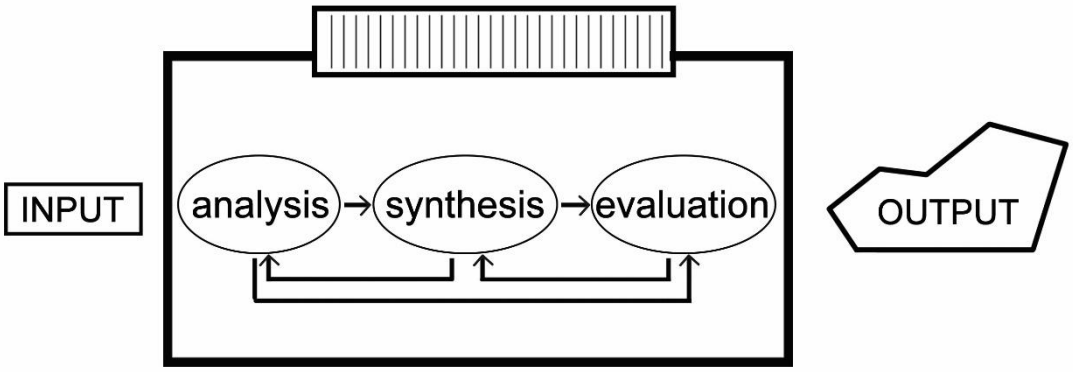


Figure 2.21 : Three basic stages of the process: Analysis, synthesis, evaluation .

Evaluation is an additional part of the dialogue between analysis and synthesis. In analysis-synthesis dichotomy, Dubberly (2005) inquires relationships of the steps. While asking if they have sequential, overlapping, cyclic relations, he suggested "oscillation" metaphor for the relations of analysis and synthesis (Figure 2.22 :). Further, he put forward several questions: "Do wave-length and amplitude remain constant? Do they vary over time? What are the beginning and ending conditions?" Another suggestion of him to think about other dichotomies, such as serialist vs holist; linear vs lateral, top-down vs bottom-up, pliant vs rigid. We should keep in our mind the question of the relationship between stages and activities for each model.

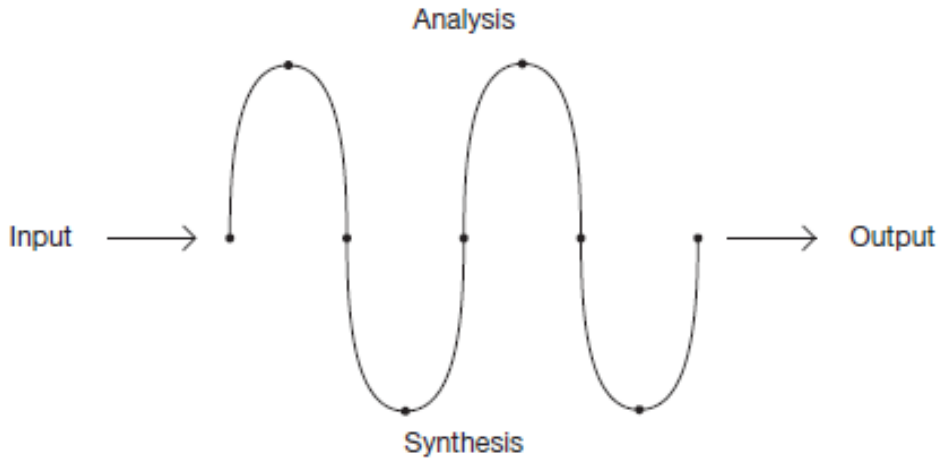


Figure 2.22 : Design process as an oscillation of the designer's attention between analysis and synthesis (Dubberly, 2005, p. 20).

Following these basic stages, Koberg and Bagnall (1974) expand the process to seven steps. They discussed seven keys to developing one's creativity. The first three are *acceptance*, *analysis* and *definition*. The fourth state, and for many the heart of the creative process, is *ideation* (or idea generation). In this state, designers discover many paths to the solution of a problem. After having enough solutions, designers move the state of *selection* and *implementation*. The time to *evaluation* to check whether the implementation works properly (Figure 2.23 :).

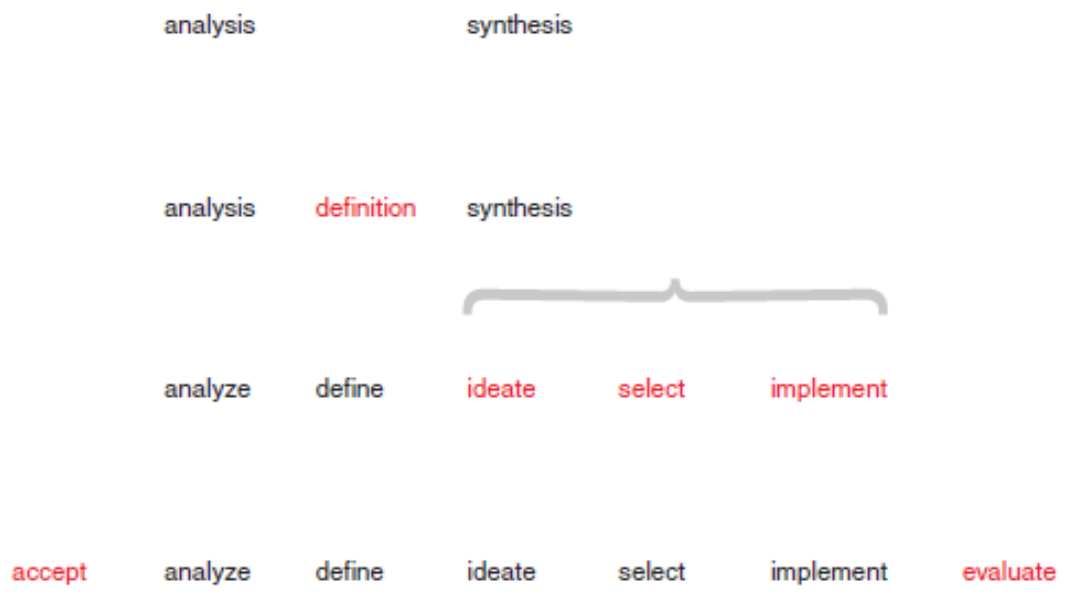


Figure 2.23 : Seven steps of design process (adapted from Dubberly, 2005, p. 16).

A more detailed prescriptive model was developed by Archer (1984) (Figure 2.24 :). In this model he identified six types of activity: (1) programming (building of significant issues); (2) data collection (collection, classification and storage); (3) analysis (identification of sub-problems); (4) synthesis (preparation of design proposals); (5) development (prototype designs); (6) communication (preparation of manufacturing documentation).

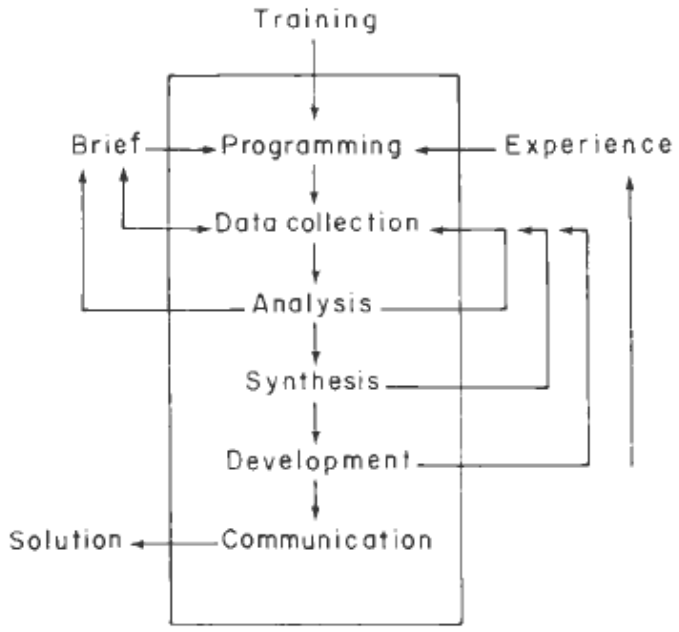


Figure 2.24 : Basic design procedure (Archer, 1984, p. 64).

To see these activities as groups, Archer (1984) set them in three phases (Figure 2.25 :): (1) analytical; (2) creative, (3) executive. The basic distinction among phases is reasoning types. While analytical and executive phase requires objective observation and inductive reasoning, creative phase involves subjective judgment and deductive reasoning. Archer delineated design process as a creative sandwich. The bread is objective and systematic (as analytical and executive phase), but the creative phase, at the heart of the process, is in the middle of the sandwich with subjective attitude. We may infer that the first and last phase is suitable for prescriptive models. However, creative phase makes the design a distinguished field and it is difficult to systemize this phase.

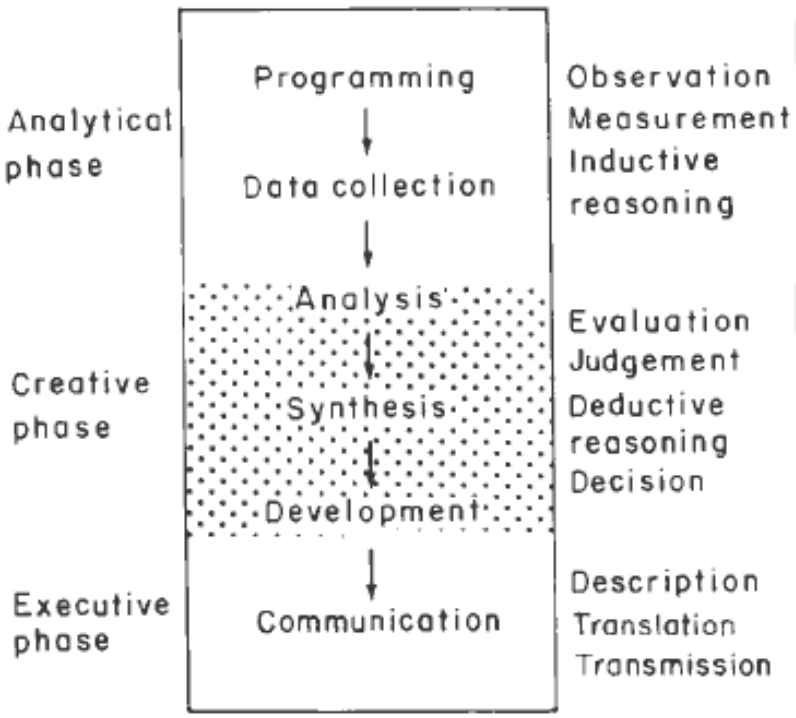


Figure 2.25 : Three phases of design (Archer, 1984, p. 64).

Similar to this view, Pugh (1991) created a four-phased model (Figure 2.26 :): (1) specification; (2) concept design; (3) detail design; (4) manufacturing.

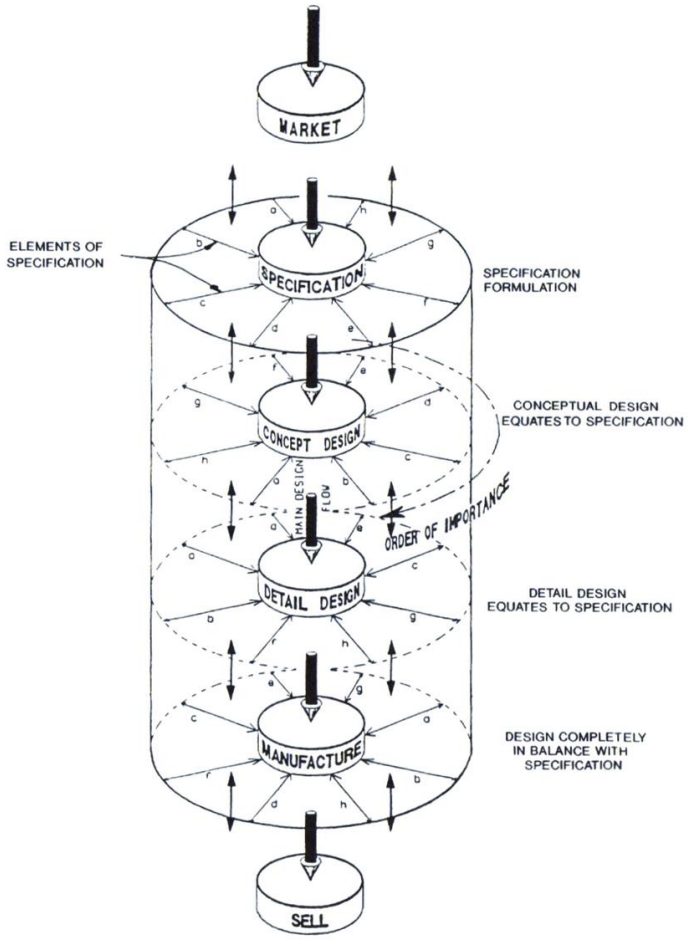


Figure 2.26 : Four-Phased Design Process Model by Pugh (1991, p. 11).

In similar prescriptive account, Dym (1992) defined the process in four stages: (1) conceptual stage; (2) preliminary design; (3) detailed design; (4) analysis and optimization. The conceptual stage includes identification and prioritization of goals and constraints, the exploration of design alternatives, the gathering of further information. The preliminary design stage is an identification of sub-parts of design. The detailed design stage is to develop specific parts needed to construct the end product. Analysis and optimization stage is the testing and evaluation of the design. Throughout the process, design can be mass-produced, mass-distributed, refined and recycled.

The more complex models may cause to get lost between activities with many detailed activities and prevention of grasp general structure. However, they can still provide some refinements of the process. Pahl et al. (2007) first described a general problem-solving process (Figure 2.27 :), then offered a comprehensive model for the design process.

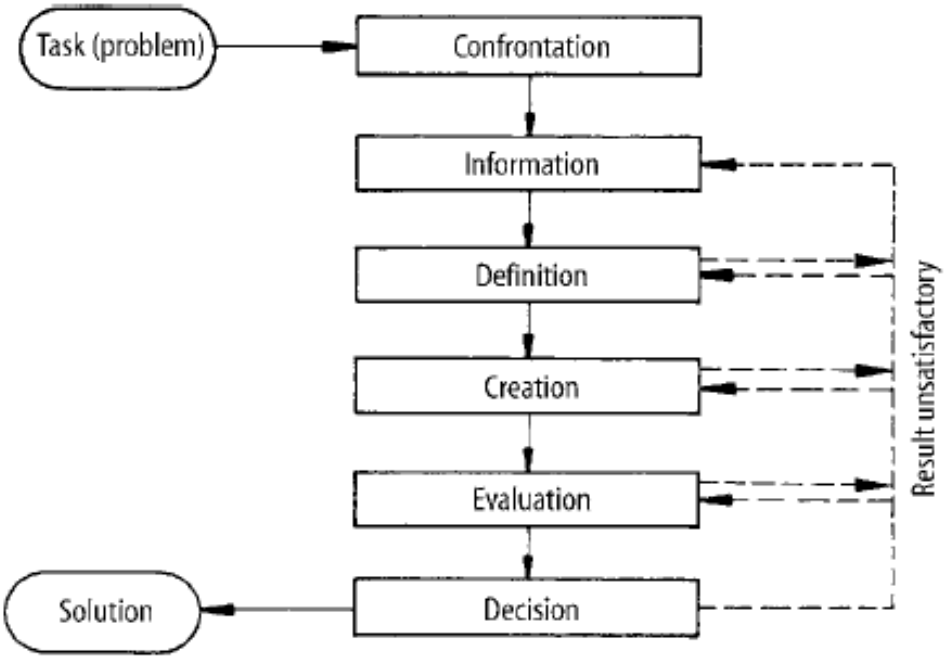


Figure 2.27 : General Problem Solving Process (Pahl et al., 2007, p. 127).

Their model is based on four stages (Figure 2.28 :): (1) Clarification of the task (collection of information about the requirements and constraints); (2) conceptual design (searching for suitable solutions and combining into concepts); (3) embodiment design (technical and economic considerations of concepts); (4) detail design (arrangement, form, dimensions, surface properties, etc. all producing of documentation about manufacturing). The more creative proposals in conceptual design result in the more creative detailed design.

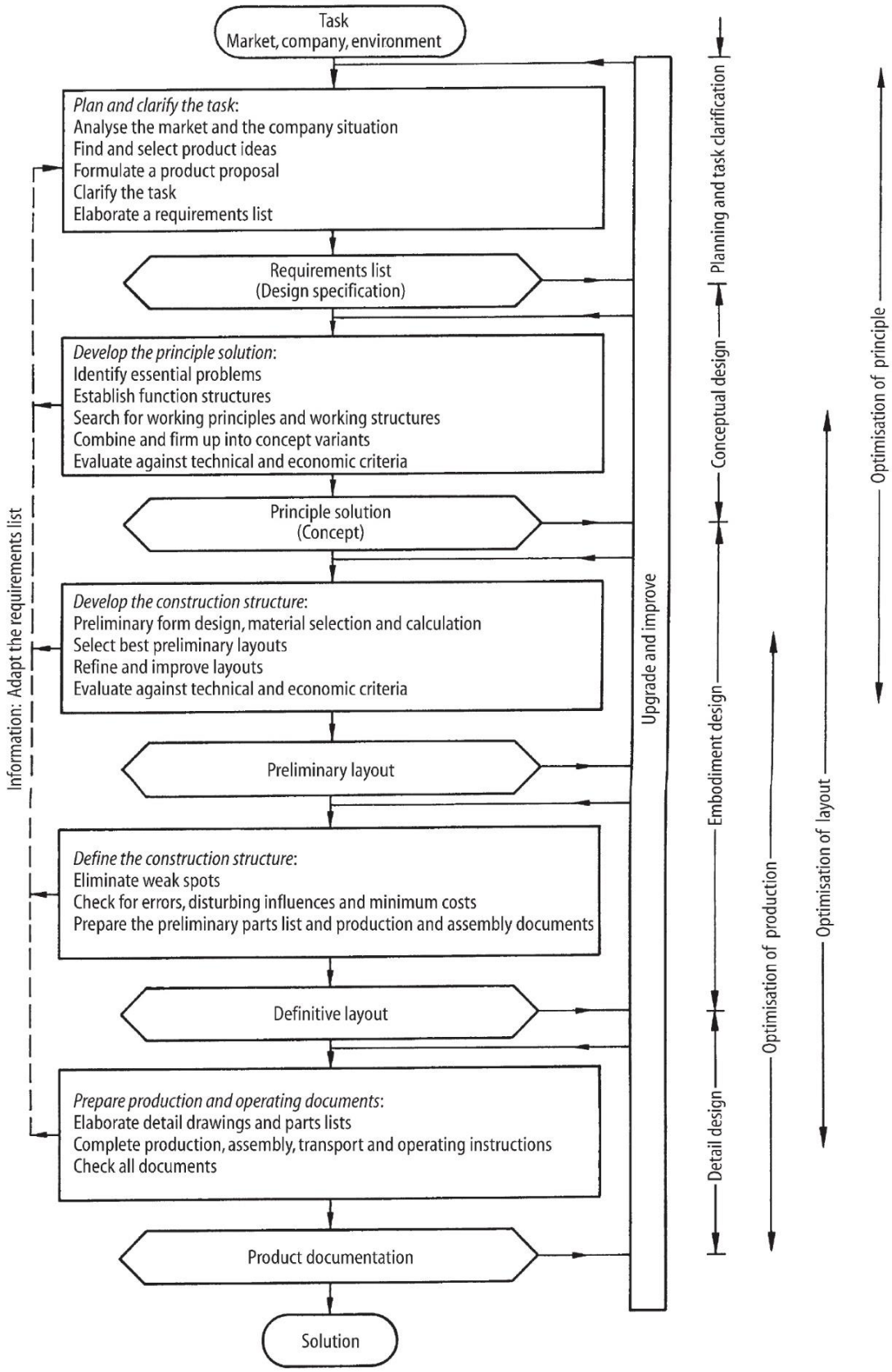


Figure 2.28 : Comprehensive model of the design process by Pahl et al. (2007, p. 130).

2.1.4.3 General discussion about design process models

Many models of the design process exist, each with a different number of stages and different dependencies between those stages. When the general tendency of all these models is examined, I have the following observations: although the design process is divided into phases, transitions between each phase are generally envisaged. Each transition between phases can add a new dimension to the design so that the multi-dimensionality of design process becomes stronger. The design process has a structure that constantly develops subsequent moves by inquiring previous moves. It also has a structure that evaluates the outputs of subsequent moves and rebuilds the previous moves. Thus, it has multi-way interactions.

The various numbers of divided phases of the models can be seen as having two main areas (Figure 2.29 :): (1) idea generation (or “ideation”) phase (an area where problem definitions are made and initial ideas are developed); (2) later phase for details (an area where tests for ideas are performed and details are applied). If the generated ideas do not fit in the problem redefinitions, the details cannot solve the design problem by itself.

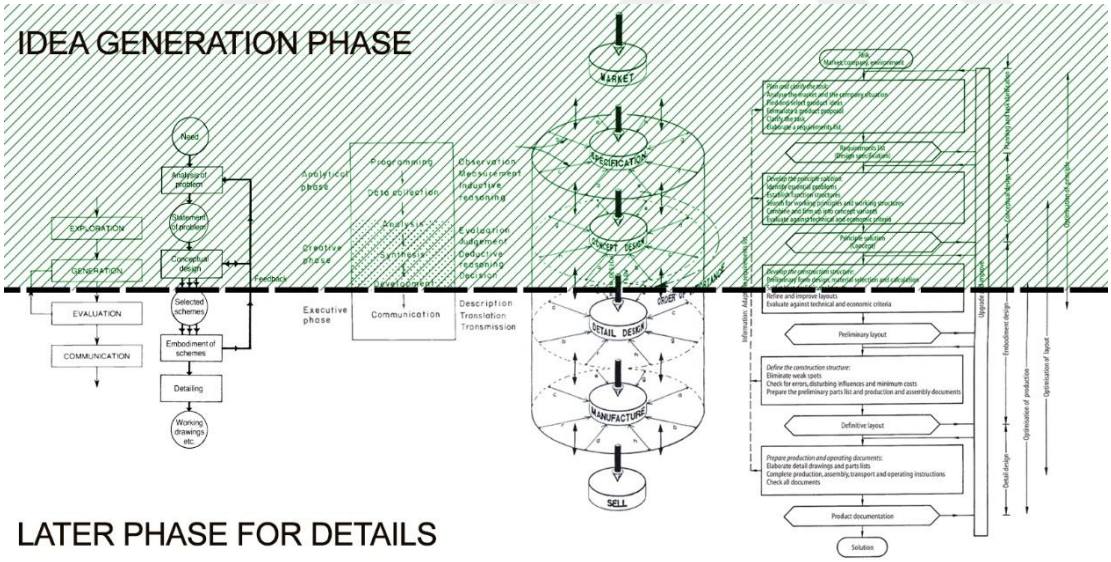


Figure 2.29 : Two Fundamental Areas of Design Process .

In the earlier chapters, I highlighted that the nature of design has an ambiguity. In the proposed models, dividing the phases sharply appears to be inconsistent with the ambiguity principle of the design process. Establishing the "uncertainty" logic between phases will strengthen the mechanism of models related to the design process. The ambiguous design idea does not only have to evolve in the idea generation phase and

be abandoned in the later phase. However, in the later phases, when the dominance of physical conditions increases, the design idea often loses its “ambiguity”. Attempt to understand these two phases separately causes to lose the basic features of the design.

In other words, although there is a structure in proposed models that gives feedback to each other and creates cyclic transitions, there is still a separation between initial and later phase. As long as this separation occurs, the idea generation phase will lose their freedom for flexible movements in the later phase. Because the transitions between these two phases do not occur exactly the same characteristics (Figure 2.30 :).

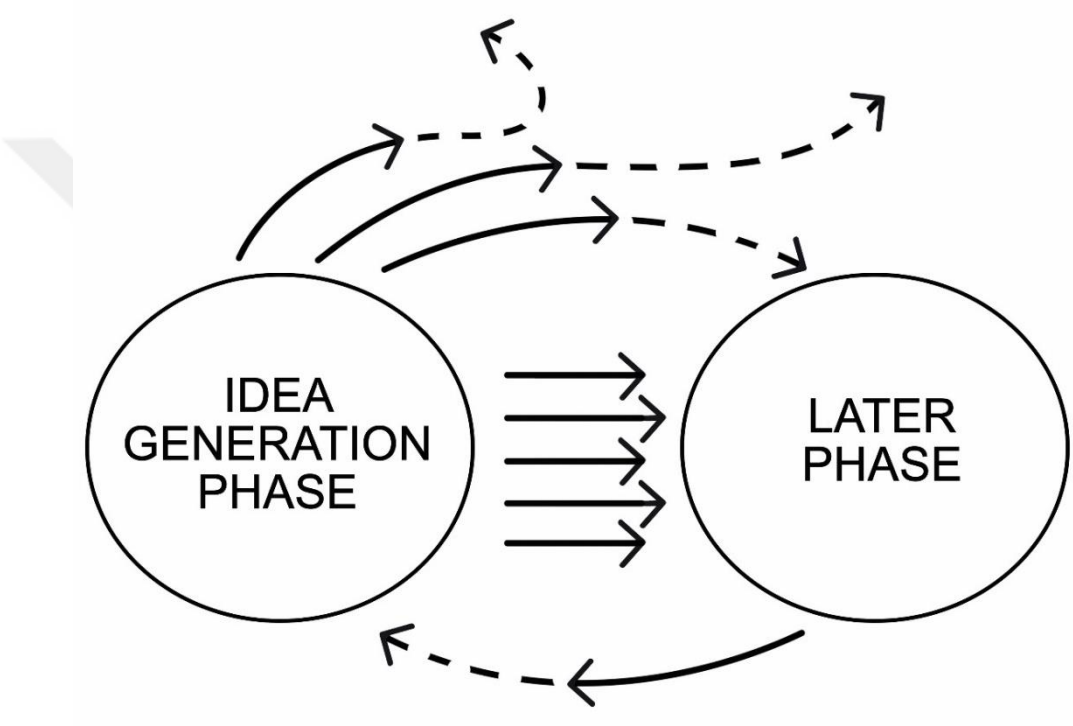


Figure 2.30 : Different Characteristics of Transitions in Design Process .

While the transition from idea generation to later phase is completely free, the later phase constantly limits the possibilities of the idea generations. Moreover, it may prevent some transitions from idea generation to a later phase. feedbacks from the later phase may cause a loss of originality in the generation of ideas. The power of the idea generation phase weakens as designers move to the later phase. Hence, it is necessary to keep the idea generation phase as effective as possible from the beginning to the end. Because it affects the entire process and design output predominantly. In other words, the idea generation plays an important role in the design process. It provides a foundation for the design project so that it is an essential element of the process. It is the area of new and creative configurations on design. For instance, Römer et al.

(2001) claimed that the initial design phases have the most significant impact on product cost. Further, it is estimated that 70% of a product's cost is defined during conceptual design (Pahl et al., 2007). Therefore, there has been growing interest in idea generation phase in the design research.

On the other hand, design students (or even some professional designers) tend to take short cuts in the idea generation phase and have difficulties understanding what the design process means (Newstetter & McCracken, 2001). This tendency has detrimental effects for designers. If design students and designers understand the importance of idea generation, they can prevent many difficulties. Because of all these concerns, this research focuses on the idea generation phase in the design process.

In addition, it should be noted that inclination of understanding the process, as divided phases, is contrary to the ambiguous nature of the design. Therefore, even if the phases are used in the researches while focusing on specific issues of design, the process needs to be grasped in a holistic way.

2.2 Creativity

Creativity is an important influence in the design process, but what is its impact specifically? Research on creativity can be arranged in various paradigms so that we can observe from which perspective researchers approach creativity. In this chapter, various approaches to creativity will be reviewed. Later, the views on the process of design and creativity will be examined and the organization between the two phenomena will be constructed. Finally, parameters of creativity on design output will be evaluated. Further, it will be observed how we can consider some designs as *creative output*.

2.2.1 Paradigms for creativity

The creative process is to produce both novel (or original) and appropriate (or useful) things (see, Lubart, 1994; Ochse, 1990; Sternberg, 1988; Sternberg & Lubart, 1991). It is a critical parameter of problem-solving in design, especially for competitive areas of designing. In the history of creativity, there have been many aspects of the understanding of "creative" situations. Sternberg (1999) grouped them as follows: (1) Mystical approaches; (2) Pragmatic approaches; (3) Psychodynamic approaches; (4) Psychometric approaches; (5) Cognitive approaches; (6) Social-personality

approaches; (7) Confluence approaches. They believed that the survey of these approaches covers some major highlights for creativity. In this section, I briefly reviewed some of these approaches.

Mystical approaches

Primeval thoughts regarding creativity possibly have a divine basis. The creative person might be full of inspiration in the body and mind. Plato claimed that the Muse lead a poet's creation ability, and accepted the Muse as a source of inspiration. Mystical sources result from creators' introspective reports (Chiselin, 1985). For instance, Kipling (1985) believed that the writer's pen has Daemon. Some people believe that creativity is a spiritual process. Therefore, the mystical approaches are not suitable for scientific studies.

Pragmatic approaches

Proponents of the pragmatic approach are interested in not theory, but practice. De Bono (1971, 1985, 1992) suggested various tools, such as PMI (pluses, minuses and interesting); word of "po" (as a reference for hy-po-thesis, sup-po-se, po-ssible, po-etry); thinking hats (individuals metaphorically wear different hats for data-based, intuitive, critical and generative thinking in order to see things from different points of view). Osborn (1953) also studied practices of advertising agencies. He developed the technique of brainstorming to, encourage people to solve problems creatively. It was a constructive way rather than critical and inhibitory. Gordon (1961) suggested *synectics* as a method of creative thinking which is based on analogy. The scientific study of creativity has been damaged by the pragmatic approach (Sternberg, 1999). These suggestions may be effective for creativity but they are empirically invalid.

Psychodynamic approaches

This approach can be seen as a source of major considerations of creativity in the twentieth-century. Freud (1908) found out the production of writers and artists ascreative work to express their unconscious wishes, such as power, richness, fame, etc. (Vernon, 1970). Consciousness and unconsciousness were the main concerns of psychodynamic approaches. Kubie (1958) highlighted the preconscious (it is between conscious reality and the encrypted unconscious) as a true source of creativity. Because thoughts are vague and interpretable at this moment. According to Kubie, unconsciousness affects creativity negatively. Because it causes fixated and repetitive

thoughts (I discussed fixated thoughts in the next chapters). It was the opposite view of Freud. The psychodynamic aspect of creativity focused on the case study, especially regarding eminent creators. However, it was criticized for the inability to measure by experimental methods (Weisberg, 1993). It indicates the need for more scientific ways to understand creativity.

Psychometric approaches

The infrequency of highly creative people (i.e., Michelangelo) may be a limitation of creativity research. However, Guilford (1950) suggested a psychometric approach to study everyday subjects by using paper and pencil tasks. "Divergent thinking" tasks became popular among researchers to measure creative thinking as a result of Guilford's suggestion. The tests were convenient to assess people on a creativity scale. Torrance (1974) developed the Torrance Tests of Creative Thinking. They include relatively simple verbal and figural tasks. The metrics of Torrance tests are as follows:

- fluency (number of solutions),
- flexibility (number of different categories of solutions),
- originality (rarity of solutions),
- elaboration (extent of detail in solutions).

This measuring system is objectively scorable assessment device. They can be used for not just eminent (and rare) creative artists but also everyday people. However, there have been some critics concerning the reliability of these metrics for capturing the concept of creativity (i.e., Amabile, 1983). There is still an ongoing debate for the definition and criteria for creativity. Researchers attempt to develop new metrics as an addition to these four criteria in recent publications.

Social-personality approaches

Personal, motivational and sociocultural variables are the foci of social-personality approach as a source of creativity. For this approach, personality traits characterize creative people (Amabile, 1983; Barron, 1968, 1969; Eysenck, 1993; Gough, 1979; MacKinnon, 1965). Barron and Harrington (1981) identified relevant traits by studying on high-creativity and low-creativity samples. Independence of judgment, self-confidence, attraction to complexity, aesthetic orientation, risk taking are some of these traits. Another view is to converge self-actualization and creativity. Boldness, courage, freedom, self-acceptance and other traits may contribute to an individual's

potential (Maslow, 1968). Having motivational force and being promoted by a supportive, evaluation-free environment are descriptions of self- actualization by Rogers (1954). On the other hand, Amabile (1983) defined the components of creative performance as follows (Figure 2.31 :): (1) domain-related skills, (2) creativity-related skills, (3) task motivation. They are three main components which constitute a complete set of the general factors necessary for creativity.

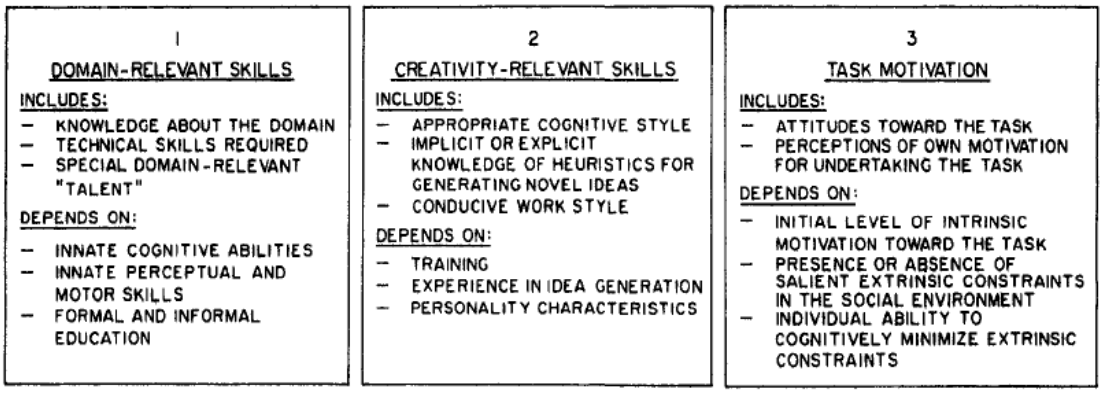


Figure 2.31 : Components of creative performance (Amabile, 1983, p. 362).

Further, he proposed a componential framework for creativity (Figure 2.32 :) and distributed three main components of the five-phased process. The first phase is related to the problem to be solved, task motivation plays an important role here. The second phase is preparatory to the actual generation of responses or solutions. Individual constructs or reactivates a store of information relevant to the problem. Duration of this phase depends on the individual's domain-relevant skills. The third phase is the generation of response possibilities by searching through the available pathways which are related to the task. Creativity-relevant skills and task motivation has an important role at this phase. The fourth phase is the validation of the response possibility that has been chosen on a particular problem. Its success depends on domain-relevant skills. The fifth phase is the decision making based on the test of the fourth phase. The process may end or return to earlier phases depending on the decision.

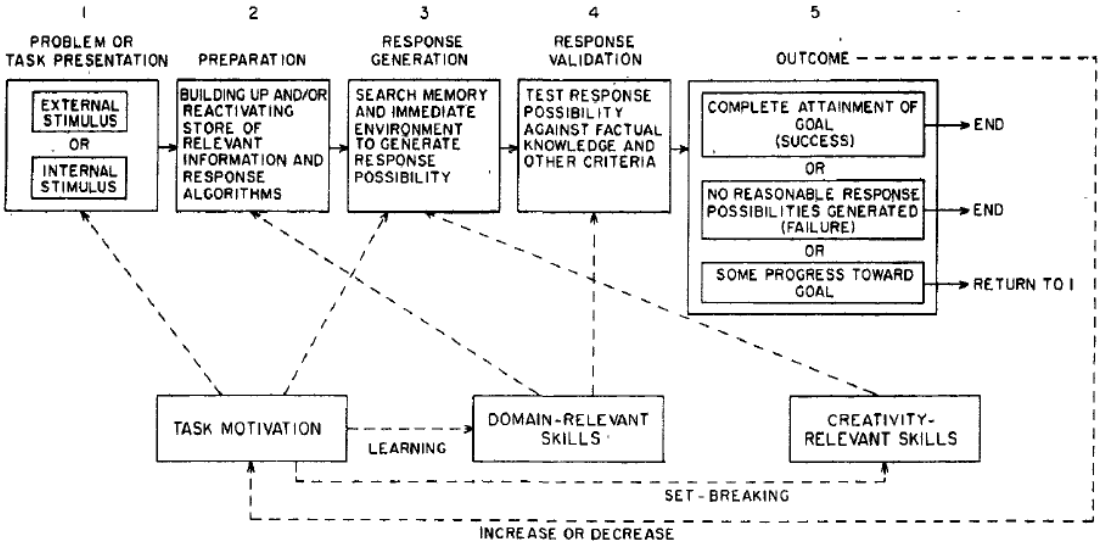


Figure 2.32 : Componential framework for creativity (Amabile, 1983, p. 367).

Task motivation (Amabile, 1983; Hennessey & Amabile, 1988), as a component of the creativity, refers to the importance of social aspects for creative performance. In addition, it can be seen that social-personality and cognitive approaches have provided significant insights into a different phase of the creative process. First component draws attention to the personality and social system, latter underlies the mental process of creativity.

Cognitive approaches

Mental process in the creative thought is the interest of the cognitive approach. Cognitive psychology and human cognition are combined in the cognitive approach of creativity. Subjects of this approach are generally human and computer simulations. Identifying the cognitive process of creative acts in scientific experiments is the main objective of this approach. Finke et al. (1992) have contributions of creative cognition (see also, S. M. Smith et al., 1995; Sternberg & Davidson, 1995). They offered *geneplore model* which has two basic phases in creative thought (Figure 2.33 :): (1) generative phase, (2) exploratory phase.

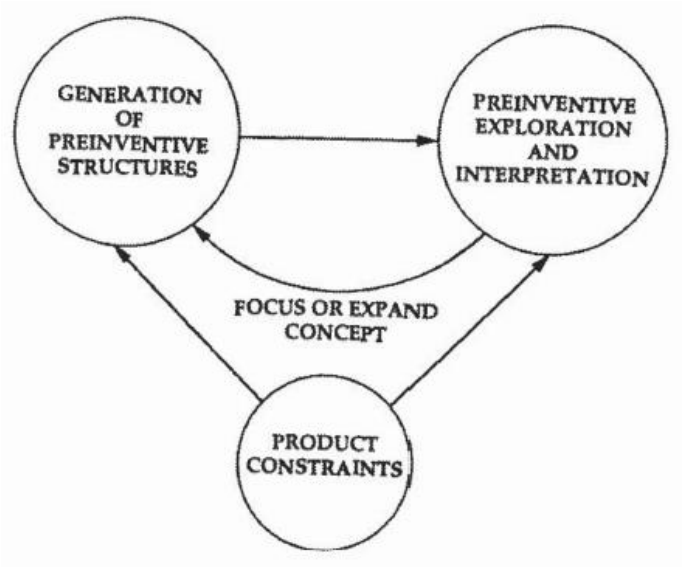


Figure 2.33 : The basic structure of the Geneplore model (Finke et al., 1992, p. 193).

A person builds up mental representations which are called pre-inventive structures in the *generative phase*. These structures have a role t*o foster creative discoveries of the individuals*. Then, creative ideas emerge in the *exploratory phase*, through mental representations. In other words, pre-inventive structures are. constructed during an initial, generative phase, and are interpreted during an exploratory phase. Then obtained creative insights can be expanded conceptually by modifying the pre-inventive structures and repeating the cycle. Product constraints can reshape the generative or exploratory phase at any time.

With this model, Finke (1990) conducted an experimental test. Subjects are asked to imagine combining of given objects to design a practical object (i.e., a piece of furniture). Then, outcomes are rated by judges for their *practicality* and *originality*. These two parameters are considered as major components of creativity in a cognitive approach. However, the effects of them on creativity may not have completely identical character. There are few studies about the different combinations of practicality and originality in the literature. This concern should be studied in-depth to understand creativity from a cognitive perspective. For instance, the combination of the two components at different percentages may result in creativities which have different qualities (Figure 2.34 :). Comparing various creativities that result from different combinations may contribute to obtaining sub-definitions of creativity beyond the standard definition. Sub-definitions may have a significant role in deciding what kind of creativity we want to achieve in the design process.

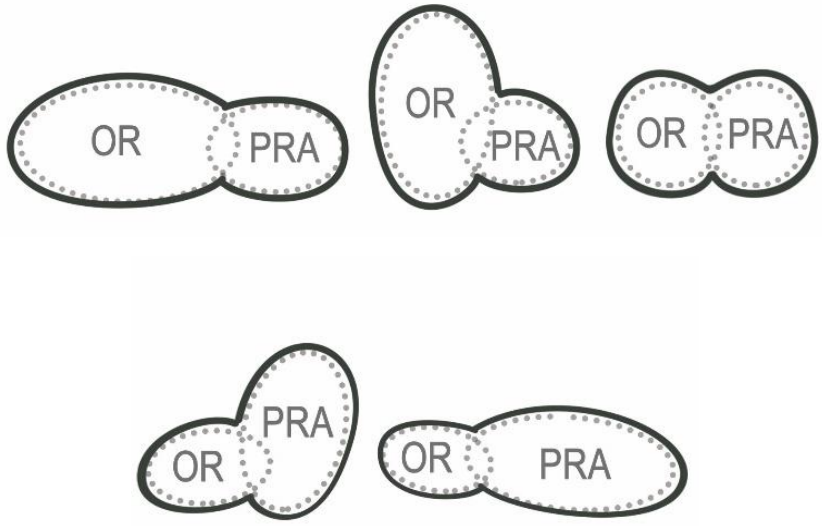


Figure 2.34 : Different Qualities of Creativity via Combinations of Originality and Practicality.

In addition, ordinary cognitive processes of extraordinary products in creativity are the proposition of Weisberg (1986, 1993). Candle problem of Duncker (1945) is a case study of Weisberg. He illustrated that the insights depend on subjects using conventional cognitive processes (such as analogical transfer) applied to knowledge already stored in memory.

The last three approaches contribute to scientific reasoning for creativity. In my research, approaches creativity is perceived as a cognitive process. Therefore, this research mostly will focus on the cognitive approach to creativity. It should be noted that other aspects are also important to grasp creativity, but they are not in the center of my research.

2.2.2 Creativity and design

Describing design as a creative occupation and designers as creative people is a common to view to relate design and creativity (e.g., Lawson, 2005). It refers to creativity as an integral part of the design process. Innovation is the area of implemented creative ideas comes from creativity in design (Amabile, 1996; Mumford & Gustafson, 1988). Illumination stage is thought as the emergence of a bright idea (Cross, 2005; Lawson, 2005). Many methods were suggested to prevent mental blocks and inhibition moments of creativity, such as brainstorming. These methods encourage people to generate ideas.

In the psychology, it is common to have four areas for creativity: (1) process, (2) product (or output); (3) person; (4) environment (Basadur et al., 2000; Murdock & Puccio, 1993; Rhodes, 1961). To recognize similarities and distinctions, Howard (2008) attempted to review the process and output of design and creativity. He believed that the integration of a creative process and design process may help to better use of creative tools and methods. His earlier studies demonstrate that design process and creative process have many similarities (Howard et al., 2007, 2008). However, in this publication, he focused on to assess and integrate the different perspectives of the two domains. Person and environment, which are a third and fourth area of creativity, are also important areas for understanding creativity but they are considered outside the scope of the research.

Design process and creative process

The nature of the design process and various models for it have been reviewed in the earlier chapters. Following the model of Pugh (1991), which has four stages, Howard (2008) added two more stages (one at the beginning, another at the end of suggested model) to offer a comparison table. It has six headings:

- establishing a need,
- analysis of the task,
- conceptual design,
- embodiment design,
- detailed design,
- the implementation phase.

In the creativity side, many psychologists developed theories regarding the creative process. (Howard, 2008) presented a comparative summary of the process models. Wallas (1926) offered a four-stage process: preparation, incubation, illumination, verification. His model remained the most well recognized creative models. However, it still has some critics (Thompson & Lordan, 2001). The sudden emergence of an idea is the main theme of his model. Later, structuralist description (Shneiderman, 2000) attempt to offer an explanation to emergence, describing conscious idea-generation as the deliberate connection of matrices of thought (Koestler, 1964). This view is similar to the structuralist proposition of Amabile (1983). According to him, new ideas are

generated through the combination of two or more old, existing ideas. Source of these views is Aristotle's rules of the association. Howard (2008) reviewed 19 process models and defined four common groups as major phases of a creative process:

- analysis,
- generation,
- evaluation,
- communication/implementation.

Similarities of the processes are the need for information and its analysis and understanding at the beginning of the processes. Thus, the "analysis phase" is the central component of the proposed integrated process. Analysis, generation and evaluation are a different types of assessment for conceptual design and the embodiment design phase. These assessments are also phases of the creative process. Hence, the creative process can be sub-process of the design process. Creative process may have constant cyclic movements between analysis phase, conceptual design phase and embodiment design phase (Figure 2.35 :).

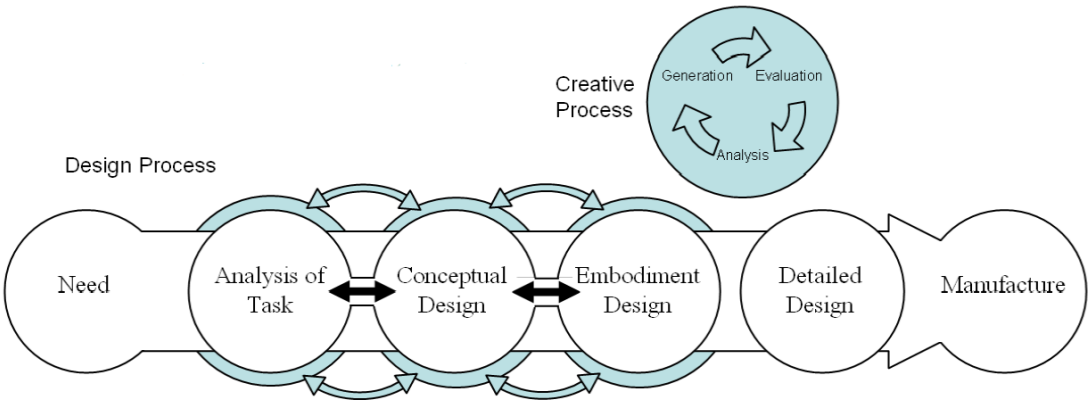


Figure 2.35 : The creative design process (Howard, 2008, p. 27).

Creative output

Output refers to a single idea, comprising of an association of two chunks of information (Howard et al., 2006). While the romantic view defines the creative output as magical or godlike (Boden, 1990; Goldenberg & Mazursky, 2002), it is considered as something original and appropriate in the scientific view. Howard (2008) organized definitions of creative outputs in the scientific literature (Table 2.1 :). *Originality* and

appropriateness are the two main elements of creativity. Researchers generally add third or more elements to focus on the more aspects of creativity.

Table 2.1 : Definitions of creative output (Howard, 2008).

Definitions	Originality			Appropriateness					Third Element										
	Novel	Original	New	Appropriate	Useful	Purposeful	Value	Meaningful	Tenable	Satisfying	Unobvious	Adaptive	Leap	Change	Unexpected	Communicated	Transformation	Resourceful
(Jackson & Messick, 1965)	X			X													X	
(Stein, 1974)	X				X				X	X			X	X				
(MacKinnon, 1975)	X									X		X				X		
(Rothenberg & Hausman, 1976)			X				X									X		
(Simon, 1979)	X						X											
(Amabile, 1983)	X			X														
(Sternberg, 1988)	X				X													
(Lumsdaine & Lumsdaine, 1995)			X					X										
(Gero, 1996)			X				X								X			
(Marakas & Elam, 1997)	X				X													
(Thompson & Lordan, 1999)			X		X													
(A. Warr & O'Neill, 2005)	X			X														
(Chakrabarti, 2006)	X					X												X
(Howard et al., 2006)		X		X								X						
(Lopez-Mesa & Vidal, 2006)	X					X						X						

To assess the appropriateness of output, the following question is used generally: Does it work or fit the specification? There is no right or wrong answer: ‘good’ rather than ‘correct’; ‘poor’, rather than ‘wrong’ (A. M. Warr, 2007). The degree of originality depends on its sample. If the same task is given to more competitive and experienced designers, an original idea may be produced faster and more than earlier subjects. Therefore, the originality of the output may change. In other words, an idea may become less original if it was produced by a large number of participants. P. Cheng et al. (2014) evaluated the originality of outputs by the following question: *Compared to the presented examples*, how original is this design? Amabile (1983) claimed that there are few objective methods of evaluating the creativity of a product and assessment is done by applying subjective judgements. On the other hand, Shalley and Gilson (2004) believed that only experts can judge whether these elements exist in a particular idea, in order to determine whether it is creative or not.

One of the important aspects of creativity review is that important role of external stimuli or inspirational inputs to increase creativity in the design process. In the next chapter, I will review what inspiration is, and its nature on the design process.

2.3 Stimulation and Inspiration

In this section, I will review the definition of stimulation; background and mechanism of stimulation; definition of inspiration. Later, my discussion will follow transitions between parameters of inspiration; benefits, aims and importance of inspiration. Next, I will elaborate on the types of inspirational sources. Then I will underline the importance of external sources in the design process. Finally, I will examine the process of selecting and adapting inspirational sources, in order to observe the influence of inspirational inputs in the design process.

2.3.1 Stimulation and stimulus

Stimulation is defined as a factor that encourages interest, motivation or excitement. This factor may promote an activity or process to initiate or improve (Cambridge, 2007; Microsoft, 2007; Oxford, 2007). Therefore, the main keywords of stimulation are "encouragement" for "interest, enthusiasm, excitement" in "the activity or process" in order to "begin or develop" (see, Figure 2.36 :).

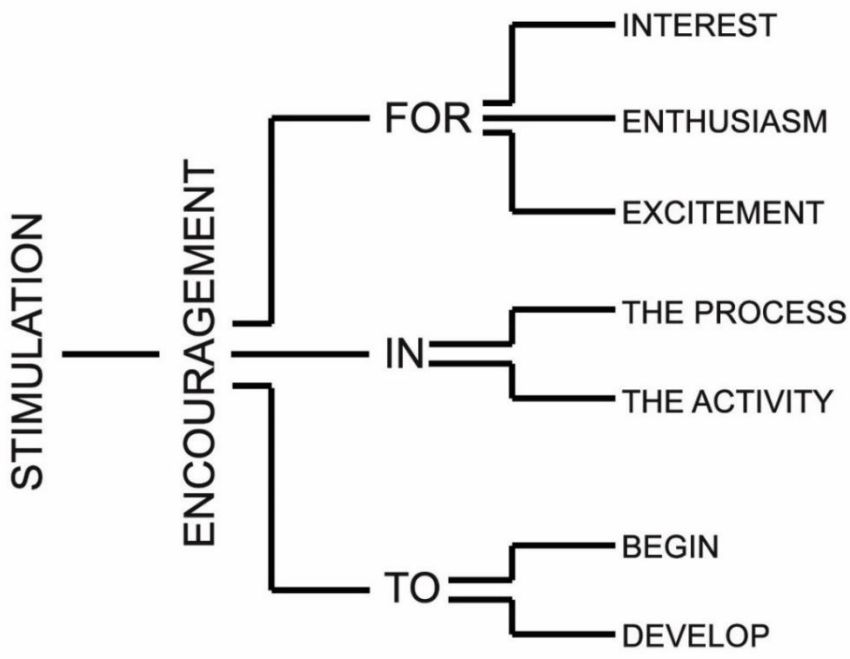


Figure 2.36 : Scheme of "stimulation" term .

Mechanism of cognitive stimulation – Theory of associative memory network

Mechanism of cognitive stimulation is that other's ideas or existing examples assist as cues that can help to keep relevant knowledge. The concept of cognitive stimulation

results from associative memory network (e.g., Anderson, 1983; A. M. Collins & Loftus, 1975; Raaijmakers & Shiffrin, 1981). It suggests that ideas are connected to each other and it communicates other related ideas. Furthermore, the nature of design contains a continuous switch between information from memory and stimuli. Internal (coming from memory) and external (coming from example solutions) stimuli provide describe, analyze and understand the world to have powerful reasoning aids (Ware, 2008) (Figure 2.37 :). Here, *internal* indicates representations which are inside the head, *external* refers representation which is outside of the head as opposed to internal sources.

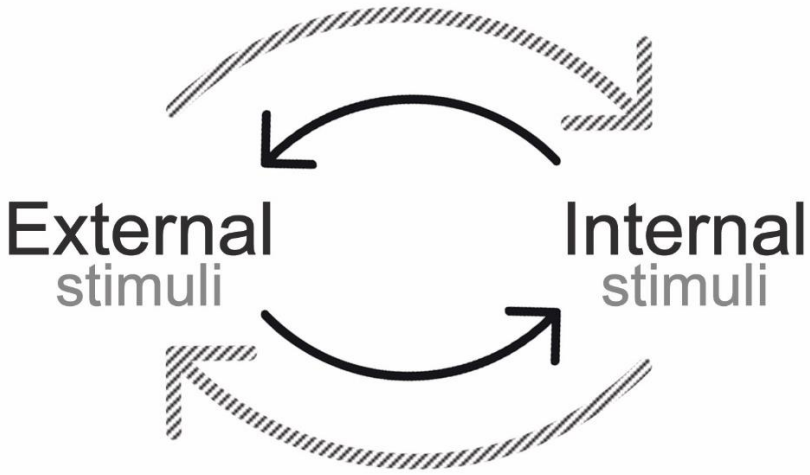


Figure 2.37 : Continuous switch between memory and stimuli (visualization adapted from Ware, 2008).

The following questions are for developing the discussion:

- Is it possible to define different characteristics of switch memory and stimuli in the theory of associative memory?
- For instance, is designer able to obtain the essence of unrelated internal stimulus and associate it related external stimulus? (Figure 2.38 :)
- In reverse, is designer able to obtain the essence of unrelated external stimulus and associate it related internal stimulus? (Figure 2.38 :)

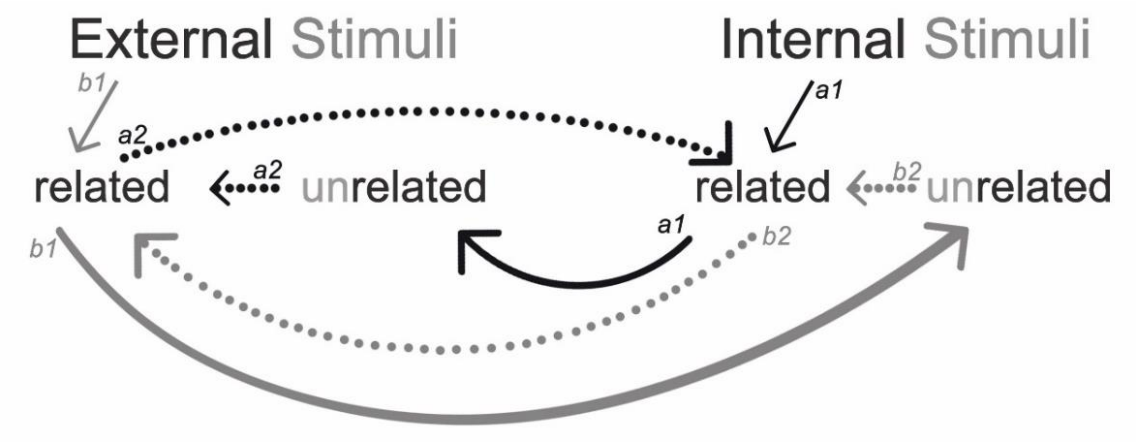


Figure 2.38 : Various types of switches.

There may be alternative types of switches between memory and stimuli. Moreover, they may be assigned to different phases of the design process depending on their impact. Although various interactions may be occurred depending on the phases, I will fundamentally focus on what kind of interaction occurs in the idea generation phase.

The efficiency of stimulus

The stimulus communicates with designers in different ways. The efficiency of stimuli may have two criteria: content and representation (Sarkar & Chakrabarti, 2008). Content of stimuli may be investigated by "which" question, while "how" questions are related to the representation of stimuli. Thus, the question of content is that "which" stimuli should be shown, while the question of representation is that "how" stimuli should be shown (Figure 2.39 :). Designers are exposed by stimuli depending on both content and representation. These two components may create two conditions:

- Different kinds of representation in the same content
- Different kinds of content in the same representation

In addition, representations may have sub-group in the same representation which has a different influence.

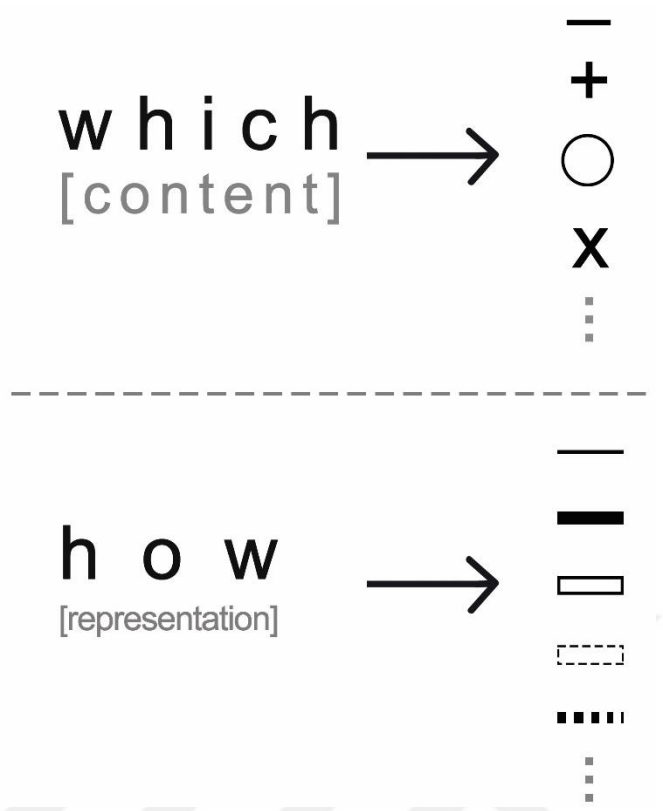


Figure 2.39 : Criteria of the efficiency of stimuli.

Stimulus as a source of inspiration

The motivation which is resulted from stimuli may emerge immediately or later on. Whenever it comes up, it may initiate potential associations. According to Mednick (1962), associations between information from memory and external stimuli can contribute to the creation of new meanings. Hence, stimuli for design students and designers at the initial stages of the design process may inspire the producing new ideas (Georgiev et al., 2008; Liu et al., 2017). It may give a reason for the assertion of P.-J. Cheng and Yen (2008) that most designers spend over one-third of their time of idea generation to search for references. In conclusion, each stimulus may be a possible source of inspiration. Definition of inspiration, its importance and its types need to be reviewed so as to clarify the relationship between inspiration and creativity.

2.3.2 Inspiration

Inspiration has been defined as *the process of being mentally stimulated to do or feel something, especially to do something creative* (Oxford, 2007). However, it seems not adequate to analyze the notion, specifically in the design process. Inspiration may be considered as (1) kind of stimulus or (2) result of the impression of the stimulus.

- (1) As a stimulus, it is retrieved from designer's memory or from external sources and influences the design process directly or indirectly in the problem space by reframing the problem or in solution space by generating alternative solutions.
- (2) The reason for the latter consideration is that every stimulation doesn't have to be inspirational activity; designers may be stimulated but neglect it. Therefore, there may be an inspirational threshold among stimuli. Further, designers may have low or high inspirational threshold depending on the level at which have an effect.

Considering all, as Gonçalves et al. (2016) claimed, information only may become inspirational after it is perceived, understood by a receiver and included in the problem and solution space. In any case, inspiration may be a motivation to strive for new meanings and possibilities. Figure 2.40 : shows parameters of inspiration: (1) its source (internal or external), (2) its ways of impact (directly or indirectly), (3) its space of impact (problem or solution space)

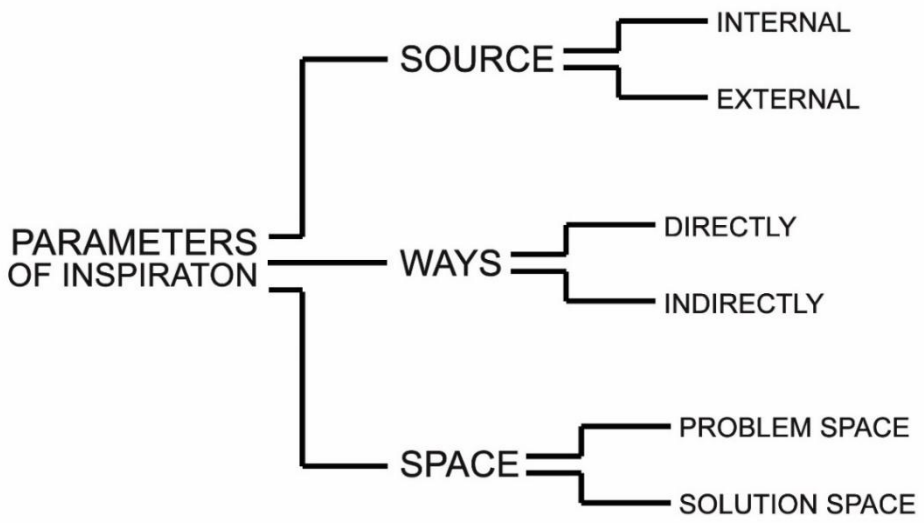


Figure 2.40 : Parameters of inspiration.

Inspiration may come from just an internal source with a direct way to generate alternative solutions (i.e., by just thinking). However, this is an isolated relationship and inconsistent with the nature of the thinking process and inspiration. One-way relation among parameters of inspiration may be infrequent activity. Because each association process stimulates new relations, not just between-parameter but also within-parameter relations. For instance, inspiration may come from an external

source, it may immediately connect some information stored in memory (as an example of within-parameter relation), designers may try to use it directly for reframing the problem. However, reframing the problem may simultaneously motivate the designer to generate new solutions indirectly. Further, the new solution may be an external inspirational source and the process may begin again. The distinction between the two examples is shown in Figure 2.41 :.

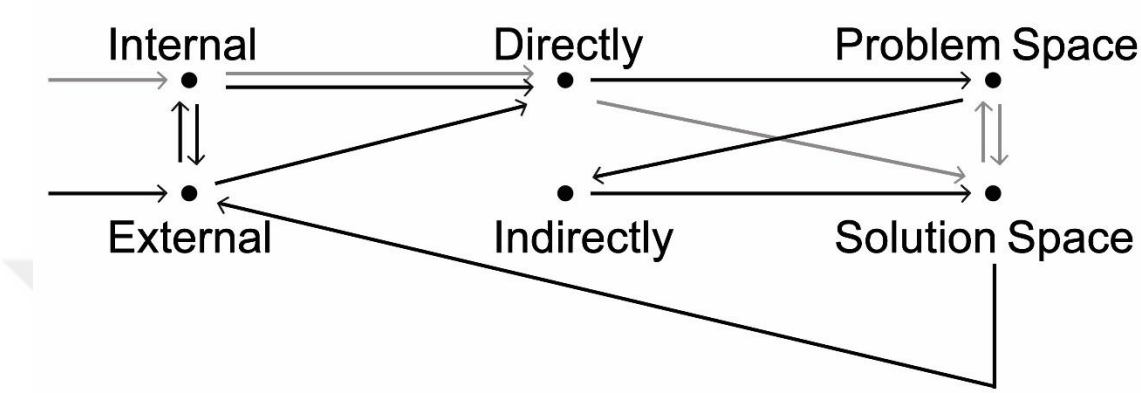


Figure 2.41 : Two examples of relations of inspirational parameters.

Besides all, the following question comes to mind: Instead of an earlier solution, designers can create their own inspiration by building up new inspirational inputs from given inspirations? I will call it *self-constructed stimuli* in the next chapters.

Types of inspirational sources

In the section of *the efficiency of stimulus*, I mentioned similar distinctions for stimuli, as content and representation. I will have a further discussion for inspirational sources.

As content - As mentioned in 'stimulus' section before, studies found that both the representation and content of sources influence designers' problem space and solution space in the design process (Cai et al., 2010; Sarkar & Chakrabarti, 2008). In the context of the content, relevance of source may be a distinctive feature. For instance, proximity to the field in the content may be a component as "near" and "far" analogical stimuli (Fu et al., 2013). Most designs are a continuation of previous design by combining and transforming them. However, the source may be elements of other objects, images and phenomena as well. Figure 2.42 : shows some examples of the content of inspiration.

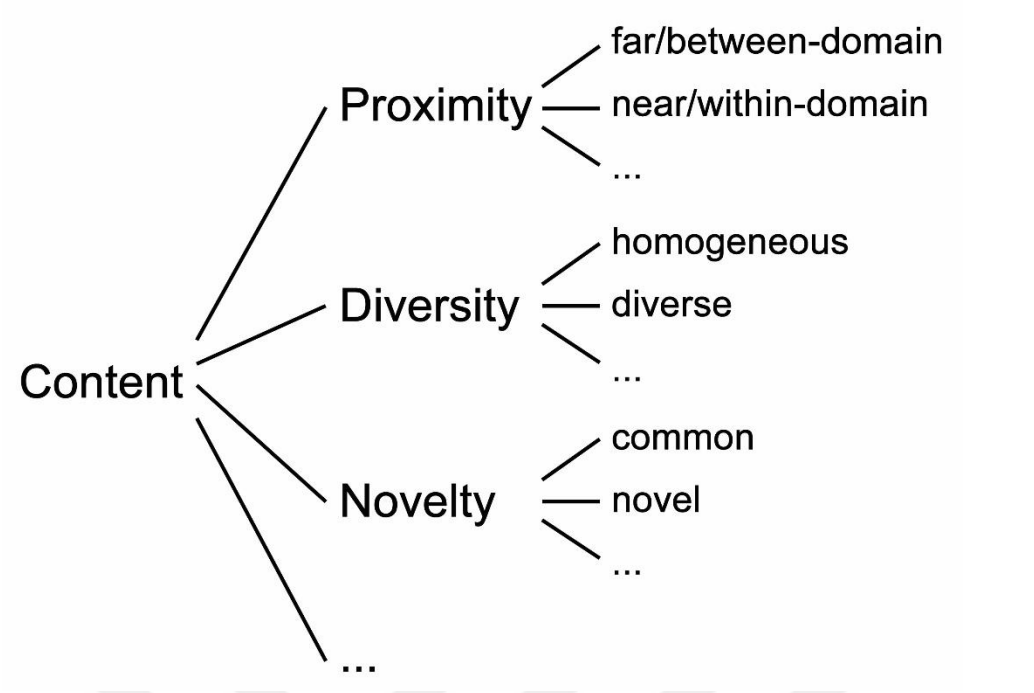


Figure 2.42 : Example for content of inspiration.

As representation - Representations of stimuli are divided into two sections: Visser (2006) highlighted design as a construction of representations where the source may be mental (e.g. from memory) or external (e.g. visual, textual, physical, etc.). As mentioned before, internal indicates representations which are inside the head, external refers representation which is outside of the head as opposed to internal sources. According to Eastman (2001), the internal source describes the designer's previous experience and background, while the external source depends on the use of other information sources. Figure 2.43 : shows some examples for both sections of representation.

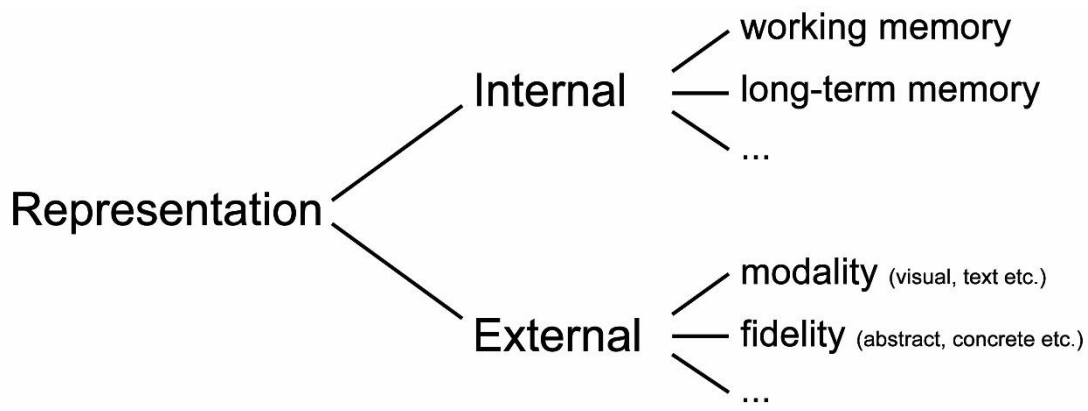


Figure 2.43 : Examples for representation of inspiration.

In addition, stimulation may emerge as other people's ideas as well as physical sources. Social psychologists have recently shown that other's ideas can positively influence the designer's qualification to generate ideas through cognitive stimulation (e.g., V. R. Brown et al., 1998; Coskun et al., 2000; Dugosh & Paulus, 2005; Dugosh et al., 2000; Hinsz et al., 1997; Nijstad, 2000; Nijstad et al., 2002; Paulus & Yang, 2000). This is parallel to the perspective of *social-personality approaches* section in the chapter of *creativity*. Hence, socialization is a point to be considered as a type of inspirational source.

Benefits of inspiration

One way or another, inspirational sources are cues that can help designers to broaden problem and solution space. Broader problem space provides a characterization of the context for new designs. It promotes the expansion of visual thinking among possible solutions. Laamanen and Seitamaa-Hakkarainen (2015), found that designers use supporting practices (such as collecting and experimenting) and stimuli (such as inspirational sources and mental images) to improve framing skills of design space. It supports the finding of Keller et al. (2006) that designers surround themselves with potential inspirational tools by collecting different kinds of materials. This is not just an operation during solving the problem, but also kind of routine. Mougenot et al. (2008) suggest that collecting inspirational materials is a continuous process. Because inspiration is not a *9-to-5-job*. Designers are the builder of their inspiring environments. It refers that collections of example ideas can serve as an important resource for creative production (Chan et al., 2014). This practice provides alternative paths among sources as a discovery process for idea generation. Following paths, designers may identify appropriate sources in order to develop the creative process. Another explanation for the designer's behavior results from daily life (Goldschmidt & Sever, 2011; Herring et al., 2009). Designers are widely influenced by their surroundings in daily lives. This influence can occur in a systematic way, when designers actively search for inspiration, or even unconsciously.

In addition to inspirational sources, instructions, as definitions of design task, provide a reference for understanding and framing the design problem. However, designers don't need to fix their minds to just given instructions and their limited possibilities. LeFevre and Dixon (1986) claimed that participants have a tendency to follow the

given examples as an inspirational source than they are to follow the instructions. This tendency raises some questions:

- Is it because of designers are more likely to think that instruction is for just information instead of an inspirational tool?
- Are designers stimulated by instructions if it includes immersive inspirational cues?
- Do they necessarily need to think inspiration and instructions separately?

Instruction of problem and its contributions are needed to be studied in detail as another research area of inspiration. However, it is not the focus of this research. The current research focus on given external stimuli as inspirational sources, rather than instructions.

Aim of inspiration studies

Studies of inspiration may supply crucial insights into design creativity. Reviewing the current literature is an important phase of creativity studies to understand how to organize future studies and their goals. Comprehensive scopes for creativity by investigations of inspiration may allow us to improve the design in education and practice. It results from new studies for developing supporting tools for design. Following that, advanced design methods may adapt to designers current and future problems of the design area in the world by producing creative outcomes. According to Mulder-Nijkamp and Corremans (2014), it is essential to support novice students in getting inspired in various ways and learning them to use inspiration techniques effectively. But how? Novice students need to internalize inspirational techniques to use them effectively.

Importance of external sources

Theory of embodied cognition claim that external representations are particularly useful for difficult tasks. In the view of M. Wilson (2002), cognitive activity happens in the context of a real-world environment, and it inherently involves perception and action. The external source (e.g., such as visual and textual examples) may assist in internal activities when the internal source (e.g., long-term memory) is not sufficient to solve the problem. Even if the external sources are unnecessary for the design process, they may contribute to generating novel ideas.

On the other hand, researchers emphasized that the type of stimulus designers search for is dependent on the context of the problem (Eckert & Stacey, 2003; Gonçalves et al., 2013; Mougenot et al., 2008). Hence, the problem itself and inspiration affect each other. The nature of the problem is inclined to vary designers' preferences for components of representation, such as modalities, fidelity, the number of stimuli and so on. Further, designers know that various forms of representation affect their thinking (V. Goel, 1995). Therefore, the following claims were inferred:

- Designers' ability to decide which modifications of representation and content is significant to adapt its effort into the context of the problem.
- This ability may be improved, for instance, with new experiences.
- On the other side, capability for using internal source make designers competent to deal with the problem. If the designer needs to use previous experience from memory as an internal source, they should have the ability to stretch out the scope of internal source to fit in the new problem. It indicates the flexibility of designers' mind in critical thinking.

Considering all, the potential of external sources and the influence of different types of sources in the process is the focus of my research. Therefore, relations between internal and external sources is crucial so as to understand the impact of inspiration in the design activity.

2.3.3 Process of selecting and adapting inspirational source

So far, phenomenon of inspiration itself has been discussed. the However, the interaction between inspirational source and designers need to be reviewed so as to elucidate the role of inspiration. Eckert and Stacey (2003) illustrated the adaptation of inspirational source as a process. At the beginning of the process, some designers pointed out that they generally design in their heads until they feel ready to draw them to associate with other ideas. Are designers inclined to fixate surface features of source, if they start with sources without getting ready for a restricted region of inspiration for problem space? In researchers' suggestion, after getting ready for sources, the features of the source are adjusted to accommodate the given constraints. The analogical mapping between source and possible design is fulfilled to catch possible improvement for design. Designers evaluated the adaption of the source into the design. If the result of the evaluation is not satisfied for them, they can modify the

form of adaptation or leave it out and select a different source. The response of authors' question of how they decide adaptation is suitable is generally "I just know". It depends on they like it or not, but there is no reason why they like. Here, some questions have appeared:

- What are the key criteria to decide whether adaptation of source is convenient for creative design?
- How can they improve their evaluation skills of inspirational sources?
- Is it possible by experiencing more and more adaptation process of inspiration source into various design problem?
- Or, much experience constraints their exploration of creativity and cause to conform themselves some practical but not much novel ideas?
- What if they may eliminate stronger creative results unconsciously in the moment of evaluation? How can they prevent the extermination of potential creativities?

If adaptations of source have a possibility to increase novelty later and designers cannot endure much cognitive load, some supporting tools (especially computational) may help designers to collect and retrieve when needed.

Parallel with the suggestion of Eckert and Stacey (2003), Gonçalves et al. (2013) developed an illustration of the inspirational search process in different steps of a design task (Figure 2.44 :). It meets the needs of definition for problem space and solutions in the process of interaction with inspirational sources.

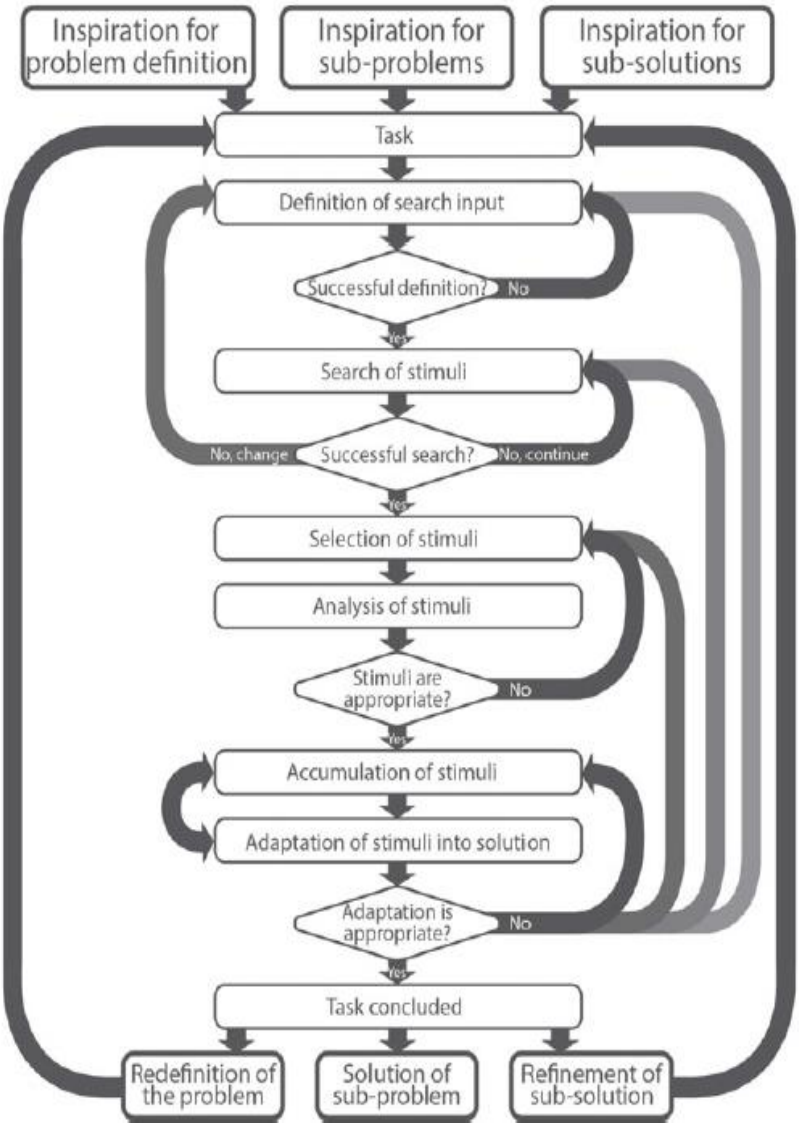


Figure 2.44 : Designers' inspiration process flowchart (Gonçalves et al., 2013, p. 10).

Inspiration may provide stimulation for both to redefine the problem and to explore or refine the solution. Again, designers start the search inputs after they think that they need them. It provides specific direction for searching (as mentioned before, the timing of inspiration in the process need to be studied to observe the influence of specific and unspecific directions). If there is a failure of convenient stimulus, they can change stimulus or direction of searching. Its achievement depends on the designers' expectations. If stimuli are satisfied for designers, they can adapt them to solve the problem. In addition, they can refine the solution and redefine the problem in the lights of the adaptation of stimulus. Then, they can initiate a new searching process. This cycle may direct designers to explore more creative designs spontaneously.

- However, when do designers end the cycling process?
- How many cycles is adequate for creative design? It may depend on the nature of the problem and capability of the designer, but the main point of the question is how designers can decide to stop this process.
- Do designers have a role in the quality of these cycles? They may be not just qualitative cycles, but also qualitative movements. Hence, designers may redefine the quality of cycles. However, it needs to be studied.
- If designers are able to foresee the next cycle may cause regression in the process, they can take precautions or stop to cycle it. Conversely, if designers can foresee the next cycle may contribute to the improvement of design, they can keep to cycle, even if they thought to have adequate creativity for its standard.

As a result, starting and ending of the interaction process need to be studied regarding dependent variables, such as the definition of the problem.

Researchers illustrated the flowchart based on the process of eight students in industrial design. This condition provides some additional questions and assumptions:

- Can the flowchart be developed by analyzing the process of more subjects? It may help to add more actions or to find out the more efficient routes or to examine the general tendency of choosing the route among novice students.
- Is there any differentiation of tendency for students of architecture? It is expected not much because of being novice students who are untrained in any fields. However, for a similar reason, it may be a critical stage of education to get proper skills for creative design.
- Is it possible to extend flowchart regarding novice and senior students and professional designers? It may be a beneficial visualization study to clarify the differences of interaction with an inspirational environment while becoming an expert.

To sum up, stimulation is a state of activating for interest or enthusiasm to begin or develop something in a moment or process. The foundation of the cognitive stimulation is the theory of associative memory network which supports ideas are connected to each other and others. A stimulus is anything which stimulates designers

to do something and which initiates potential associations. Inspiration can be defined as the process of stimulation, especially for creative activity. It has either a direct or indirect influence to motivate designers' endeavor for new possibilities. This motivation reinforces its importance in the process. Inspirational sources are cues that promote designers to broaden problem and solution space which indicates more creative designs. Designers are influenced by their environment. Therefore, they intentionally collect materials for inspiring surroundings. Inspirational sources are basically divided into two forms of sorting: content and representation. The efficiency of stimuli depends on them. Internal and external sources are two bases of representational division. They are identified depending on existing inside (i.e., previous experience) or outside (i.e., other information sources) of the head. The focus of the thesis is on external representations. Because external sources may be a significant collaborator of internal activities in the case that internal source is not adequate to solve the problem, especially with creative outcomes. However, anyone cannot assure designers that each stimulus concludes with a more creative result. Even if designers want to utilize stimulus as an inspirational source, somehow it may fixate their mind to its surface features and they may lose potential creative contributions of the source. In the next chapter, I will review fixation literature and discuss several concerns regarding fixation in detailed.

2.4 Fixation in Design Process

Inspirational sources may serve for a critical dimension of the design process. However, every source examined in the process may not result in increasing the creativity of the designer. Sometimes it causes to fix the process, instead of using that source to advance to the next steps. This fixated situation has been termed as fixation in the literature. In this chapter, I will review a short history of fixation and its various definitions in design in order to examine its common features. Related terms to fixation will be shown to spot similar concerns to fixation in different terms. Next, I will explain the fundamental reasons for fixation and how fixation may affect designers. Finally, I will add further questions regarding fixation in order to be aware of research areas for fixation.

2.4.1 A short history of fixation: Types of fixation

Fundamental field of fixation studies was cognitive psychology. The earliest use of the term was in the research of this field. Cognitive psychologists were interested in fixation in problem solving theory around the 1930s. The protagonists of the Gestalt theory introduced the concept of fixation through a series of studies conducted to explore the occurrence of fixated behavior (Duncker, 1945; Luchins & Luchins, 1959; Maier, 1931). Different types of fixation in the history of the term can be observed. Three types of fixation are typically acknowledged: (1) functional fixedness (Duncker, 1945; Maier, 1931); (2) mental set or Einstellung (Luchins, 1942); (3) memory blocking (S. M. Smith, 1995).

Functional Fixedness - Maier (1931) gave a problem of tying together two strings which were suspended some distance apart from each other from the ceiling. There was a need to use the pliers as a pendulum weight, as an atypical use for pliers, in order to solve the problem. He noticed that subjects were mostly not able to use the pliers in any way other than to grasp objects in the normal functioning mode. It was the restriction of the subject's use of an object to previously encountered functions. Therefore, fixation was initially thought to be related to the way that a person is ‘fixated’ by the common functional properties of the object. It was the way that the use of an object is limited to its intended function. It is termed as functional fixedness (Duncker, 1945). In other words, the designer focuses on a certain function in a design or object despite there being numerous other functions that need to be addressed in order to solve a problem (Arnon & Kreitler, 1984; Maier, 1931).

Mental Set / Mechanized Thought / The Effect of Einstellung - It refers to a behavior whereby people follow a constant frame of mind relating to an existing approach to solve a problem. Luchins (1942); Luchins and Luchins (1959, 1972) have conducted many pieces of research of mental set. In his studies, subjects were given several mathematics/word problems. Most of them could be solved by the same complex algorithm, however, one of them could not be solved by this algorithm. Subjects need to find the solution from a simple and obvious alternative approach. Most subjects were fixated on the first algorithm and did not recognize the simple solution for the last problem. This blind adherence to one solution has been termed as mechanized thought. It is a learning process of a routine representation of the problem and it causes to create an obstacle to find a correct solution when encountering an out of routine

representation. Another example of studies of Luchins is a water-jar problem. There are three various sized containers and unlimited water. Several consecutive problems can be solved with a simple rule (fill the biggest jar and reduce the amount of water by filling both of the smaller ones). However, the next problem needs a different rule for the solution. Subjects couldn't solve the last problem. Because their thinking is mechanized by the repetition of a particular rule.

Memory Blocking - S. M. Smith (1995) introduced fixation as a memory block. He has used Remote Associates Test problem by Mednick (1962) to demonstrate memory blocking. Remote Associates Test problems encompass associating three words with a single correct word. It is used to associate words of house-apple-family with a related word – and the correct solution is tree. Thinking of the word green causes ending up in an impasse. The retrieval process becomes stuck because of the more activation to the incorrect solution of a negative start

When comparing these three types of fixation, functional fixedness is a long-term and enduring type of block to successful problem solving. Nonetheless, the mental set and memory blocking are situationally-induced. It means that it causes because of a given situation. Hence, it can be changed by inducing different situation.

More recently, there have been specific approaches for fixation: Cognitive fixation and Design Fixation.

Cognitive Fixation - Many studies regarding cognitive fixation have appeared in the last decades. S. M. Smith and Blankenship (1989, 1991) manipulated fixating cues to investigate the effects of past experiences on a different problem-solving task. According to them, if knowledge is applied inappropriately, performance could fail. Thus, the use of prior experience may be counterproductive and may cause interference effects in memory.

Design Fixation - Initial attempts to understand the situation of fixation by using mostly mathematics and word problems. In solving mathematical problems, fixating on an example solution path can guarantee to focus and provide a clear notion to a correct solution (Goldschmidt, 1989; Voss et al., 1980). However, design problems are less restrictive than problems in mathematics. Although a more limited scope may be helpful to solve mathematical problems, it may limit the design space of designers in developing novel solutions. This distinction results from whether there is a

requirement of novel solutions in the fields. Therefore, the attributes and concerns of the design fixation may be different from other types of fixations. (Jansson & Smith, 1991) were the first to document fixation in the design field. They conducted an experiment with four different design problems and found significant evidence of conformity effects across the design problems.

Definitions of fixation

The use of fixation term specifically for design is based on the study of Jansson and Smith (1991). They showed designers an example solution with the design brief and found that this prevented movements between the conceptual space (which involves abstract ideas) and the configuration space (which involves potential solutions). They observed the blind adherence to a limited set of ideas in the design process. This blind adherence may lead designers to counterproductive ways. Design fixation refers to the innate attachment of a person to initial ideas (or existing examples), which in turn confines the person's scope for creativity. Such attachment to existing solutions causes an *inappropriate repetition of existing key attributes of available solutions*. Fixation is a kind of tendency to reuse principles of examples without thinking about their suitability. It refers to the phenomenon that designers adhere to a couple of existing ideas or concepts, consciously or unconsciously. Fixation can be considered as an obstacle for solving a given design problem, generally self-imposed by the designer. Therefore, the given examples, especially in the idea generation phase, may unfavorably interfere with the creative process. Following the study of Jansson and Smith (1991), fixation in design has attracted many researchers. I have listed some of the other definitions of design fixation:

- Form of cognitive interference, which is influential in the design and other problem-solving (S. M. Smith et al., 1993).
- Something that impedes the successful completion of various types of cognitive operations, such as solving problems, and generating creative ideas (S. M. Smith et al., 1993).
- A negative transfer of knowledge between a source (perceived stimuli) and target (solution idea/concept) (S. M. Smith et al., 1993).

- “Fixation … is an example of negative transfer in which one adheres to example elements or previous solutions that may not be useful in the current problem-solving context” (Chrysikou & Weisberg, 2005, p. 1134).
- “A cognitive memory phenomenon related to interfering effects of prior knowledge” (Perttula, 2006, p. 34).
- “Inadequate and excessive reuse of existing (parts of) available solutions” (Cardoso et al., 2009, p. 995).
- “Premature, and sometimes inappropriate, attachment to design features” (Cardoso et al., 2009, p. 995).
- “An effect in which an individual might unconsciously focus on certain aspects of an object or a task, whilst leaving others aside” (Vasconcelos & Crilly, 2016, p. 3).
- An inadvertent attachment to, and subsequent reuse of, particular key attributes (features or principles) from existing concepts/objects without analysis of their appropriateness (Cardoso & Badke-Schaub, 2011). To make the definition of fixation clearer, Figure 2.45 : shows a fixation schema in the design process.

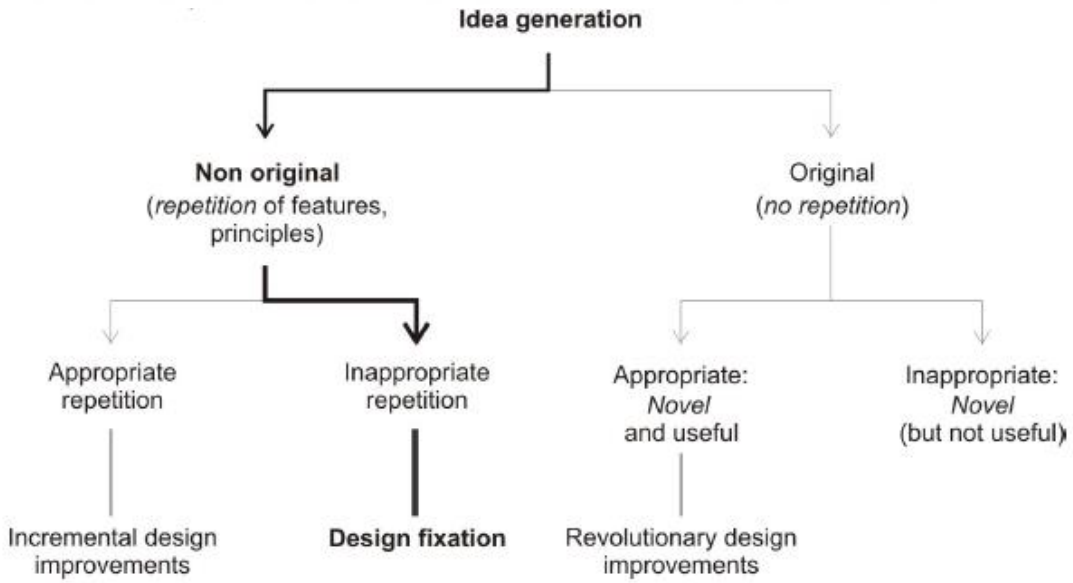


Figure 2.45 : Possible outcomes of an idea generation process (Cardoso & Badke-Schaub, 2011, p. 132).

Further, Finke (1996) defined the design fixation as a tendency to build up new generations similar to familiar forms. He related this concept with the theory of structured imagination by Ward (1994). Structured imagination is the propensity of

generating new ideas that are heavily structured based on the properties of existing concepts (Ward, 1995). In a similar vein, other design researches have shown that designers are inclined to match the current problem to parallel design problems that they have previously encountered (Lawson, 2005).

Considering the definitions summarized above, descriptions for design fixation has both narrow and broad scopes in the literature. A designer's overreliance on the features given in examples (Youmans & Arciszewski, 2014) or a tendency to build up new creations similar to familiar forms (Finke, 1996) refers to narrower interpretation. Nonetheless, any cognitive interference that guides the design work (Perttula & Sipilä, 2007) or any process that can interfere during creative acts (Agogué et al., 2014) or a specific instance of low creativity levels (Zahner et al., 2010) refers to broader interpretations.

To develop a comprehensive description of design fixation, Crilly and Cardoso (2017) proposed a definition that is inclusive of many different kinds of design activity (not just conceptual design), many different sources of bias (not just example solutions) and many different consequences of that bias (not just limited design outputs):

> "Design fixation is a state in which someone engaged in a design task undertakes a restricted exploration of the design space due to an unconscious bias resulting from prior experiences, knowledge or assumptions". (pp. 6)

Related terms to fixation

There have been developed terms which are similar to fixation in the various researches. Crilly and Cardoso (2017) made a list of alternative terms to fixation. I present them in chronological order as follows:

- tolerance for ambiguity (e.g., Stanley Budner, 1962)
- paradigm-induced blindness (e.g., Kuhn, 1962)
- primary generator (e.g., Darke, 1979)
- priming (e.g., Tulving et al., 1982)
- sunk cost effect (e.g., Arkes & Blumer, 1985)
- attentional blink (e.g., Raymond et al., 1992)
- path of least resistance (e.g., Ward, 1994)
- satisfaction of search - SOS (e.g., Berbaum et al., 1994)
- confirmation bias (e.g., Nickerson, 1998)

- inattentional blindness (e.g., Simons & Chabris, 1999)
- stuckness (e.g., Sachs, 1999)
- local search bias (e.g., Rosenkopf & Nerkar, 2001)
- premature commitment (e.g., Carroll, 2002)
- memory blocking or mental-rut (e.g., S. M. Smith, 2003)
- cognitive entrenchment (e.g., Dane, 2010)
- IKEA effect (e.g., Norton et al., 2012)
- psychological ownership (e.g., Baer & Brown, 2012)
- hill climbing or local minima/maxima (e.g., Minda, 2015, p. 199)
- subsequent search misses - SSM (e.g., Biggs et al., 2015)

The list has been shared to be aware of the growing interest in fixation-related researches. Thus, I won't discuss each related term in detail in order to avoid to distract the focus of the research.

2.4.2 Fundamental reasons for fixation

There is a common concern regarding fixation and its detrimental effect on design. Before suggesting some solutions to mitigate fixation, the fundamental reasons for fixation need to be reviewed. Here, I created basic groups for explanations as follows: (1) Cognitive and psychological tendencies (e.g., avoidance to rework by Youmans and Arciszewski (2014)); (2) Profile of subjects (e.g., novice designers tend to fixate more than experts by Gonçalves et al. (2014)); (3) Methods (e.g., using case-based reasoning, instead of rule-based reasoning VanLehn (1998)); (4) Attributes of external stimuli (e.g., 2D examples has negative impact on idea generation Linsey et al. (2010); Perttula and Sipilä (2007)). I will discuss the cognitive and psychological tendencies in detail.

For cognitive and psychological tendencies, as the reason for fixation, I observed the following four aspects: avoidance of cognitive load; avoidance to rework and to change the idea; cryptomnesia; additional reasons.

Avoidance of cognitive load

Ambiguity, as a nature of the design process, provides plenty of alternative paths to make a trip while designing. Because of too many alternatives, the cognitive process may be exhausting for the designer. Depending on the density, the design process may

cause too much cognitive load. In this line, the path of least resistance model is the extension of the theory of structured imagination (as I mentioned before) by Ward (1994, 1995). This model is an explanation of why it is too easy for designers to become fixated on the existing examples. It is the cognitive tendency of people to invest the least effort to deal with the creative process. The trouble with this cognitive shortcut is that it may blind people to more efficient solutions than the ones they already fixated. Individuals rely on given examples, instead of searching for alternative solutions in more general or different domains. Existing examples may unconsciously stimulate designers to take the path of least resistance and result in not much original outcome, even if it has the potential of high-level original designs. Consequently, initial creations may have low novelty results, if the designer does not show more effort to improve initial creations.

Avoidance to rework and to change the idea

Designers may be reluctant to change their initial ideas and choose to be fixated the given examples. This tendency is related to psychological suggestions that people become attached to their ideas and seek to defend them, rather than seek new alternatives (Baer & Brown, 2012; Pierce et al., 2003). There is another explanation for this inclination: the sunk cost effect (Arkes & Blumer, 1985). This theory refers to an individual's reluctance to choose a different path of action once he/she invests a significant cost (money, time, or effort). As designers spend more time, money or effort to design something, they tend to generate ideas with lower novelty and variety. In the interpretation of behavioral economics (Arkes & Blumer, 1985; Kahneman & Tversky, 1979), a person is inclined to continue in the current path in fear of losing the cost already sunk into that path, regardless of the potential future benefits in an alternate path. Changing of paths may provide more divergent thinking and creative results, in especially idea generation phase. If designers spend greater resources for their ideas, they are inclined to adhere more to their initial ideas, as a sunk cost effect. Therefore, the sunk cost effect may be an explanation of design fixation (Christensen & Schunn, 2007; Kiriyama & Yamamoto, 1998).

Emphasis on the fixation issues is that the repetition of negative features from an example solution. Because individuals tend to think that example solutions may be flawless. Nonetheless, they need to keep their critical review for any stimulation. If they do not keep it, the fixation, as a source of the detrimental effect, may occur

because of the features from a flawed example. Once the examples are introduced as a potential solution, individuals may ignore details of the example, not expecting flaws and transferring the features of designs as they are in order to avoid unnecessary rework (Youmans & Arciszewski, 2014). However, they should be able to spot these flaws and thus avoid copying the examples.

Cryptomnesia: Fixation as unconscious plagiarism

As a basic characteristic of fixation, I have seen unconsciousness in some definitions of fixation. Even in the earliest studies of fixation, subjects were not realized that they had difficulty to find the right solutions because they inevitably thought earlier solutions. In recent studies, subjects were not aware that they copied the properties of existing solutions. It refers to the phenomenon of cryptomnesia or unconscious plagiarism. Participants tend to reproduce involuntarily previously seen ideas of examples. Interestingly, they believed that they had entirely original performance (or at least original within a given context) (A. S. Brown & Murphy, 1989; R. L. Marsh, Bink, et al., 1999; R. L. Marsh & Bower, 1993; R. L. Marsh & Landau, 1995; R. L. Marsh, Ward, et al., 1999). Cryptomnesia has been the study of implicit memory phenomena. It is interpreted as an example of source amnesia (Schacter, 1987; Schacter et al., 1984). It is the inability to remember where, when or how previously learned information has been acquired.

In specifically design and engineering area, Linsey et al. (2008) also observed that engineers were unaware that they attempted to solve problems similar to prior examples to which they had been exposed. Therefore, there is similar unawareness of being influenced by example solutions in design (R. L. Marsh, Bink, et al., 1999; S. M. Smith et al., 1993; Ward, 1994).

In the experiments, designers may think that they may be more successful if they reproduce from given examples. S. M. Smith et al. (1993) proposed that subjects may assume that they should conform to examples when the existing examples are present. Even if the subjects were required to generate design solutions which should be different from the example solution, design fixation did not significantly decrease when compared with participants' solutions who were not told to avoid solutions similar to the given examples. Perttula and Sipilä (2007) had similar conclusions, even though they clearly instructed subjects not to reproduce the examples as such. In conclusion, conformity effects occur even when explicit instructions to avoid

reproduction are given examples (R. L. Marsh, Bink, et al., 1999; R. L. Marsh et al., 1996; S. M. Smith et al., 1993; Ward & Sifonis, 1997).

An awareness of fixation might be developed over repeated projects and in response to feedback that results from prior fixation episodes. Learning about fixation may reduce its occurrence or mitigate its effects (Howard et al., 2013). In other words, recognizing fixation episodes and reflecting on them encourages designers to guard against such episodes in the future and make them more creative (Crilly, 2015). Thus, designers need to have intensive effort to be aware of moments of design fixation and how they solve the design problem.

Additional reasons as cognitive and psychological tendencies

As I mentioned in the earlier chapters, there are two basic spaces for design in the problem-solving approach: problem space and solution space. Redefinition of the problem has significance in the development of the design process. Purao et al. (2002) interpreted fixation as a threat to the transition between spaces. He claimed that *they shifted their emphasis quickly to the solution space from* the problem space. Designers should pay attention to their behavior about spaces in order to aware of fixation. On the other hand, Ho (2001) showed that designers adopt a 'working-backwards' strategy. They formulate the requirements based on their first concept or on an example familiar to them. I may call it an early commitment to the first concepts or examples. Early commitments may be the reason for fixation (Restrepo & Christiaans, 2004). Hence, the designer should see every idea that comes into his mind and example that is stimulated as a development tool, not directly acceptance tool. Another reason for fixation may be the level of satisfaction for designers. The satisfaction of search (Fleck et al., 2010) accounts for how individuals become less likely to find further targets in a search when they have already found one. If designers do not easily satisfy with the earlier solution, they can endeavor to improve without fixing to the examples.

2.4.3 How fixation affect designers

In general, fixation may affect what individuals remember (e.g., S. M. Smith & Blankenship, 1991), how they solve problems (e.g., Chrysikou & Weisberg, 2005; Kershaw & Ohlsson, 2004; Luchins, 1942; Luchins & Luchins, 1959), how they adapt to malfunctions (e.g., Youmans & Ohlsson, 2008), how they general novel solutions

(e.g., German & Barrett, 2005; S. M. Smith, 2003). Here, I will discuss some influences of fixation in detail.

The most common influence of fixation is the obstruction of the creative process (e.g., Chrysikou & Weisberg, 2005; R. L. Marsh et al., 1996; Sio et al., 2015; S. M. Smith et al., 1993). The reason for the intention to use existing examples is to inspire the generation of new ideas. Conversely, it may cause to hinder creativity. The main concern for the researcher results from expectation which does not match the outcome.

In addition to creativity, fixation may obstruct the better results for diversity and fluency (Vasconcelos et al., 2017). According to the study of Perttula (2006), examples limit the diversity of output. As an explanation for hindering to generate with high fluency, Nijstad et al. (2002) proposed that ideas are activated in semantic clusters, and stimulus ideas can disrupt a train-of-thought, resulting from abandoning a given category.

Fixation can be seen as output interference in a flowing process. It is commonly accepted that output interference from the provided list cues causes competition at recall, blocking retrieval of other list items (e.g., Raaijmakers & Shiffrin, 1981; Roediger & Neely, 1982; Rundus, 1973). Because interruptions may be detrimental to performance (Bailey et al., 2000). It is a part of associative theories. Many pieces of research declared that examples do not promote remote associations at a level that would be from the flexibility of total session output (Larey & Paulus, 1999; Perttula & Liikkanen, 2006b; Ziegler et al., 2000). Potential associations may be damaged because of fixation moments in the design process.

As mentioned before, fixation may be a result of a tendency to select a path of least to avoid cognitive load. Following this tendency, the shorter paths are perhaps not recognized, since the intention to choose the shortest path causes focusing on just one path and neglecting the potentials of other paths. Thus, fixation may obstruct even its own tendency. Tracz (1979) suggested that individuals may be suffering from fixation, even if there were a shorter, simpler or better proposition. The reason for missing a better or shorter way is only seeing things in one particular way.

May fixation be beneficial?

When I review of the definition of fixation, I found many negative terms, such as blind or *inadvertent* (Jansson & Smith, 1991); *conforming* (S. M. Smith et al., 1993);

negative or *counterproductive* (Moreno et al., 2015). Moreover, there is a similar indication from influences of fixation. However, Perttula and Liikkanen (2006a) and Perttula and Sipilä (2007) refused that the effects do not necessarily hinder idea generation performance and behavior.

Learning and benefiting from prior experience is one of the most important human adaptive traits, it may be important even in creative problem solving (e.g., Weisberg & Alba, 1981). While many negative aspects may occur in idea generation, fixation may be beneficial at the later stages of design. For instance, changes may critical for the cost and resources for prototyping (Baxter, 1995). It is valid not just for some phases of design, but also some industries. In the aerospace, healthcare, pharmaceuticals and so on, the cost of change might be extremely high (Eckert et al., 2005). The cost may correlate with time. Fixation may be beneficial in terms of decreased time and increased confidence. Furthermore, if fixation fosters a deep exploration of a narrow set of solutions, this might save time (Bilalić et al., 2008; Luchins, 1946; Schwartz, 1982). Again, it indicates reducing the cost of a project.

Further questions regarding fixation

To expand the understanding of fixation, Crilly and Cardoso (2017) conducted a workshop whose participants were researchers and experts on the basis on fixation, inspiration and creativity. Their expertise is in basically two areas: (1) various branches of design (engineering design, complex design, industrial design, fashion design and architecture, with special attention to design creativity, design fixation, inspiration in design, design cognition, design reasoning, design philosophy, design methodology, design processes, design models); (2) various branches of psychology (cognitive psychology, human factors psychology, health psychology and design psychology, with special attention to human mind and memory processes, problem solving, planning, expertise, habits and goals).

Here, the key questions of this workshop is presented as follows:

- Why are we even interested in design fixation?
- Why are we so fixated on one kind of fixation?
- How does design fixation relate to other concepts?
- Is fixation really always a bad thing?
- Can you be creative and fixated at the same time?

- What does fixation look like in the wild?
- How can the experimental methods be improved?
- What other research methods might be used?
- How should knowledge about fixation be applied?

These questions will not be discussed in my research. However, it is useful to know key questions of this event to follow current discussion topics as regards fixation, inspiration and creativity in design. Those who wish to examine the discussions on these questions in detail can read the given reference.

The main goal of my research is to develop several ways to overcome or reduce fixation, in addition to increase creativity. The given examples are the source of fixation. In the next chapter, the main concerns of researches regarding creativity and fixation to constitute parameters of them will be discussed. Particularly, profile of the designers, given examples and procedure in the design process will be reviewed.

2.5 Features of Designers, Given Examples and Procedure

Reducing fixation and increasing creativity in the design process is the aim of this research. The given examples to designers may cause both higher-level fixation and creativity depending on the profile of the designers. Therefore, features of participants, given examples and procedure will be reviewed. "The given example" refers to examples introduced by someone such as tutors or encountered without intention.

Detailed parameters of profile of participants, given examples and procedure

In parallel to the increasing interest in creativity and fixation, several studies have been conducted. Laamanen and Seitamaa-Hakkarainen (2015) had interviews with professional designers. They found that designers used (1) supporting practices (e.g., collecting) and (2) triggers (e.g., sources of inspiration) for framing the design space. Later, they distinguished four approaches to ideation: graphic, material, verbal and mental.Vasconcelos and Crilly (2016) reviewed the literature in-depth, to analyze some studies of creativity and fixation. They have a more detailed analysis of variables of fixation and creativity than Laamanen and Seitamaa-Hakkarainen (2015). They have reviewed the literature in the following headings: (1) External stimuli variables; (2) Design process variables (that have been manipulated); (3) Design process

variables (that have not been systematically manipulated); (4) Experimental variables. Table 2.2 : shows these headings with sub-titles.

Table 2.2 : Variables of fixation and creativity (adapted from Vasconcelos & Crilly, 2016).

EXTERNAL STIMULI VARIABLES		**DESIGN PROCESS VARIABLES** **(that have been manipulated)**	
Modality of representation	Text Picture Diagram Physical Object	**Experience**	Novice student Senior student Novice designer Expert designer
Fidelity	Abstract Concrete	**Disciplinary background**	Mixed Unique
Quantity	One More	**Problem abstraction**	Concrete Abstract
Proximity	Within Between	**Instructions for reproduction**	None Constraining
Diversity	Self-similar Diverse	**Time available**	30 min 60 min 2 hours Gap
Novelty	Common Novel		
Timing	Before brief Along brief During IG	**Testing**	None Prototype
		Group size	One Team
DESIGN PROCESS VARIABLES **(that have not been systematically manipulated)**		**EXPERIMENTAL VARIABLES**	
Previous task experience	Yes No	**Input focus**	Process Participant Example
Existence of solutions	Known Unknown	**Output focus**	Process Participant Solution
Complexity of the task	Complex Simple		
Complexity of the problem statement	Complex Simple	**Output evaluation focus**	Quality Quantity
Number of ideas	One or a few Many	**Evaluation metrics**	Various Metrics
		Methods and tools	Various Methods
Modality of the communication	Text Sketch Prototyping	**Evaluators**	Number of Evaluators Profile of Evaluators
Complexity of the communication	Concept Detailed		

They analyzed existing research. However, it did not develop an analytical view of the authors' conclusion which indicates the double-edge situation between inspiration and fixation. Some researcher supported that given examples are able to increase the creativity, while others advocated that given examples cause the fixation. Hatıpoğlu

and Yıldız (2018) examined the following parameters: modality of representation, fidelity, quantity and proximity. They filtered the current studies as those supporting inspiration (positive-side) and fixation (negative side). They found out the parameters supported whether positive-side or negative-side (see, Table 2.3 :). Their work can be seen as an initial attempt to elaborate parameters and see the shortcomings in the fixation and creativity literature.

Table 2.3 : The review of researches which supported that examples increased creativity and caused fixation (adapted from Hatıpoğlu & Yıldız, 2018).

Impacts	Modality				Fidelity		Quantity		Proximity	
(+: Positive) (-: Negative)	Text	Picture	Diagram	P. Object	Abstract	Concrete	One	More	Within	Between
(Cardoso et al., 2009)	+	+			+	+	+		+	
(Cardoso et al., 2012)	+	+			+		+		+	
(P. Cheng et al., 2014)		+			+	+		+	+	
(Dahl & Moreau, 2002)		+			+		+		+	
(Figl & Recker, 2016)	+		+		+	+	+		+	+
(Fu et al., 2013)	+		+		+			+	+	+
(Goldschmidt & Sever, 2011)	+				+	+		+	+	+
(Goldschmidt & Smolkov, 2006)		+			+			+	+	+
(Gonçalves et al., 2016)	+	+		+	+	+		+	+	+
(Gonçalves et al., 2012)	+				+	+	+		+	+
(Jang, 2014)	+	+			+			+	+	+
(Linsey et al., 2011)	+	+			+	+	+		+	+
(Lopez-Mesa et al., 2011)	+	+				+		+		+
(Moreno et al., 2014)	+	+			+			+		+
(Mougenot et al., 2010)		+				+		+		+
(Mougenot & Watanabe, 2012)		+				+		+		+
(Nijstad et al., 2002)	+				+			+	+	+
(Sarkar & Chakrabarti, 2008)	+	+	+		+	+		+		+
(Siangliulue, Chan, et al., 2015)	+					+		+	+	
(Toh & Miller, 2014)		+		+		+	+		+	
(Tseng et al., 2008)	+				+			+	+	+
(Yilmaz et al., 2010)	+				+			+	+	
(Youmans, 2011a)	+	+				+	+		+	
(Youmans, 2011b)				+		+	+		+	
(Cardoso & Badke-Schaub, 2011)		-			-	-	-		-	
(P.-J. Cheng, 2015)	-	-			-	-		-	-	-
(Chrysikou & Weisberg, 2005)	-	-			-		-		-	
(Jansson & Smith, 1991)	-	-			-		-		-	
(Liikkanen & Perttula, 2010)	-				-		-			-
(Linsey et al., 2010)	-	-			-		-		-	
(Lujun, 2011)	-	-			-		-		-	
(Perttula & Liikkanen, 2006b)	-	-			-			-	-	
(Perttula & Sipilä, 2007)	-	-			-			-	-	
(Purcell & Gero, 1996)	-	-			-			-	-	
(S. M. Smith et al., 1993)		-			-			-	-	
(Sun et al., 2013)			-		-	-	-		-	
(Viswanathan et al., 2014)				-		-	-		-	
(Viswanathan et al., 2016)				-	-	-	-		-	-

2.5.1 Parameters for the profile of participants

The profile of the potential designers is as important as the attributes of given examples. Before the investigations regarding the given examples and procedure, the profile of the participants will be discussed in three aspects: (1) expertise, (2) disciplinary, (3) group size.

Expertise

Experience can shape the process of students or designers. Having a large body of domain knowledge is central to expertise. Ball et al. (2004) reported that experts use more analogies than novices so that experience seems to increase retrieval frequency. In the context of analogical reasoning, expertise increases the ability to retrieve high-level principles derived from sets of analogies. Novices had a tendency to use case-driven analogies (where a specific concrete example was used to develop a new solution (A. K. Goel, 1997)). However, experts tended to use more schema-driven analogies (that more general design solutions derived from a number of examples (Gick & Paterson, 1992)). In other words, expert designers would show more schema-driven than case-driven analogizing, whilst novices would demonstrate the reverse pattern of analogizing (Ball et al., 2004). Similarly, but with different terms, Cai and Do (2007) claim that experts tended to make higher-level structural analogy while novice designers tended to make a surface analogy from the source. It may provide an inference that novices have more difficulty retrieving relevant information and mapping concepts from disparate domains due to a lack of experience (Kolodner, 1997). Linsey et al. (2010) found that experienced academic designers produced a larger number of highly novel solutions with examples than novices. Dahl and Moreau (2002) suggested that experience may supply immunity to fixation and foster the designers to create potential problem spaces.

On the other hand, there are some reports that show the advantages of novices over experts in various fields. For instance, the reminiscence of chess experts regarding randomized chess boards is worse than that of novices (Chase & Simon, 1973). Another example is that individuals with low baseball knowledge remembered a greater number of baseball-irrelevant propositions from a text passage describing one half-inning of a baseball game (Voss et al., 1980). Similarly, Arkes and Freedman (1984) found that baseball experts are worse than novices on recognition tasks that require verbatim memory for baseball stories. In computer programming, novices are

better at recognizing programs they have analyzed than experts (Adelson, 1984). In the radiology, experts are worse than novices at recognizing normal X rays, while they have a better memory of atypical features of X rays (Myles-Worsley et al., 1988). These results show that experts may lose a more abstract or principled nature of their processing while accumulating experiences. Expertise also may make individuals less flexible in new contexts. For instance, Frensch and Sternberg (1989) observed that expert bridge players had difficulty adapting to a new version of the game, while it is easier for novices.

In creative problem-solving studies, Wiley (1998) reported that experts may solve problems more efficiently than novices. It results from their structured knowledge. Nonetheless, this also causes a limitation on solution space with just known space. Kim and Ryu (2014) found that expert designers are more effective at framing design problems. They also may have more fixation than novice designers because of their previously developed design concepts. According to Lai et al. (2008), graduating engineers are often less innovative than freshmen students.

Disciplinary

The disciplinary background of the individuals may be the concern of the creative process. Purcell and Gero (1996) compared mechanical engineers with industrial designers. They found that production of a greater number of designs, more diversity and uniqueness on the solutions of the industrial designer than mechanical engineering. This may be a conclusion of design education which encourage the students to continuously search for difference. Later, Agogué et al. (2014) conducted an experiment that he compared the process of students from different disciplines, such as psychology students, engineering students, entrepreneurs, designers. Exploration of solution space was the main distinction: Industrial designers generated novel solutions and easily-accessible solution spaces. It indicates that designers may be stronger to avoid fixation. However, engineering students had more complex and detailed solutions. In other words, industrial designers generated more solutions with various aspects, while engineering students focused on how to solve the given problem in detail. Hence, the more scientific approach of engineers and entrepreneurs made them slower than psychology students or designers. These findings indicate that some individuals from different disciplines may be more susceptible to fixation effects and be more sensitive for better creative performance than others.

Group Size

There are studies working on design teams and individual designers. B. E. Collins and Guetzkow (1964) proposed that small groups could perform at a higher level of the capabilities of each member. They called it assembly (bonus) effect. In a similar line, Michaelsen et al. (1989) reported scores of groups were higher than the score of best group members. It indicates the existence of an assembly bonus effect. Nevertheless, Davis (1969) and (Hill, 1982) showed that assembly bonus effects happen rarely and groups generally do not perform better than their best members. On the other hand, group work may contribute to share the cognitive load of the problem-solving process (Youmans, 2011a). Avoiding heavy cognitive load can be considered as a crucial reason for fixation. Therefore, it may help to resist fixation. In detailed, Liikkanen and Perttula (2010) compared to homogeneous and heterogeneous teams. They found that heterogeneous teams are more efficient in idea generation and had a greater variety of ideas.

On the other hand, Steiner (1972) reported that groups rarely perform at optimal levels. The reason for it is a lack of perfect coordination and the use of available resources. Another reason for decreasing productivity can be social interference which is known as mutual production blocking effect (Nijstad et al., 2002). Ideas of others may become new search cues for the designers and it causes interruption of the idea generation process of individuals. However, it can reduce the time needed to produce new search cues and speed up the search for related knowledge in memory as well (Nijstad et al., 2002; Perttula & Sipilä, 2007).

2.5.2 Parameters for the given examples and procedure

The given example play an important role in the process of creativity and fixation. Following the examination of its importance, the investigations regarding the given examples and procedure will be discussed in seven aspects: (1) fidelity, (2) expansion, (3) commonality, (4) digitality, (5) quantity, (6) given time, (7) timing.

Importance of given example

The study of Lujun (2011) concluded that fixation occurred when example solutions were introduced, on the other hand, that the designers could create higher quality solutions as well. There is a need for research to find ways to avoid fixation traps or

reduce their adverse impact. It may provide ways to develop better quality solutions without much-fixated mind.

To reduce fixation, a number of critical moves can be developed regarding the process of using the given examples. In fact, many variables may shape the moment of fixation and creativity in the process, such as given examples, written instructions, the profile of designers, physical conditions of practice area and so on. LeFevre and Dixon (1986) conducted many experiments to compare the reaction of written instruction and given examples. Their experiments had the following findings:

- Examples and instructions were followed equally well when presented alone.
- Examples were followed more often than instructions regardless of their order.
- Examples were still used more than instructions when it was the instructions that described the incorrect alternatives.
- Subjects followed the example even when the instructions were long and redundant.

These experiments showed that there still a strong tendency to follow the example, the example effect seems to be pervasive and robust. In other words, examples are much more compelling than written instructions. Thus, this research focuses on variables of the given example. Olson et al. (1983) concluded that good examples are useful, but poor examples can be worse than none at all. If examples have such dominance, understanding how the examples lead to a cognitive process is critical for a better or worse process. Similarly, LeFevre and Dixon (1986) suggested that there is a potential danger only when examples are added to the written instruction indiscriminately. Therefore, designers and educators need attention while selecting the examples in the design process.

Fidelity

Given examples may have different levels of detail or abstraction. (Gonçalves et al., 2012) reported that industrial designers who are given only verbal descriptions had more numerous, original and diverse ideas than those who saw the description. The verbal descriptions may activate a generation of mental images. Further, these mental images may be more abstract than described examples. (P. Cheng et al., 2014) presented only partial photographs of products for one of their experimental groups.

Participants of this group generated more original ideas than participants of the group given full photographs. Participants of the group given partial photographs reported that they paid more attention to details. Further, they assessed their own design more positively. The partial photograph gives a space to think about lacked pieces by the designer. The completed part in mind is probably more abstract than the given part.

As a specific study on the fidelity of given example, Cardoso and Badke-Schaub (2011) created three groups that have different stimuli for experimental setup: line drawings as the abstract or low-fidelity source, real photos which show mechanism as concrete or high-fidelity source, control group without any stimuli. The repetition of key attributes of the design solution was not significantly different. However, a group that has concrete representations had less novel ideas while a line-drawing illustration resulted in potentially newer concepts. Due to the simplistic or schematic representation of line-drawing illustration, designers may neglect too detailed examination. However, they can observe simple and important features of the example to convert them to novel ideas.

Expansion

The proximity of the stimuli refers to the level of relatedness of examples to design problems.Fu et al. (2013) defined it as relatively near or far from the problem domain. Benami and Jin (2002) presented unrelated stimuli to design students. They observed that the type of stimuli resulted in varying performance effects. Common view regarding proximity of stimuli is that neither too near nor too far stimuli are more likely to produce more novel solutions (Chan et al., 2011; Dahl & Moreau, 2002; Fu et al., 2013; Gentner & Markman, 1997; Gonçalves et al., 2012; Linsey et al., 2010). Fu et al. (2013) named it as sweet spot for distance. Hence, a moderate level of distance is accepted. In psychology, when there are no directive hints, analogical reasoning is not likely to be enhanced (Anolli et al., 2001; Gick & Holyoak, 1980, 1983). Still, if there is enough surface similarity or proximity, designers may be able to transfer information between the two cases (Holyoak & Koh, 1987; Keane, 1987). It also indicates a moderate level of distance. In this context, given examples of Study 1 has a moderate level of distance. On the other hand, J. O. Wilson et al. (2010) found that unfamiliar examples increased the novelty of solutions. Furthermore, familiar examples increased the variety of ideas.

Commonality

The response to the given examples may vary depending on whether it is common or not. Purcell and Gero (1996) conducted an experiment to investigate the novel example in the design process. Adopting novel examples did not have a significant impact to be fixated to them. However, too novel ideas may cause little association (Mednick, 1962). Common ideas may be found more valid (e.g., Brauer & Judd, 1996; Stasser & Birchmeier, 2003; Wittenbaum & Park, 2001). On the contrary, Perttula and Sipilä (2007) found that novel examples reduce fixation. They observed that common examples reduced the number of new solutions and increased the fixation to features of examples. Dugosh and Paulus (2005) supported this observation with their experiment. They also indicated more tendency of fixation when subjects had common examples than when they had novel examples.

Complexity

Complex examples may be difficult to analyze and understand. If designers have a complex example, it is difficult to determine whether the designers understand it. Because the designer who finds the examples complex may have a tendency not to use the given example.

Digitality

The study of Herring et al. (2009) demonstrated that designers use digital and printed sources of examples but have different storage strategies for each modality. Some designers merge the two modalities. For instance, they could take digital photos or scan pages of physical magazines or paper sketches. These kinds of practices allow designers to have a holistic example of space and to retrace their overall search process. However, in order to develop different strategies for a merged use of digital and printed sources, the distinctive interaction of each modality with the designer needs to be well understood.

As detailed research, P.-J. Cheng (2015) had online-group (searching information online) and printed-group (searching for information from books) in her study. She purposed to evaluate how information obtained from printed and online sources. Ideation of most participants began with thoughts being entered keywords to search for inspirational materials online. Many designers are getting used to having the keyword-based data during the ideation. Printed-group generated more categories of

ideas sketches than online-group. It suggests that designers can generate more diverse ideas when they are referring to printed materials. The more diverse ideas, the more the possibility of creative results. On the other hand, online-group continually revised previous idea sketches to prepare their final work. Thus, she concluded that online-group tend to develop ideas vertically, while printed-group have a propensity to develop ideas horizontally during ideation. In addition, printed-group focused on mainly visual thinking, while online-group involved both visual and verbal thinking. Therefore, she found that images influenced to printed-group to a greater degree, while words affected the online-group.

In a similar vein, Mougenot et al. (2008) have interviewed designers regarding magazines, books and internet sources. They concluded that magazines are often used as a source of information, can be accessed more flexibly than the internet. Designers memorize better what they saw in magazines. Participants signified that reading a magazine is a pleasurable moment, which is not the case while browsing the internet. They enjoyed with physical interaction. Internet is found as a complementary tool to books or magazines. Thus, it is a natural extension of the designers' working environment. When searching on the internet, designers find interesting things they were initially not looking for. It indicates the inspirational side of it. Considering the quantity, designers found a higher quantity of inspirational materials through the magazines (i.e., 55 pictures) than on websites (i.e., 31 pictures).

Quantity

The number of external stimulation maybe just one or more than one. Perttula and Liikkanen (2006b) studied on presenting multiple stimuli to subjects. They found the absence of fixation on the group which was given multiple stimuli. However, there were no significant differences when comparing with the control group. The study of Perttula and Sipilä (2007) had similar results. Likewise, Dahl and Moreau (2002) reported that increasing the number of examples did not increase the originality (depending on the number of analogical transfers). Giving several examples may cause restrict creativity rather than enhancing it (Sio et al., 2015). However, the reason for it may be concrete properties of the examples (Dahl & Moreau, 2002), not directly a number of examples.

Given time

The attention of most research has been committed to understanding which properties of examples. However, other aspects of the creative performance of designers with stimuli have received less attention, such as time (given time for problem-solving, the timing of stimulation) and the profile of individuals. Generally, participants have limited time to generate ideas in the experiments. Tsenn et al. (2014) tested performance in different lengths of time. They found that participants who had a longer time produced more diverse solutions. In other words, a longer time provides more varied solutions. They also found that additional time increased the creativity of solutions.

The short duration allows the student to focus on the generation of ideas and avoid interruptions such as the need for a break. Youmans (2011b) revealed that interruption (especially in the very early stages) may have a positive impact to reduce design fixation. In contrast, Siangliulue, Chan, et al. (2015) found that regularly interruption cause less productive process and fewer ideas. In addition, if designers have a short time, they may be aware that their time is limited and some ideas need to be developed in this limited time. Thus, instead of dialogue with the people around them, they may stay away from all possible interruptions and focus on the design problem.

Timing

Research on flow and interruptions also proposed that automatic example delivery can be harmful to creativity if not timed appropriately. They can be perceived as just interruption (Bailey & Iqbal, 2008; Bailey et al., 2000; Csikszentmihalyi, 1997). Therefore, ill-timed examples can disrupt a person's train of thought (Nijstad et al., 2002). These suggestions emphasized the importance of the moment when stimuli are provided. Sio et al. (2015) reported that stimuli may have a positive impact on the design process if they have provided as earlier as possible. Tseng et al. (2008) compared the conditions before the problem solving began and during the problem-solving in addition to test the similarity of the given information. They found that highly similar information impacted problem-solving even before problem-solving began. However, distantly related information only affected problem-solving when it was presented during a break. Therefore, the type of stimuli has also an important role to determine the right moments to have stimuli.

Moss et al. (2011) demonstrated that presenting examples after a period of initial work on the problem is more effective than at the beginning of the process. Similarly, having stimuli in the middle of the process encourages the designers to explore more categories, comparing with having them at the beginning (Perttula & Liikkanen, 2006a). However, exposure to example after the problem solving has begun may not be very effective due to the sunk cost effect (tendency to continue an endeavor once an investment in money, effort, or the time has been made) (Arkes & Blumer, 1985). It may be too late to inspire towards the end of the design process. Kulkarni et al. (2014) concluded that early or repeated exposure to examples enhances the creativity of idea generation.

In addition, as a modality of the given example, text is selected in this research. Reasons for it and importance of textual examples will be reviewed in the next section.

2.5.3 Modality of given examples: Text

Verbalizing by writing notes, drawing mind maps etc. was used to frame the design space. Therefore, textual components play an important role in the process and it influences the design process. However, activities with texts need to be advanced. Today, visual materials and linguistics materials have been identified as major vectors of design creativity (Casakin & Goldschmidt, 1999; Goldschmidt & Smolkov, 2006; Mougenot et al., 2008). However, there is still lack an acute description of the roles of textual examples within the designers' cognitive process.

Comparison of other modalities with textual example: Text is not the best

Visual and textual examples are the most frequently investigated modalities of representation. Researches which compared the textual and visual example have different conclusions. While some suggest that visual example is better for the design process, others found that textual stimuli are better. Further, some researchers had inference advantageous moments for both modalities.

Visual examples may be found more flexible when compared to textual examples. Cardoso et al. (2012) compared textual and pictorial representations of the same information. The results showed that the textual group was anchored to some of the characteristics of its respective stimulus. This tendency indicates that the textual group was less flexible in spending the same amount of effort in equally exploring other possible categories of solution ideas. In a similar vein, a significant number of ideas

generated by the text group repeated key attributes of the example. It indicates potential fixations. One possible explanation may be the complexity level of representation. The more complex presentation by a given example, the greater difficulties of moving away from the perceived entity. Textual representation may be more complex than a visual representation of the same example.

Findings of Figl and Recker (2016) showed that diagrammatic examples led to more creative process changes than textual examples. However, the level of originality did not differ significantly between text and diagram models. Their result differs from that of Gonçalves et al. (2012) (who found higher originality of ideas with textual stimuli) and Malaga (2000) (who reported more creative ideas for users of pictures). Further, their results indicate that users develop a higher number of appropriate ideas when they work with a diagram than with text. Diagrammatic representation may be a transformation of example. It may be helpful to overcome fixation. However, textual representation can be transformed diagrammatic or other types of representation in mind. Students may need assistance to practice these kinds of transformations. According to Jang (2014), visual and textual examples had no difference in the creativity of solutions for concepts in the same categories. Nevertheless, visual examples fostered more creativity than textual examples for concepts in different categories. The relationship between the different categories may be more difficult to establish with the textual example than with the visual example.

Comparison of other modalities with textual example: Text is better

Analogical thinking, as a well-known method, is often triggered by visual examples which are a major way of stimulating designer's creativity (Casakin & Goldschmidt, 1999; Goldschmidt & Smolkov, 2006). However, designers are multi-sense human beings. They claim to seek inspiration in many types of sources, not only visual sources. Besides visual materials, Dong (2006) emphasized that language serves as representations of ideas by linguistic behaviors and these kinds of behaviors represent the structure of thought during the design process. It should be noted that even a single word can affect subsequent design work (Liikkanen & Perttula, 2010).

Purcell and Gero (1991) found that there were both design fixation and an increased variety of solutions in familiar example condition, while no effect if the example was unfamiliar. Verbal descriptions of the same examples also produced similar effects although they were much less fixation. In the research of Cardoso and Badke-Schaub

(2009), design fixation has occurred on the visual example group, while the textual example group was not significantly fixated. A lot of the features comprised of the priming example were reproduced by the participants of the visual example group. It led them to poorly designed solution ideas as a negative aspect of fixation. Textual examples can be seen as an alternative way of conveying information during the design process. In addition, Van der Lugt (2000) reported that sentential variations of the brainstorming tool perform stronger than graphic variations on the brainstorming tool, such as brainstorming with sketches. An explanation may be potential abstract relations that emerged by texts. Textual examples enable the communication of abstract relationships, at the expense of loss of immediate understanding (Ware, 2008). This aspect makes textual examples stronger if the designer has patience enough. Textual examples operate more abstract form than visual examples and textual descriptions can provide a concise way of conveying information (Sun et al., 2013). Thus, idea generation with text involved more structured consideration and a greater number of creative elements. Sun et al. (2013) emphasized that texts provide higher diverse analytical thinking and broaden creative possibilities rather than improving creative quality.

Compromise of visual and textual example: Different modalities for different conditions

Some comparative studies don't follow only one side and draw attention to the use of different modalities depending on the conditions. Lopez-Mesa et al. (2011) focused on different types of stimuli to provide to design teams and to understand the cognitive reactions. Their findings regarding better choice depending on conditions are as follows:

- Quantity of solutions – Teams should be triggered with visual examples.
- Variety and non-obviousness of solutions – Teams should be triggered with sentential examples at the function level, teams should be triggered with visual examples at the conceptual structure level.
- A high rate of reflections – Teams should use sentential examples.
- Use their own frame while being triggered with stimuli (it may indicate to avoid from fixation) – Sentential examples are advisable.

Five prespecified stimulations (video/animation and audio, text, explanation, and others) were administered to designers and asked to generate solutions in the study of Sarkar and Chakrabarti (2008). They divided these representations into two categories: verbal and nonverbal representation. Their findings are as follows:

- Nonverbal representation is more effective for the total number of generated ideas
- Nonverbal representation is more effective for the quality of the ideas.
- The variety of ideas gets increased when the triggers are represented non-verbally.

Their final implication is that nonverbal representations could be followed by verbal representations to make more effective stimulation. Thus, it is better to represent the content first using images or videos followed by explanatory texts and linked texts. This implication results from an inclination of designers. They tend to represent their outcome in nonverbal ways when they were exposed to nonverbal examples. Likewise, they tend to represent their outcome by verbal means when they were exposed to verbal examples. This tendency affects the number and variety of ideas which is generated by nonverbal ways, such as sketching. During design education, a training where one means (i.e., verbal) is given and the other means (i.e., nonverbal) is requested may improve designers' skills to use the presented example comprehensively. Therefore, the transformation between modalities from getting examples (such as texts) to generating solutions (such as conceptual sketches) may be a significant ability to use an example for creative designs.

In the study of Cardoso et al. (2012), *primacy and recency effects* were used to explain the cognitive biases of textual groups. Primacy effect refers to the tendency that people are able to remember more easily words read or heard first, such as, at the beginning of the text. Recency effect refers to people’s tendency to more easily retain the last few words read or heard. It suggests us to be careful while selecting the beginning and ending part of textual examples. Thus, if designers should use both visual and textual examples, visual examples may be supplementary sources for the gap between the first and last statements of textual examples.

As a final suggestion, Ware (2008) claim that images provide a close relationship between what is represented in the image and our perception of what is represented.

Conversely, texts enable the communication of abstract relationships, at the expense of loss of immediate understanding. Hence, some information can only be processed in words, while other information is better communicated via images. This explanation shows that there are cases where the textual example is unique in the design process.

Current literature related to textual example

As we mentioned before, Liikkanen and Perttula (2010) showed that even a single word, when introduced to participants prior to idea generation, can affect the subsequent design work. Texts have an important role to learn similar products and the ability to use them (Linsey et al., 2008). According to Cai and Do (2007), when text is a between-domain source, the analogy to text is mainly based on everyday experience. Thus, novice and experienced designers are similar in the use of inspirational examples. Further, the text has no obvious fixation effect for both novices and experts.

One of the prominent research regarding textual stimuli is the study of Goldschmidt and Sever (2011). Their study has demonstrated the positive influence that text can have during idea generation when used as stimuli. They have three conditional groups: (1) subjects without any stimuli; (2) subjects with stimuli as related text; (3) subjects with stimuli as unrelated text. Although there was no discernible difference between stimuli by related and unrelated texts, they found a significant difference for originality between no stimuli and stimuli by texts. Their results suggest that the use of textual stimuli can be potentially beneficial for the creative process.

There are also studies using electroencephalography (EEG) as a different research method in the text-related examinations. Sun et al. (2013) have used EEG to understand creativity in the design process. EEG is a way of directly monitoring brain activity by recording neuronal synchronization related to a task. The specific terms of this method, such as *theta activity*, *theta1 synchronization* and so on will be skipped. Textual examples perform as a more abstract form than visual examples and textual descriptions can provide a concise way of conveying information. They found that text assisted participants generate a greater number of creative elements in a more structured way. Thus, text encouraged designers for structured and systematic consideration, promoting the number of creative elements. Nevertheless, the quality of ideas, especially in terms of spatial relations, was significantly lower when the text was used. Hence, they found that text helps with generating possibilities and defining

problems, but not finding solutions. It refers to the generation of a greater number of solutions, rather than more creative solutions. In other words, using text in idea generation helps broaden creative possibilities rather than improving creative quality.

As a specific form of text, P.-J. Cheng et al. (2013) studied about keywords on the idea generation. It was particularly some keywords related to several main themes. Their results showed that most designers retrieved some related information in the "nature" category and the idea from the "people" category is difficult to be combined with other category ideas. Further, most designers were inclined to generate an idea sketch with the feature of simple and abstract for the task. Thus, the abstraction level is one of the parameters of textual examples. Nagai and Noguchi (2002) investigated the role of keywords in the creative process as well. They claimed that drawings are low-level information and abstract keywords (illustrating feelings or intangible concepts) are high-level information. A high-level of abstraction may be necessary to generate visual ideas from textual examples. This may be an explanation for the preference of designers to work with visual examples instead of textual when generating ideas. However, this attribute of textual example may be very useful if designers can change their tendency to prefer visual examples first. Since language can support the mental manipulation of abstract concepts and stimulate the creative process. Further, Chiu and Shu (2007, 2012) claimed that language can offer enough ambiguity to stimulate the creative generation process and is potentially a valuable stimulus for design. In addition to these discussions, it should be noted that the keyword is one of many forms of texts. There are other textual forms as well, such as sentence, paragraph, poem and so on.

Importance of textual example

Having a visual example may seem positive in terms of its quick readability. Nonetheless, this situation also has detrimental effects on the design process. A quick grasp of visual examples leads to a tendency to leave the analytical examination. It may, therefore, remain a superficial acquisition from the given example. It refers to uncreative outcomes and fixation to surface features of example. Textual examples may be more difficult to analyze and grasp than visual examples, but they may be the impulsive force for potential creative designs as well.

Another superiority of textual examples results from the way of production of mental images. Even the most abstract image still presents the visual as a ready-image. Thus,

the visual example is a modality of representation that is more likely to conclude with fixation. However, there are only narratives in the texts, it is possible for each designer to visualize the given example in different ways. This may contribute not being fixated on particular things. Designers transform words into mental images individually then finally into product images, with several moves of abstraction levels. Hence, they can interact with the text actively throughout the process as it creates individual mental formations. However, as said before, texts may not be as attractive to the designer as they are not grasped as quickly as visual examples and because the transformation of mental images from text requires an extra effort. In this respect, designers need a process in which they can focus on textual examples and internalize them.

The textual example needs to be examined extensively because of its potential. The text has many parameters in itself but there are very few studies on content and representation of texts to provide a more efficient design process. In this context, texts were presented in my research to discover the tendencies of designers.

2.5.4 Self-construction of textual examples

Self-reflexive drawing exercise is quite consistent with the ambiguous nature of the design process. Herbert (1988) showed that study drawings are more than just a handy way of working out a design problem. The origin, nature, and methods of obtaining knowledge in architectural design can be explained with processes of the study drawings in which design problems are formulated. Study drawings provide a graphic means of generating new information within the design task. In the study drawing process, the designer's simultaneous interpretation and manipulation of the graphic image in a complex discourse continuously reconstitute itself. This is a self-reflexive exercise that the graphic processes actively shape rather than passively record the designer's thought (Herbert, 1992). A similar exercise can be described through the use of texts and their role in the process. Therefore, a self-constructed text which has self-reflexive exercise may be called as "study text". The preferred term by the author is “self-construction” for this practice.

Psychological aspects of self-construction

Self-construction practice may have psychological reflections. People develop feelings of ownership for physical and non-physical things. Pierce et al. (2003) refer to it as psychological ownership. They proposed that its roots result from a set of intra-

individual motives (such as self-identity, and having a place to dwell). It is a feeling as though an object, such as an idea, is “ours”. Designers who feel a strong sense of psychological attachment to given stimuli can explore them in detail, rather than just surface attributes. Self-construction may stimulate psychological ownership of designers regarding a given example. Thus, it may encourage them to perform a more creative process. Most previous studies focused exclusively on the positive implications associated with ownership (e.g., O’driscoll et al., 2006; Van Dyne & Pierce, 2004) and widely ignored its potential negative consequences (as exception, De Dreu & van Knippenberg, 2005). However, psychological ownership is a double-edged sword with very different consequences. Baer and Brown (2012) supported that it may have negative affect which is an important determinant of whether feelings of ownership will cause individuals to remain open to or resist others’ suggestions for change. This may be a consequence of high ownership. It should be noted that people need to be aware of their level of psychological investment in order to avoid refusing others’ potentially helpful advice (Baer & Brown, 2012). In design, they can voluntarily improve their design via ownership. However, they can create resistance for change as well, which indicates potential fixations. If the outcome of self-construction is abstract and ambiguous enough (such as the coexistence of random words), the probability of resistance to change is reduced.

Another psychological aspect of self-construction may be “do-it-yourself” practice. This increases the valuation of what people do or have. In this sense, Norton et al. (2012) examined the process of the IKEA effect. Langer (1975) and Kahneman et al. (1990) showed that people prefer goods with which they have been endowed. Further, Peck and Shu (2009) suggested that greater time spent touching objects can increase feelings of ownership and value. Touching is a kind of interaction. such interaction may emerge via self-construction in design. Metaphorically, the hands of the designer's mind touch the inspirational tools and construct them with hand craftsmanship. It triggers feelings of ownership. Occurrence due to an effort (Aronson & Mills, 1959) and successful completion of tasks (Bandura, 1977) may be key motives for the feeling of ownership. Building product provides a tendency to think about the positive attributes of that product (Ariely & Simonson, 2003; Carmon et al., 2003; Dhar & Wertenbroch, 2000). It also increases emotional attachment to the product (e.g., McGraw et al., 2003). On the other hand, self-assembly of products may support

people to feel competent (Franke et al., 2010; Spence, 1973). With do-it-yourself, participants become co-creators of value.

Considering all, self-construction activities have a kind of “do it yourself” process. Hence, designers can increase the value of stimuli and it may reflect more efficient use of examples. Further, successful completion of tasks is significant for satisfaction with a self-constructed example. Therefore, the process of self-construction should be completed to motivate designers.

Self-construction on creativity and fixation

In the perspective of creativity and fixation, Agogué et al. (2014) claimed that resisting fixation is not enough to explore alternative solutions and investigate new creative possibilities. There is a need for the development of expansive heuristics and support expansion capabilities. Creating expanded stimuli from given stimuli may help to develop expansive heuristics. The study of Ansburg and Hill (2003) resulted that people who are inclined to make unusual connections are more likely to allocate their attention in a diffuse manner than those who are more analytical. Creative thinkers use a different cognitive resource allocation strategy than do analytic thinkers. Hence, they predicted that people who have a tendency to diffuse their attention are more likely to benefit from an incubation period than are those whose attentional resources are narrowly focused. Activities in a diffuse manner can make designers feel like they are playing a game. Further, the incubation period is a part of their game for creative performance. There is much debate in the cognitive literature that the development of creative solutions has a different process from the development of more routine solutions (Metcalfe, 1986; Schooler et al., 1993; Weisberg, 1986). In this sense, getting an example and just try to use it as a raw source may be a routine process.

My suggestion is that if designers construct their own example from a given example, they may have a creative process in which they feel like they're playing a game in a diffuse manner. This effort refers to “self-construction” in the design process. To support this suggestion, the study of (Zahner et al., 2010) may be an example. They fostered participants to create an abstract solution by themselves, rather than being provided one, a process termed re-representation. They suggest that a good procedure for increasing design creativity is to instruct designers to first generate an abstract solution and then generate concrete solutions. Generating an abstract solution seems to encourage developing a deeper understanding and mental model (e.g., Gentner &

Stevens, 1983; Gentner & Wolff, 2000; Kotovsky & Gentner, 1996; Ross, 1989). This process may lead to generate more solutions. Re-representation is a method to reduce fixation for individual designers because designers may free up associational processes. Their study focused on the generation of a solution in two phases, rather than the regeneration of a given example. However, it still supports that the preliminary construction of a given example or solution can stimulate designers for more creative and less fixated solutions.

In the next chapter, the structure of the experiments for my research will be explained.

3. RESEARCH DESIGN

Following the aim of this research, reducing fixation and increasing creativity in the design process, the method and procedure of my studies will be presented in detail.

3.1 Main Concerns of the Studies: Forms of Text and Self-constructed Text

In the aforementioned researches, the investigated parameters were collected and initial discussions were made about their influence on creativity and fixation. However, the relationships between the given example and idea generation in design still need to be investigated further. Following claims show some research areas remained unclear:

- (1) Some researchers investigated textual examples as (e.g., Cardoso et al., 2012; Goldschmidt & Sever, 2011; Gonçalves et al., 2012)- one of the modalities of representation - but did not focus on forms of textual examples.
- (2) Much research has been conducted with examples which are selected by the researcher (e.g., P. Cheng et al., 2014; Chrysikou & Weisberg, 2005; Perttula & Sipilä, 2007). Nevertheless, designers can also choose or produce their own stimuli. There is not much research on this possibility.

For the first research area, “forms of textual/visual/physical… example” can be added as a sub-branch of the modality of representation. For the latter research area, there is not any recognized parameter in the literature. I will add a parameter which is called “the interaction of designer with example”. Potential sub-titles of this parameter are as follows:

- (2.1) to be exposed with example and then designing,
- (2.2) to be given example and re-construct them to inspire oneself.

It will be call as “self-construction” for the second move in the design process.

Understanding the role that positive and negative impact on various parameters of external stimuli may help designers to develop suitable precautions for fixation and to enhance the creativity of design solutions. It motivates me to review the parameters of external stimuli and set up experiments to test them. In this context, my research focuses on the following two variables:

- (1) forms of textual examples;
- (2) self-construction of textual examples.

In doing so, basic reviews of other parameters mentioned before will be discussed (such as expertise, disciplinary, group size) and how they are included in the research conditions will be explained.

3.1.1 Focus of Study 1 – Different forms of textual example

Most of the studies in the literature have focused on visual presentation and there is not enough research on the content and form of the text. The study of textual examples has still not been awarded enough attention especially as various forms of text. Further, its contribution to design has not been fully assessed. Some forms of text are as follows: keyword, paragraph, sentence, poem. These observations lead me to the following research question:

- Which forms of textual example increase creativity and reduce fixation more?

3.1.2 Focus of Study 2 - A model for self-constructed text: Surrealist poem

The role of random and structured moves in the design process is needed to be reviewed. Siangliulue, Arnold, et al. (2015) compared the creative example group and random examples group. They found that people presented with creative examples generated more creative ideas than those who saw a set of random examples. And people presented with the examples so selected generate more diverse ideas than those presented with random examples. However, there was not any construction of random examples in their study. Up to now, there is no such research that random examples are tried to be structured with potential relations. In other words, a study to stimulate psychological ownership with random examples. Jaarsveld and van Leeuwen (2005) examined whether there is an underlying macrostructure in the design process or not. Another option was erratic ways in which the design evolves imply that the evolution is essentially random. They found that the design process as a whole is more than just a sequence of random generations. Designers consciously move from one generation to the next. It indicates the presence of macrostructure in the design process. How about microstructures? Randomness may foster divergent thinking and increase creativity in microscale moves, although macroscale moves have well-defined structures. It means a combination of random examples in a structured way.

Current literature triggered me to compose a textual example which is a mix of external and internal stimuli that has both well-defined structure (self-construction) and area of freedom (randomness): the surrealist poem.

The origins of the surrealist poem date back to the beginning of surrealism. Andre Breton is the founder of surrealism and he published a manifesto called *La Revolution Surrealiste* (surrealist revolution) in 1924 (Artun, 2015, pp. 178-225). Surrealists argue that art can be practiced without any concern of usefulness. Infinite imagination is an important principle of surrealism. Surrealist methods and tools have been developed to implement their manifestos, such as collage and papers on artworks pasted by Picasso and Braque (Figure 3.1 :).

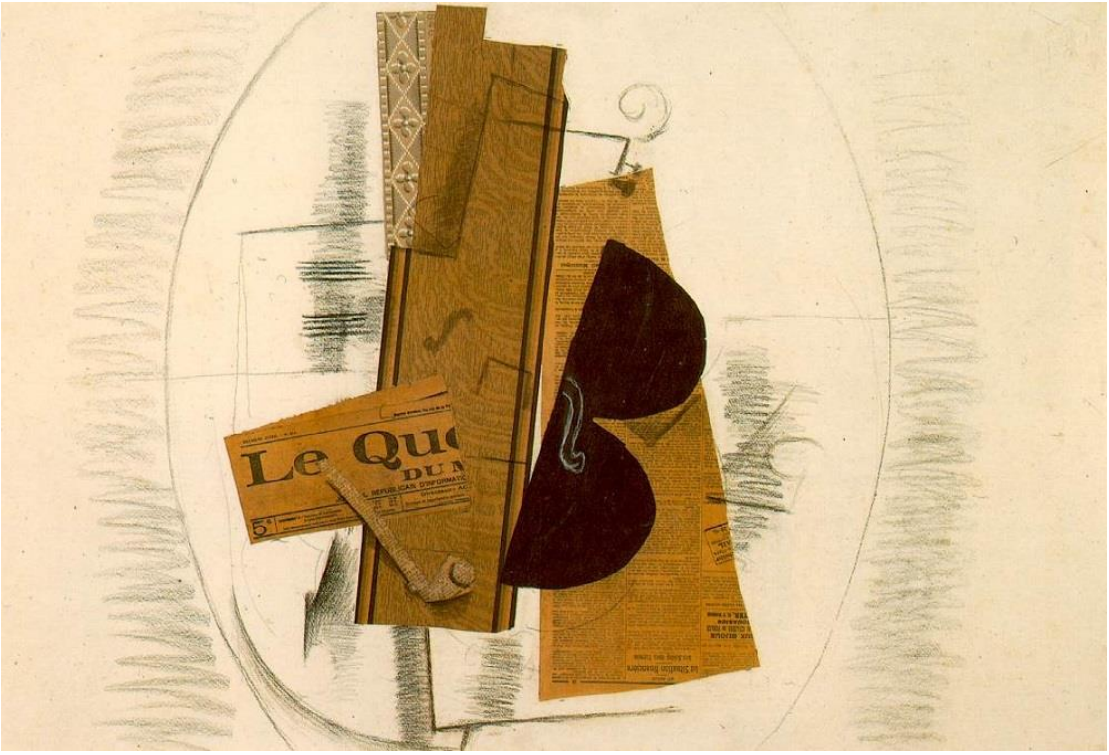


Figure 3.1 : Violin and Pipe, 1913, by Georges Braque (Url-1).

Another example is random assemblies with headlines and sentences which is cut from newspapers. They can be called as the surrealist poems (Figure 3.2 :).

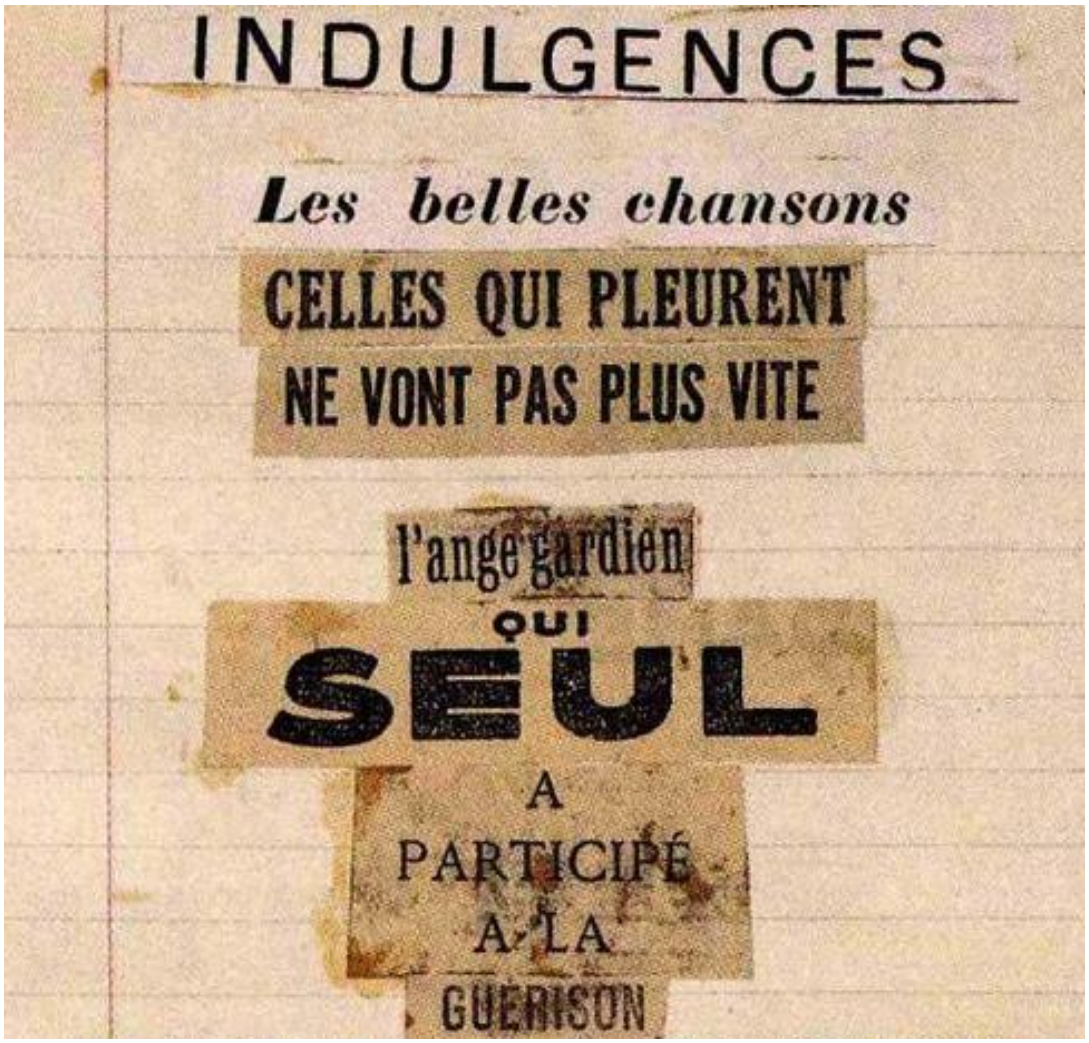


Figure 3.2 : A poem by Andre Breaton (Url-2).

This is a part of a poem written by Andre Breton. This poem in English is as follows:

The beautiful songs
Those who cry
Do not go faster
Guardian Angel
Who
Alone
Participated
In the
Recovery.

When these poems are read, they trigger the imagination. Because of the words that seem to be unrelated to each other, the reader tries to relate them and solve the puzzle of meaning. Thus, novel meaning networks are formed. This activates the creative

performance of the reader. Reconstruction of the text in the design process, but its development as a self-construction, may increase the creative process. It can also prevent fixations from the given text. In order to test the performance of this suggestion, I developed a model that designers write their own surrealist poems. This suggestion led me to the following research question:

- If the designers write their own poem instead of a given poem (as a self-construction practice), can they internalize the textual example? In addition, does it produce more creative and less fixated designs?

3.2 Experimental Setup

Two experiments were planned to partially answer previously asked questions, in which students of architecture were asked to solve two different design problems, under different conditions.

3.2.1 Participants

The profile of participants is a significant variable for empirical studies. In order to minimize the variables in my research, the following variables regarding participants have been fixed: expertise (as novice students), disciplinary (as architecture), group size (as an individual).

Expertise: Novice students

The interaction with stimuli may depend on the type and quality of design education. In many educational institutions, internships are carried out in design offices in order to increase practical experiences before graduation. Experiences inside and outside the school may reveal additional variables that cause different design processes of participants in the experimental group. Therefore, it may be useful to study on novices to minimize the variables that may affect the design outcome and to organize more homogeneous experimental groups.

In other respect, since fixation is an unconscious activity, the designers may have a harmful habit that they don't realize unless they have the ability to aware of fixation. If fixation becomes a habit, it may become an ordinary activity and increasingly difficult to get rid of the habit and reduce the state of fixation. If it is taken precautions for fixation by educators and students in the early years of education, the students can

refrain from having the habit of fixation. Students who have acquired awareness and resistance to fixation in their early years can develop an auto-control mechanism for fixation in the rest of their design practice. This opinion motivates us to operate researches on novice designers. In this context, subjects were selected from novice design students in our studies. Discussions about novices provide implications on what kind of experience the student should have for the next years of education.

Disciplinary: Architecture

Most researches have been conducted with participants who have a disciplinary background in industrial design and mechanical engineering. However, the propensity of architectural design students and architects may have different characteristics. There are fewer studies on architectural design (see, Casakin & Goldschmidt, 2000; Goldschmidt & Smolkov, 2006) and most of them did not intend to compare disciplines. Therefore, there is a need for comparative study with individuals in architecture and different fields.

It is accepted that disciplinary background may cause different approaches to idea generation. Different approaches may be associated with obtaining of discipline-specific information in education. For discipline-specific information, it is necessary to have the training of its discipline and experience. Nevertheless, design-specific knowledge acquisition is not a concern about the experimental setup for novice students. Thus, studies on first-year students of any design discipline may not be specific to a discipline. These studies may provide general implications for all departments. There is still a need for empirical findings for this claim. In this context, the participants of our research were composed of students of the architecture department.

Group size: Individual

Although design discipline requires collaboration, we are living in an age of increasing individualism. It is also important to develop individual skills for situations where group work is not needed. In any case, the skills of the individual in the group is a significant criterion for more productive group work. This is a motivation for research on how to improve the performance of individuals. In this context, subjects perform as an individual in our research.

Participants of Study 1 and 2

After the overview regarding the fixed profile attributes for this research, participants were identified as follows:

Study 1 – The participants were 117 architecture students in their first year of undergraduate studies, who were not told the goal, hypotheses or methods of assessment that applied in the experiment. However, 8 participants were excluded from the study. Because they did not fill the confirmation form for potential researches. The initial number of participants was eventually reduced to 109 as outliers were identified. 56 male and 53 female novice students, aged 18-25, participated in the experiment. The average age of the students was 19.8 years.

Study 2 - The participants were 74 architecture students in their first year of undergraduate studies, who were not told the goal, hypotheses or methods of assessment that applied in the experiment. However, 8 participants were excluded from the study. Because they did not fill the confirmation form for potential researches. The initial number of participants was eventually reduced to 66 as outliers were identified. 32 male and 34 female novice students, aged 19-25, participated in the experiment. The average age of the students was 21 years.

Both studies were executed in the second semester of first-year education. Thus, students had some experiences to relate key components of the problem by previous exercises regarding basic design principles

3.2.2 Design task

In order to test the hypotheses and answer the research question, an experiment was set up in which participants were asked to solve two design tasks. They were asked to design two architectural spaces: (1) festival area; (2) space of experience. Both project areas are public spaces including the riverside and green areas around the city center of Eskişehir. Students living in the city know the place because they are central places. The time allotted to each task was 60 minutes so as to generate ideas. Figure 3.3 : shows the design task of Study 1 and Figure 3.4 : demonstrates the design task of Study 2.

SKETCH EXAM

TASK: Your task is to design a "*Festival Area*". You are expected to develop the forms of celebration in the area, the types of performance, the characteristics of temporary accommodation and other activities.

Your work should contain a detailed description of your design. You are kindly asked to draw as many different ideas as you can.

GIVEN TIME: 60 minutes.

AREA: Public space which is included a river. It is attached as an image.

Figure 3.3 : Problem statement of Study 1.

SKETCH EXAM

TASK: Your task is to design a "*Space of Experience*". You are also expected to develop the experience itself in the space

Your work should contain a detailed description of your design. You are kindly asked to draw as many different ideas as you can.

GIVEN TIME: 60 minutes.

AREA: Public space which is included a river. It is attached as an image.

Figure 3.4 : Problem statement of Study 2.

In addition, participants were asked to write short explanations and keywords if they considered necessary to clarify their concepts.

3.2.3 Conditional groups and given examples

Many variables that may affect the process are discussed in the previous chapters. In order to minimize the variables in my research, the following variables regarding the given example have been fixed: fidelity (as abstract), expansion (as optimal distance), commonality (as novel), digitality (as printed), quantity (as multiple but inter-related), given time (as sixty minutes), timing (as along with design brief).

Fidelity: Abstract

Due to the simplistic or schematic representation of abstract examples, designers may neglect too detailed examination. However, they can observe simple and important features of the example to convert them to novel ideas. In this context, the given examples of my research have depictions of imaginary cities, as an abstract source.

Expansion: Optimal distance

If designers wish to achieve more novel ideas, they should be able to transfer information from more unfamiliar examples to the given problem. Here, it is claimed that designers need to develop their ability to find the linkage between the problem domain and distantly related (as distant as possible, and then they can explore their optimal and effective distance) stimuli. If they endeavor to explore relations between distantly related stimuli, they can benefit from them even if they seem totally unrelated. In this context, study 2 has a random choice of unrelated contents and self-construction of them to make them related.

Commonality: Novel

Common examples may offer more limited inspiration than novel examples. Since novel examples have the potential to encourage the designer to make new imaginations with inspiration. Because of the commonness of example, even if designers produce some solutions, they may not be stimulated to produce novel designs. In this context, I have presented texts containing imaginary city depictions that do not exist as novel examples.

Complexity: Simple

As mentioned before, if designers have a complex example, it is difficult to determine whether the designers understand it. Because the designer who finds the examples complex may have a tendency not to use the given example. In this case, the impact of the presented example on the designer may not be measured consistently. Thus, whatever a study investigates, having simple examples can provide the research with more reliable results. In this context, texts of imaginary cities are presented as simple examples.

Digitality: Printed

In the new age, everything is becoming digitized, and the design process needs to compromise with digitality. Designers and students are constantly searching for

examples from web browsers and applications and creating collections. However, when the studies are applied to a large experimental group, some problems arise such as the supply of digital equipment and difficulty of systematic control. It is no longer necessary to provide digital equipment because everyone has their own technological tools. However, since these are personal tools, it becomes difficult to construct the conditions of the experiment and to ensure compliance with the requirements. For instance, it is possible to ask design students to use their own telephone. Nonetheless, digital platforms offer many distracting connections and applications and it is very difficult to make sure if a large number of students are only interested in stimuli. Therefore, it is easier to be sure that participants interact only with the examples when stimuli in a printed version. Moreover, printed examples facilitate to develop consistent research. In this context, printed examples were presented in my research.

Quantity: Multiple

The number of external stimulation maybe just one or more than one. Hatıpoğlu and Yıldız (2018) found that researches concluding positive impact about the process of using external stimuli had multiple examples instead of one, in each condition of their review. In this context, multiple examples were presented to participants.

Given time: Sixty minutes

If the research is on idea generation and given a long time, the designers may be satisfied and stop producing after producing some ideas. These designers can interrupt other designers around. For the researcher, all kinds of external factors such as interaction with the environment increase the variable of the research. Giving a short time to generate ideas may be useful to minimize variables. In this context, the given time has been planned as sixty minutes for my research regarding idea generation.

Timing: Along with design brief

There may be different moments to have stimuli in the design process. Some of them may be as follows: before the design brief, along with the design brief, in different timings during idea generation. Exposure to example after the problem solving has begun it may not be very effective due to the tendency to continue an endeavor once an investment in money, effort, or time has been made and not change and improve ideas. Therefore, giving examples before it's too late with minimum interruption (if

there is no incubation period) may be an optimal timing. In this context, along with the design brief is selected timing to observe the direct impact of examples on solutions.

Conditional groups and given examples of Study 1 and 2

After the overview regarding the fixed attributes of the given example for this research, a pilot study has been conducted. Following that, conditional groups were identified for Study 1 and Study 2.

Pilot Study – The conditionals groups were not allocated randomly. When forming groups, successful students can be intensely involved in a group and cause heterogeneous groups. It is a problem to reveal the students' individual success rather than to test the use of the given examples. A pilot study was carried out in order to make a homogeneous distribution to conditional groups. First, all participants had the same sketch exam with the same textual example. Second, the generated ideas were divided into three groups by three academics who were blind to the research goals: (1) highly-original, (2) moderate-original, and (3) low-original. Third, the participants within these three levels were equally distributed to each group. Then the research was conducted as two studies.

Study 1 – Subjects were divided into five groups. Each group worked under different conditions as far as the example to which they were exposed are concerned. We, therefore, distinguish among the groups in terms of the given example. Different forms of textual examples were given to participants. The content of the texts purposefully comes from the same text. Hence, just the form of text was changed for each condition. To investigate the possible influence of the priming materials utilized, the participants were allocated into five groups:

- Control group (n=22): This group did not have access to any given example along with the design task.
- Keyword group (n=21): This group received a textual example as keywords besides the design brief. The participants were asked to highlight keywords in the text to ensure they actually read it.
- Sentence group (n=21): This group was presented a textual example as sentences beside the design brief. The participants were asked to highlight keywords in the text to ensure they actually read it.

- Paragraph group (n=20): This group was given a textual example as paragraphs beside the design brief. The participants were asked to highlight keywords in the text to ensure they actually read it.
- Poem group (n=25): This group received a textual example as poems beside the design brief. The participants were asked to highlight keywords in the text to ensure they actually read it.

Again, the content of the texts purposefully comes from the same text. Therefore, just the form of text was changed for each condition. The given textual examples for Study 1 presented as follows:

Keyword Group

Celestial city | The sky | A maximum of laborious study | Underground city | Rubbish bins

Sentence Group

This belief is handed down in Beersheba: that, suspended in the heavens, there exists another Beersheba, where the city's most elevated virtues and sentiments are poised, and that if the terrestrial Beersheba will take the celestial one as its model the two cities will become one.

They also believe, these inhabitants, that another Beersheba exists underground, the receptacle of everything base and unworthy that happens to them, and it is their constant care to erase from the visible Beersheba every tie or resemblance to the lower twin.

In Beersheba's beliefs, there is an element of truth and one of error.

Paragraph Group

Cities and The Sky 2

“This belief is handed down in Beersheba: that, suspended in the heavens, there exists another Beersheba, where the city's most elevated virtues and sentiments are poised, and that if the terrestrial Beersheba will take the celestial one as its model the two cities will become one. The image propagated by tradition is that of a city of pure gold, with silver locks and diamond gates, a jewel-city, all inset and inlaid, as a maximum of laborious study might produce when applied to materials of the maximum worth. True to this belief, Beersheba's inhabitants honor everything that suggests for them the celestial city: they accumulate noble metals and rare stones, they renounce all ephemeral excesses, they develop forms of composite composure.

They also believe, these inhabitants, that another Beersheba exists underground, the receptacle of everything base and unworthy that happens to them, and it is their constant care to erase from the visible Beersheba every tie or resemblance to the lower twin. In the place of roofs, they imagine that the underground city has overturned rubbish bins, with cheese rinds, greasy paper, fish scales, dishwater, uneaten spaghetti, old bandages spilling from them. Or even that

its substance is dark and malleable and thick, like the pitch that pours down from the sewers, prolonging the route of the human bowels, from black hole to black hole, until it splatters against the lowest subterranean floor, and from the lazy, encircled bubbles below, layer upon layer, a fecal city rises, with twisted spires.

In Beersheba's beliefs, there is an element of truth and one of error. It is true that the city is accompanied by two projections of itself, one celestial and one infernal; but the citizens are mistaken about their consistency. The inferno that broods in the deepest subsoil of Beersheba is a city designed by the most authoritative architects, built with the most expensive materials on the market, with every device and mechanism and gear system functioning, decked with tassels and fringes and frills hanging from all the pipes and levers.

Intent on piling up its carats of perfection, Beersheba takes for virtue what is now a grim mania to fill the empty vessel of itself; the city does not know that its only moments of generous abandon are those when it becomes detached from itself, when it lets go, expands. Still, at the zenith of Beersheba there gravitates a celestial body that shines with all the city's riches, enclosed in the treasury of cast-off things: a planet a-flutter with potato peels, broken umbrellas, old socks, candy wrappings, paved with tram tickets, fingernail-cuttings and pared calluses, eggshells. This is the celestial city, and in its heavens long-tailed comets By past, released to rotate in space from the only free and happy action of the citizens of Beersheba, a city which, only when it shits, is not miserly, calculating, greedy." (Calvino, 1974, pp. 111-113)

Poem Group

- it is translated from the Turkish poem which is generated from Turkish paragraph, instead of writing it from English paragraph.

It is carved into the depths of a flawless city and decorated
The most expensive cube of all parts shining
Potato shells are merging in a composite way
They show her how to be ugly and happy

They value it like a virtue which is forgotten
They made up flying moments without caring for her
They're thinking of a similarity rising from the black hole
They show the stones that go down to the sewers.

Study 2 – Subjects were divided into three groups. Each group worked under different conditions as far as the example to which they were exposed are concerned. We, therefore, distinguish among the groups in terms of the given example. The content of the texts purposefully comes from the same text. It indicates that ready poem comes from several paragraphs which were given to another group to write their own poem. The ready poem was written by the researcher. To investigate the possible influence

of the priming materials utilized, the participants were allocated to the following conditions:

- Control group (n=20): This group did not have access to any given example along with the design task.
- Ready Poem group (n=23): This group received a ready poem. The participants were asked to highlight keywords in the text to ensure they actually read it.
- Self-constructed Poem group (n=23): This group was given several paragraphs. The participants were asked to highlight potential words to write a surrealist poem. Next, they wrote their own poem with these words. These poems were their example to inspire after the self-construction process.

Please, note that poems have a rhyme in Turkish. The given textual examples and various examples of the self-constructed poem are presented as follows:

Ready Poem Group

Since the magic was unfinished against the sky
Since the water connected to the siphons is destroyed arbitrarily
Webs of spider accustomed to living with large pebbles
Spiders' forest looks complicated than before

Bricklayers care the relations of representations
They weave the walls of the city with colored ropes
Those who leave relationships do not reveal themselves
Ropes are removed without notice, walk away piece by piece

Self-Constructed Poem Group (two examples constructed by participants)

(1)

Half of the magic, I don't know
It shows the reality on the ground, I see it piece by piece
Water is squirted from slim sponges
I know it is confusing, I live in the bathroom

Abandoned windows in the sun
It enables wind songs, just as the invasion of a young girl
And rising pile becomes sharper
I decided, the game is off anymore

(2)

Since the city's forest was unfinished
It's like ants are gone
Scents in the space were abandoned
The water has a slim shine in the mirror

The pipes of the city have come to the underworld
Perhaps the city was gifted to the water fairies
The corners of the city have changed
Ropes were increased and removed by fairies

3.2.4 Structure of the Experimental Studies

To sum up, Table 3.1 : shows the structure of these studies.

Table 3.1 : The structure of Study 1 and Study 2

	Method	Sub-Research Question	Set Up
Study 1	Experimental study	Which forms of textual example increase creativity and reduce fixation more?	Producing ideas for a design problem in 60 min. Participants: 109 student designers from architecture (in their first year of undergraduate) 5 Conditions: Control Keyword Sentence Paragraph Poem
Study 2	Experimental study	If the designers write their own poem instead of a given poem (as a self-construction practice), can they internalize the textual example? + In addition, does it produce more creative and less fixated designs?	Producing ideas for a design problem in 60 min. Participants: 66 student designers from architecture (in their first year of undergraduate) 3 Conditions: Control Ready Poem Self-constructed Poem

3.2.5 Data Analysis

All of the experimental sessions were conducted in a design education studio (which is available flexible uses such as design projects, technical drawings, and theoretical lectures).. Participants were controlled individually by the researcher who dispensed design tasks to the participants and explained the procedure but did not intervene in what the participants did.

The participants produced sketches and added a written explanation relating to their designs. The sketches and written descriptions of participants were the main sources of analysis on the influence of the given examples. Measures of assessment include both qualitative and quantitative methods. While the researcher calculated some metrics quantitatively, other metrics were scored by two judges qualitatively (with their experience). The judges are research assistants in design school and who also have professional design experience.

The following metrics were calculated by the researcher:

- Fluency
- Flexibility
- Repetition of key attributes

The following metrics were ranked by two judges:

- Originality
- Practicality
- Understanding of the task
- Quality

Fluency

Idea fluency is an established measure of creative output (Guilford, 1968; Torrance, 1974). It refers to the total number of unique (non-redundant, non-repeated) ideas. The participants were asked to code their drawings. They assigned ‘A’ code to their first solution and used letters in alphabetical order, in each different project development. For example; the fluency score of the participant who developed ideas separately by using the letters 'A, B, C, D’ is 4. Figure 3.5 : and Figure 3.6 : show example solutions that achieved high and low grades for fluency in Study 1 and Study 2.

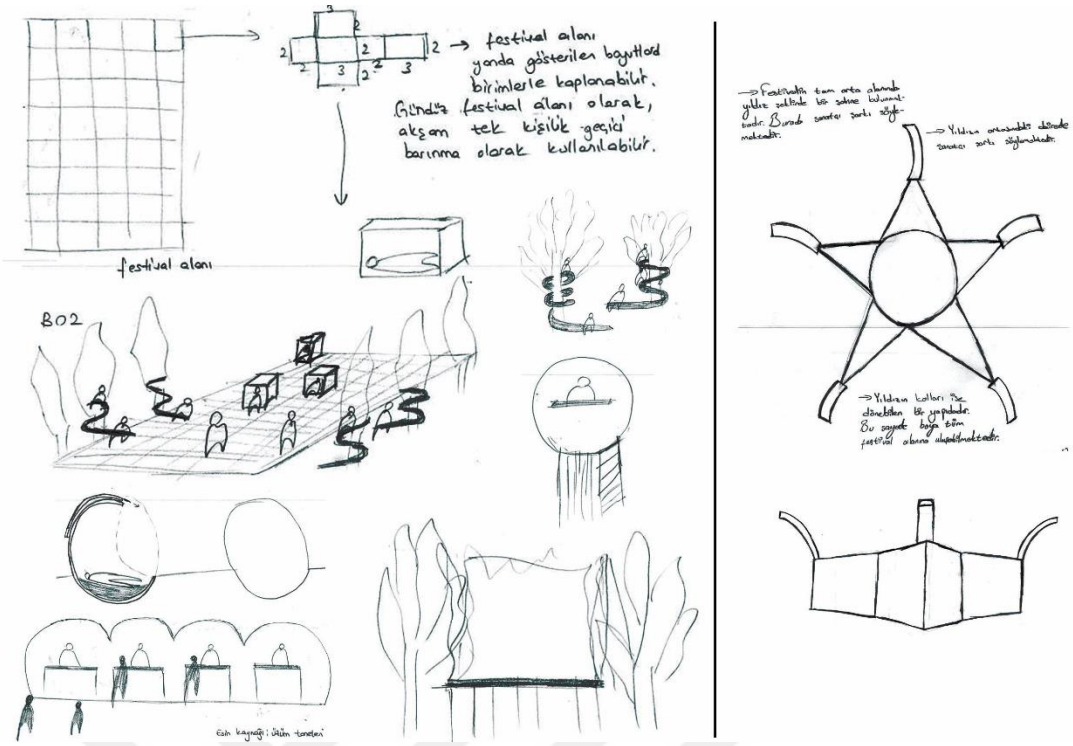


Figure 3.5 : High (left) and low (right) scored examples for fluency in Study 1.

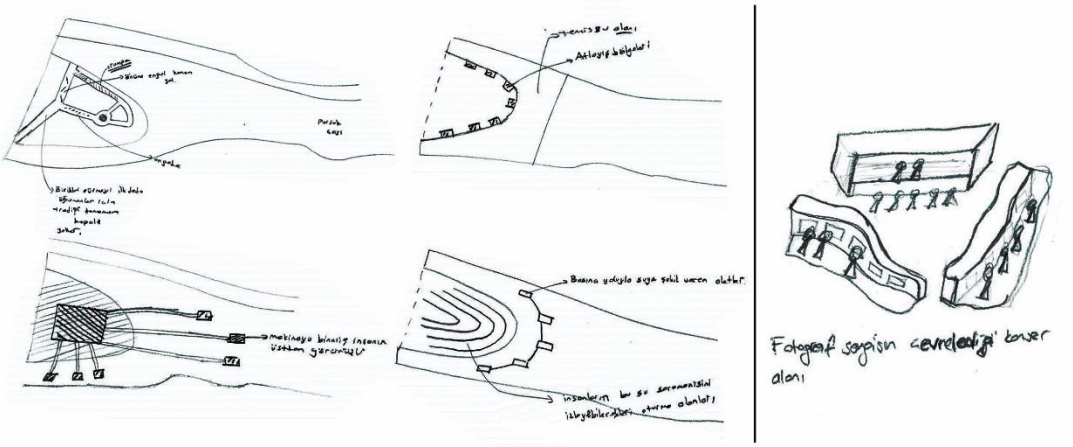


Figure 3.6 : High (left) and low (right) scored examples for fluency in Study 2.

Flexibility

Flexibility is the ability to produce a large variety of ideas (Torrance, 1979). It can be considered as the capacity to switch between different domains of ideas and the ability to alter how a problem is approached. Prior to the analysis of idea flexibility, the sketches need to be clustered into categorical groups. Next, each solution should be categorized inductively according to its basic principles. All solutions were reviewed, titles and sub-titles were identified as Table 3.2 : and Table 3.3 :.

Table 3.2 : Categorization scheme of flexibility in Study 1.

STUDY 1			
outline of festival concert area culture-art activities entertainment recreational areas rest areas technological practices activities around the river observational activities myth-religion activities traditional celebrations physical games/sports individual isolation	**public/private** public space private space semi-public space	**form** curvilinear form triangular form orthogonal form circular form	**orientation** vertical horizontal
	terrestrial relations relations with river creating slopes creating elevations transitions	**position** underground on ground in the air underwater on water	**overall** (total score)

Table 3.3 : Categorization scheme of flexibility in Study 2.

STUDY 2			
mode of experience being in the show use of different senses light-shadow circulatory experience mystical experience different volume perceptions emotional reactions experience of the river movement-based experience	**public/private** public space private space semi-public space	**form** curvilinear form triangular form orthogonal form circular form	**orientation** vertical horizontal
	terrestrial relations relations with river creating slopes creating elevations transitions	**position** underground on ground in the air underwater on water	**overall** (total score)

Figure 3.7 : and Figure 3.8 : shows example solutions that achieved high and low grades for flexibility in Study 1 and Study 2.

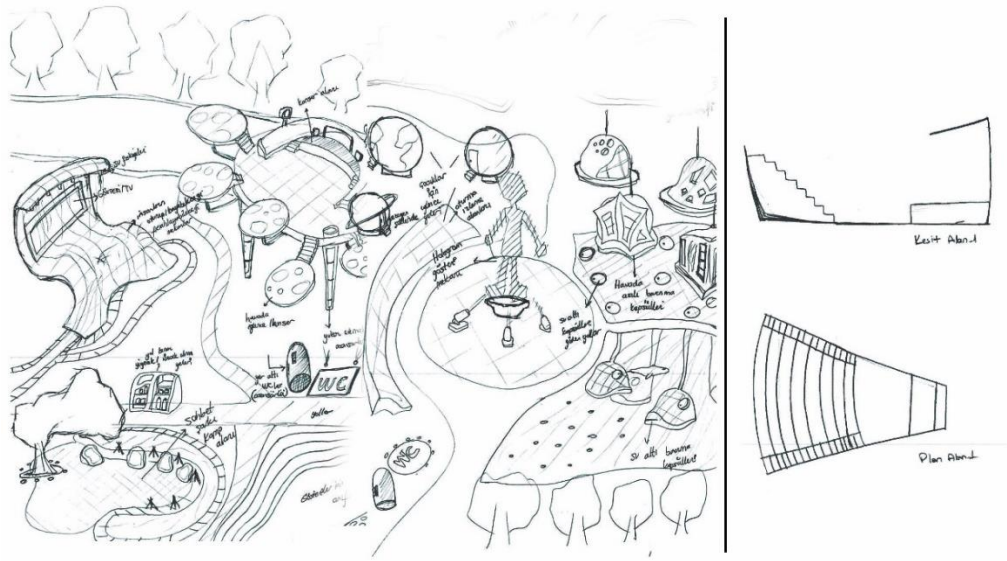


Figure 3.7 : High (left) and low (right) scored examples for flexibility in Study 1.

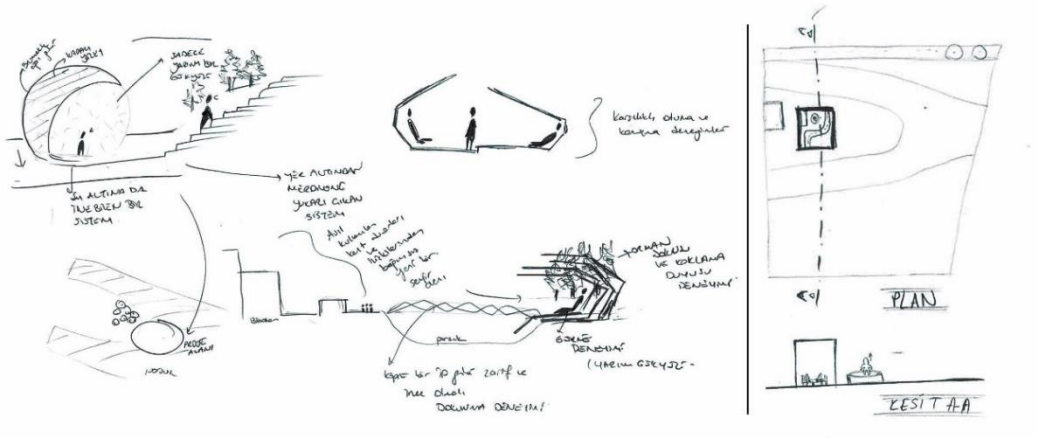


Figure 3.8 : High (left) and low (right) scored examples for flexibility in Study 2.

Repetition of key attributes

Repetition of key attributes is acquired by assessing the new solution ideas on their similarity to the given examples. It is a measurement of fixation. The higher the score of repetition of key attributes the designers have, the higher the fixated mind they have. In order to search for repetition in the outcome of the participants, there is a need for categorization based on the physical and functional characteristics of the given example presented to the participants (see, Jansson & Smith, 1991).

For Study 1, each participant (except the control group) obtained different forms of texts with the same content. In these forms, the group with the least words is the keyword group. Therefore, the following words are included in all groups and are identified as possible fixation features: (1) underground city, (2) celestial city, (3) the sky, (4) rubbish bins. If participants incorporated these ideas, outcomes the participants showed signs of design fixation.

For Study 2, the ready poem was written from 3 different texts which were also used in the self-constructed poem group. In other words, the words in the ready poem are the common words of the sources presented to the two groups. Therefore, the following words are included in all groups and are identified as possible fixation features: (1) webs of spider, (2) ropes, (3) walls of the city, (4) forest. If participants incorporated these ideas, outcomes the participants showed signs of design fixation.

Figure 3.9 : and Figure 3.10 : show example solutions that achieved high and low grades for the repetition of key attributes in Study 1 and Study 2.

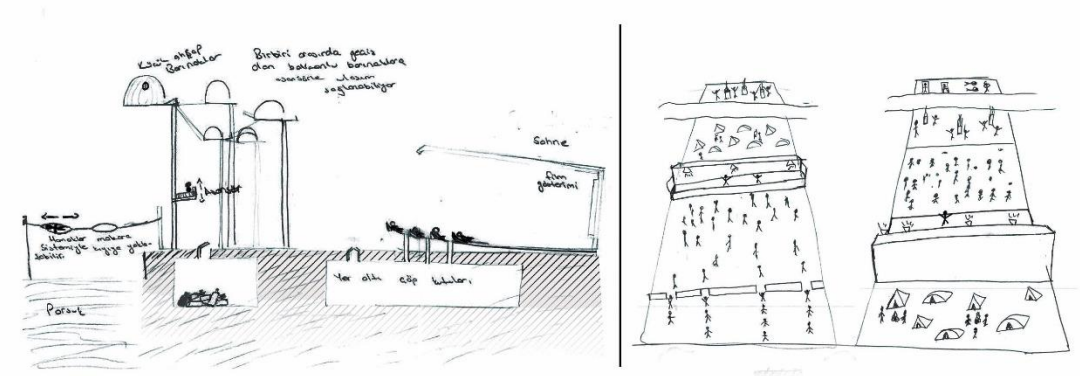


Figure 3.9 : High (left) and low (right) scored examples for the repetition of key attributes in Study 1.

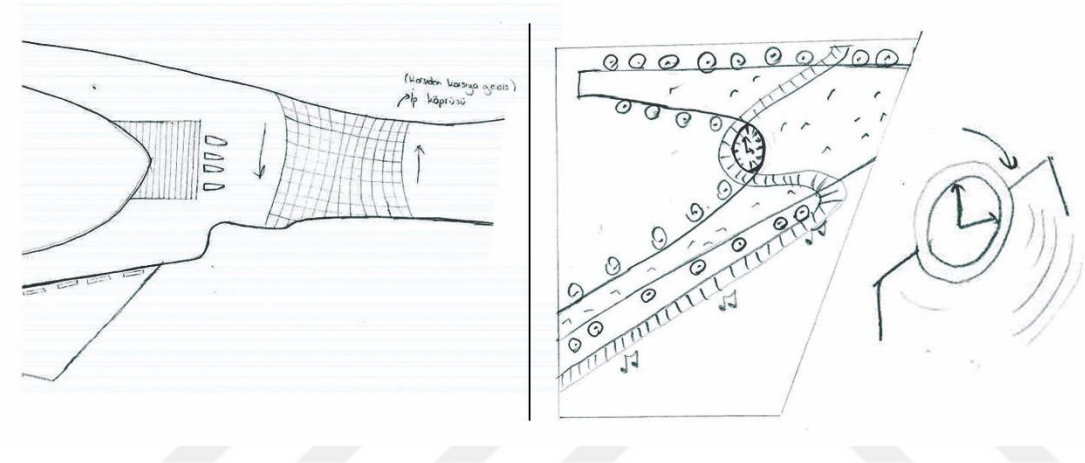


Figure 3.10 : High (left) and low (right) scored examples for the repetition of key attributes in Study 2.

Originality

Originality is a measure of how unusual or unexpected an idea is compared to other ideas (Shah et al., 2003). It is whether the idea is novel. This is one of two metrics for the creativity evaluation method given in Finke et al. (1992). Figure 3.11 : and Figure 3.12 : show example solutions that achieved high and low grades for originality in Study 1 and Study 2.

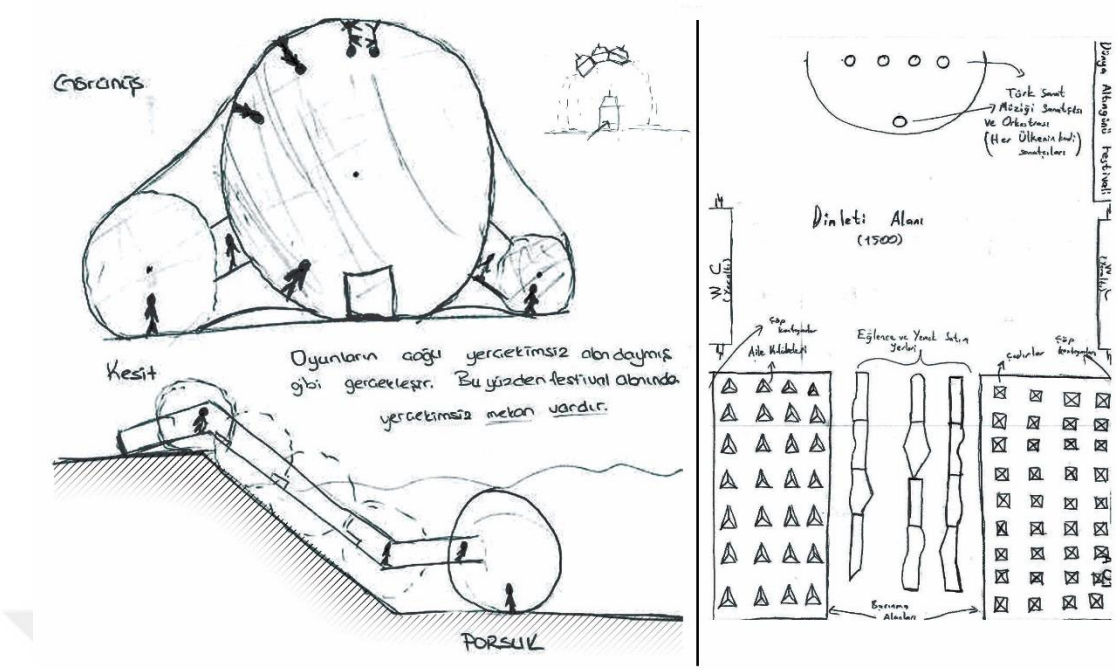


Figure 3.11 : High (left) and low (right) scored examples for originality in Study 1.

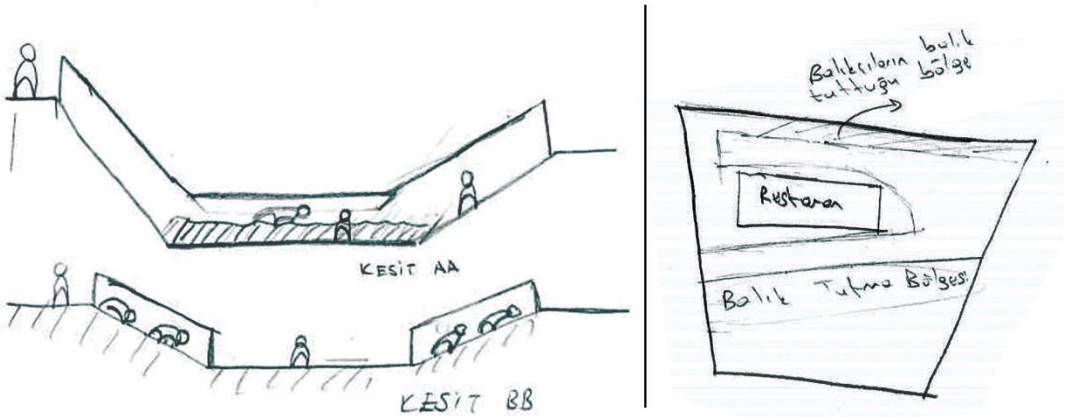


Figure 3.12 : High (left) and low (right) scored examples for originality in Study 2.

Practicality

Creativity is evaluated in terms of novelty and practicality. These two criteria offered by the study of Sternberg and Lubart (1999). They reported that creativity is the ability to produce work with both novelty and appropriateness. It is whether the idea is achievable and feasible. This is one of two metrics for the creativity evaluation method given in Finke et al. (1992). Figure 3.13 : and Figure 3.14 : shows example solutions that achieved high and low grades for practicality in Study 1 and Study 2.

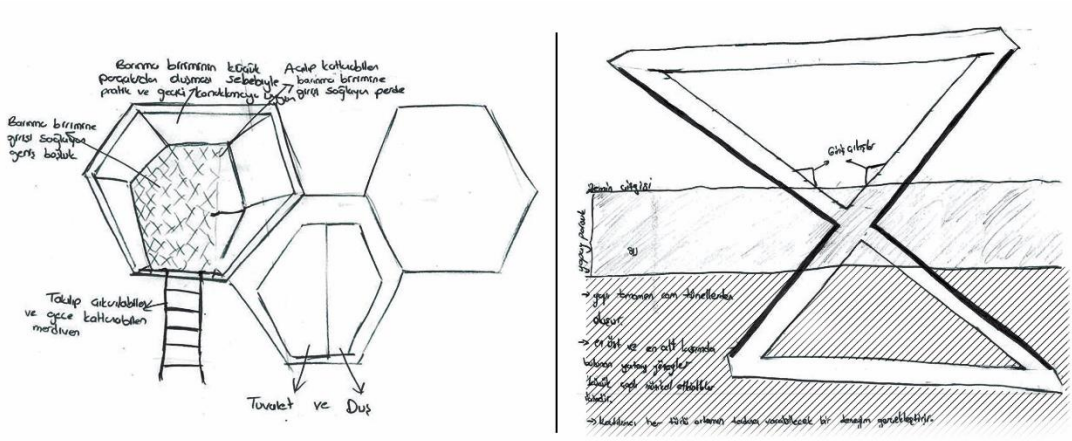


Figure 3.13 : High (left) and low (right) scored examples for practicality in Study 1.

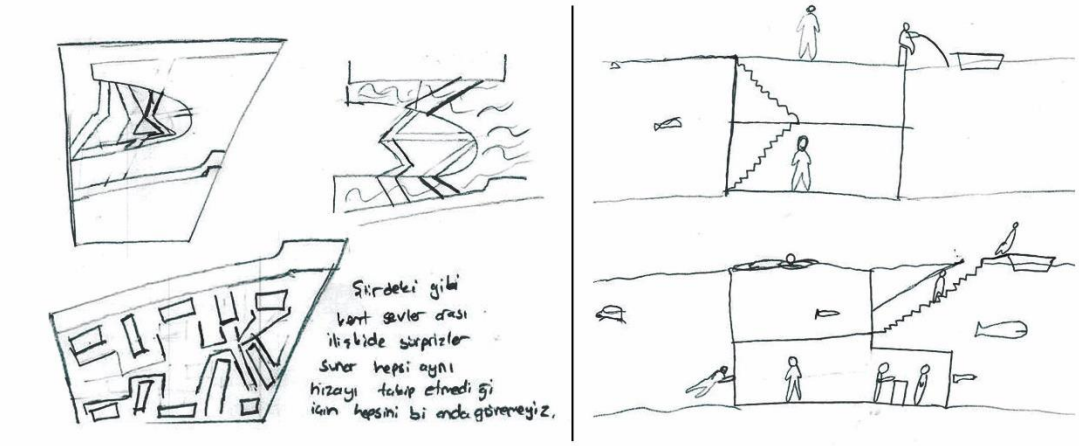


Figure 3.14 : High (left) and low (right) scored examples for practicality in Study 2.

Understanding of the task

It is a degree of understanding of the design brief and developing solutions to respond to the given design task. Figure 3.15 : and Figure 3.16 : show example solutions that achieved high and low grades for understanding of the task in Study 1 and Study 2.

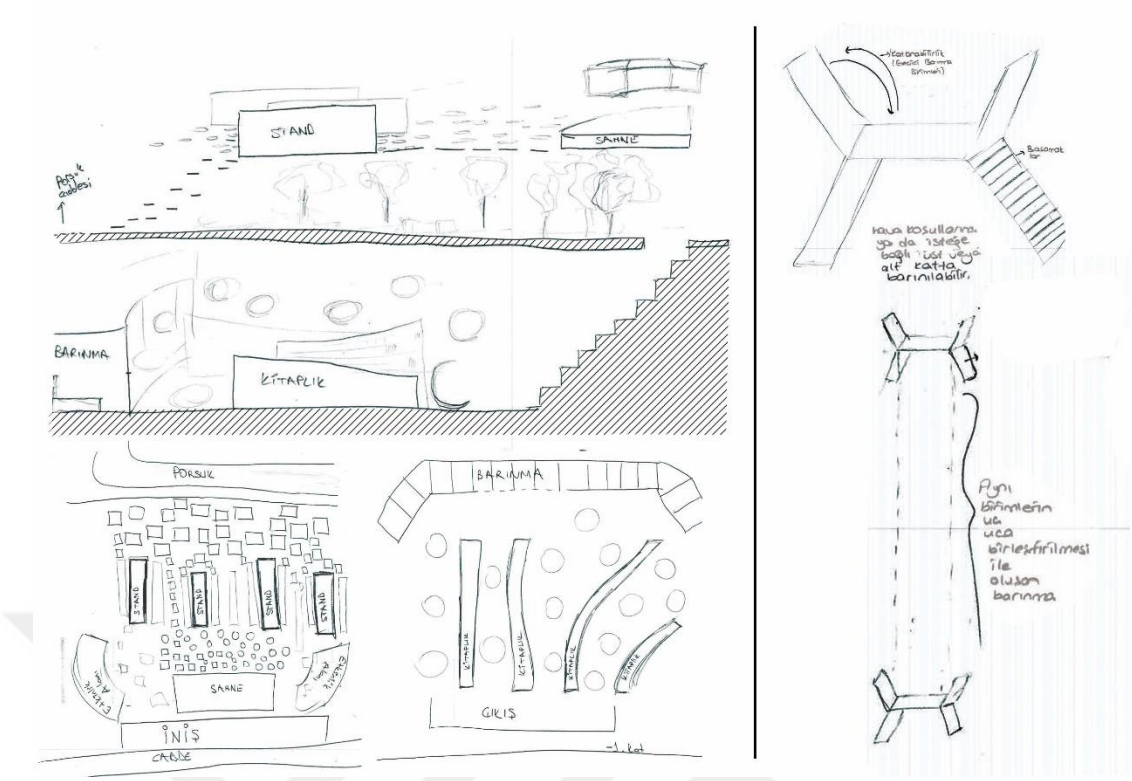


Figure 3.15 : High (left) and low (right) scored examples for understanding of the task in Study 1.

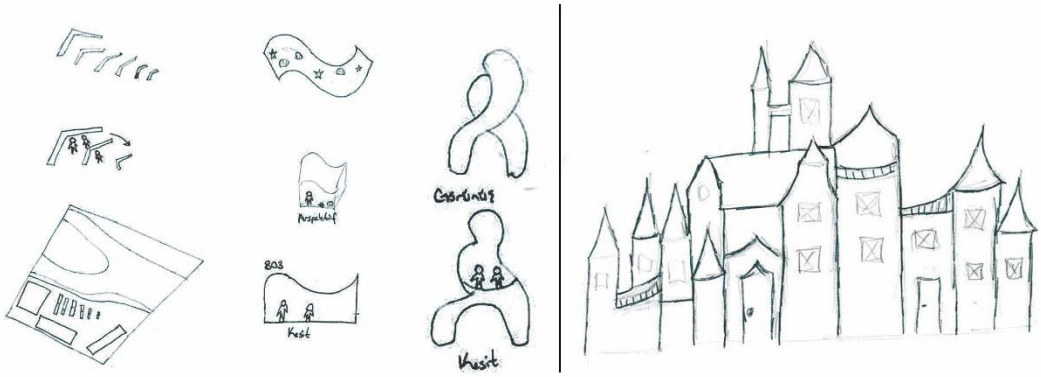


Figure 3.16 : High (left) and low (right) scored examples for understanding of the task in Study 2.

Quality

Quality is a measure of an idea's feasibility and how well it meets the design specifications (Shah et al., 2003). In this sense, Toh and Miller (2014), similar to Linsey et al. (2011), measured quality on an anchored multipoint scale. The quality metric was calculated using the answers of judges to the four questions, as shown in Figure 3.17 :.

Is it a solution for the given design problem? → NO → **1/5**

↓ YES

Is it feasible to build the designer's solution up? → NO → **2/5**

↓ YES

Does this solution relate to or create its own context? → NO → **3/5**

↓ YES

Is this solution original? → NO → **4/5**

↓ YES

5/5

Figure 3.17 : Four questions to assess the quality of design .

In addition, Figure 3.18 : and Figure 3.19 : show example solutions that achieved high and low grades for quality in Study 1 and Study 2.

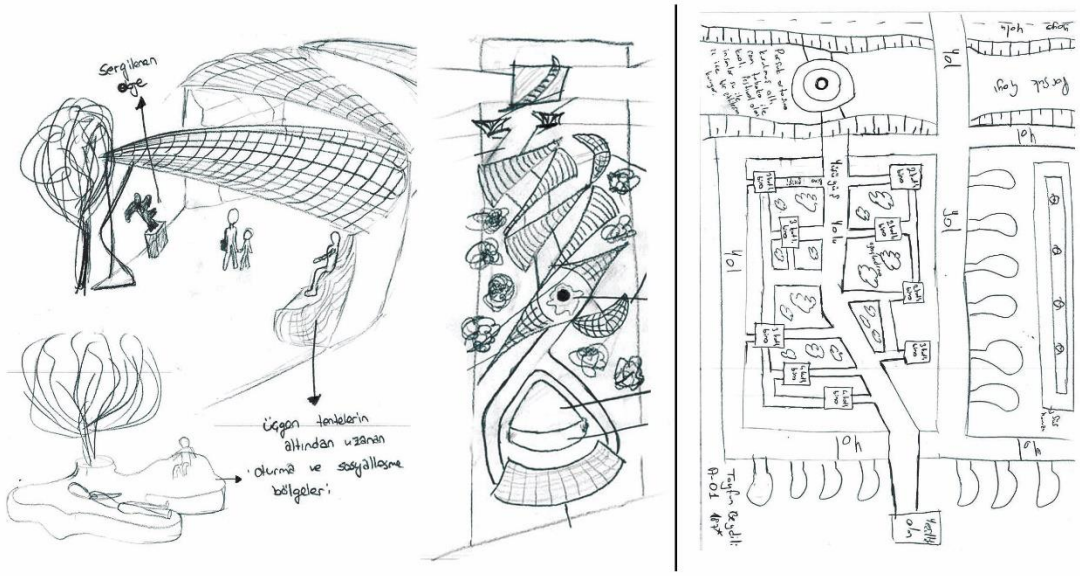


Figure 3.18 : High (left) and low (right) scored examples for quality in Study 1.

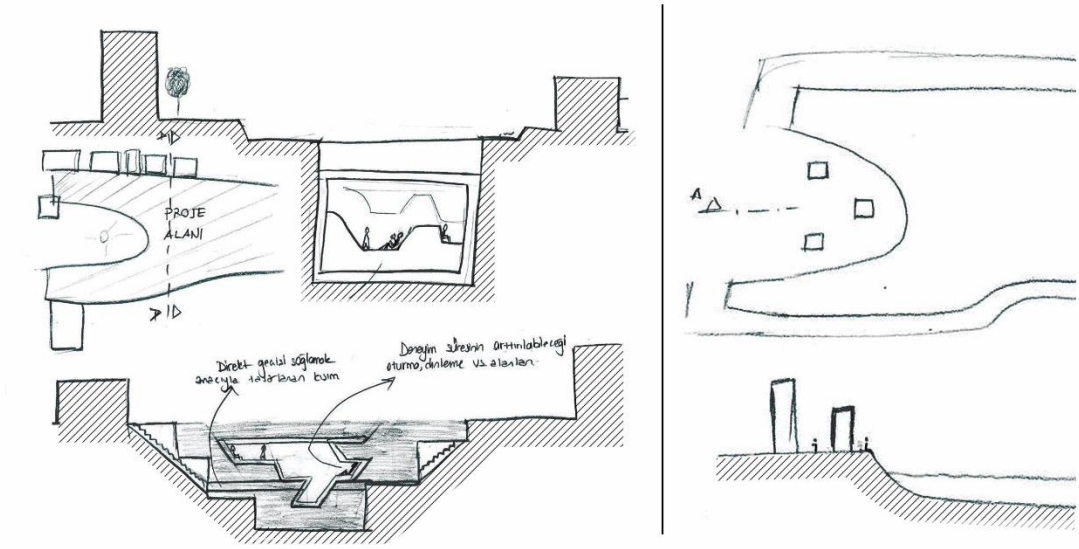


Figure 3.19 : High (left) and low (right) scored examples for quality in Study 2.

The metrics mentioned before are common measurements in creativity and fixation literature (e.g., Goff & Torrance, 2002; Jansson & Smith, 1991; Piffer, 2012).

As mentioned before, the designs were graded by two judges who are experts in the field of design. Each design solution was assessed for (1) originality, (2) practicality, (3) understanding of the task, (4) quality. Scores were given on a scale of 1-5, where 1 is low and 5 is high. The judges were blind to the goals of the research and the experimental conditions.

The process of judgment has several steps. First, the assignment was read and some of the relevant information was shown to judges in an abbreviated form. The judges could ask questions for further clarification. Second, slides of all ideas were shown in random order for 15 seconds, accompanied by a one-sentence summary to explain the way each of them works. Third, the first scoring category was briefly introduced, and all the design solutions were again presented for 15 seconds. Each judge graded the ideas individually in the introduced category. Then, the similar sessions were held for other categories repeatedly.

The level of the agreement for two independent judges was computed using Cronbach's alpha coefficient (Landis & Koch, 1977). The two judges showed an acceptable agreement when assessing the originality, practicality, understanding of task and quality for all conditions. This supports the use of this coding system as a

reliable measure to categorize the data on these metrics. The agreement between the two evaluators was calculated and is shown in Table 3.4 :.

Table 3.4 : Inter-rater reliability scores for each metric.

Metric	α (Study 1)	r (Study 1)	α (Study 2)	r (Study 2)
Originality	0,766	0,625**	0,869	0,769**
Practicality	0,603	0,441*	0,888	0,801**
Understanding of Task	0,763	0,631**	0,811	0,683**
Quality	0,804	0,674**	0,885	0,798**

** Correlation is significant at the 0.01 level (two-tailed). (in other words, $p < 0.01$)

* Correlation is significant at the 0.05 level (two-tailed) (in other words, $p < 0.05$)

4. RESULTS

The following sections present the results gathered from the studies in terms of fluency, flexibility, repetition of the key attributes, originality, practicality, understanding of the task, quality. A one-way analysis of variance (ANOVA) was used to compute the results and to analyze conditional groups which have different examples.

4.1 Study 1

Fluency

There are some numerical differences between the fluency score of the five groups. However, the examination of the average scores shows no significant differences between the groups ($p > 0.5$).

Flexibility

Overall, the analysis revealed that participants of the keyword group developed significantly more flexible ideas than the other groups ($p < 0.05$). Further, sub-titles of flexibility were analyzed in detailed.

For the outline of the festival, the participants of the keyword group and sentence group produced more diverse ideas than the participants of the control group and poem group. For the public / private approach to the design, the participants of the poem group produced more diverse ideas than the participants of the keyword and paragraph group. For the form of the design, the participants of the keyword group produced more diverse ideas than the participants of the sentence group. For the orientation of the design, the participants of the keyword group produced more diverse ideas than the participants of other groups. For terrestrial relations, the participants of the keyword group produced more diverse ideas than the participants of other groups. For the position of the design, the participants of the keyword group produced more diverse ideas than the participants of other groups. For spatial organization, the participants of the keyword group produced more diverse ideas than the participants of the control and poem group. Moreover, the participants of the sentence group produced more diverse ideas than the participants of the poem group. The results can be found in Table 4.1 : and Table 4.2 :.

Table 4.1 : Means and standard deviations for flexibility.

Groups	outline of festival (mean – SD)	public/private (mean – SD)	form (mean – SD)	orientation (mean – SD)	terrestrial relations (mean – SD)	position (mean – SD)	spatial organization (mean – SD)	overall (mean – SD)
Control (N=22)	4,136 (1,166)	2,181 (0,501)	1,863 (0,888)	1,181 (0,394)	1,500 (1,144)	1,727 (0,767)	2,227 (0,685)	14,818 (2,648)
Keyword (N=21)	5,809 (1,470)	2,523 (0,601)	2,476 (0,813)	1,666 (0,483)	2,809 (1,167)	2,809 (1,077)	3,000 (0,836)	21,095 (4,023)
Sentence (N=21)	5,476 (1,631)	2,095 (0,624)	1,761 (0,768)	1,000 (0,316)	1,428 (1,121)	1,523 (0,980)	2,714 (0,717)	16,000 (4,024)
Paragraph (N=20)	4,500 (1,701)	2,500 (0,512)	1,950 (0,686)	1,200 (0,410)	1,850 (0,933)	1,650 (0,933)	2,300 (0,978)	15,950 (3,859)
Poem (N=25)	4,120 (0,971)	1,960 (0,675)	2,240 (0,778)	1,080 (0,276)	1,480 (1,004)	1,240 (0,435)	2,120 (0,439)	14,240 (2,602)

Table 4.2 : Multiple comparisons for the flexibility of designs.

	outline of festival	public / private	form	orientation	terrestrial relations	position	spatial organization	overall
Control VS Keyword	-1,339*	-0,341	-0,612*	-0,484*	-1,309*	-1,082*	-0,772*	-6,277*
Control VS Sentence	-0,363	0,086	0,101	0,181	0,071	0,203	-0,487	-1,181
Control VS Paragraph	0,0163	-0,318	-0,086	-0,018	-0,350	0,077	-0,072	-1,131
Control VS Poem	-1,339*	0,221	-0,376	0,101	0,020	0,487	0,107	0,578
Keyword VS Sentence	0,333	0,428	-0,188	0,666*	1,380*	1,285*	0,285	5,095*
Keyword VS Paragraph	1,309	0,023	-0,478	0,466*	0,959*	1,159*	0,700	5,145*
Keyword VS Poem	1,689*	0,563*	-0,188	0,586*	1,329*	1,569*	0,880*	6,855*
Sentence VS Paragraph	0,976	-0,404	-0,478	-0,200	-0,421	0-,126	0,414	0,050
Sentence VS Poem	1,356*	0,135	-0,188	-0,080	-0,051	0,283	0,594*	1,760
Paragraph VS Poem	0,380	0,540*	-0,290	0,120	0,370	0,410	0,180	1,710

* Represents comparisons that are statistically significant at p = 0.05 or less.

Repetition of key attributes

The analysis revealed that participants of the keyword group developed significantly more fixated ideas to key attributes of the given example than the participants of the control group, sentence group and poem group ($p < 0.05$). This indicates that presenting examples in the format of the keyword causes stronger fixation. The paragraph group is not included in this distinction, thus, paragraphs have a potential danger to fall into the tendency of fixation. However, no significant difference was found between the control group, sentence group and poem group for the repetition of

key attributes of the created designs. Therefore, sentence and poem show weak or no fixation to the given examples. The results can be found in Table 4.3 : and Table 4.4 :.

Table 4.3 : Means and standard deviations for the repetition of key attributes.

Groups	Sample Size (N)	Mean	Standard Deviation (SD)
Control	22	0,272	0,455
Keyword	21	1,428	1,075
Sentence	21	0,238	0,538
Paragraph	20	0,800	1,005
Poem	25	0,200	0,408

Table 4.4 : Multiple comparisons for the repetition of key attributes of designs.

	Control	Keyword	Sentence	Paragraph	Poem
Control	-	-1,155*	0,034	-0,527	0,072
Keyword	1,155*	-	1,190*	0,628	1,228*
Sentence	-0,034	-1,190*	-	-0,561	0,038
Paragraph	0,527	-0,628	0,561	-	0,600
Poem	-0,072	-1,228*	-0,0381	-0,600	-

* Represents comparisons that are statistically significant at p = 0.05 or less.

Originality

The analysis revealed that participants of the keyword group developed significantly more original ideas than the participants of the control group, sentence group and paragraph group ($p < 0.05$). This indicates that presenting examples in the format of keyword inspires designers to create more original designs. However, no significant difference was found between the control group, sentence group and paragraph group for the originality of the created designs.

In addition, a significant difference was found between the poem group, the control group and the sentence group. The participants who were presented with the poem created significantly more original designs than participants who did not have any given examples, and who had examples in the form of the sentence ($p < 0.05$). This indicates that presenting examples in the format of the poem inspires designers to create more original designs. However, no significant difference was found between poem group and paragraph group for the originality of the created designs. Although the poem group and keyword group produce more original results compared to the control group, there is no significant difference between poem group and keyword group. The results can be found in Table 4.5 : and Table 4.6 :.

Table 4.5 : Means and standard deviations for originality.

Groups	Sample Size (N)	Mean	Standard Deviation (SD)
Control	22	2,295	0,868
Keyword	21	3,476	0,980
Sentence	21	2,404	0,982
Paragraph	20	2,525	0,865
Poem	25	3,080	0,606

Table 4.6 : Multiple comparisons for the originality of design.

	Control	Keyword	Sentence	Paragraph	Poem
Control	-	-1,180*	-0,109	-0,229	-0,784*
Keyword	1,180*	-	1,071*	0,951*	,396
Sentence	,109	-1,071*	-	-,120	-,675*
Paragraph	0,229	-0,951*	0,120	-	-0,555
Poem	0,784*	-0,396	0,675*	0,555	-

* Represents comparisons that are statistically significant at p = 0.05 or less.

Practicality

There are some numerical differences between the practicality score of the five groups. However, the examination of the average scores shows no significant differences between the groups ($p > 0.5$).

Understanding of the task

The analysis revealed that participants in the keyword group understood the design task better than the participants of the control group ($p < 0.05$). This indicates that presenting keywords encourage the participants to investigate the meaning of the design task in depth. The participants may ask some questions to the design task via keywords, in order to check whether there are implicit meanings or not. On the other hand, there is no significant difference between the keyword group and other groups which was presented various forms of text. The results can be found in Table 4.7 : and Table 4.8 :.

Table 4.7 : Means and standard deviations for the understanding of the task.

Groups	Sample Size (N)	Mean	Standard Deviation (SD)
Control	22	2,500	0,707
Keyword	21	3,547	0,893
Sentence	21	2,928	1,040
Paragraph	20	3,025	0,895
Poem	25	3,000	0,829

Table 4.8 : Multiple comparisons for the understanding of the task of designs.

	Control	Keyword	Sentence	Paragraph	Poem
Control	-	-1,047*	-0,428	-0,525	-0,500
Keyword	1,047*	-	0,619	0,522	0,547
Sentence	0,428	-0,619	-	-,096	-0,071
Paragraph	0,525	-0,522	0,096	-	0,025
Poem	0,500	-0,547	0,071	-0,025	-

* Represents comparisons that are statistically significant at p = 0.05 or less.

Quality

The analysis revealed that participants in the keyword group, paragraph group and poem group developed ideas in significantly better quality than the participants of the control group ($p < 0.05$). This indicates that presenting examples in the format of keyword, paragraph and poem inspires designers to create designs in better quality. However, the same result does not apply to sentence group. Furthermore, paragraph group also developed ideas in significantly better quality than the participants of keyword group. Nevertheless, no significant difference was found between the keyword group, paragraph group and poem group for the quality of the created designs. The results can be found in Table 4.9 : and Table 4.10 :.

Table 4.9 : Means and standard deviations for quality.

Groups	Sample Size (N)	Mean	Standard Deviation (SD)
Control	22	2,613	0,634
Keyword	21	3,619	1,071
Sentence	21	2,738	1,124
Paragraph	20	3,700	1,018
Poem	25	3,360	0,784

Table 4.10 : Multiple comparisons for the quality of designs.

	Control	Keyword	Sentence	Paragraph	Poem
Control	-	-1,005*	-0,124	-1,086*	-0,746*
Keyword	1,005*	-	0,880	-0,080	0,259
Sentence	0,124	-0,880	-	-0,961*	-0,621
Paragraph	1,086*	0,080	0,961*	-	0,340
Poem	0,746*	-0,259	0,621	-0,340	-

* Represents comparisons that are statistically significant at p = 0.05 or less.

4.2 Study 2

Fluency

There are some numerical differences between the fluency score of the three groups. However, the examination of the average scores shows no significant differences between the groups ($p > 0.5$).

Flexibility

Overall, the participants of the ready poem produced more diverse ideas than the participants of control group. Nevertheless, the analysis revealed that participants of the self-constructed poem group developed significantly more flexible ideas than the other groups ($p < 0.05$). Further, sub-titles of flexibility were analyzed in detailed.

For the mode of experience, the participants of the self-constructed poem and ready poem group produced more diverse ideas than the participants of the control group. For the public / private approach to the design, no significant difference was found between the conditional groups. For the form of the design, the participants of the self-constructed poem produced more diverse ideas than the participants of the ready poem and control group. Moreover, the participants of the ready poem produced more diverse ideas than the participants of the control group. For the orientation of the design, no significant difference was found between the conditional groups. For terrestrial relations, the participants of the self-constructed poem produced more diverse ideas than the participants of the ready poem and control group. For the position of the design, no significant difference was found between the conditional groups. For spatial organization, the participants of the self-constructed poem produced more diverse ideas than the participants of the ready poem and control group. The results can be found in Table 4.11 : and Table 4.12 :.

Table 4.11 : Means and standard deviations for flexibility.

Groups	mode of experience (mean – SD)	public/private (mean – SD)	form (mean – SD)	orientation (mean – SD)	terrestrial relations (mean – SD)	position (mean – SD)	spatial organization (mean – SD)	overall (mean – SD)
Control (N=20)	2,000 (1,076)	1,2000 (0,410)	1,050 (0,394)	1,150 (0,366)	1,200 (0,894)	1,700 (0,656)	1,000 (0,458)	9,300 (2,556)
Ready Poem (N=23)	3,173 (1,336)	1,3043 (0,634)	1,391 (0,499)	1,260 (0,619)	1,782 (0,998)	2,087 (0,900)	1,173 (0,491)	12,173 (3,242)
Self-constructed Poem (N=23)	4,217 (1,832)	1,3913 (0,499)	2,087 (0,996)	1,217 (0,421)	2,608 (0,988)	1,869 (0,757)	2,130 (0,868)	15,521 (4,241)

Table 4.12 : Multiple comparisons for the flexibility of designs.

	mode of experience	public / private	form	orientation	terrestrial relations	position	spatial organization	overall
Control VS Ready Poem	-1,173*	-	-0,341*	-	-0,582	-	-0,173	-2,873*
Control VS Self-constructed Poem	-2,217*	-	-1,036*	-	-1,408*	-	-1,130*	-6,221*
Ready Poem VS Self-constructed Poem	-1,043*	-	-0,695*	-	-0,826*	-	-0,956*	-3,347*

* Represents comparisons that are statistically significant at p = 0.05 or less.

Repetition of key attributes

The analysis revealed that participants of the ready poem group developed significantly more fixated ideas to key attributes of the given example than the participants of the control group, self-constructed group ($p < 0.05$). This indicates that presenting ready examples causes stronger fixation than constructing examples by the designer. However, no significant difference was found between the control group and the self-constructed group. Therefore, self-constructed poems show weak or no fixation to the given examples. In other words, self-construction of the given examples mitigates or breaks the potential fixation and allows designers to think freely. The results can be found in Table 4.13 : and Table 4.14 :.

Table 4.13 : Means and standard deviations for the repetition of key attributes.

Groups	Sample Size (N)	Mean	Standard Deviation (SD)
Control	20	0,200	0,376
Ready Poem	23	1,130	1,217
Self-constructed Poem	23	0,130	0,344

Table 4.14 : Multiple comparisons for the repetition of key attributes of designs.

	Control	Ready Poem	Self-constructed Poem
Control	-	-0,930*	0,069
Ready Poem	0,930*	-	1,000*
Self-constructed Poem	-0,069	-1,000*	-

* Represents comparisons that are statistically significant at p = 0.05 or less.

Originality

The analysis revealed that participants of the self-constructed poem group developed significantly more original ideas than the participants of the control group and ready poem group ($p < 0.05$). This indicates that constructing inspiring examples from the given example inspires designers to create more original designs, rather than presenting ready examples. However, no significant difference was found between the control group and the ready poem group for the originality of the created designs. The results can be found in Table 4.15 : and Table 4.16 :.

Table 4.15 : Means and standard deviations for originality.

Groups	Sample Size (N)	Mean	Standard Deviation (SD)
Control	20	2,375	0,998
Ready Poem	23	2,500	1,138
Self-constructed Poem	23	3,543	1,043

Table 4.16 : Multiple comparisons for the originality of designs.

	Control	Ready Poem	Self-constructed Poem
Control	-	-0,125	-1,168*
Ready Poem	0,125	-	-1,043*
Self-constructed Poem	1,168*	1,043*	-

* Represents comparisons that are statistically significant at p = 0.05 or less.

Practicality

There are some numerical differences between the practicality score of the three groups. However, the examination of the average scores shows no significant differences between the groups ($p > 0.5$).

Understanding of the task

There are some numerical differences between the understanding of the task score by the three groups. However, the examination of the average scores shows no significant differences between the groups ($p > 0.5$).

Quality

The analysis revealed that participants in the self-constructed poem group and ready poem group developed ideas in significantly better quality than the participants of the control group ($p < 0.05$). This indicates that presenting a poem and writing one's own poem inspires designers to create designs in better quality. However, no significant difference was found between the self-constructed poem group and the ready poem group for the quality of the created designs. The results can be found in Table 4.17 : and Table 4.18 :.

Table 4.17 : Means and standard deviations for quality.

Groups	Sample Size (N)	Mean	Standard Deviation (SD)
Control	20	2,325	1,216
Ready Poem	23	3,347	1,525
Self-constructed Poem	23	3,413	1,276

Table 4.18 : Multiple comparisons for the quality of designs.

	Control	Ready Poem	Self-constructed Poem
Control	-	-1,022*	-1,088*
Ready Poem	1,022*	-	-0,065
Self-constructed Poem	1,088*	0,065	-

* Represents comparisons that are statistically significant at p = 0.05 or less.

The design outcomes were analyzed in many metrics. In the next chapter, all results will be interpreted as a conclusion.

5. CONCLUSIONS

Designers are widely influenced by their surroundings in daily lives. This influence can occur in a systematic way, when designers actively search for inspiration, or even unconsciously. Inspirational inputs play important roles to increase creativity. They can support moments of stimulation. However, each stimulus may not conclude with a more creative result. Even if designers want to utilize stimulus as an inspirational source, somehow it may fixate their mind to its surface features and they may lose potential creative contributions of the source. It is called fixation. The most common influence of fixation is the obstruction of the creative process. Therefore, there is a need to develop some ways to mitigate fixation and increase creativity. Two studies have been conducted to explore alternative ways for this need: (1) forms of textual forms and (2) self-construction practice in idea generation.

In this chapter, the results will be reviewed and interpreted through the issues that the research examines and focus on. In light of these interpretations, general discussions and conclusions will be drawn. Parallel to the conclusions, recommendations for design practice will be developed. Finally, the limitations of this research will be explained and potential future studies will be proposed.

5.1 Discussions and Contributions

In order to examine the role of textual examples' forms and self-construction practice in idea generation, various metrics were used. Basic distinctions between forms of textual examples have been found by the assessment of design outcomes. In addition, distinctions between ready examples and self-constructed examples have revealed by these qualitative and quantitative evaluations.

In Study 1, there are no significant differences in terms of fluency and practicality. The keyword group generated significantly more flexible ideas than all others. They also have more fixated ideas than sentence and poem group. The keyword group developed significantly more original ideas than the sentence and paragraph group. The poem group developed significantly more original ideas than the condition and the sentence group. The keyword group shows more understanding of task score which is related to clarification of the problem. Keyword, paragraph and poem group developed better

quality than the condition group. Figure 5.1 : shows a summary of findings in studies of this research.

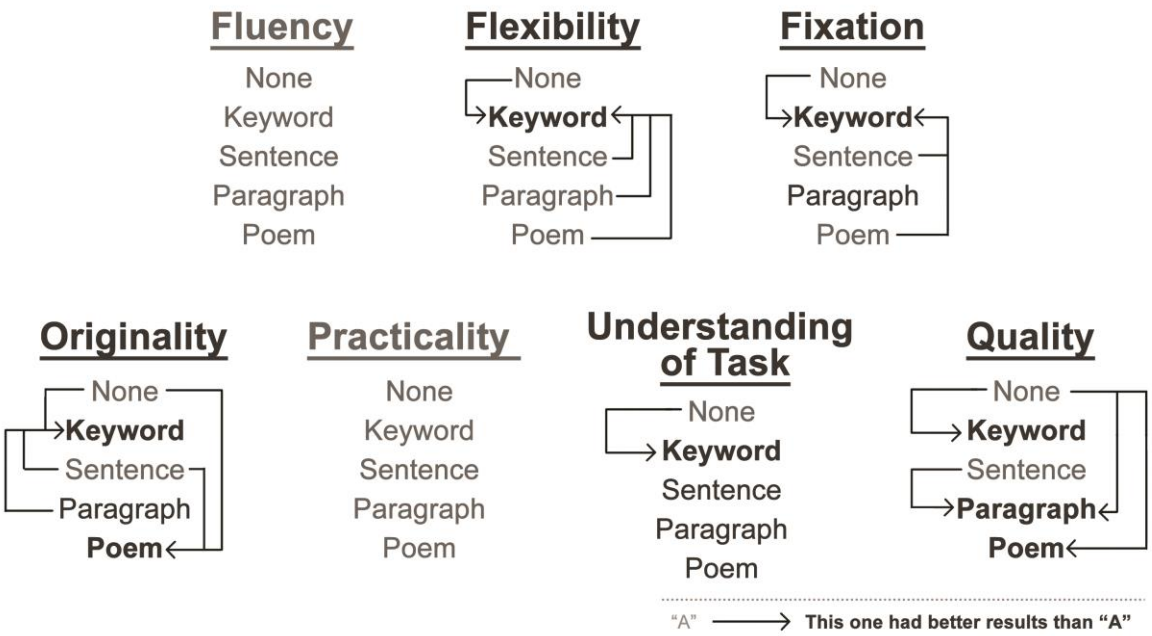


Figure 5.1 : Summary of findings in Study 1.

In Study 2, there is no significant differences in terms of fluency, practicality and understanding of task. Self-constructed poem group generated significantly more flexible ideas than all others. Ready poem group have more fixated ideas than self-constructed poem group. Further, self-constructed poem group developed significantly more original ideas than ready poem group. Both group developed better quality than condition group. Figure 5.2 : show a summary of findings in studies of this research.

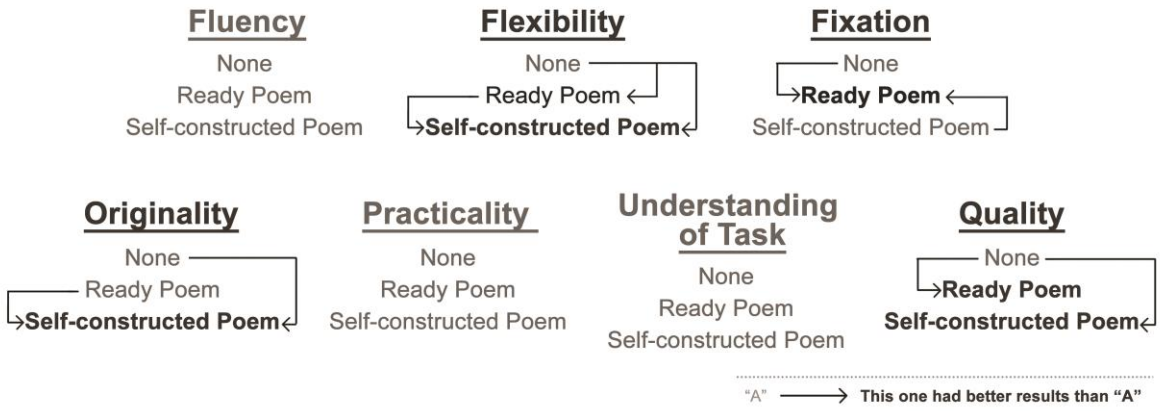


Figure 5.2 : Summary of findings in Study 2.

5.1.1 Study 1: Pros and cons of keywords and poems

Flexibility (Study 1) – As an overview, the keywords support the designer's flexible thinking process. In detail, the following sub-titles contribute to the generation of more diverse ideas with keywords:

- outline of festival
- form
- orientation
- terrestrial relations
- position
- overall

The detailed calculation of the contents of the ideas gives a clue as to which aspects of the given example enhance the design outcome. The outline of the festival is a problem-specific sub-title of flexibility. Being able to produce more diverse ideas regarding this concept plays an important role in productive designs. On the other hand, other sub-titles of flexibility increase spatial probabilities much. This allows the designer to produce a much more diverse set of spatial arrangement than to see no example.

In addition, more ideas were produced with the poem in the sub-title of public/private variations. To be exposed to the poem has a positive impact on investigating relationships of interior and exterior and on developing potential spaces in their intersection.

While designers use keywords and poems as inspirational input, they think of many possible alternative meanings between keywords and between lines of the poem. Possible alternative meanings give them flexibility. Using this flexibility, they can produce more diverse ideas. The more diverse the idea, the greater the probability of combinations. So, it increases the data needed to develop creative results.

Repetition of Key Attributes (Study 1) – This research has two foci: Creativity and Fixation. Repetition of key attributes, as one of these two foci, the metric used to measure the amount of fixation and fixation moments. The high repetition of key attributes indicates that the designer is (1) experiencing a lot of fixation, (2) getting stuck in the given example, and (3) not getting rid of the fixation. The fact that keywords have significantly higher repetition compared to other text forms represents

a major threat of fixation. Designers may not be able to foresee beyond the primary meaning of the keywords presented to them. Even if keywords contribute to creative design outcomes, they may not be preferred by designers due to excessive fixation tendency. A second way is to endeavor for developing a novel practice to reduce or prevent the fixation of keywords. It should be noted that there should be no dramatic reduction in creativity when attempts are made to reduce fixation.

Originality (Study 1) – Since keywords do not specify a clear definition as in sentences, they may have the potential for “infinite inference". Keywords allow designers to make their own inferences. Therefore, it produces more creative results than sentences that combine words to achieve a single meaning. Paragraphs bring sentences together and form a structure of meaning that is limited. That is, paragraphs have a nature that restricts inference. For this reason, keywords can broaden the designer's imagination much more than in paragraphs. However, keywords have no superior to poems in terms of creativity as in sentences and paragraphs. Because poems are like expanded versions of keywords. Unlike sentences, they do not come together to indicate a single meaning. Each person who reads the same poem can build different meanings. Therefore, the poem supports the designer to develop more creative designs compared to taking no example, as in the keyword.

In other words, poems have a similar structure to keywords, but they did not have dominance on other text forms, unlike keywords. Because poems have a more complex structure than keywords so that it's more difficult to analyze and understand. Hence, there may be a need for developing different methods to improve analyzing and understanding poems clearly. For instance, exercises to internalize poems can facilitate the analysis of their complex structures and it can increase creativity in a similar way with keywords. As a conclusion, poems and keywords appear to be the most useful forms of text in terms of creativity.

Understanding of the task (Study 1) – The findings were surprising in relation to how the researcher foresaw that understanding of the task by designers. In fact, the presented texts were not expected to have an impact on the understanding of the design task. Because the design task is constructed independently of the given example. It was not expected that reading different texts would have an influence on understanding the problem better. However, the results show that the designer who is exposed to keywords is not limited to the proposition of the given example, unlike sentences,

paragraphs and poems. While the designer tried to understand the meaning of the given keywords, they spent extra effort to understand the design problem. In other words, they have tried to find out whether keywords are related to the design task or not. In doing so, they have repeatedly thought about the design task through keywords. Thus, they have conducted an in-depth inquiry for the design task.

Quality (Study 1) – Quality is a multi-dimensional metric. The solution in relation to the design problem, feasibility to built, awareness of its contexts and originality are four characteristics of quality. Having these features indicates having potential qualities of originality and practicality, as two parameters of creativity. Presenting keywords, paragraphs and poems triggered designers to produce ideas in better quality compared to having no example. This signifies that presenting various text forms will contribute to producing high-quality designs. Nevertheless, the sentence is not one of these forms. The textual form in which sentences are organized is paragraph and poem. However, if the sentences were not presented in an organized way, there was no support for the designer to improve the quality of their designs.

General discussions for Study 1

Study 1 shows us tendencies of using various textual forms. Distinctions of keywords and of poems have appeared among them. This emphasizes the role of keyword and poem in the design process as inspirational sources and provides many tips for their potential use (see, Figure 5.3 :).

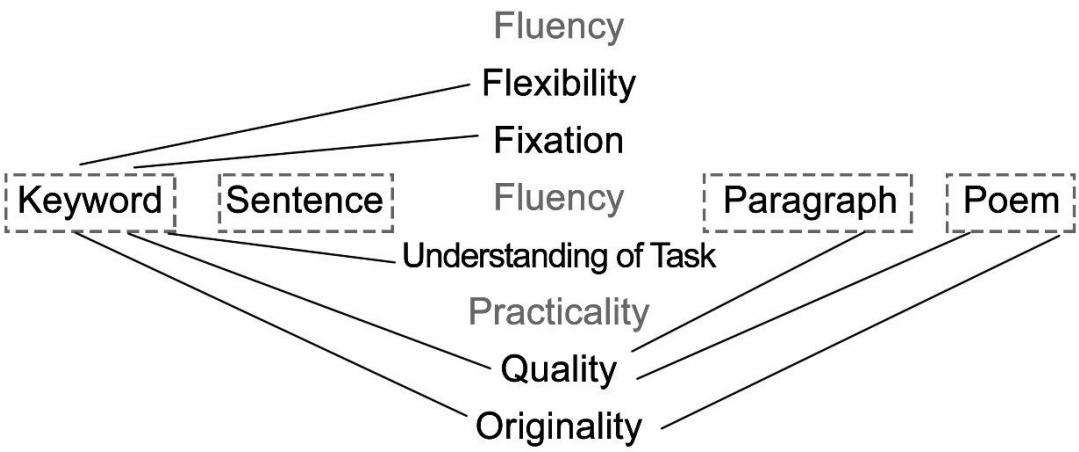


Figure 5.3 : The dominance of different textual forms.

Although the keyword has superior in several metrics such as originality and flexibility, it also leads to a high degree of fixation. Similar to the keyword, the poem

yields much efficient design solutions as well. Furthermore, a low degree of fixation is observed when poems are presented as inspirational examples. In this case, one can look for ways (1) to reduce fixation in a creative form (such as keyword) or (2) to develop more creative designs in a form where fixation is low (such as the poem). Figure 5.4 : shows these two ways. The researcher may follow either way.

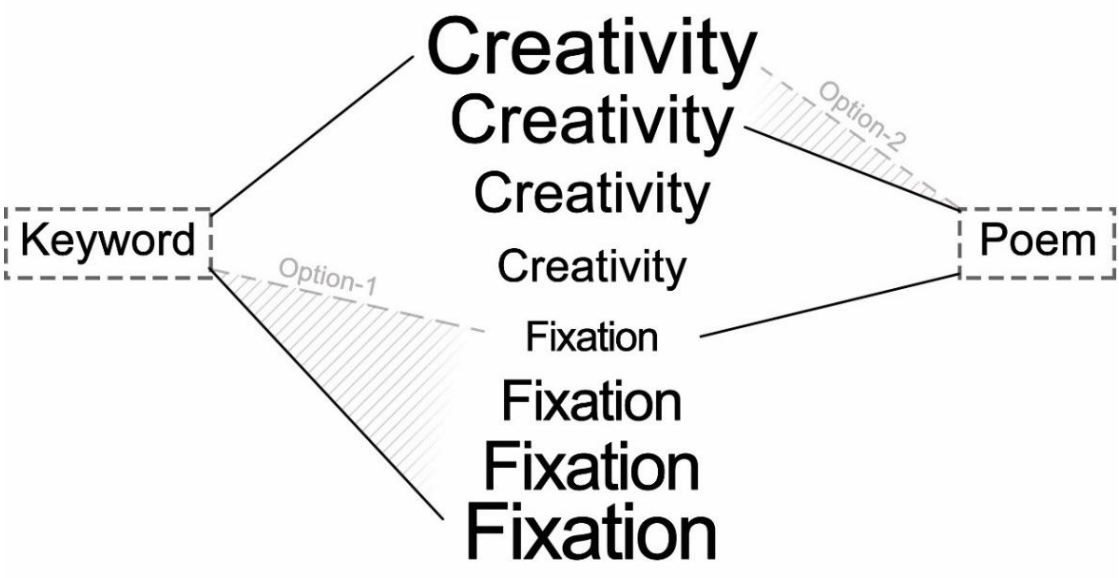


Figure 5.4 : Two options to develop more effective examples.

Reducing fixation for the keyword seems challenging. The designers may lose the creative side of ideas while reducing fixation. Nonetheless, it seems easier to develop the high-creative and low-fixated mode of the poem. Since there is almost no fixation tendency, it does not seem to have a contingency to increase fixation while searching for more creative ways. For all these reasons, the second option was preferred for Study 2 and a way to increase creativity in the surrealist poem has been investigated.

5.1.2 Study 2: Power of self-construction practice

Flexibility (Study 2) – As an overview, self-constructed poems support the designer's flexible thinking process. In detail, the following sub-titles contribute to the generation of more diverse ideas with self-constructed poems:

- mode of experience
- form
- terrestrial relations
- spatial organization

The detailed calculation of the contents of the ideas gives a clue as to which aspects of the given example enhance the design outcome. The mode of experience is a problem-specific sub-title of flexibility. Being able to produce more diverse ideas regarding this concept plays an important role in productive designs. On the other hand, other sub-titles of flexibility increase spatial probabilities much. This allows the designer to produce a much more diverse set of spatial arrangement than to see no example.

As designers produce their own poetry, they also think of many possible alternative structures for other poems. Possible alternative poems give them flexibility so that they can produce more diverse ideas. The more diverse the idea, the greater the probability of combinations. So, it increases the data needed to develop creative results.

Repetition of Key Attributes (Study 2) – This research has two foci: Creativity and Fixation. Repetition of key attributes, as one of these two foci, the metric used to measure the amount of fixation and fixation moments. The high repetition of key attributes indicates that the designer is (1) experiencing a lot of fixation, (2) getting stuck in the given example, and (3) not getting rid of the fixation.

Since ready poems are examples that the designers obtain without any effort, the designers are not stimulated to have an active role. The designers who cannot be activated does not go beyond the ready examples. Designers fixate their minds to attributes of the presented examples with a passive role. This situation results in a fixation. On the other hand, self-construction practice is a process that activates the designers. As designers produce their own poetry, they also think of many possible alternative structures for other poems. This points out that they don't have to stick with the last poem he wrote. Since the designers experience a pre-phase with self-construction practice, they discover alternative precautions against fixation at the very beginning of the process

A second explanation is that the designers transform the presented example with a self-construction practice. This transformation is a process that goes beyond the given example. Therefore, possible strong fixation ties are weakened by this transformation. If fixation ties are weak, they can be easily removed. In other words, the limits of the existing text are deconstructed with self-construction practice. This makes designers much more free to interpret the text and develop alternative ideas.

Originality (Study 2) – In regards to originality, while the designers who received ready poems did not differentiate from the designers who did not take the example, self-constructed poem writers produced more original designs. Designers may not be able to understand ready poems and match them with the design problem. This may demotivate the designers. However, the designers who wrote their own poems from the presented texts create the pre-design phase while re-structuring the text: designing the combination of words. This phase can be considered as an enjoyable warm-up study for the designers. The designers internalize the given example while they were rebuilding it themselves. Thus, they are able to establish bridges between text and design problem and their motivation increased.

In addition, the surrealist poem creates an explosion of possibilities. The designers, who created this explosion themselves, experience and realize that many new possibilities may arise. This experience stimulates designers in the sense of the existence of creative designs and triggers them to produce more creative designs.

Quality (Study 2) – As mentioned in the section of quality for Study 1, the quality is a multi-dimensional metric. Having these dimensions indicates having potential qualities of originality and practicality, as two parameters of creativity. Both ready poems and self-constructed poems uphold designers to produce high-quality design ideas, compared with the designers who are not presented examples. Thus, surrealist poems obtained by both ways contributed to the improvement of the quality of design ideas produced.

Additional observations (Study 2) – The designers in the self-constructed poem group were initially stunned when asked to write surrealist poems. Then, they figured out how to produce it and had a lot of fun writing. It was sometimes seen that they were excited and laughed while reading the sentences they wrote. While checking their sentences, their attention was increased and the self-construction of poems was very interesting to them.

On the other hand, designers in the ready poem group had difficulty understanding the given poem. Instead of attempting to understand the given poem, they preferred not to use it or to use partial-keywords. Unless there is an impulse that drives the designers to internalize, they may lose his motivation to use the given example. Demotivated designers may not be able to use the given example effectively. Further, a similar

problem was observed in the poem group of Study 1. While conducting Study 1, some of the participants in the poem group complaint to the experimenter that they could not understand the given example. Hence, they were concerned about how to develop a solution.

General discussions for Study 2

In this study, kinds of poems which is prominent depending on the evaluation metrics has been revealed (see, Figure 5.5 :). The self-constructed poem seems to support develop more successful design ideas from many perspectives.

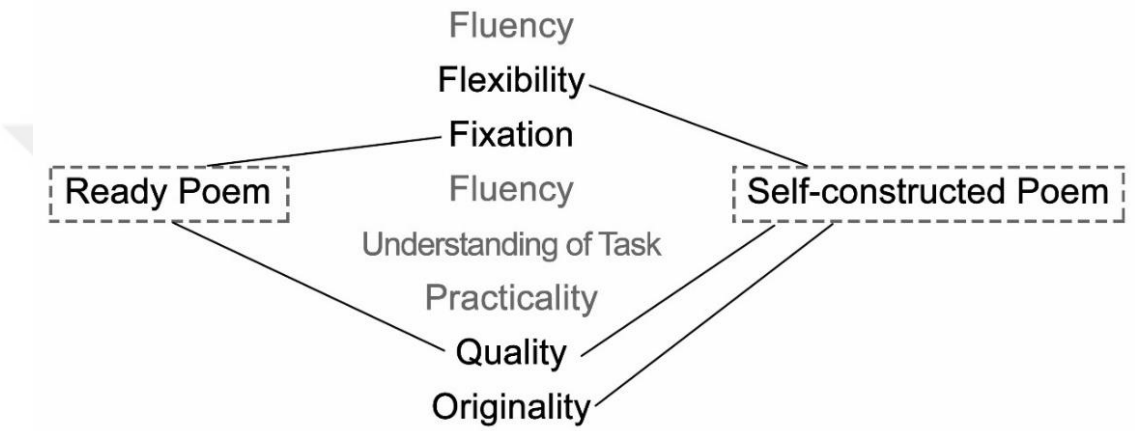


Figure 5.5 : The dominance of ready poems and self-constructed poems.

In the context of the surrealist poem, writing and reading the surrealist poem trigger the designers' imagination. At first, the words and lines of poems seem unrelated to each other and designers try to relate them and solve the puzzle of meaning. Hence, novel meaning networks are formed. It indicates that surrealist poems are able to activate the creative performance of the designers.

In the context of self-construction of the given example, writing their own surrealist poems motivated designers to begin to produce by having fun. Motivated designers have stimulated themselves to produce creative ideas. In other words, the self-construction process may be added to the design process models in the earlier part of the idea generation phase which is called as *pre-design and warm-up phase* (see, Figure 5.6 :). This earlier phase makes designers highly motivated and they internalized the given examples.

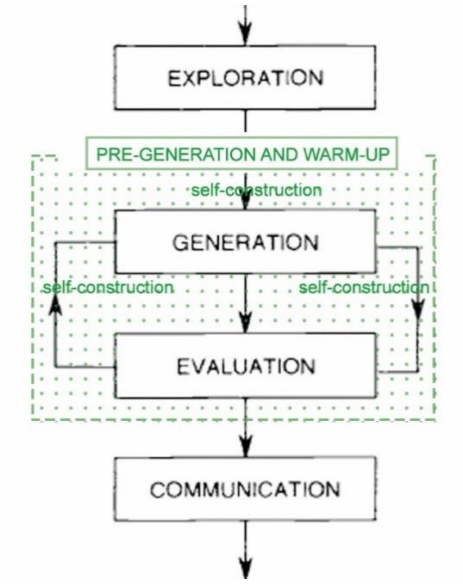


Figure 5.6 : Additional phase: Pre-design and warm-up by self-construction.

In addition, self-construction practice can be integrated into the inspiration process flowchart of (Gonçalves et al., 2013). Figure 5.7 : shows the suggested model by this research.

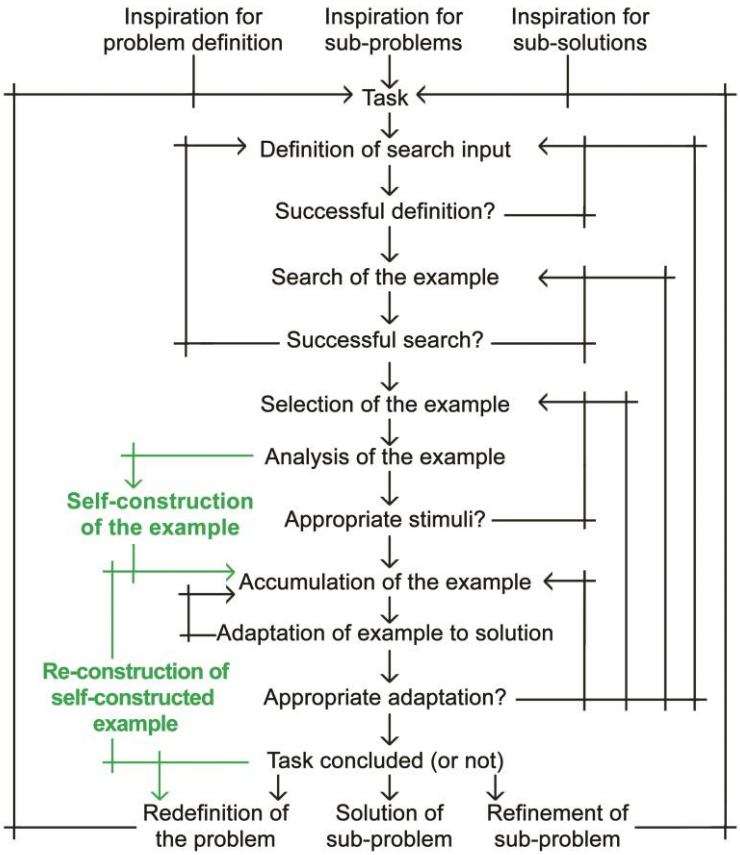


Figure 5.7 : Inspiration process with self-construction practice (adapted from Gonçalves et al., 2013).

5.2 Recommendations for Design Practice and Education

Frequent Use of Keywords and Poems – these two textual forms can be used frequently in education, the more used and the awareness of fixation is created, the more habit the designer candidates gain. Moreover, this practice improves the ability to use the given textual examples with high creativity without attached to the fixation. This can be seen as the development of an important expertise parameter in the process of transformation from novice students to expert designers. The increasing fixation problem of the experts and the tendency of developing less creative solutions compared to novices can be prevented by this expertise parameter.

Constructed Randomness – Randomness always reveals possible approaches that are overlooked in design. However, if there is only randomness, the design process may not conclude successfully even if creative ideas emerge. It is beneficial that the flow of the design process is structured, even to a minimum. Randomness can enhance the ambiguity of the design process, but constructed randomness prevents the designer's sense of loss or anxiety and enhances the quality of the design idea. Randomness can be provoked by the surrealist poem, but if the convergent construction of the poem is built by designers, they may claim their personal randomness and build it purposefully. Consequently, the construction process is also random, as it will be different among designers. Although the raw example is the same, different self-construction processes may arise from one another.

Self-construction as a method – Self-construction is also underlined in this research independently from the surrealist poem. The concept of self-construction was proposed through my research. Although self-construction has many variables, it provides a fundamental perspective on the role of examples in the design process. In the idea generation process, the designer can implement self-construction practice in any way. Thus, self-construction can become a habit and the designers do not stick to the given examples, feed their creative side.

Self-construction increase creativity, decrease fixation – Creativity and fixation seem to have a double-edge character in the literature of the design process. In many cases where creativity increases, implicitly fixation is also increasing. The tendency for increasing fixation parallel with creativity may be prevented by self-construction practice. The practice of self-construction avoids fixation because each self-

constructed example is reconstructed in different ways, even though their source is the same example. Furthermore, it significantly increases the creativity of the designer. It appears that self-construction practice has many contributions to the design process. Therefore, this practice can be used on many examples in different content and representations and its place in the literature can be expanded.

5.3 Limitations of This Research

Some of the other methods that are not implemented in this study, but may be applied in the future research are as follows:

- Protocol Analysis (Ericsson & Simon, 1984)
- Linkography (Cai et al., 2010; Goldschmidt, 1990)
- EEG or Electroencephalography (Dietrich, 2004; Liu et al., 2017; Sun et al., 2013)

Concerns of this research may be examined by other methods, such as those listed above. This provides alternative confirmations or denials for the suggestions of the current research. Consequently, these concerns can be discussed with detailed examinations in various ways.

On the other hand, although the conditional groups were formed with proper sample size, not having larger student groups is a limitation. The current study can be verified with much larger groups. In other words, future research may be carried out with the involvement of a higher number of participants to compensate for the impact of inter-individual differences in each group.

5.4 Recommendations for Future Studies

Here, there are several points to investigate with the light of the current research. Some research ideas from general to the specific fields are presented.

First, this research focused on the idea generation phase of the design process by underlining the importance of this phase. However, the influence of the given example can be examined in later phases. Further, several experiments may be conducted to explore how the given example may facilitate the transitions between two fundamental phases

Second, Study 1 examines the different forms of textual examples. Likewise, forms of other modalities may be examined in detail. Thus, forms that act as in keywords and poems can be discovered in other modalities

Third, Study 2 has an introductory content to the concept of self-construction. It has previously been mentioned that there are many parameters to understand the influence of the given example in the design process (i.e., fidelity, proximity, expertise, discipline, timing, etc.). Future research should investigate how self-construction practice reacts to and correlates with other parameters. In other words, future works may involve variations on: the types of interaction (ready example, self-construction, etc.) and the other parameters regarding attributes of external stimuli, time, the profile of the subject.

Finally, most research about analogical reasoning aims to contribute to the development of computer-aided systems. The objective of the researchers while exploring the ill-defined nature of the design process is to understand it and develop artificial intelligence. Similarly, if more detailed research on the surrealist poem is conducted and supported by other studies in which it is useful to produce such examples, a “surrealist poem generator" that understands the design problem and produces poems in infinite possibilities can be developed. As a second way, computer-based systems can be developed that build interactive relationships with the designer, that accelerate the self-construction process and that produce hugely varied and unique examples. They are potential directions for the extension of this research.

REFERENCES

Adelson, B. (1984). When novices surpass experts: The difficulty of a task may increase with expertise. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 10*(3), 483.

Agogué, M., Poirel, N., Pineau, A., Houdé, O., & Cassotti, M. (2014). The impact of age and training on creativity: a design-theory approach to study fixation effects. *Thinking Skills and Creativity, 11*, 33-41.

Alexander, C. (1973). *Notes on the Synthesis of Form* (7 ed.). Cambridge, Massachusetts: Harvard University Press.

Alexander, C. (1977). *A pattern language: towns, buildings, construction*. New York: Oxford university press.

Amabile, T. M. (1983). The social psychology of creativity: A componential conceptualization. *Journal of personality and social psychology, 45*(2), 357.

Amabile, T. M. (1996). *Creativity in context*. Boulder, Colorado: Westview Press.

Anderson, J. R. (1983). A spreading activation theory of memory. *Journal of verbal learning and verbal behavior, 22*(3), 261-295.

Anolli, L., Antonietti, A., Crisafulli, L., & Cantoia, M. (2001). Accessing source information in analogical problem-solving. *The Quarterly Journal of Experimental Psychology Section A, 54*(1), 237-261.

Ansburg, P. I., & Hill, K. (2003). Creative and analytic thinkers differ in their use of attentional resources. *Personality and Individual Differences, 34*(7), 1141-1152.

Archer, B. (1963). Systematic Method for Designers, Part One: Aesthetics and Logic. *Design, 172*, 46-49.

Archer, B. (1984). Systematic method for designers. In N. Cross (Ed.), *Developments in design methodology* (pp. 57-81). Chichester: Wiley.

Ariely, D., & Simonson, I. (2003). Buying, bidding, playing, or competing? Value assessment and decision dynamics in online auctions. *Journal of consumer psychology, 13*(1-2), 113-123.

Arkes, H. R., & Blumer, C. (1985). The psychology of sunk cost. *Organizational behavior and human decision processes, 35*(1), 124-140.

Arkes, H. R., & Freedman, M. R. (1984). A demonstration of the costs and benefits of expertise in recognition memory. *Memory & Cognition, 12*(1), 84-89.

Arnon, R., & Kreitler, S. (1984). Effects of meaning training on overcoming functional fixedness. *Current psychological research & reviews, 3*(4), 11-24.

Aronson, E., & Mills, J. (1959). The effect of severity of initiation on liking for a group. *The Journal of Abnormal and Social Psychology, 59*(2), 177.

Artun, A. (2015). *Sanat manifestoları: Avangard sanat ve direniş* (4th ed.): İletişim Yayınları.

Baer, M., & Brown, G. (2012). Blind in one eye: How psychological ownership of ideas affects the types of suggestions people adopt. *Organizational behavior and human decision processes, 118*(1), 60-71.

Bailey, B. P., & Iqbal, S. T. (2008). Understanding changes in mental workload during execution of goal-directed tasks and its application for interruption management. *ACM Transactions on Computer-Human Interaction (TOCHI), 14*(4), 21.

Bailey, B. P., Konstan, J. A., & Carlis, J. V. (2000). *Measuring the effects of interruptions on task performance in the user interface.* Paper presented at the Smc 2000 conference proceedings. 2000 ieee international conference on systems, man and cybernetics.'cybernetics evolving to systems, humans, organizations, and their complex interactions'(cat. no. 0.

Ball, L. J., Ormerod, T. C., & Morley, N. J. (2004). Spontaneous analogising in engineering design: a comparative analysis of experts and novices. *Design studies, 25*(5), 495-508.

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychological review, 84*(2), 191.

Barron, F. (1968). *Creativity and personal freedom*. Princeton, NJ: Van Nostrand.

Barron, F. (1969). *Creative person and creative process*. Oxford, England: Holt, Rinehart, & Winston.

Barron, F., & Harrington, D. M. (1981). Creativity, intelligence, and personality. *Annual review of psychology, 32*(1), 439-476.

Basadur, M., Pringle, P., Speranzini, G., & Bacot, M. (2000). Collaborative problem solving through creativity in problem definition: Expanding the pie. *Creativity and innovation management, 9*(1), 54-76.

Baxter, M. (1995). *Product design*: CRC Press.

Benami, O., & Jin, Y. (2002). *Creative stimulation in conceptual design.* Paper presented at the ASME 2002 international design engineering technical conferences and computers and information in engineering conference.

Berbaum, K. S., El-Khoury, G. Y., Franken, E. A., Kuehn, D. M., Meis, D. M., Dorfman, D. D., . . . Kathol, M. H. (1994). Missed fractures resulting from satisfaction of search effect. *Emergency Radiology, 1*(5), 242-249.

Biggs, A. T., Adamo, S. H., Dowd, E. W., & Mitroff, S. R. (2015). Examining perceptual and conceptual set biases in multiple-target visual search. *Attention, Perception, & Psychophysics, 77*(3), 844-855.

Bilalić, M., McLeod, P., & Gobet, F. (2008). Why good thoughts block better ones: The mechanism of the pernicious Einstellung (set) effect. *Cognition, 108*(3), 652-661.

Boden, M. A. (1990). *The creative mind: Myths and mechanisms*. Great Britain: George Weidenfeld and Nicolson Ltd.

Brauer, M., & Judd, C. M. (1996). Group polarization and repeated attitude expressions: A new take on an old topic. In W. Stroebe & M. Hewstone (Eds.), *European Review of Social Psychology* (Vol. 7, pp. 173-207). Chichester, England: John Wiley.

Brown, A. S., & Murphy, D. R. (1989). Cryptomnesia: Delineating inadvertent plagiarism. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15*(3), 432.

Brown, V. R., Tumeo, M., Larey, T. S., & Paulus, P. B. (1998). Modeling cognitive interactions during group brainstorming. *Small group research, 29*(4), 495-526.

Buchanan, R. (1992). Wicked problems in design thinking. *Design issues, 8*(2), 5-21.

Cai, H., & Do, E. Y.-L. (2007). The Dual Effects of Inspiration Sources Designers' Use of Analogy in Creative Design. *IASDR) International Association of Societies of Design Research the Hong Kong Polytechnic University 12th to 15th November*.

Cai, H., Do, E. Y.-L., & Zimring, C. M. (2010). Extended linkography and distance graph in design evaluation: an empirical study of the dual effects of inspiration sources in creative design. *Design studies, 31*(2), 146-168.

Calvino, I. (1974). Invisible Cities, trans. William Weaver. *London: A Harvest Book (Le città invisibili, Torino, Einaudi, 1972)*.

Cambridge. (Ed.) (2007) Cambridge Advanced Learner's Dictionary. Cambridge: Cambridge University Press.

Cardoso, C., & Badke-Schaub, P. (2009). *Idea Fixation in Design: The In uence of Pictures and Words.* Paper presented at the ICORD 09: Proceedings of the 2nd International Conference on Research into Design, Bangalore, India 07.-09.01. 2009.

Cardoso, C., Badke-Schaub, P., & Luz, A. (2009). *Design fixation on non-verbal stimuli: the influence of simple vs. rich pictorial information on design*

problem-solving. Paper presented at the ASME 2009 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference.

Cardoso, C., & Badke-Schaub, P. (2011). The influence of different pictorial representations during idea generation. *The Journal of Creative Behavior, 45*(2), 130-146.

Cardoso, C., Gonçalves, M., & Badke-Schaub, P. (2012). *Searching for inspiration during idea generation: pictures or words?* Paper presented at the DS 70: Proceedings of DESIGN 2012, the 12th International Design Conference, Dubrovnik, Croatia.

Carmon, Z., Wertenbroch, K., & Zeelenberg, M. (2003). Option attachment: When deliberating makes choosing feel like losing. *Journal of consumer Research, 30*(1), 15-29.

Carroll, J. M. (2002). *Scenarios and design cognition.* Paper presented at the Proceedings IEEE Joint International Conference on Requirements Engineering.

Casakin, H. P., & Goldschmidt, G. (1999). Expertise and the use of visual analogy: Implications for design education. *Design studies, 20*(2), 153-175.

Casakin, H. P., & Goldschmidt, G. (2000). Reasoning by visual analogy in design problem-solving: the role of guidance. *Environment and Planning B: Planning and Design, 27*(1), 105-119.

Chakrabarti, A. (2006). *Defining and supporting design creativity.* Paper presented at the DS 36: Proceedings DESIGN 2006, the 9th International Design Conference, Dubrovnik, Croatia.

Chan, C. S. J., Dow, S., & Schunn, C. (2014). *Conceptual distance matters when building on others' ideas in crowd-collaborative innovation platforms.* Paper presented at the Proceedings of the companion publication of the 17th ACM conference on Computer supported cooperative work & social computing.

Chan, C. S. J., Fu, K., Schunn, C., Cagan, J., Wood, K., & Kotovsky, K. (2011). On the benefits and pitfalls of analogies for innovative design: Ideation performance based on analogical distance, commonness, and modality of examples. *Journal of Mechanical Design, 133*(8), 081004.

Chase, W. G., & Simon, H. A. (1973). Perception in chess. *Cognitive psychology, 4*(1), 55-81.

Cheng, P.-J. (2015). Dissimilarities of Designer Ideation by Identified Searching-Retrieval Behavior in Referencing Online-Offline Material. *Bulletin of Japanese Society for the Science of Design, 62*(3), 3_85-83_94.

Cheng, P.-J., Chen, L.-H., & Cheng, Y.-C. (2013). How the Designers' Keyword-Thinking Influences on the Ideation.

Cheng, P.-J., & Yen, J. (2008). Study on Searching-Retrieving Behaviour in Desıgners' Ideation Process. *Bulletin of Japanese Society for the Science of Design, 55*(3), 91-98.

Cheng, P., Mugge, R., & Schoormans, J. P. (2014). A new strategy to reduce design fixation: Presenting partial photographs to designers. *Design studies, 35*(4), 374-391.

Chiselin, B. (Ed.) (1985). *The creative process: A symposium* Berkeley: University of California Press.

Chiu, I., & Shu, L. (2007). Biomimetic design through natural language analysis to facilitate cross-domain information retrieval. *AI EDAM, 21*(1), 45-59.

Chiu, I., & Shu, L. (2012). Investigating effects of oppositely related semantic stimuli on design concept creativity. *Journal of Engineering Design, 23*(4), 271-296.

Christensen, B. T., & Schunn, C. D. (2007). The relationship of analogical distance to analogical function and preinventive structure: The case of engineering design. *Memory & Cognition, 35*(1), 29-38.

Chrysikou, E. G., & Weisberg, R. W. (2005). Following the wrong footsteps: fixation effects of pictorial examples in a design problem-solving task. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 31*(5), 1134.

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological review, 82*(6), 407.

Collins, B. E., & Guetzkow, H. S. (1964). *A social psychology of group processes for decision-making*: Wiley.

Coskun, H., Paulus, P. B., Brown, V., & Sherwood, J. J. (2000). Cognitive stimulation and problem presentation in idea-generating groups. *Group Dynamics: Theory, Research, and Practice, 4*(4), 307.

Court, A. (1995). *The modelling and classification of information for engineering designers.* (Doctoral Dissertation), University of Bath Bath.

Crilly, N. (2015). Fixation and creativity in concept development: The attitudes and practices of expert designers. *Design studies, 38*, 54-91.

Crilly, N., & Cardoso, C. (2017). Where next for research on fixation, inspiration and creativity in design? *Design studies, 50*, 1-38.

Cross, N. (2005). *Engineering design methods* (4 ed.). England: John Wiley & Sons ltd.

Cross, N. (2006). *Designerly ways of knowing*. London: Springer.

Csikszentmihalyi, M. (1997). Flow and the psychology of discovery and invention. *HarperPerennial, New York, 39*.

Dahl, D. W., & Moreau, P. (2002). The influence and value of analogical thinking during new product ideation. *Journal of Marketing Research, 39*(1), 47-60.

Dane, E. (2010). Reconsidering the trade-off between expertise and flexibility: A cognitive entrenchment perspective. *Academy of Management Review, 35*(4), 579-603.

Darke, J. (1979). The primary generator and the design process. *Design studies, 1*(1), 36-44.

Darwin, C. (1859). *On the origin of species by means of natural selection, or, the preservation of favoured races in the struggle for life*. London: J. Murray.

Davis, J. (1969). *Group Performance*. Reading, MA: Addison-Wesley.

De Bono, E. (1971). *Lateral thinking for management*. New York: McGraw-Hill.

De Bono, E. (1985). *Six thinking hats*. Boston: Little, Brown.

De Bono, E. (1992). *Serious creativity: Using the power of lateral thinking to create new ideas*. New York: HarperCollins.

De Dreu, C. K., & van Knippenberg, D. (2005). The possessive self as a barrier to conflict resolution: effects of mere ownership, process accountability, and self-concept clarity on competitive cognitions and behavior. *Journal of personality and social psychology, 89*(3), 345.

Dewey, J. (1933). *How we think: A restatement of the relation of reflective thinking to the educative process*. Lexington, Massachusetts: D. C. Heath and Company.

Dhar, R., & Wertenbroch, K. (2000). Consumer choice between hedonic and utilitarian goods. *Journal of Marketing Research, 37*(1), 60-71.

Dietrich, A. (2004). The cognitive neuroscience of creativity. *Psychonomic bulletin & review, 11*(6), 1011-1026.

Dong, A. (2006). Concept formation as knowledge accumulation: A computational linguistics study. *AI EDAM, 20*(1), 35-53.

Dorst, K. (2006). Design problems and design paradoxes. *Design issues, 22*(3), 4-17.

Dorst, K., & Cross, N. (2001). Creativity in the design process: co-evolution of problem–solution. *Design studies, 22*(5), 425-437.

Dorst, K., & Dijkhuis, J. (1995). Comparing paradigms for describing design activity. *Design studies, 16*(2), 261-274.

Dubberly, H. (2005). *How do you design A compendium of Models* Retrieved from http://www.dubberly.com/wp-content/uploads/2008/06/ddo_designprocess.pdf (last access: 20.07.2019)

Dugosh, K. L., & Paulus, P. B. (2005). Cognitive and social comparison processes in brainstorming. *Journal of experimental social psychology, 41*(3), 313-320.

Dugosh, K. L., Paulus, P. B., Roland, E. J., & Yang, H.-C. (2000). Cognitive stimulation in brainstorming. *Journal of personality and social psychology, 79*(5), 722.

Duncker, K. (1945). On problem-solving. *Psychological monographs, 58*(5).

Dunne, D., & Martin, R. (2006). Design thinking and how it will change management education: An interview and discussion. *Academy of Management Learning & Education, 5*(4), 512-523.

Dym, C. L. (1992). Representation and problem-solving: the foundations of engineering design. *Environment and Planning B: Planning and Design, 19*(1), 97-105.

Eastman, C. M. (1970). On the analysis of intuitive design processes. *Emerging Methods in Environtmental Design and Planning*, 21-37.

Eastman, C. M. (2001). New directions in design cognition: studies of representation and recall. In C. Eastman, W. C. Newstetter, & M. McCracken (Eds.), *Design knowing and learning: Cognition in design education* (pp. 147-198). Oxford:: Elsevier Science Ltd.

Eckert, C., & Stacey, M. (2003). Sources of inspiration in industrial practice: The case of knitwear design.

Eckert, C., Stacey, M., & Earl, C. (2005). References to past designs. *Studying designers, 5*(2005), 3-21.

Ericsson, K. A., & Simon, H. A. (1984). *Protocol analysis: Verbal reports as data*: MIT Press.

Eysenck, H. J. (1993). Creativity and personality: Suggestions for a theory. *Psychological inquiry, 4*(3), 147-178.

Figl, K., & Recker, J. (2016). Process innovation as creative problem solving: An experimental study of textual descriptions and diagrams. *Information & Management, 53*(6), 767-786.

Finke, R. A. (1990). *Creative Imagery: Discoveries and Inventions in Visualization*. New Jersey, London: Lawrence Erlbaum Associates Publishers.

Finke, R. A. (1996). Imagery, creativity, and emergent structure. *Consciousness and cognition, 5*(3), 381-393.

Finke, R. A., Ward, T. B., & Smith, S. M. (1992). *Creative cognition: Theory, research, and applications*. Cambridge, MA: MIT Press.

Fleck, M. S., Samei, E., & Mitroff, S. R. (2010). Generalized "satisfaction of search": Adverse influences on dual-target search accuracy. *Journal of Experimental Psychology: Applied, 16*(1), 60.

Franke, N., Schreier, M., & Kaiser, U. (2010). The "I designed it myself" effect in mass customization. *Management science, 56*(1), 125-140.

French, M. J. (1985). *Conceptual design for engineers* (2 ed.): Springer.

Frensch, P. A., & Sternberg, R. J. (1989). Expertise and intelligent thinking: When is it worse to know better. *Advances in the psychology of human intelligence, 5*, 157-188.

Freud, S. (1908). The relation of the poet to day-dreaming. *Collected papers, 4*(9), 173-183.

Fu, K., Chan, J., Cagan, J., Kotovsky, K., Schunn, C., & Wood, K. (2013). The meaning of "near" and "far": the impact of structuring design databases and the effect of distance of analogy on design output. *Journal of Mechanical Design, 135*(2), 021007.

Galbraith, J. R. (1973). *Designing complex organizations*: Addison-Wesley.

Galbraith, J. R. (1995). *Designing organizations*. San Francisco: Jossey-Bass.

Gentner, D., & Markman, A. B. (1997). Structure mapping in analogy and similarity. *American Psychologist, 52*(1), 45.

Gentner, D., & Stevens, A. (Eds.). (1983). *Mental models*: Lawrence Erlbaum Associates.

Gentner, D., & Wolff, P. (2000). Metaphor and knowledge change. In E. Dietrich & A. B. Markman (Eds.), *Cognitive dynamics: Conceptual change in humans and machines* (pp. 295-342). Hillsdale, NJ: Erlbaum.

Georgiev, G. V., Taura, T., Chakrabarti, A., & Nagai, Y. (2008). *Method of design through structuring of meanings.* Paper presented at the ASME 2008 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference.

German, T. P., & Barrett, H. C. (2005). Functional fixedness in a technologically sparse culture. *Psychological Science, 16*(1), 1-5.

Gero, J. S. (1996). Creativity, emergence and evolution in design. *Knowledge-based Systems, 9*(7), 435-448.

Gick, M. L., & Holyoak, K. J. (1980). Analogical problem solving. *Cognitive psychology, 12*(3), 306-355.

Gick, M. L., & Holyoak, K. J. (1983). Schema induction and analogical transfer. *Cognitive psychology, 15*(1), 1-38.

Gick, M. L., & Paterson, K. (1992). Do contrasting examples facilitate schema acquisition and analogical transfer? *Canadian Journal of Psychology/Revue canadienne de psychologie, 46*(4), 539.

Goel, A. K. (1997). Design, analogy, and creativity. *IEEE Expert, 12*(3), 62-70.

Goel, V. (1995). *Sketches of thought*: MIt Press.

Goff, K., & Torrance, E. P. (2002). *Abbreviated Torrance test for adults: Manual*: Scholastic Testing Service Bensenville, IL.

Goldenberg, J., & Mazursky, D. (2002). *Creativity in product innovation*: Cambridge University Press.

Goldschmidt, G. (1989). Problem representation versus domain of solution in architectural design teaching. *Journal of Architectural and Planning Research, 6*(3), 204-215.

Goldschmidt, G. (1990). *Linkography: assessing design productivity*. Paper presented at the Cyberbetics and System'90, Proceedings of the Tenth European Meeting on Cybernetics and Systems Research.

Goldschmidt, G., & Sever, A. L. (2011). Inspiring design ideas with texts. *Design studies, 32*(2), 139-155.

Goldschmidt, G., & Smolkov, M. (2006). Variances in the impact of visual stimuli on design problem solving performance. *Design studies, 27*(5), 549-569.

Gonçalves, M., Cardoso, C., & Badke-Schaub, P. (2012). *Find your inspiration: exploring different levels of abstraction in textual stimuli*. Paper presented at the Proceedings of the 2nd international conference on design creativity (ICDC2012), Glasgow (UK), 18-20 Sept., 1-8.

Gonçalves, M., Cardoso, C., & Badke-Schaub, P. (2013). Through the looking glass of inspiration: case studies on inspirational search processes of novice designers. *Proceedings of the International Association of Societies of Design Research, IASDR*.

Gonçalves, M., Cardoso, C., & Badke-Schaub, P. (2014). What inspires designers? Preferences on inspirational approaches during idea generation. *Design studies, 35*(1), 29-53.

Gonçalves, M., Cardoso, C., & Badke-Schaub, P. (2016). Inspiration choices that matter: the selection of external stimuli during ideation. *Design Science, 2*.

Gordon, W. J. (1961). *Synectics: The development of creative capacity*. New York: Harper & Row.

Gough, H. G. (1979). A creative personality scale for the adjective check list. *Journal of personality and social psychology, 37*(8), 1398-1405.

Groot, A. d. (1965). *Thought and Choice in Chess (ed. GW Baylor) Translated from the Dutch version from 1946.* . The Hague: Mouton Publishers.

Guilford, J. P. (1950). Creativity. *American Psychologist, 5*, 444-434.

Guilford, J. P. (1968). Creativity, intelligence, and their educational implications. *San Diego, CA: EDITS/Knapp*.

Hatchuel, A. (2001). Towards Design Theory and expandable rationality: The unfinished program of Herbert Simon. *Journal of management and governance, 5*(3), 260-273.

Hatchuel, A., & Weil, B. (2003). *A new approach of innovative Design: an introduction to CK theory.* Paper presented at the DS 31: Proceedings of ICED 03, the 14th International Conference on Engineering Design, Stockholm.

Hatchuel, A., & Weil, B. (2009). CK design theory: an advanced formulation. *Research in engineering design, 19*(4), 181.

Hatıpoğlu, S. C., & Yıldız, D. (2018). Examples in Design Education: Inspiration or Fixation? *SHS Web Conf., 48*, 01061.

Henderson, L. J. (1913). *The fitness of the environment*: Macmillan.

Hennessey, B. A., & Amabile, T. M. (1988). The conditions of creativity. In R. J. Sternberg (Ed.), *The nature of creativity* (pp. 11-38): Cambridge University Press.

Herring, S. R., Chang, C.-C., Krantzler, J., & Bailey, B. P. (2009). *Getting inspired!: understanding how and why examples are used in creative design practice.* Paper presented at the Proceedings of the SIGCHI Conference on Human Factors in Computing Systems.

Hicks, B. J., Culley, S. J., Allen, R. D., & Mullineux, G. (2002). A framework for the requirements of capturing, storing and reusing information and knowledge in engineering design. *International journal of information management, 22*(4), 263-280.

Hill, G. W. (1982). Group versus individual performance: Are N+ 1 heads better than one? *Psychological bulletin, 91*(3), 517.

Hinsz, V. B., Tindale, R. S., & Vollrath, D. A. (1997). The emerging conceptualization of groups as information processors. *Psychological bulletin, 121*(1), 43.

Ho, C.-H. (2001). Some phenomena of problem decomposition strategy for design thinking: differences between novices and experts. *Design studies, 22*(1), 27-45.

Holyoak, K. J., & Koh, K. (1987). Surface and structural similarity in analogical transfer. *Memory & Cognition, 15*(4), 332-340.

Howard, T. J. (2008). *Information management for creative stimuli in engineering design.* (Doctoral Dissertation), University of Bath.

Howard, T. J., Culley, S., & Dekoninck, E. (2006). *Information as an input into the creative process.* Paper presented at the DS 36: Proceedings DESIGN 2006, the 9th International Design Conference, Dubrovnik, Croatia.

Howard, T. J., Culley, S. J., & Dekoninck, E. (2007). *Creativity in the engineering design process.* Paper presented at the DS 42: Proceedings of ICED 2007, the 16th International Conference on Engineering Design, Paris, France, 28.-31.07. 2007.

Howard, T. J., Culley, S. J., & Dekoninck, E. (2008). Describing the creative design process by the integration of engineering design and cognitive psychology literature. *Design studies, 29*(2), 160-180.

Howard, T. J., Maier, A., Onarheim, B., & Friis-Olivarius, M. (2013). *Overcoming design fixation through education and creativity methods.* Paper presented at the 19th International Conference on Engineering Design.

Jaarsveld, S., & van Leeuwen, C. (2005). Sketches from a design process: Creative cognition inferred from intermediate products. *Cognitive science, 29*(1), 79-101.

Jackson, P. W., & Messick, S. (1965). The person, the product, and the response: conceptual problems in the assessment of creativity 1. *Journal of personality, 33*(3), 309-329.

Jang, S. (2014). The effect of image stimulus on conceptual combination in the design idea generation process. *Archives of Design Research, 27*(4), 59-72.

Jansson, D. G., & Smith, S. M. (1991). Design fixation. *Design studies, 12*(1), 3-11.

Jones, J. C. (1984). A Method of Systematic Design. In N. Cross (Ed.), *Developments in design methodology*. Chichester: Wiley.

Kahneman, D., Knetsch, J. L., & Thaler, R. H. (1990). Experimental tests of the endowment effect and the Coase theorem. *Journal of political Economy, 98*(6), 1325-1348.

Kahneman, D., & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica, 47*(2), 263-292.

Keane, M. (1987). On retrieving analogues when solving problems. *The Quarterly Journal of Experimental Psychology, 39*(1), 29-41.

Keller, I., Pasman, G., & Stappers, P. J. (2006). Collections designers keep: Collecting visual material for inspiration and reference. *CoDesign, 2*(01), 17-33.

Kershaw, T. C., & Ohlsson, S. (2004). Multiple causes of difficulty in insight: the case of the nine-dot problem. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 30*(1), 3.

Kim, J., & Ryu, H. (2014). A design thinking rationality framework: Framing and solving design problems in early concept generation. *Human–Computer Interaction, 29*(5-6), 516-553.

Kimbell, L. (2009). Design practices in design thinking. *European Academy of Management*, 1-24.

Kipling, R. (1985). Working-tools. In B. Chiselin (Ed.), *The creative process: A symposium* (pp. 161-163). (Original article published in 1937): University of California Press.

Kiriyama, T., & Yamamoto, T. (1998). Strategic knowledge acquisition: a case study of learning through prototyping. *Knowledge-based Systems, 11*(7-8), 399-404.

Koberg, D., & Bagnall, J. (1974). *The Universal Traveler: A Soft-Systems Guide to: Creativity, Problem Solving, and the Process of Reaching Goals (Revised Edition)*: William Kaufmann Inc.

Koestler, A. (1964). *The act of creation*. New York: Macmillan.

Kolodner, J. L. (1997). Educational implications of analogy: A view from case-based reasoning. *American Psychologist, 52*(1), 57.

Kotovsky, L., & Gentner, D. (1996). Comparison and categorization in the development of relational similarity. *Child Development, 67*(6), 2797-2822.

Köhler, W. (1938). *The place of value in a world of facts*. London: Kegan Paul, Trench, Trubner & Co.

Kubie, L. S. (1958). *Neurotic distortion of the creative process*. Lawrence: University of Kansas Press.

Kuhn, T. S. (1962). The structure of scientific revolutions. *Chicago and London*.

Kulkarni, C., Dow, S. P., & Klemmer, S. R. (2014). Early and repeated exposure to examples improves creative work *Design thinking research* (pp. 49-62): Springer.

Laamanen, T.-K., & Seitamaa-Hakkarainen, P. (2015). Interview Study of Professional Designers' Ideation Approaches. *The Design Journal, 17*(2), 194-217.

Lai, J. Y., Roan, E. T., Greenberg, H. C., & Yang, M. C. (2008). *Prompt versus problem: Helping students learn to frame problems and think creatively*. Paper presented at the Third international conference on design computing and cognition.

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *biometrics*, 159-174.

Langer, E. J. (1975). The illusion of control. *Journal of personality and social psychology, 32*(2), 311.

Larey, T. S., & Paulus, P. B. (1999). Group preference and convergent tendencies in small groups: A content analysis of group brainstorming performance. *Creativity Research Journal, 12*(3), 175-184.

Lawson, B. (2005). *How designers think* (4 ed.): Architectural Press.

LeFevre, J.-A., & Dixon, P. (1986). Do written instructions need examples? *Cognition and Instruction, 3*(1), 1-30.

Liikkanen, L. A., & Perttula, M. (2010). Inspiring design idea generation: insights from a memory-search perspective. *Journal of Engineering Design, 21*(5), 545-560.

Linsey, J. S., Clauss, E., Kurtoglu, T., Murphy, J., Wood, K., & Markman, A. (2011). An experimental study of group idea generation techniques: understanding the roles of idea representation and viewing methods. *Journal of Mechanical Design, 133*(3), 031008.

Linsey, J. S., Tseng, I., Fu, K., Cagan, J., Wood, K. L., & Schunn, C. (2010). A study of design fixation, its mitigation and perception in engineering design faculty. *Journal of Mechanical Design, 132*(4), 041003.

Linsey, J. S., Wood, K. L., & Markman, A. B. (2008). Modality and representation in analogy. *AI EDAM, 22*(2), 85-100.

Liu, Y.-C., Yang, Y.-H. S., & Liang, C. (2017). How do creativity levels and stimulus types matter? A preliminary investigation of designer visual association. *Journal of Neurology and Neuroscience, 8*(2).

Lopez-Mesa, B., Mulet, E., Vidal, R., & Thompson, G. (2011). Effects of additional stimuli on idea-finding in design teams. *Journal of Engineering Design, 22*(1), 31-54.

Lopez-Mesa, B., & Vidal, R. (2006). *Novelty metrics in engineering design experiments.* Paper presented at the DS 36: Proceedings DESIGN 2006, the 9th International Design Conference, Dubrovnik, Croatia.

Lubart, T. I. (1994). *Product-centered self-evaluation and the creative process.* (Doctoral Dissertation), Yale University.

Luchins, A. S. (1942). Mechanization in problem solving: The effect of Einstellung. *Psychological monographs, 54*(6), i.

Luchins, A. S. (1946). Classroom experiments on mental set. *The American journal of psychology, 59*(2), 295-298.

Luchins, A. S., & Luchins, E. H. (1959). *Rigidity of behavior: A variational approach to the effect of Einstellung*. Oxford, England: Univer. Oregon Press.

Luchins, A. S., & Luchins, E. H. (1972). *Wertheimer's Seminars revisited: problems in perception*: State University of New York at Albany.

Lujun, Z. (2011). *Design fixation and solution quality under exposure to example solution.* Paper presented at the Computing, Control and Industrial Engineering (CCIE), 2011 IEEE 2nd International Conference on.

Lumsdaine, M., & Lumsdaine, E. (1995). *Creative Problem Solving - Thinking skills for A Changing World*. New York: McGraw-Hill Education.

MacKinnon, D. W. (1965). Personality and the realization of creative potential. *American Psychologist, 20*(4), 273-281.

MacKinnon, D. W. (1975). An Overview of Assessment Centers. Technical Report l.

Maher, M. L., Poon, J., & Boulanger, S. (1996). Formalising design exploration as co-evolution *Advances in formal design methods for CAD* (pp. 3-30): Springer.

Maier, N. R. (1931). Reasoning in humans. II. The solution of a problem and its appearance in consciousness. *Journal of comparative Psychology, 12*(2), 181.

Malaga, R. A. (2000). The effect of stimulus modes and associative distance in individual creativity support systems. *Decision Support Systems, 29*(2), 125-141.

Marakas, G. M., & Elam, J. J. (1997). Creativity enhancement in problem solving: through software or process? *Management science, 43*(8), 1136-1146.

March, L. (Ed.) (1976). *The architecture of form*. Cambridge: Cambridge University Press

Marsh, J. (1997). *The capture and structure of design experience.* (Doctoral Dissertation), Cambridge University Engineering Department.

Marsh, R. L., Bink, M. L., & Hicks, J. L. (1999). Conceptual priming in a generative problem-solving task. *Memory & Cognition, 27*(2), 355-363.

Marsh, R. L., & Bower, G. H. (1993). Eliciting cryptomnesia: Unconscious plagiarism in a puzzle task. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19*(3), 673.

Marsh, R. L., & Landau, J. D. (1995). Item availability in cryptomnesia: Assessing its role in two paradigms of unconscious plagiarism. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*(6), 1568.

Marsh, R. L., Landau, J. D., & Hicks, J. L. (1996). How examples may (and may not) constrain creativity. *Memory & Cognition, 24*(5), 669-680.

Marsh, R. L., Ward, T. B., & Landau, J. D. (1999). The inadvertent use of prior knowledge in a generative cognitive task. *Memory & Cognition, 27*(1), 94-105.

Maslow, A. H. (1968). *Toward a psychology of being*. New York: Von Nostrand.

Matlin, M. W. (2012). *Cognition* (8 ed.): Wiley.

Maynard, A. M., Maynard, D. C., & Rowe, K. A. (2004). Exposure to the fields of psychology: Evaluation of an introductory psychology project. *Teaching of Psychology, 31*(1), 37-39.

McGraw, A. P., Tetlock, P. E., & Kristel, O. V. (2003). The limits of fungibility: Relational schemata and the value of things. *Journal of consumer Research, 30*(2), 219-229.

Mednick, S. (1962). The associative basis of the creative process. *Psychological review, 69*(3), 220.

Metcalfe, J. (1986). Premonitions of insight predict impending error. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12*(4), 623.

Michaelsen, L. K., Watson, W. E., & Black, R. H. (1989). A realistic test of individual versus group consensus decision making. *Journal of Applied Psychology, 74*(5), 834.

Michlewski, K. (2008). Uncovering design attitude: Inside the culture of designers. *Organization studies, 29*(3), 373-392.

Microsoft. (Ed.) (2007) Encarta World English Dictionary. Redmond, WA: Microsoft Corporation.

Minda, J. P. (2015). *The psychology of thinking: Reasoning, decision-making and problem-solving*: Sage.

Moreno, D. P., Hernandez, A. A., Yang, M. C., Otto, K. N., Hölttä-Otto, K., Linsey, J. S., . . . Linden, A. (2014). Fundamental studies in Design-by-Analogy: A focus on domain-knowledge experts and applications to transactional design problems. *Design studies, 35*(3), 232-272.

Moreno, D. P., Yang, M. C., Hernández, A. A., Linsey, J. S., & Wood, K. L. (2015). A step beyond to overcome design fixation: a design-by-analogy approach *Design Computing and Cognition'14* (pp. 607-624): Springer.

Moss, J., Kotovsky, K., & Cagan, J. (2011). The effect of incidental hints when problems are suspended before, during, or after an impasse. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 37*(1), 140.

Mougenot, C., Aucouturier, J.-J., Yamanaka, T., & Watanabe, K. (2010). *Comparing the effects of auditory stimuli and visual stimuli in design creativity*. Paper presented at the Proceedings of The Third International Workshop on Kansei.

Mougenot, C., Bouchard, C., Aoussat, A., & Westerman, S. (2008). Inspiration, images and design: an investigation of designers' information gathering strategies.

Mougenot, C., & Watanabe, K. (2012). *Studying designers: affective components of design creativity.* Paper presented at the DS 73-2 Proceedings of the 2nd International conference on Design Creativity Volume 2.

Mulder-Nijkamp, M., & Corremans, J. (2014). *Muses in Design: A Comparison of Inspiration Techniques in Product Form Giving Education.* Paper presented at the DS 78: Proceedings of the 16th International conference on Engineering and Product Design Education (E&PDE14), Design Education and Human Technology Relations, University of Twente, The Netherlands, 04-05.09. 2014.

Mumford, M. D., & Gustafson, S. B. (1988). Creativity syndrome: Integration, application, and innovation. *Psychological bulletin, 103*(1), 27.

Murdock, M. C., & Puccio, G. J. (1993). A contextual organizer for conducting creativity research. *Understanding and recognizing creativity: The emergence of a discipline*, 249-280.

Myles-Worsley, M., Johnston, W. A., & Simons, M. A. (1988). The influence of expertise on X-ray image processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 14*(3), 553.

Nadler, D., Tushman, M., Tushman, M. L., & Nadler, M. B. (1997). *Competing by design: The power of organizational architecture*: Oxford University Press.

Nagai, Y., & Noguchi, H. (2002). *How designers transform keywords into visual images.* Paper presented at the Proceedings of the 4th conference on Creativity & cognition.

Newell, A., & Simon, H. A. (1972). *Human problem solving*. New Jersey: Prentice-Hall.

Newstetter, W. C., & McCracken, W. M. (2001). Novice conceptions of design: Implications for the design of learning environments *Design knowing and learning: Cognition in design education* (pp. 63-77): Elsevier.

Nickerson, R. S. (1998). Confirmation bias: A ubiquitous phenomenon in many guises. *Review of general psychology, 2*(2), 175-220.

Nijstad, B. A. (2000). *How the group affects the mind: Effects of communication in idea generating groups.* (Doctoral Dissertation), University of Utrecht.

Nijstad, B. A., Stroebe, W., & Lodewijkx, H. F. (2002). Cognitive stimulation and interference in groups: Exposure effects in an idea generation task. *Journal of experimental social psychology, 38*(6), 535-544.

Norton, M. I., Mochon, D., & Ariely, D. (2012). The IKEA effect: When labor leads to love. *Journal of consumer psychology, 22*(3), 453-460.

O'driscoll, M. P., Pierce, J. L., & Coghlan, A.-M. (2006). The psychology of ownership: Work environment structure, organizational commitment, and citizenship behaviors. *Group & Organization Management, 31*(3), 388-416.

Ochse, R. (1990). *Before the gates of excellence: The determinants of creative genius*: Cambridge University Press.

Olson, G., Trahan, M., Roshwalb, L., & Eaton, M. (1983). *Natural-language descriptions of procedures.* Paper presented at the Bulletin of the Psychonomic Society.

Osborn, A. F. (1953). *Applied Imagination*. New York: Charles Scribner's Sons.

Oxford. (Ed.) (2007) Oxford Compact English Dictionary. New York: Oxford University Press.

Pahl, G., Beitz, W., Feldhusen, J., & Grote, K. (2007). *Engineering design: a systematic approach* (3 ed.): Springer Science & Business Media.

Pandza, K., & Thorpe, R. (2010). Management as design, but what kind of design? An appraisal of the design science analogy for management. *British Journal of Management, 21*(1), 171-186.

Paulus, P. B., & Yang, H.-C. (2000). Idea generation in groups: A basis for creativity in organizations. *Organizational behavior and human decision processes, 82*(1), 76-87.

Peck, J., & Shu, S. B. (2009). The effect of mere touch on perceived ownership. *Journal of consumer Research, 36*(3), 434-447.

Perttula, M. K. (2006). *Idea generation in engineering design: Application of a memory search perspective and some experimental studies.* (Doctoral Dissertation), Helsinki University of Technology.

Perttula, M. K., & Liikkanen, L. A. (2006a). Exposure effects in design idea generation: Unconscious conformity or a product of sampling probability? *Development Process: From Idea to the World's First Bionic Prosthetic Foot*.

Perttula, M. K., & Liikkanen, L. A. (2006b). *Structural tendencies and exposure effects in design idea generation.* Paper presented at the ASME 2006 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference.

Perttula, M. K., & Sipilä, P. (2007). The idea exposure paradigm in design idea generation. *Journal of Engineering Design, 18*(1), 93-102.

Pierce, J. L., Kostova, T., & Dirks, K. T. (2003). The state of psychological ownership: Integrating and extending a century of research. *Review of general psychology, 7*(1), 84-107.

Piffer, D. (2012). Can creativity be measured? An attempt to clarify the notion of creativity and general directions for future research. *Thinking Skills and Creativity, 7*(3), 258-264.

Pugh, S. (1991). *Total design: integrated methods for successful product engineering*: Addison-Wesley.

Purao, S., Rossi, M., & Bush, A. (2002). Towards an understanding of the use of problem and design spaces during object-oriented system development. *Information and Organization, 12*(4), 249-281.

Purcell, A. T., & Gero, J. S. (1991). The effects of examples on the results of a design activity *Artificial Intelligence in Design'91* (pp. 525-542): Elsevier.

Purcell, A. T., & Gero, J. S. (1996). Design and other types of fixation. *Design studies, 17*(4), 363-383.

Raaijmakers, J. G., & Shiffrin, R. M. (1981). Search of associative memory. *Psychological review, 88*(2), 93.

Raymond, J. E., Shapiro, K. L., & Arnell, K. M. (1992). Temporary suppression of visual processing in an RSVP task: An attentional blink? *Journal of experimental psychology: Human perception and performance, 18*(3), 849.

Restrepo, J., & Christiaans, H. (2004). Problem structuring and information access in design. *Journal of Design Research, 4*(2), 1551-1569.

Rhodes, M. (1961). An analysis of creativity. *The Phi Delta Kappan, 42*(7), 305-310.

Rittel, H. W., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy sciences, 4*(2), 155-169.

Roediger, H. L., & Neely, J. H. (1982). Retrieval blocks in episodic and semantic memory. *Canadian Journal of Psychology/Revue canadienne de psychologie, 36*(2), 213.

Rogers, C. R. (1954). Toward a theory of creativity. *ETC: A review of general semantics*, 249-260.

Rosenkopf, L., & Nerkar, A. (2001). Beyond local search: boundary-spanning, exploration, and impact in the optical disk industry. *Strategic Management Journal, 22*(4), 287-306.

Ross, B. H. (1989). Distinguishing types of superficial similarities: Different effects on the access and use of earlier problems. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15*(3), 456.

Rothenberg, A., & Hausman, C. R. (1976). *The creativity question*: Duke University Press.

Römer, A., Pache, M., Weißhahn, G., Lindemann, U., & Hacker, W. (2001). Effort-saving product representations in design—results of a questionnaire survey. *Design studies, 22*(6), 473-491.

Rundus, D. (1973). Negative effects of using list items as recall cues. *Journal of verbal learning and verbal behavior, 12*(1), 43-50.

Sachs, A. (1999). Stuckness' in the design studio. *Design studies, 20*(2), 195-209.

Sarkar, P., & Chakrabarti, A. (2008). The effect of representation of triggers on design outcomes. *AI EDAM, 22*(2), 101-116.

Schacter, D. L. (1987). Implicit memory: History and current status. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13*(3), 501.

Schacter, D. L., Harbluk, J. L., & McLachlan, D. R. (1984). Retrieval without recollection: An experimental analysis of source amnesia. *Journal of verbal learning and verbal behavior, 23*(5), 593-611.

Schooler, J. W., Ohlsson, S., & Brooks, K. (1993). Thoughts beyond words: When language overshadows insight. *Journal of Experimental Psychology: General, 122*(2), 166.

Schön, D. A. (1983). *The Reflective Practitioner: How Professionals Think in Action* Basic Book Inc: USA.

Schön, D. A. (1987). *Educating the reflective practitioner*. San Francisco: Jossey-Bass Inc.

Schön, D. A. (1992). Designing as reflective conversation with the materials of a design situation. *Knowledge-based Systems, 5*(1), 3-14.

Schwartz, B. (1982). Reinforcement-induced behavioral stereotypy: How not to teach people to discover rules. *Journal of Experimental Psychology: General, 111*(1), 23.

Shah, J. J., Smith, S. M., & Vargas-Hernandez, N. (2003). Metrics for measuring ideation effectiveness. *Design studies, 24*(2), 111-134.

Shalley, C. E., & Gilson, L. L. (2004). What leaders need to know: A review of social and contextual factors that can foster or hinder creativity. *The leadership quarterly, 15*(1), 33-53.

Shneiderman, B. (2000). Creating creativity: user interfaces for supporting innovation. *ACM Transactions on Computer-Human Interaction (TOCHI), 7*(1), 114-138.

Siangliulue, P., Arnold, K. C., Gajos, K. Z., & Dow, S. P. (2015). *Toward collaborative ideation at scale: Leveraging ideas from others to generate more creative and diverse ideas.* Paper presented at the Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing.

Siangliulue, P., Chan, J., Gajos, K. Z., & Dow, S. P. (2015). *Providing timely examples improves the quantity and quality of generated ideas.* Paper presented at the Proceedings of the 2015 ACM SIGCHI Conference on Creativity and Cognition.

Simon, H. A. (1973). The structure of ill structured problems. *Artificial intelligence, 4*(3-4), 181-201.

Simon, H. A. (1979). *Models of thought*. New Haven: Yale University Press.

Simon, H. A. (1996). *The sciences of the artificial* (3 ed.): MIT press.

Simons, D. J., & Chabris, C. F. (1999). Gorillas in our midst: Sustained inattentional blindness for dynamic events. *perception, 28*(9), 1059-1074.

Sio, U. N., Kotovsky, K., & Cagan, J. (2015). Fixation or inspiration? A meta-analytic review of the role of examples on design processes. *Design studies, 39*, 70-99.

Smith, G. F., & Browne, G. J. (1993). Conceptual foundations of design problem solving. *IEEE Transactions on Systems, Man, and Cybernetics, 23*(5), 1209-1219.

Smith, S. M. (1995). Getting into and out of mental ruts: A theory of fixation, incubation, and insight. In R. J. Sternberg & J. E. Davidson (Eds.), *The nature of insight* (pp. 121-149). Cambridge: MIT Press.

Smith, S. M. (2003). The constraining effects of initial ideas. *Group creativity: Innovation through collaboration*, 15-31.

Smith, S. M., & Blankenship, S. E. (1989). Incubation effects. *Bulletin of the Psychonomic Society, 27*(4), 311-314.

Smith, S. M., & Blankenship, S. E. (1991). Incubation and the persistence of fixation in problem solving. *The American journal of psychology*, 61-87.

Smith, S. M., Ward, T. B., & Finke, R. A. (Eds.). (1995). *The creative cognition approach*: MIT press.

Smith, S. M., Ward, T. B., & Schumacher, J. S. (1993). Constraining effects of examples in a creative generation task. *Memory & Cognition, 21*(6), 837-845.

Spence, M. (1973). Job Market Signaling. *The Quarterly Journal of Economics, 87*(3), 355-374.

Stanley Budner, N. (1962). Intolerance of ambiguity as a personality variable 1. *Journal of personality, 30*(1), 29-50.

Stasser, G., & Birchmeier, Z. (2003). Group creativity and collective choice. In P. B. Paulus & B. A. Nijstad (Eds.), *Group creativity: Innovation through collaboration* (pp. 85-109). New York: Oxford University Press.

Stein, M. I. (1974). *Stimulating creativity*. New York: Academic Press.

Steiner, I. D. (1972). *Group processes and productivity*. San Diego, CA: Academic press.

Sternberg, R. J. (1988). *The nature of creativity: Contemporary psychological perspectives*: CUP Archive.

Sternberg, R. J. (Ed.) (1999). *Handbook of creativity*: Cambridge University Press.

Sternberg, R. J., & Davidson, J. E. (Eds.). (1995). *The nature of insight*. Cambridge: The MIT Press.

Sternberg, R. J., & Lubart, T. I. (1991). An investment theory of creativity and its development. *Human development, 34*(1), 1-31.

Sternberg, R. J., & Lubart, T. I. (1999). The concept of creativity: Prospects and paradigms. In R. J. Sternberg (Ed.), *Handbook of creativity* (Vol. 1, pp. 3-15).

Sun, L., Xiang, W., Chai, C., Wang, C., & Liu, Z. (2013). Impact of text on idea generation: an electroencephalography study. *International Journal of Technology and Design Education, 23*(4), 1047-1062.

Taura, T., & Nagai, Y. (2013). *Concept generation for design creativity: A systematized theory and methodology*: Springer Science & Business Media.

Thompson, G., & Lordan, M. (1999). A review of creativity principles applied to engineering design. *Proceedings of the Institution of Mechanical Engineers, Part E: Journal of Process Mechanical Engineering, 213*(1), 17-31.

Thompson, G., & Lordan, M. (2001). Experience of creativity enhancement teaching in industry and university. *WDK Publications*, 355-362.

Toh, C. A., & Miller, S. R. (2014). The impact of example modality and physical interactions on design creativity. *Journal of Mechanical Design, 136*(9), 091004.

Torrance, E. P. (1974). *Torrance Tests of Creative Thinking: Norms-Technical Manual*. New Jersey: Personal Press.

Torrance, E. P. (1979). The gifted and the talented: their education and development. In A. H. Passow (Ed.), *The Gifted and the Talented: Their Education and Development* (pp. 352–371). Chicago: National Society for

the Study of Education.

Tracz, W. J. (1979). Computer programming and the human thought process. *Software: Practice and Experience, 9*(2), 127-137.

Tseng, I., Moss, J., Cagan, J., & Kotovsky, K. (2008). The role of timing and analogical similarity in the stimulation of idea generation in design. *Design studies, 29*(3), 203-221.

Tsenn, J., Atilola, O., McAdams, D. A., & Linsey, J. S. (2014). The effects of time and incubation on design concept generation. *Design studies, 35*(5), 500-526.

Tulving, E., Schacter, D. L., & Stark, H. A. (1982). Priming effects in word-fragment completion are independent of recognition memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 8*(4), 336.

Url-1. http://www.georgesbraque.org/violin-and-pipe.jsp (date retrieved: 15.10.2019)

Url-2. https://www.poemsearcher.com/topic/andre+breton (date retrieved: 15.10.2019)

Valkenburg, R., & Dorst, K. (1998). The reflective practice of design teams. *Design studies, 19*(3), 249-271.

Van der Lugt, R. (2000). Developing a graphic tool for creative problem solving in design groups. *Design studies, 21*(5), 505-522.

Van Dyne, L., & Pierce, J. L. (2004). Psychological ownership and feelings of possession: Three field studies predicting employee attitudes and organizational citizenship behavior. *Journal of Organizational Behavior: The International Journal of Industrial, Occupational and Organizational Psychology and Behavior, 25*(4), 439-459.

VanLehn, K. (1998). Analogy events: How examples are used during problem solving. *Cognitive science, 22*(3), 347-388.

Vasconcelos, L. A., Cardoso, C. C., Sääksjärvi, M., Chen, C.-C., & Crilly, N. (2017). Inspiration and fixation: The influences of example designs and system properties in idea generation. *Journal of Mechanical Design, 139*(3), 031101.

Vasconcelos, L. A., & Crilly, N. (2016). Inspiration and fixation: Questions, methods, findings, and challenges. *Design studies, 42*, 1-32.

Vernon, P. E. (Ed.) (1970). *Creativity: Selected readings*. Baltimore: Penguin.

Visser, W. (2006). Both generic design and different forms of designing. *arXiv preprint cs/0612022*.

Viswanathan, V., Atilola, O., Esposito, N., & Linsey, J. (2014). A study on the role of physical models in the mitigation of design fixation. *Journal of Engineering Design, 25*(1-3), 25-43.

Viswanathan, V., Tomko, M., & Linsey, J. (2016). A study on the effects of example familiarity and modality on design fixation. *AI EDAM, 30*(2), 171-184.

Voss, J. F., Vesonder, G. T., & Spilich, G. J. (1980). Text generation and recall by high-knowledge and low-knowledge individuals. *Journal of verbal learning and verbal behavior, 19*(6), 651-667.

Wallas, G. (1926). *The Art of Thought*. London, UK: Jonathan Cape.

Ward, T. B. (1994). Structured imagination: The role of category structure in exemplar generation. *Cognitive psychology, 27*(1), 1-40.

Ward, T. B. (1995). What's old about new ideas. *The creative cognition approach*, 157-178.

Ward, T. B., & Sifonis, C. M. (1997). Task Demands and Generative Thinking: What Changes and What Remains the Same? *Journal of Creative Behavior, 31*(4), 245-259.

Ware, C. (2008). *Visual thinking: For design*: Morgan Kaufmann.

Warr, A., & O'Neill, E. (2005). *Understanding design as a social creative process.* Paper presented at the Proceedings of the 5th conference on Creativity & cognition.

Warr, A. M. (2007). *Understanding and supporting creativity in design*: University of Bath, Department of Computer Science.

Weick, K. E. (2004). Rethinking organizational design. In F. Collopy & R. J. Boland (Eds.), *Managing as designing* Stanford University Press.

Weisberg, R. W. (1986). *Creativity: Genius and other myths*. New York: WH Freeman.

Weisberg, R. W. (1993). *Creativity: Beyond the myth of genius*. New York: WH Freeman.

Weisberg, R. W., & Alba, J. W. (1981). An examination of the alleged role of" fixation" in the solution of several" insight" problems. *Journal of Experimental Psychology: General, 110*(2), 169.

Wertheimer, M. (1934). On truth. *Social Research*, 135-146.

Wertheimer, M. (1938). *Laws of organization in perceptual forms*.

Wiley, J. (1998). Expertise as mental set: The effects of domain knowledge in creative problem solving. *Memory & Cognition, 26*(4), 716-730.

Wilson, J. O., Rosen, D., Nelson, B. A., & Yen, J. (2010). The effects of biological examples in idea generation. *Design studies, 31*(2), 169-186.

Wilson, M. (2002). Six views of embodied cognition. *Psychonomic bulletin & review, 9*(4), 625-636.

Wittenbaum, G. M., & Park, E. S. (2001). The collective preference for shared information. *Current Directions in Psychological Science, 10*(2), 70-73.

Yilmaz, S., Seifert, C. M., & Gonzalez, R. (2010). Cognitive heuristics in design: Instructional strategies to increase creativity in idea generation. *AI EDAM, 24*(3), 335-355.

Yoo, Y., Boland Jr, R. J., & Lyytinen, K. (2006). From organization design to organization designing. *Organization Science, 17*(2), 215-229.

Youmans, R. J. (2011a). Design fixation in the wild: design environments and their influence on fixation. *The Journal of Creative Behavior, 45*(2), 101-107.

Youmans, R. J. (2011b). The effects of physical prototyping and group work on the reduction of design fixation. *Design studies, 32*(2), 115-138.

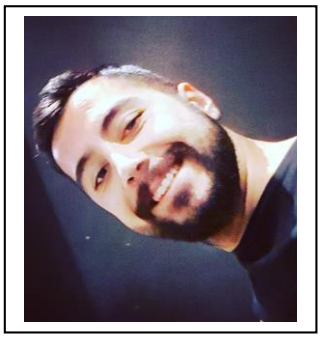
Youmans, R. J., & Arciszewski, T. (2014). Design fixation: Classifications and modern methods of prevention. *AI EDAM, 28*(2), 129-137.

Youmans, R. J., & Ohlsson, S. (2008). Suboptimal adaptations to redundant instrument failure: The role of noticing behavior in feedback effectiveness. *Ergonomics, 41*, 441-475.

Zahner, D., Nickerson, J. V., Tversky, B., Corter, J. E., & Ma, J. (2010). A fix for fixation? Rerepresenting and abstracting as creative processes in the design of information systems. *AI EDAM, 24*(2), 231-244.

Ziegler, R., Diehl, M., & Zijlstra, G. (2000). Idea production in nominal and virtual groups: Does computer-mediated communication improve group brainstorming? *Group Processes & Intergroup Relations, 3*(2), 141-158.

CURRICULUM VITAE



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PUBLICATIONS, PRESENTATIONS AND PATENTS ON THE THESIS:

- **Hatıpoğlu, S. C. (2019)**. *Analyzing The Transformation of The Concept of "Mobility" Depending on Refugee Problems via Design Competitions.* Paper presented at the Proceedings of Livenarch VI: Replacing Architecture, 963-975.
- **Hatıpoğlu, S. C., & Yıldız, D.** (2018). *Examples in Design Education: Inspiration or Fixation?* SHS Web Conf., 48, 01061.
- **Hatıpoğlu, S. C., Mutlu, D. & Kaplan, M.** (2018). *Investigation of Changes on Squares as a Tectonic Element of The City: Taksim Square*. Paper presented at the Proceedings of the International Symposium on Urbanization and Environmental Problems.