**İSTANBUL TECHNICAL UNIVERSITY ★ INSTITUTE OF SCIENCE AND TECHNOLOGY**

# EXPLORING THE TERM "EXPERIMENT" IN INDUSTRIAL DESIGN

**M.Sc. Thesis by**

**Elif KÜÇÜKSAYRAÇ, B.Sc.**

**Department : Industrial Product Design**

**Programme: Industrial Product Design**

**OCTOBER 2007**

**İSTANBUL TECHNICAL UNIVERSITY ★ INSTITUTE OF SCIENCE AND TECHNOLOGY**

# EXPLORING THE TERM "EXPERIMENT" IN INDUSTRIAL DESIGN

**M.Sc. Thesis by**

**Elif KÜÇÜKSAYRAÇ, B.Sc.**

**(502031969)**

**Date of submission: 14 September 2007**

**Date of defence examination: 30 October 2007**

**Supervisor (Chairman): Prof.Dr. H. Alpay ER**

**Members of the Examining Committee: Assoc.Prof.Dr. Belkıs ULUOĞLU**

**Asst.Prof.Dr. Şebnem TİMUR ÖĞÜT**

**OCTOBER 1997**

**İSTANBUL TEKNİK ÜNİVERSİTESİ ★ FEN BİLİMLERİ ENSTİTÜSÜ**

# ENDÜSTRİYEL TASARIMDA "DENEY" KAVRAMI

**YÜKSEK LİSANS TEZİ**

**Müh. Elif KÜÇÜKSAYRAÇ**

**(502031969)**

**Tezin Enstitüye Verildiği Tarih: 14 Eylül 2007**

**Tezin Savunulduğu Tarih: 30 Ekim 2007**

**Taz Danışmanı (Bölüm Başkanı): Prof. Dr. H. Alpay ER**

**Diğer Jüri Üyeleri: Doç.Dr. Belkıs ULUOĞLU**

**Y.Doç.Dr. Şebnem TÜMUR ÖĞÜT**

**EKİM 2007**

**ACKNOWLEDGEMENTS**

At the first place, I would like to express my gratitude to my thesis supervisor, Prof.Dr. H. Alpay Er for his contribution, patience and support throughout my research study, my graduate education and my academic life as a research assistant, his guidance to my academic development is invaluable.

I am also grateful to Asst.Prof.Dr. Şebnem Timur Öğüt and Assoc.Prof.Dr. Belkıs Uluoğlu for their contribution to my research study and to all faculty of the Department of Industrial Design at Istanbul Technical University for their support.

I would also like to thank to my family and my friends Arzu Yayıntaş, Burcu Kaya Kızılöz and Elif Refiğ for their endless love, support, and patience.

**TABLE OF CONTENTS**

## LIST OF TABLES

**LIST OF FIGURES**

## ÖZET

Bu çalışmada, endüstriyel tasarım alanına odaklanarak tasarımda 'deney' kavramı araştırılır ve tasarımda deneyselliğin önemi vugulanır ve savunulur. Çalışmada öncelikle bilim ve sanat alanlarında deney kavramı ve deneyselliğin tarihi, konuya disiplinlerarası bir temel oluşturması ve gerekli bağlantıları kurması amacı ile ele alınır. Deney kavramının tanımlandığı, açıklandığı ya da deney kavramının entegre edilmesi önerilen temel tasarım konuları bu bilgiler ışığında irdelenir. Tasarım tarihinde deneyselliği vurgulamış ve uygulamış kişiler ve kurumlar karşılaştırmalı olarak incelenir. Tasarım kuramınının gelişmesine sebep olan ekonomik sebeplerden bahsedilerek, deneyselliğin ekonomisi ve değişimi, deneyselliğin öneminin vurgulandığı inovasyon yazını incelenerek ve sektörel örnekler de verilerek araştırılır. Prototip üretimi ve kullanıcının tasarım sürecine dahil edilmesini öneren yazın ve örnekler tartışılarak deney kavramının gelecekteki rolü ve önemi öngörülür. 'Deney' ve 'deneysel tasarım' kavramları, tasarım alanında az sayıda yayında tanımlanmasına ve konu edilmesine karşın, sıkça ve geniş bir konu yelpazesini kapsayacak şekilde kullanılmaktadır. 'Deney' kavramının kullanımında kavrama yüklenen anlamları ve kullanıldığı bağlamları incelemek ve yorumlamak için, tasarım yazınının önemli iki uluslararası dergisi olan 'Design Issues' ve 'Design Studies' dergilerinde bulunan makaleler, içerik analizi yöntemi ile tablolaştırılarak zaman içindeki değişimler gösterilerek ve birbirleriyle karşılaştırılarak irdelenir. Sonuçlar grafik olarak ifade edilir ve önceki bilgiler ışığında yorumlanır. Bu sonuçlara dayanarak ayrıca ilerideki çalışmalar için yeni araştırma soruları da önerilir.

**SUMMARY**

In this study, the term “experiment” is explored in industrial design. The term “experiment” and history of experimentalism in art, natural and social sciences are firstly subjected, to build an interdisciplinary background and correlations in the study. The design literature in which the term experiment is defined or described and also which are suggested to be integrated with the term experiment are investigated. People and institutions that emphasized experimentation in design history are subjected as well. Mentioning the economic reasons for the design methodology to be developed, the economics of experimenting is explored subjecting the innovation literature which emphasizes the importance of experimentalism, also with case studies of important firms. The culture of prototyping and the integration of users to the design process were also subjected as future directions of the subject. Although the term “experiment” is defined and subjected in just a few design publications, it is used widely to describe a product or design process. To explore in which contexts and referring to which meanings the term ‘experiment’ is being used, the articles in two important design publications ‘Design Issues’ and ‘Design Studies’ were subjected to quantitative content analysis in comparison. The results were shown graphically and discussed in the light of the literature review of the study; also research questions for further studies are suggested.

# 1. INTRODUCTION

## 1.1. Justification of the Study

This study started with the interest in experimental design and the question, what the term 'experiment' actually means in design. The term 'experimental' is widely used to describe a design product or a design process but its meaning is not well defined, the basic publications on industrial design usually don't subject experimental design or the term 'experiment' doesn't appear in most indexes. Yet, 'experimental design' compromises high potentials.

On the contrary to the design literature, the term 'experiment' is very fundamental in science and. To subject the term experiment in science and art was inevitable for setting the conceptual background of the study and find out if there is a correlation between science, art and design from a perspective concentrating on experimentalism.

While exploring the term 'experiment', it was interesting to find out that the innovation literature was emphasizing its importance in design process, in rather recent and important publications, which cover examples of very complex and successful design processes of companies like BMW, GE Plastics etc. It was pronounced boldly that experimenting leads to innovation. And one of the most prestigious design firms IDEO was studied also as they handle the design projects as experiments. These supported the importance of questioning experiment in design and design theory. (Thomke, 2003)

From the beginning of the study, the paper of Ken Friedman, "*Theory construction in design research: criteria: approaches, and methods*" was a great source of inspiration. After determining the subject and the question, the related data started to be gathered. By doing that, Varian (1997)'s approach which Friedman cites was followed, "*Rather than starting with literature or seeking general features, he advocates seeking useful data on interesting issues. Moving from interesting issues, Varian proposes creating models that exhibit the characteristics of the issues, repeating the process until one has the simplest possible model that demonstrates the phenomena under consideration*." (Varian, 1997; cited in Friedman, 2003)

Also the seven questions of theoretical contributions by Whetten (1989) which Friedman (2003) cites were kept in mind throughout the study. The questions are (1) what's new? (2) so what? (3) why so? (4) well done? and (5) done well? (6) why now?, and (7) who cares? (Whetten, 1989; Friedman, 2003)

The answer to the question 'What's new?', can be given by stating that the subject of 'experimental design' is new, as it is not thoroughly explored and explained in design literature. The second question, 'so what?', can shortly be answered with the fact that experimentation is gaining importance in the innovation literature which encourages to discuss experimentation in design theory (Thomke, 2003). 'Why so?' can also be answered by referencing Thomke (2003) again, who suggests that the economics of experimentation has changed through the developments in technology. Leaving the questions 'well done?' and 'done well?' to the jury, the answer to the question 'who cares?' is the design theory and practice as the subject of 'experiment' is very important and worth to be discussed in detail which is emphasized and justified throughout the study.

### 1.2. Aims and Scope of the Study

This study aims to;

- explore the definitions, descriptions and history of experiment in art and science literature to look for a correlation between them and design
- explore the term 'experiment' in design literature
- emphasize the importance of 'experiment' in design

The study focuses on defining, describing and emphasizing the importance of 'experiment' in design, especially in industrial design. 'Experiment' and 'experimentalism' in art and science are subjected to constitute a historical and conceptual background for the study. It is impossible to cover the story of experimentalism totally but it was aimed to find relevant and important points to be discussed in the study. The study takes the subject from its roots and brings it till recent developments and future predictions covering related subjects that are discussed and could/should be discussed in.

### 1.3. Structure of the Thesis

This study consists of two methods, the literature review and the content analysis which can be read complementarily aiming to explore the research question.

### 1.3.1. Literature Review

In the literature review of this study the relevant data was gathered to fulfill the aims of the study. It was a challenge to subject experiment and experimentalism in science and art, as it is very fundamental and the number of the publications is enormous. The representative publications of the paradigms were selected for the literature review.

Another challenge was to gather the data for ‘experiment in design literature’ as beside Schön (1983) and Thomke (2003), it was hard to find a publication dedicated for the subject. Aiming both to establish the theoretical and conceptual background of the subject and also build a complementary background for the content analysis, the publications which subject experiment and also the ones that don’t subject directly but which are important for reading and interpreting the conclusions were subjected and explored. The points where parallelisms occurred are indicated and brought together in the conclusion as well.

### 1.3.2. Content Analysis

When exploring the term ‘experiment’ in design literature, it was necessary to conduct a systematic search to find out in which context and referring to which meaning the term ‘experiment’ was being used. For this, the periodicals ‘Design Issues’ and ‘Design Studies’ were subjected to content analysis, of which the details wick be discussed in Chapter 4.

## 2. THE TERM ‘EXPERIMENT’ IN ART AND SCIENCE

When writing about the history of experimentalism in science, it should be mentioned that this is one of the greatest paradigms of history of science and is still being discussed by the science historians. But in the base of these discussions lies the fact that experimentalism wasn’t invented by someone suddenly but it references to a mental act like thought experiments in earlier history and then physical acts like Galileo’s, Newton’s, and Boyle’s experiments. (Kuhn, 1977; Shapin, 1996).

This inconsistency of the history of experimentalism in both the literature of the sciences and arts continues throughout the chapter. To build a flow, the subjects those were necessary to illuminate the subject of ‘experiment in design’ were selected and the correlations that were built are noted.

### 2.1. The Term ‘Experiment’ in Literature of Natural Sciences

Robert Boyle is one of the most important characters in science history, especially about experimentalism. Shapin (1985) in his book “*Leviathan and the Air-Pump*”, subjects the famous experiment of Boyle, which also gives the book its name and which he describes as “*the great paradigm of experimental procedure*”. He describes Boyle’s researches in pneumatics in 1660s, the air-pump experiments that he designed to provide a heuristic model about how authentic scientific knowledge should be secured and the circumstances and the effects of the experiments at that time in detail.

Building a more general perspective on the history of experimentalism, Shapin (1996), i his book “*The Scientific Revolution*”, Shapin (1996) discusses that time generally, subjecting Galileo, Pascal, Descartes, Hobbes and again Boyle. He describes two opposite approaches on experimentalism as Descartes advocating experiments as necessary for natural philosophy and Hobbes advocating that artificial experiments were unnecessary and experience was sufficient that was “*shown by the high heavens and the seas and the broad Earth*".

Shapin (1996) subjects the "*inclined-plane experiments*" of Galileo which were conducted by means of a ball and a ramp to mathematically express the law of fall, and names as "*some of the most celebrated early experimental performances*" of the Scientific Revolution. But he also states that although Galileo announced that he's performed these experiments "*often, even as often as a hundred times*", the historians doubt that the experiments actually performed rather than just imagining as "*thought experiments*" as he doesn't describe how he did them but states findings as "*this is what happens*". Shapin (1996) suggests that it was Boyle, whose experimental writing aimed to "*reliably extend experience by indirect means*".

Shapin (1996) defines the air-pump experiment of Robert Boyle and his assistant Robert Hooke in Royal Society of London as "*the Scientific Revolution's greatest fact-making machine*". He summarizes the emblematic character of the air-pump in two respects, firstly being that it became a model for the procedure of experimental natural philosophy, also by vigorously advertisements of the Royal Society, it was pointed as a "*paradigm of experimental philosophy*", the use of instruments was recognized as a new thing in the 17th century attracting both support and opposition, and these experiments were recognized as an origin of experimentation in natural science by many historians. Secondly, until the air-pump experiments, the similarity between the products and nature and human artifice was accepted but experimental manipulations with instruments were thought to be unable to stand for how things were in the nature; and the experimentation with such instruments opened up the possibilities of enormous control and convenience for making cases accessible and visible like the effects of air. (Shapin, 1996)

Shapin (1996) also emphasizes the techniques that Boyle and his associates developed for making the experimental experience public as; they encouraged witnesses to observe the repeated experiments, and under Boyle's recommendations, all the methods, materials and circumstances were reported very detailed to allow the experiment to be reproduced. But he also adds that neither of these techniques was very powerful, and after years, even Boyle himself was convinced that few competent replications of his air pump experiments had been carried out and concluded that few were ever likely to be. The importance of reporting the experimental data rigorously will be held also in the next chapter, which is essential for providing effective learning from experiments.

Barnes, Bloor and Henry (1996), in their book called '*Scientific Knowledge: A Sociological Analysis*' also stating that Boyle is often remembered today as a key figure in the elaboration of experimentalism mention that Francis Bacon had also

worked on experimentalism fifty years earlier than Boyle but has dismissed the narrower motives for experimentation. They state that Bacon suggested "*a new kind of empiricism which sought only to generate new facts and advocated the gathering of, supposedly, theory-free factual data in 'natural histories' compiled by the collaborative efforts of trustworthy individuals*".

Barnes, Bloor and Henry (1996) state that Boyle was committed to Baconianism and described his approach as new Baconian kind of experimentalism, insisting that "*the knowledge which they presented in their accounts of the physical world was concerned solely with demonstrable matters of fact, and was free from any bias introduced by preconceived hypotheses*".

As there is much confusion and disagreements in the standard historical literature, Kuhn (1977) states what more important is, was the circumstances that made Boyle a key figure of experimentalism. Barnes, Bloor and Henry (1996) handle the history of science from a sociological aspect and describe the circumstances at that time detailed. They state that Robert Boyle, the seventh son of one of the wealthiest men in England, the Earl of Cork was a founder member of the Royal Society of London and used his personal prestige to influence this earliest of scientific societies, the intellectual leaders of the Royal Society were inspired by Boyle and they presented The Royal Society as "*a forum for establishing incontrovertible truths and for settling controversies*". Barnes, Bloor and Henry (1996) don't comment on the wealth of Boyle as a circumstance reinforcing the experimental circumstances; but it may be read as an example of changing economics which will be a subject of experimenting for innovation in the following chapter.

Kuhn (1977), in his book "*Essential Tension: Selected Studies in Scientific Tradition and Change*" subjects experimentalism stating that it is usually mentioned with Francis Bacon as Baconian Sciences in the seventeenth century, together with the Scientific Revolution. Kuhn (1977) puts forward the question, '*What, if anything, was new about the experimental movement of the seventeenth century?*' and claims that Aristotle', in his methodological writings insistet upon the need for close observation as much as Francis Bacon did in his writings. He references Crombie (1953) and Randall (1961)'s studies on an important medieval methodological tradition that elaborated rules for drawing sound conclusions from observation and experiment. (Crombie, 1953; Randall, 1961 cited in Kuhn 1977)

Kuhn (1977) describes the experimental situation within ancient and medieval tradition as "*thought experiments"*, which he describes as "*the construction of*

*potential experimental situations the outcome of which was foretold from previous everyday experience*". He states that there were performed experiments as well, especially in optics, but which were often extremely difficult for the historian to decide whether a particular experiment discovered in the literature was mental or real.

Kuhn (1977) admits that the observations and experiments are made far more frequently in the seventeenth century but argues that this generalization missed the essential qualitative differences between the older forms of experiment and the new. He states that there are three novelties which distinguish the new experimental movement from the old movements.

First of these novelties, according to Kuhn (1977), is the attitude toward the role and status of experiment. As examples to Baconian practitioners, who performed experiments, he mentions Gilbert, Boyle, and Hooke, stating that their aim was seldom to demonstrate what was already known or to determine a detail required for the extension of existing theory but rather they wished to see how nature would behave under previously unobserved, often previously nonexistent, circumstances. The product of the experimental process at their time was *"the vast natural or experimental histories which amassed the miscellaneous data that many of them thought prerequisite to the construction of scientific theory*". Experiment was highly valued and theory often decried and the interaction between them occurred usually unconsciously (Kuhn, 1977).

The second novelty, according to Kuhn (1977), is the major emphasis given to experiments; that these experiments constrained nature, exhibiting it under conditions which could not be attained without the forceful intervention of man. He indicates placing grain, fish, mice, and various chemicals seriatim in the artificial vacuum of a barometer or an air pump exhibit as examples of the new tradition.

The third novelty, which Kuhn (1977) comments as the most striking one, is that the physical science became instrumental, introducing telescopes, microscopes, thermometers, barometers, air pumps, electric charge detectors, and numerous other new experimental devices. He states that these instruments, reagents, and techniques have used to be the property of craftsmen, pharmacists, and alchemists until the late sixteenth century, and they were reevaluated and regularly deployed in the experimental search for natural knowledge.

As a summary, Kuhn (1977) references Koyre (1939) and Butterfield (1950) stating that the transformation of the classical sciences during the Scientific Revolution can

be described as new ways of looking at old phenomena rather than a series of unanticipated experimental discoveries. (Koyre, 1939; Butterfield, 1950, cited in Kuhn, 1977)

In his book '*Philosophy of Science'*, Gillies (1993) states that Bacon believed that in the long run, technology could only be improved by improving our knowledge of the natural world, by carrying out basic research in science. And he cites Bacon who makes a distinction between "*experiments of fruit"* with "*experiments of light",* that he puts out as follows:

> All industry in experimenting has begun with proposing to itself certain definite works to be accomplished, and has pursued them with premature and unseasonable eagerness; it has sought, I say, experiments of Fruit, not experiments of Light; not imitating the divine procedure, which in its first day's work created light only and assigned to it one entire day; on which day it produced no material work, but proceeded to that on the days following. (Bacon, 1629, cited in Gillies, 1993)

The controversies in history of science about experimentalism can be read as experimentalism wasn't invented but the circumstances have changed and it gained importance in science methodology. The discussion might be seen parallel to the objectives of this thesis that experiment in design should be more emphasized and studied in detail.

### 2.2. The Term 'Experiment' in Social Sciences

In his book "*A History of Experimental Psychology*", Boring (1950) describes how natural science and mental philosophy came together in the middle of the nineteenth century to create what was later called the new psychology, experimental psychology or scientific psychology. He subjects nine important developments which were first in the scope of physiology and constituted the psycho-physiological knowledge and the experimental psychology of that period, which are, (1) sensory and motor nerves, (2) specific nerve energies, (3) sensation, (4) phrenology, (5) localization of function in the brain, (6) reflex action, (7) electrical nature of the nerve impulse, (8) velocity of the nerve impulse and (9) the personal equation, some of which he studies detailed in his book.

Boring (1950) states that the scientists did not think that the subject-matter of these developments were psychology, but they were physiologists, physicists or astronomers. There were no scientists who called themselves as psychologists until 1860, but there was progress in conventional history of psychology and philosophers that subject the problems of mind and knowing like the British em-

piricists and associationists, Descartes and his tradition in France, Leibnitz, Kant and Herbart in Germany.

Boring (1950) states that at the beginning of the century, Kant's dictum that psychology cannot be experimental was accepted but the experiment for measuring the velocity of the nervous impulse that Helmholz conducted in 1850 was an anchorage in the history of psychology. And the time he describes as "*psychology was getting ready to declare its immediate independence of both philosophy and physiology*", mentioning that at that time Fechner thought of the way for measuring sensation by laborious experiments, and Wundt was lecturing on "*how the new experimental science of physiological psychology could be brought about*".

McGuigan (1990) starts his book "*Experimental Psychology*" with the definitions of sciences, stating that there are two types of definitions, content definitions and process definitions. He states that the content definition is, "*science is an accumulation of integrated knowledge*" and the process definition is, "*science is that activity of discovering important variables in nature, of relating those variables, and of explaining those relationships (laws)*". And for a definition that incorporates both, he cites Conant (1951), who defines science as "*an interconnected series of concepts and conceptual schemes that have developed as a result of experimentation and observations*". (Conant, 1951; cited in McGuigan, 1990) He also proposes a similar definition that science is "*a systematically organized body of knowledge about the universe obtained by the scientific method*".

McGuigan (1990) states that the classical behaviorists with the leadership of John B. Watson in the early 20th century, were developing the psychology as a science with instrument approach, citing Heidbreder (1933) who summarizes the approach as "*if psychology is ever to become a science, it must follow the example of the physical sciences; it must become materialistic, mechanistic, deterministic, objective*". (Heidbreder, 1933; cited in McGuigan, 1990). He states that with materialistic, they mean only the physical events with observable responses but not concepts like ideas or consciousness, with objective, the principle of "*intersubjective reliability*" which means "*scientifically observed events are reliably reported through the subjective perceptions of a number of observers, not just one*", with determinism, "*the assumption that there is lawfulness in nature", and with mechanism, the assumption "that organisms behave in accordance with the laws of physics*".

By adapting these considerations and general definition of science to psychology, McGuigan (1990) suggest the following;

> The more abstruse and enigmatic a subject is, the more rigidly we must adhere to the scientific method and the more diligently we must control variables. Chemists work with a relatively limited set of variables, whereas psychologists must study considerably more complex phenomena. We cannot afford to be sloppy in our research. Since experimentation is the most powerful application of the scientific method, we shall focus on how we conduct experiments. (McGuigan, 1990)

After discussing the scientific method step by step in detail, McGuigan (1990) summarizes them as a list suggesting that there are no rigid rules when following these steps. The list is as follows;

1. selecting an area of research and stating a problem
2. formulating a hypothesis as a tentative solution to the problem
3. collecting data relevant to the hypothesis
4. designing experiments by organizing the data through statistical methods and making inferences for testing the hypothesis to see whether the data supports the hypothesis or not
5. If the hypothesis is supported, generalizing it to what it is concerned with but also stating "the generality with which we wish to advance the hypothesis"
6. making predictions and also the experiment can be conducted again with new samples to determine "whether the estimate of the probability of the hypothesis can legitimately be increased"
7. explaining the findings by means of a more general theory. (McGuigan, 1990)

McGuigan (1990) also summarizes the steps for designing experiments which are as follows;

1. selecting a sample of participants
2. randomly assigning the participants to groups
3. randomly assigning groups to conditions
    a. the experimental group will serve under novel conditions
    b. the control group will serve under a normal or standard condition
4. defining the independent variable which is an aspect of environment that is studied experimentally and which varies such that normal value is assigned to the control group and the novel value to the experimental group
5. defining the dependent variable which is the resulting measure of any change in behavior
6. controlling and holding constant all the variables which may affect and influence the dependent variable, except independent variable

7. conducting statistical tests to determine whether the two groups differ in measures of the dependent variable and so confirm or disconfirm the the hypothesis
8. if the hypothesis is confirmed, generalizing and explaining the hypothesis
9. predicting new situations, perhaps through replication (McGuigan, 1990)

### 2.3. The Term 'Experiment' in Art Literature

According to the philosopher and educator Dewey (1934), one of the essential traits of the artist is that he or she is born an experimenter. He justifies his statment that the artists have to express an intensely individualized experience through means and materials that belong to the common and public, they have to not repeat themselves and they operate experimentally to open new fields of experience and disclose new aspects and qualities in familiar scenes and objects. But he also finishes his argument stating "*if, instead of saying "experimental" one were to say "adventurous," one would probably win general assent—so great is the power of words".*

Gombrich (1995), in his famous book "*The Story of Art*" names the chapter on the first half of the twentieth century as "*Experimental Art*". He states that the roots of experimentalism in art goes bask to French Revolution of 1789 with these words; "*it was then, as we know, that artists had become self-conscious about style, and had begun to experiment and to launch new movements which usually raised a new 'ism' as a battle-cry*". As one the early examples of experimenting, Gombrich (1995) indicates the "*Art Nouveau*", which was a gathering for seeking a new style in building and ornament by technical experiments with the materials like iron.

Then Gombrich (1995) mentions the reactions of modern architects by avoiding all kinds of ornaments and so breaking with the traditions of many centuries. But again he defines the path they went through was experimenting with building materials. As an example he gives the building of Bauhaus in Dessau which he describes as "*one of the experimental buildings which became a storm-centre of propaganda for and against modern architecture*" whose motto he states as to unite art engineering so that they benefit each other and the students were encouraged to "*use their imagination and to experiment boldly yet never to lose sight of the purpose which their design should serve*". And the tubular steel chairs and similar furnishings he defines as "*inventions*", and describes as "*designed by men of tact and taste who knew how to make a building fit for its purpose and yet 'right' for the eye*", where the

harmony was derived by great deal of trial and error. He describes the works of Bauhaus and the contemporaries as follows;

> To discover these secret harmonies a great deal of trial and error is needed. Architects must be free to experiment with different proportions and different materials. Some of these experiments may lead them into a blind alley, but the experience gained need not be in vain for all that. No artist can always 'play safe', and nothing is more important than to recognize the role that even apparently extravagant or eccentric experiments have played in the development of new designs which we have now come to take almost for granted. (Gombrich, 1995)

On the other hand, Gombrich (1995) states that the inventions and innovations in fine arts, wasn't as widely realized as in architecture. He states that art lost its bearing for experimenting, continuing to "*paint what they see*". Instead they moved totally away from the conventions until "*the Impressionists proclaimed that their methods allowed them to render on the canvas the act of vision with 'scientific accuracy'*". The tendency of young artists was to surpass the Impressionists and reject the Western tradition but start from the beginning, from the "*primitives*" like masks of tribes and Negro sculptures which had the "*intense expressiveness, clarity of structure and a forthright simplicity of technique*" that Western art have lost. The new movements had inherited from the experiments of the three rebels, Van Gogh, Cezanne and Gauguin, which Gombrich (1995) defines as "*inventors*". (Gombrich, 1995)

Stating that "*the history of twentieth-century art must take note of this restless experimentation because many of the most gifted artists of the period joined in these efforts*", Gombrich (1995) describes the doctrines of the movements expressionism, cubism, abstract painting, surrealism and dada. And for the recent art scene, he comments that "*the shock has worn off and that almost anything experimental seems acceptable to the press and the public*" which he also defines as a problem.

On the contrary to Gombrich (1995), Focillon (1934) in his paper "*The Life Forms in Art*" interprets the art movements in the far early stages of art by means of experimenting. He mentions the details of Gothic architecture as experimenting and his interesting description of experimentation is as follows;

> By experiment I mean an investigation that is supported by prior knowledge, based on a hypothesis, conducted with intelligent reason and carried out in the realm of technique. In this sense it may well be said that Gothic architecture is guesswork and reasoning, empirical research and inner logic all at once. The proof of its experimental character is the fact that, in spite of the rigorousness of its methods, some of its experiments remained almost wholly without results; in other words, much was wasted and much was barren. How little do we know of the innumerable mistakes that lurk in the shadow of success! (Focillon, 1934)

Focillon (1934) defines the term style by means of experimenting and as having two opposite meanings, style as absolute and style as variable but in generic senses as "*a special and superior quality in a work of art: the quality, the peculiarly eternal value that allows it to escape the bondage of time*". He suggests that several styles may exist in neighboring districts and styles develop differently regarding to their technical domain and with these reservations established, "*the life of a style may be considered either as a dialectic or as an experimental process*".

According to Focillon (1934), each style passes through several ages and several phases of being which he lists as (1) the experimental stage, (2) the classical age, and (3) the age of refinement. He states that these ages present the same formal characteristics at every epoch and in every environment of art. The experimental state, he describes as the state where style is seeking to define itself and adds that "*it is generally called archaism, in either the pejorative or the laudatory sense*". And the classical state, Focillon (1934) describes as consisting *"the greatest propriety of the parts one to the other*" with its stability, security and following on experimental unrest which it solidifies.

By these interpretations, Focillon (1934) subjects the experimental art belonging to times when the scientific revolution hasn't happened yet and the scientists haven't started to subject experimentalism. Not discussing the experimental tradition before scientific revolution, here the important point is that Focillon (1934) places experimental thinking and techniques, very fundamentally throughout the Western art.

Poggioli (1968), in his book "*Theory of the Avant-Garde*" studies the movement of avant-garde both internally and externally, with its ideological and psychological motivations as well as its practical, sociological consequences. By doing that, he subjects various movements in art history with the tendency of avant-garde nature. His examples mostly are from poetry and literature, but he also subjects plastic arts.

To start with, Poggioli (1968) describes the activist, antagonist, nihilist and agonist aspects of avant-garde movement. Avant-garde movement is activist in the way that it behaves with dynamism, enthusiasm, a taste for action and "*emotional fascination of adventure*". It is antagonist in the way it behaves permanently in hostility and opposition. It is nihilist, "*a kind of transcendental antagonism*" in the way that it drives itself beyond the point of control of any convention and reservation. And it is agonistic in the way that it accepts and even welcomes the losses, catastrophes and self-ruin. Defining these moments of the movement, Poggioli (1968) suggests that

the first two of the moments represent the ideology and mythology of avant-garde, whereas the other two adds the 'dialectic of movements'. He adds that the third and fourth irrational moments cannot be conceived except psychologically and sociologically and that they cannot held apart from the dimension of time and history. (Poggioli, 1968)

Describing these relations above, Poggioli (1968) describes the experimentalism of the avant-garde as follows;

> From these derives a further category, which may be summed up by saying that one of the primary characteristics of avant-garde art is, technically and formally, experimentalism. It is in fact evident that in each of the above categories there inheres a single stimulus sufficient to lead the avant-garde artist to experiment. But we hardly need say that, in the majority of cases in which the experimental comes into play, a variety of stimuli and a complex of multiple motivations determine its activity. (Poggioli, 1968)

According to Poggioli (1968), experimentalism forms the artist to transform the public, so it educates the public, it is a "*laboratory*" and a "*proving ground*" but in a pure and simple sense, not as regarding to scientific metaphors. He suggests that a "*laboratory*", the "*proving ground*" trains the artist differently from the classical, traditional and academic practices, as the aim is the perfection of the artist, not the perfection of the school. He emphasizes that laboratory serve for a even higher aim, the technical and scientific progress of art itself.

Poggioli (1968) also discusses that the avant-garde's experimental nature, different than traditional art and many modernist movements, is not essentially and exclusively a matter of art. He gives as example the experiments of surrealism, which he defines as 'psychological', in the unknown unconscious and the soul, rather than being technical or stylistic. In this sense, Poggioli (1968) suggests that the experimentalism of the avant-garde also differs from the romantic aesthetic experimentation, not just searching for new forms aiming to destroy the rules, but also aiming of creation of a 'new morphology of art, a new spiritual language'.

### 2.4. The Relation of Art and Sciences

In '*The Quest for Certainty'*, Dewey (1929) states that there was a time when art and science were virtually equivalent terms, indicating the phrase "*faculty of arts and sciences*" in the universities as the reminiscence of this period. He states that by then the distinction was drawn between the "*mechanical*" and the "*liberal*" arts, partly between industrial arts and social arts, as those concerned with things and those concerned directly with persons.

In '*Art as Experience'*, Dewey (1934) states that the reproduction of the order of natural changes and the perception of that order were at first close together, so close that no distinction existed between art and science which were both called "*téchne*".

Dewey (1934) describes the history of progress of natural sciences and art growing together beautifully, drawing a flow between story, rhythm and law of nature. He starts from the early Greek philosophers; they told the story of nature and as a story has a beginning, movement, and climax, the story needed aesthetic form. Within the story, minor rhythms became part of the great rhythms like of generation and destruction, of coming into being and passing out of being and of aggregation and dispersion, and the idea of law emerged with the idea of harmony, and conceptions that are now prosaic commonplaces emerged as parts of the art of nature as that was construed in the art of language. Every uniformity and regularity of change in nature is a rhythm, and the terms "*natural law*" and "*natural rhythm*" are synonymous. And the formulae for these rhythms are the canons of laws. Every science like astronomy, geology and dynamics concentrate on various rhythms. Concepts of molecule, atom and electron are subtler rhythms that are discovered and mathematics is the most generalized order for conceiving universally rhythms. The development has reached a point when the sciences and arts got separated and physical sciences are only concerned with rhythms that are obvious to thought but not to immediate experience, with the symbols which cannot be perceived by senses, and so their manifestation is only for those who have undergone a long and severe discipline. Dewey (1934) continues as follows;

> Yet a common interest in rhythm is still lie tie which holds science and art in kinship. Because of this kinship, it is possible that there may come a day in which subject-matter now exists only for laborious reflection that appeals only to those who are trained to interpret that which to sense are only hieroglyphics, will become the substance of poetry, and thereby be the matter of enjoyed perception. (Dewey, 1934)

Another citing from Dewey (1946) is made by Buchanan (1992) where he treats science as primary and art as secondary with the following sentences;

> The consideration that completes the ground for assimilating science to art is the fact that assignment of scientific status in any given case rests upon facts which are experimentally produced. Science is now the product of operations deliberately undertaken in conformity with a plan or project that has the properties of a working hypothesis. (Dewey, 1946, cited in Buchanan, 1992).

Preusser (1973) also writes about the relationship of art and science, his approach refers to the history of technology. He argues that Man's technological capabilities

were first realized when he began attempting innovative procedures to create visual form; and methods of manipulating tools and techniques as practiced by ancient cultures. The outcome by forming the materials was desired both to be perceptual and also practical.

Preusser (1973) states that the parallelism of art and science and the evolution of scientific thought being expressed artistically can be still observed, giving the examples of Neo-Impressionism, utilizing and substantiating scientific research in color perception, the developments of Cubism and the theory of relativity and the Surrealist movement occurring at the same time as the development of psychoanalysis.

## CHAPTER 3

## THE TERM 'EXPERIMENT' IN DESIGN AND INNOVATION LITERATURE

In this chapter, it is aimed to provide an overlook to the design process from the perspectives of design theory and innovation literatures. The subjects and the references that are studies are in this chapter are selected concerning the aim of the study, which is to explore the term 'experiment' in design and describe the approach the term suggests for the design process; providing necessary fundamental knowledge. This literature review is suggested to be read by the light of the previous chapter, building the interdisciplinary connections and comparisons provides a basis for the content analysis that will be held in the next chapter.

### 3.1. The Term 'Experiment' in Design Theory

This part of the study is written not just searching the word "*experiment*" in design theory, but also investigating the related or fundamental subjects that are necessary to build a basis for the study. Although it isn't claimed to cover up the whole design theory, it subjects a wide scale of design process.

The first two parts "*Design vs. Science*" and "*Design vs. Art*" aim to build connections of design with art and sciences and to provide an introduction for an interdisciplinary approach.

Although the suggestion of Buchanan (1992) should be considered and admitted, which is "*Despite the efforts to discover the foundations of design thinking in the fine arts, the natural sciences, or most recently, the social sciences, design eludes reduction and remains a surprisingly flexible activity*.", it can be answered and the motivation can be justified with the suggestion again of Buchanan and Margolin (1995), "*Employing concepts and methods drawn from other disciplines to explore design, or encouraging individuals from other disciplines and professional perspectives to address what they regard as important issues or themes in the phenomenon of design – is provocative*."

### 3.1.1. Design vs. Science

Buchanan (1995), in his paper '*Discovering Design'*, discusses the fundamental differences between design and sciences, criticizing the tendency among theorists to reduce design to a form of science. His first argument is that the subject matter of design is not given as the subject matter of nature is given in science. The subject matter of the sciences is also not entirely given but it must be discovered in the activities of scientific inquiry, however, the subject matter of design is created through activities of invention and planning, or through whatever other methodology or procedures a designer finds helpful in characterizing his or her work, he states. (Buchanan, 1995)

Buchanan (1995) states determinacy as the other fundamental difference between sciences and design. He states that there is determinacy in sciences, as discovery implies that there is something constantly available, waiting to be uncovered, and that the discovery will yield only to one result, which may be confirmed by other experimental techniques for questioning nature, whereas there is no determinacy in the activity of design, the subject matter of design is radically indeterminate, open to alternative resolutions even with the same methodology.

Emphasizing the difference between invention and discovery, Buchanan (1995) argues that the scientist discovers a natural process or a natural law, but the engineer or designer invents a possible application or a new use suited to a particular product.

Cross (1995), in his paper '*Discovering Design Ability'* cites Lawson's experiments which compare the different strategies of architects and scientists basing on a specific problem-solving task. What Lawson (1979) found from this experiment was that "*The scientists were [attempting to] discover the structure of the problem; the architects were proceeding by generating a sequence of high-scoring solutions until one proved acceptable. . . . [The scientists] operated what might be called a problem-focusing strategy.*" Lawson (1979) made an experiment and found that these different strategies developed during the architects' and scientists' education; while the difference was clear between fifth-year, postgraduate students, it was not clear between first-year students. The architects had therefore learned their solution-focusing strategy, during their design education, as an appropriate response to the problems they were set. (Lawson, 1979, cited in Cross, 1995)

Simon (1988), in his paper "*The Science of Design: Creating the Artificial*", summarizes the difference between a scientific approach and a design approach as

"*The natural sciences are concerned with how things are. . . . Design, on the other hand, is concerned with how things ought to be*." He suggests that the professional schools will reassume their professional responsibilities just to the degree that they can discover a science of design, a body of intellectually tough, analytic, partly formalizable, partly empirical, teachable doctrine about the design process. He describes the tendency at that time as "*Such a science of design not only is possible but is actually emerging at the present time. ... It has already begun to penetrate the engineering schools, particularly through programs in computer science and "systems engineering," and business schools through management science*."

Glanville (1999) has more provocative thoughts about the relationship of design with science. His paper '*Researching Design and Designing Research'*, he starts by criticizing design world in 1960s, when the design research began. He mentions the Oxford Conference in 1956, when, he states that architectural education in the UK and its sphere of influence accepted architecture as a second-class subject, i.e., not properly scientific, and architects -a significant subdivision of designers, were determined to become scientific, so the syllabus was changed to invent design science, as proper scientific research was expected to yield the secrets of the designer, allowing to find the right answers to problems unsentimentally.

Then criticizing the world of science, Glanville (1999) defines experiments as "*the main means by which scientists extract knowledge of the world we inhabit*." He states that the scientists do this by radical simplification which he describes as follows;

> In the (idealized) scientific experiment, we divide systems into distinct, isolated variables. We fix all but one of the variables, and change some factor we believe is influential in the behavior of the system, realized in the free variable. Changing this factor, we observe any change in the behavior of the system and attribute it to the response of that variable. We organize the "inputs and outputs" so that there appears to be a simple relationship, and we determine that this relationship is determined by the variable. (Glanville, 1999)

Glanville (1999) emphasizes the role of the 'experimenter' in a scientific experiment, which he describes as choosing to do experiment, setting it up, observing and determining what the outcomes are and carrying out the actions. He suggests that the experimenter is influenced by social factors, and epistemological outlook does not reduce his or her responsibility, the experimenter accepts these social factors, and acts accordingly. The whole process, he states, is deeply embedded in circularity, particularly the greatest of all scientific circularities, and the active involvement of the experimenter - the observer.

Glanville (1999) mentions the linguistic analysis over the last thirty years, which has shown that the aims of the scientific communication and the use of language indicating this have changed, stating that publications are no longer concerned with "*the truth*" but communicate the author's or the editor's wish to join or remain in a group of fellow workers. (Hunston, 1993 and Hyland, 1997; cited in Glanville, 1999).

Also mentioning writing “theory from experiment” and “theory from theory” in science, Glanville (1999) suggests that (scientific) research is a form of design -a specifically restricted form and so it is inappropriate to require design to be "*scientific*"; for scientific research is a subset (a restricted form) of design, and the set of a subset isn’t generally required to act as the sub subset to that subset any more than we require the basement of the building is its attic.

Glanville (1999) discuses the definition of design at that point which he characterizes concentrating as a means of exercising our creativity, as a conversation usually held via a medium such a paper and pencil, with an other as the conversational partner. (Pask, 1969; cited in Glanville, 1999)

Glanville (1999) describes the (scientific) research as a design activity with these sentences;

> We design experiments, but we also act as designers in how we act in these experiments. We design the experiences and objects we find through experiment by finding commonalities (simplification): and we design how we assemble them into patterns (explanatory principles, theories). Looking at these patterns, we make further patterns from them-the theories of our theories. Thus, in doing science, we learn. (Glanville, 1999)

Glanville (1999) describes the (scientific) research as a branch of design, in which the designer is central, and through which we construct the world of the scientific knowledge we design and adds “*So the act of design, as we understand and value it, has much to offer as an example of how science and scientific research might be in a new era*.”

According to Glanville (1999), the people who are interested in design and in researching into it are still inclined to insist that the research should be prosecuted according to the old and no longer sustainable view of (scientific) research, even while scientists come to realize their creative involvement in their processes. He suggests that especially now, when design researchers are again asking about the benefits available from other disciplines, the disciplines that study circularity and include observer-participant for the insights they may afford, should be looked for. And he adds,

> And how better to acknowledge design in research: as a way of understanding, acting, looking, and searching. But design should be studied on design's terms. For, design is the form, the basis. And research is a design act. (Glanville, 1999)

Cross (1999), in his paper "*Design Research: A Disciplined Conversation*" subjects a similar approach. He states that the view of design as a distinct culture is also embodied in attempts to break away from "*two cultures*" view of Western intellectual tradition, the two cultures of the arts and sciences suggested by C. P. Snow. He suggests that "*It has to be recognized that there is at least one other culture, which we might regard as the culture of design, which can be articulated in comparison with the other two*".

Cross (1999) defines as the "*things to know*" in science, art and design respectively as the natural world for science, human experience for art, and the artificial world for design and as the "*ways of knowing*" he defines that the values of science are rationality and objectivity, those of art are reflection and subjectivity, and those of design are imagination and practicality. He also differentiates the "*ways of finding out*" which are the intellectual skills and can be differentiated as those of science are experiment and analysis, those of art are criticism and evaluation, and those of design are modeling and synthesis. But he also admits that these classifications might be rather simple.

Cross (1999) states as the point that he wants to emphasize is that design does indeed have its own strong and appropriate intellectual culture which he states that many researchers in the design world have realized and that design world must avoid totally swamping our research with different cultures imported either from science or art. He also states that he doesn't mean too ignore different cultures imported either from science or art which have much stronger histories of inquiry, scholarship, and research than design. He suggests to draw upon those histories and traditions where appropriate, while building the own intellectual culture of design, acceptable and defensible in the world on its own terms with an intellectual culture that match of the others.

Lastly for this part, Cross (1999) cites H. Simon (1996) who states that "*The proper study of mankind is the science of design.*" He interprets this as that the study of design could be a fundamental, interdisciplinary study accessible to all those involved in the creative activity of making the artificial world. He justifies this again with Simon's words which are as follows;

> Few engineers and composers . . . can carry on a mutually rewarding conversation about the content of each other's professional work. What I am suggesting is that they can carry on such a conversation about design, can begin to perceive the common creative activity in which they are both engaged, can begin to share their experiences of the creative, professional design process. (Simon, 1996; cited in Cross, 1999)

### 3.1.2. Design vs. Art

Exploring design in art history, Buchanan (1995) handles the subject as an evolution of integrative thinking through time. He describes the time following Renaissance as a loss of the essentially humanistic dimension of production as the consequence of separating the theoretical from the practical, the ideal from the real, and the cognitive from the non-cognitive. He states that at that time, design became a servile activity rather than a liberal art, being practiced by chance and intuition as a trade activity or military occupation, rather than in its full potential as an architectonic master art that guides all of the diverse forms of making which are central to human culture; it was not conceived as an art which could promote the freedom of men and women in the circumstances of the newly emerging technological culture.

The situation at the end of the nineteenth century, Buchanan (1992) describes as existing subjects being explored with progressively more refined methods, and new subjects being added to accord with advances in knowledge, resulting in the further division and subdivision of the circle of learning, until all that remained was a patchwork quilt of specializations.

According to Buchanan (1995), efforts to reunite design with the arts of making starts in the nineteenth century, when Ruskin, Morris, and others attempted to elevate the status of craft production as an alternative to mass production by machines and evolved with the cultural and philosophic revolution at the beginning of the twentieth century. This evolution, Buchanan (1995) indicates also as the reason why the origins of design are traced to the early decades of the twentieth-century, when individuals began to formulate new disciplines of design thinking that would combine theoretical knowledge with practical action for new productive purposes.

Buchanan (1995) calls Walter Gropius among the first to recognize the design as a new liberal art of technological culture. He states that Gropius realized that he had a responsibility to train a new generation of architects who could help to overcome the disastrous gulf which had emerged between idealism and reality on the basis of a "*modern architectonic art*" of design. Buchanan (1995) cites Gropius where he says that "*Experiment once more became the center of architecture, and that demands a broad, coordinating mind, not the narrow specialist*." (Gropius, 1962, cited in Buchanan, 1995)

Buchanan (1995) interprets Gropius as claiming that the new art of design revitalized design thinking by initiating a new path of experimentation and pluralistic

exploration grounded in art and human character. He comments that aside from the broad principle that an architectonic art of design connected the arts, the path or discipline presented by Gropius did not presuppose or require any particular principles of art but rather it was a way to explore a variety of principles in order to discover their potential consequences for making and practical life. Buchanan (1996) describes the goal as "*to provide a concrete connection between artistic exploration and practical action, where artists could learn how their conceptions of art might be carried forward as experiments in shaping the broad domain of the artificial in human experience, extending beyond traditional forms of artistic expression into making in all phases of life, supported by new technologies and advances in science."*

About the search for new integrative disciplines to complement the arts and sciences in the twentieth century, Buchanan (1992) comments that "*Without integrative disciplines of understanding, communication, and action, there is little hope of sensibly extending knowledge beyond the library or laboratory in order to serve the purpose of enriching human life.*"

Coles (2005), in his book '*Designart*' discusses the artists and designers in history, blurring the borders in between the two disciplines. He subjects mostly the artists who have either been receptive to or worked with design, rather than focusing on designers. He mentions the purists who suggest that the distance between art and design has to be preserved in the name of specificity; in an age where there is a multimedia meltdown, and warn that art must take care not to relinquish what is specific to it. On the contrary, he mentions the view which insists that to survive and be relevant in such an age art needs to be more gregarious - it must reach out beyond its own confines - and design is surely one of its more suitable bedfellows. He finds it important to make connections between disciplines.

Coles (2005) explains the term '*designart*' stating that it blurs the ideological gulf between the disciplines too smoothly, citing Scanlan and Jackson (2001)'s description which is; "*Design art could be defined loosely as any artwork that attempts to play with the place, function and style of art by commingling it with architecture, furniture and graphic design.*" (Scanlan and Jackson, 2001; cited in Coles, 2005). He states that Sonia Delaunay was the first to use the term in the 1920s. Most often, he adds, when designart is discussed, it is in terms of the way it "*transgresses*" boundaries.

Coles (2005) also subjects the economy of the exchange between art and design with these words; "*To artists, design is attractive because it provides a way to make money, to reach a larger audience, to look stylish - not to mention having something to sit on and live in while you are making more designart*." He lists what artists uses design for, as to achieve a more rigorous composition; to play disciplines off one another in a creative show-down; to gain control over the various elements that represent them, such as exhibition catalogues, that are so often left to designers; or to produce a new speculative type of work truly somewhere in-between art and design.

Coles (2005) cites the essay "*Ornament and Crime"* of Adolf Loos where he says "*I have discovered the following truth and present it to the world: cultural evolution is equivalent to the removal of ornament from articles in daily use.*" (Loos, 1908; cited in Coles, 2005). Calling the essay infamous, he states that since then there has been a tendency to assume that ornament, and with it the decorative effects of art, architecture and design, are degenerate or are at the very least superfluous to what is required.

As a repercussion, Coles (2005) cites Ruskin (1859) who said,

> There is no existing highest-order for art but is decorative. The best sculpture yet produced has been the decoration of a temple front - the best painting, the decoration of a room... Get rid, then, at once of any idea of Decorative art being a degraded or a separate kind of art. (Ruskin, 1859; cites in Coles, 2005).

According to Coles (2005), the avant-gardes in the early twentieth century -De Stijl in the Netherlands, the Bauhaus in Germany and the Russian Constructivists - forwarded theories sympathetic to the art and design issue, but writings by the exponents of these movements pursued a much more exacting sense of how correlations between art and design could be pressed into service by utilising a muscular theoretical programme. He criticizes Gropius, whose discourse, he states, allowed the avant-garde's aim of bringing the arts together, but the sense of flexibility that such a meeting ought to yield is forfeited -the running together of the arts became a dry theoretical programme almost as disagreeable as Loos's. And as a result, Coles (2005) states that the widespread dissemination of Bauhaus dogma, especially in the United States the speculative aspects of design and decoration were hampered, if not embarrassed, into silence until the mid-1950s, when the likes of the Independent Group returned to the issue anew.

Lastly, Coles (2005) praises Matisse work for being malleable enough to take inspiration from border disciplines and yet strong enough to stimulate them in return.

He cites Matisse's words in 1908 -the same year as Loos's attitude against ornament- that he defines as "*ingeniously turning a painting into a piece of design without even sweating*":

> What I dream of is an art of balance, of purity and serenity, devoid of troubling or depressing subject matter, an art that could be for every mental worker, for the businessman as well as the man of letters, for example, a soothing, calming influence on the mind, something like a good armchair that provides relaxation from fatigue. (Matisse, 1908; cited in Coles, 2005)

### 3.1.3. Experiment in Design Literature

The subject of '*Experiment in Design Literature*' will be held in three parts, namely, (1) Bauhaus, (2) Reflective Practitioner, and (3) Experiment in Design Research. Under these titles, three important subjects where experimentation is discussed will be studied. Bauhaus and Gropius are one of the most referenced names mentioning experimental process who practiced and encouraged being experimental in design education (Buchanan, 1995; Bürdek, 2005; Coles, 2005, etc.) and "*Reflective Practitioner*" is the name of the book of Schön (1983), who defines and describes the term "*experiment*" in design very detailed, and these both subjects are studied separately because of their importance. The last part of this title, "*Experiment in Design Research*" subjects the relevant discussions in design research.

#### 3.1.3.1. Bauhaus

Staatliches Bauhaus Weimar was founded in 1919 with Walter Gropius as its director (Gropius was the director till 1927, the school was closed in 1933 by Nazi regime), and became the flagship for the subsequent development of design (Wingler 1962; cited in Bürdek, 2005). Bürdek (2005) states that Gropius was guided by the idea that the Bauhaus should bring together art and technology to form a new, modern unity when the unity of design and execution that had existed in the craft trades had been torn asunder by the advance of industrial modes of production during the nineteenth century. He states that Gropius' motto was that technology might not need art, but art certainly needed technology. This idea, he adds, was associated with a fundamental social objective, namely to anchor art in society.

According to Bürdek (2005), the foundation course at the Bauhaus represented the heart of the program of basic polytechnical artistic education. It was introduced in 1919-1929 by Johannes Itten, which was obligatory for all students and the purposes of the course were "*to encourage students to experiment and to explore*

*their own creative talents, and to teach fundamental design skills through an understanding of an objective science of design*".

According to Bürdek (2005), the foundation course was first conducted by Laszlo Moholy-Nagy and later by Josef Albers, whose goals were "*inventive building and observational discovery*." He states that Albers, like Itten, methodogically took an inductive approach to design, which allows the student to investigate, explore, and experiment, by this manner, cognitive skills were fostered indirectly. Bürdek (2005) emphasizes that instead of theory leading the way, the conclusions drawn from analysis and discussion of experiments were progressively distilled into a generalized 'theory of design'.

In his paper "*Moholy-Nagy's Design Pedagogy in Chicago*", Findeli (1990) examines the model and method of organic functionalism, which Moholy-Nagy developed intuitively in detail, referring it implicitly to two major philosophical systems. He states that the humanistic anti-materialism recalls Goethe's epistemological system and the methodological aspects refer to John Dewey's pragmatic philosophy (Moholy-Nagy directed the New Bauhaus in Chicago between 1937 and 1938, the school was closed by financial reasons. In 1939 he opened the School of Design, which in 1944 became the Institute of Design).

Findeli (1990) focuses on two important aspects of Moholy-Nagy's approach, firstly, that he insisted on hiring only teachers who were also artists; the reason being that the teacher had to be familiar with the intuitive process, which is indeed inherent in artistic practice. The second approach, he mentions is that the student was considered as a living organism, both physically and spiritually, instead of an empty box to be filled with skill and knowledge. Findeli (1990) states that for him, creative potentialities were not to be gathered or imposed from outside the individual, but rather to be developed from inside, provided there was an adequate environment to do so.

Findeli (1990) states that Dewey's philosophical influence upon Moholy-Nagy was even more direct, they met each other and Dewey enjoyed meeting Moholy-Nagy both for his personality and for his unusual intellectual penetration which he later wrote in a letter to a friend which Findeli (1990) cites. On Bauhaus side, he states that Dewey's "*Art as Experience*" was a compulsory textbook in the Product Design workshop of the ID. Beside that he states that innumerable parallels could be drawn between Moholy-Nagy's pedagogical principles and Dewey's powerful philosophy

and Moholy-Nagy found in Dewey's work the theoretical foundation and justification of his own pedagogy.

As one the numerous examples of the analogy between both pedagogical and methodological models, Findeli (1990) give the example of the experimental aspects, referring to Dewey's instrumentalist sense. He also resembles Moholy-Nagy's views to Moholy-Nagy's Dewey's fundamental theoretical model which is relativistic in the sense that he was claiming that no human phenomenon can be considered without its general physical and social environment. For Dewey, a situation is the interactions between the individual, or a group, and the environment, calling situation and interaction as internal and external conditions, respectively. And then the experience is "*a set of situations; the structure of the set, its gestalt, decides whether the experience is meaningful or not for the individual*." (Findeli, 1990)

As a consequence of these thoughts, Findeli (1990) describes Dewey's view on education as "*the art of conceiving situation sets susceptible to promote the growth of personality, that is, the art of proposing a meaningful 'continuum of experience'*." He defines two extremes in education, the classical education, focusing mainly external conditions and progressive education, mainly focusing on internal education and states that a dynamic interaction and balance should be maintained by the educator as the former might cause coercion and the latter to laxity.

Another point, which might integrate with the part "*Design vs. Science*" of the study, is that Findeli (1990) states as one of the updates that Moholy-Nagy found necessary when rebuilding the Bauhaus in Chicago, introducing scientific courses and also a method of analysis of design problems which was adapted to the emerging scientific and philosophical paradigms of the 20th century. He also adds that Moholy-Nagy believed that a new individuality was a prerequisite condition for a new society and the artists and designers had the responsibility of their profession just as Dewey considered that philosophers had to commit themselves within their socio-cultural environment and it was necessary to encourage this through a pedagogical method, which he suggested as a "process-oriented" education leading to inner transformation of the students.

#### 3.1.3.2. The Reflective Practitioner

In his book '*Reflective Practitioner'*, Schön (1983) describes and defines 'experiment' in design process very detailed. He starts his arguments about experimenting as follows;

> Seeing-as is not enough, however. When a practitioner sees a new situation as some element of his repertoire, he gets a new way of seeing it and a new possibility for action in it, but the adequacy and utility of his new view must still be discovered in action. Reflection-in-action necessarily involves experiment (Schön, 1983).

Schön (1983) cites Popper (1968) and discusses, that there is another sense of experiment which is central to the model of professional knowledge as technical rationality, which is an activity by which a researcher confirms or refutes a hypothesis, when the experimenter tries to produce conditions that disconfirm each of the competing hypotheses, by showing that the conditions that would follow from each hypothesis are not the observed ones. He comes to the conclusion that on this view, reflection-in-action is not really experiment (Popper, 1968, cited in Schön, 1983). He steps back to consider what experimenting means, stating that hypothesis-testing experiment is only one of several kinds of experiment, each of which has its own logic and its own criteria of success and failure; and because in practice these several kinds of experiment are mixed up together, experiment in practice is of a different order than experiment in the context of research.

Schön (1983) suggests that to experiment, in the most generic sense, is to act in order to see what the action leads to. He states that the most fundamental experimental question is, "*What if?*" He classifies the experiment in three categories, which are namely, (1) exploratory experiment, (2) move-testing experiment, and (3) hypothesis-testing experiment and defines and describes them as follows;

- '*Exploratory experiment'*, Schön (1983) calls when action is undertaken only to see what follows, without accompanying predictions or expectations. He states that it is essential to the sort of science that does not appear in the scientific journals, because it has been screened out of the scientists' accounts of experimental results -perhaps because it does not conform to the norms of controlled experiment, and is the probing, playful activity by which we get a feel for things. It succeeds when it leads to the discovery of something there.
- '*Move-testing experiment'*, Schön (1983) calls when action is taken in order to produce an intended change, in order to see what happens. He summarizes it as, where there is no intended outcome and *one either gets the intended consequences or does not* -which is the simplest case, the move is affirmed when it produces what is intended for it and is negated when it does not. However, in more complicated cases, he states that the moves produce effects beyond those intended which he continues as *"One*

*can get very good things without intending them, and very bad things may accompany the achievement of intended results. Here the test of the affirmation of a move is not only 'Do you get what you intend?' but 'Do you like what you get from the action, taking its consequences as a whole?' If you do, then the move is affirmed. If you do not, it is negated."*

- '*Hypothesis testing experiment'*, Schön (1983) defines, as *"The practitioner puts forward hypotheses and, within the limits of the constraining features of the practice context, tries to discriminate among them—taking as disconfirmation of a hypothesis the failure to get the consequences predicted from it. The logic of his experimental inference is the same as the researcher's."*

About the important difference of experimenting in practice from the research context, and what is distinctive about it, Schön (1983) suggests that is has to do with the relationship between changing things and understanding them. He describes the process as "*When the practitioner reflects-in-action in a case he perceives as unique, paying attention to phenomena and surfacing his intuitive understanding of them, his experimenting is at once exploratory, move testing, and hypothesis testing. The three functions are fulfilled by the very same actions. And from this fact follows the distinctive character of experimenting in practice*."

About where the experiment stops, Schön (1983) suggests that it is again different in practice context than it is in the context of controlled experiment. He states that in the context of controlled experiment, again referring to Popper, the experimenter might keep on experimenting indefinitely -as long as he is able to invent new, plausible hypotheses which might resist refutation more effectively than those he has already tried. Whereas, he adds, in practice situations where experimental action is also a move and a probe, where the inquirer's interest in changing the situation takes precedence over his interest in understanding it -it is initiated by the perception of something troubling or promising, and it is terminated by the production of changes one finds on the whole satisfactory, or by the discovery of new features which give the situation new meaning and change the nature of the questions to be explored. Such events, he states, bring hypothesis testing to a close even when the inquirer has not exhausted his store of plausible alternative hypotheses. He also comments that because the practitioner has produced changes he has found satisfactory, has made of unintended outcomes something that he likes, an unintended artifact has been produced which creates a new whole idea.

Going into detail, Schön (1983) describes the process of the experimenting and its distinctive rigor, as "*playing a game*" with the situation in which he is bound by considerations relevant to the three levels of experiment -exploration, move testing, and hypothesis testing where the primary interest is changing situation. He states that the resistances to change shouldn't be ignored; the inquirer should both experiment rigorously, and remain open to the evidence of a failure. He adds that the play is in relation to a moving target, changing the phenomena during the experiments, and how he ought to experiment, will depend on the changes produced by his earlier moves. The metaphor of "*playing a game*" that Schön (1983) uses will be subjected again later in this chapter.

About the failure, Schön (1983) comments that when a move fails to do what is intended and produces consequences considered on the whole to be undesirable, the inquirer surfaces the theory implicit in the move, criticizes it, restructures it, and tests the new theory by inventing a move consistent with it. He states that the learning sequence, initiated by the negation of a move, terminates when new theory leads to a new move which is affirmed. He states that other theories of action or models might also account for the failure of the earlier move and the success of the later one, but in the practice context, priority is placed on the interest in change and therefore on the logic of affirmation which he states that it is what sets the boundaries of experimental rigor. Examples to this "*other theories*" will be discussed later in this chapter as well, that encourage the early failure.

#### 3.1.3.3. Experiment in Design Research

In his paper, Buchanan (1995) uses the term '*experiment*' when defining design as follows;

> Design rests on the ability of human beings to reason and act with prudence in solving problems that are obstacles to the functioning development, and well-being of individuals and society. Furthermore, design is inquiry and experimentation in the activity of making, since making is the way that human beings provide for themselves what nature provides only by accident (Buchanan, 1995).

Cross (1999) cites the general definition of Archer at the Design: Science: Method conference of the Design Research Society, 1980, "*Research is systematic inquiry, the goal of which is knowledge*." (Archer, 1981; cited in Cross, 1999) And he suggests three sources for design research; people, process and products. With people, he refers the "*designers especially, but also everyone to some extent*" and so he suggest that the first subject of design research to investigate is how people design including designer behavior, the nature of design ability, design education.

Secondly, he names the processes, referring to the tactics and strategies of designing, methodology, modeling, from sketch to computer simulations and new practices in industry. And thirdly he names the product referring form, material and finishes, with the theoretical studies of morphology, semantics, ergonomics and efficiency.

Cross (1999) suggest a taxonomy for design research based on these three categories, which are as follows;

- *design epistemology*, study of designerly ways of knowing
- *design praxiology*, study of the practices and processes of design
- *design phenomenology*, study of the form and configuration of artifacts (Cross, 1999)

Strickler (1999) in his paper "*Elicitation Methods in Design Research*", focuses on user research in communication design. From that point of view, he also discusses the conceptions of design research, as a liberal art and as a social science. He argues that these are not contradictory but rather complimentary, in the way they express two aspects of the same system, the theoretical and experimental branches respectively. He notes that with the term experiment he means "*any form of original social research in which data are gathered through direct contact with persons identified as representative members of a study population*". He suggests that as experimental and theoretical efforts inform and stimulate each other in design research as it is physical sciences.

Strickler (1999) discusses that the theory/practice dichotomy in design, with theory subordinated to practice, roots back to Bauhaus which is still influential in design education in North America. He criticizes Bauhaus view, citing Winkler, with its education of "*vocational practice*" which lacks intellectual theories like economical or political history, natural and social sciences, art history or literature. He claims that the workshop education from the craft or trade traditions didn't involve questioning sources of knowledge nor the instructors' relationship with the students as masters, did involve reflection. He also mentions that the design research has meant "*the (usually brief) literature and visual reference search performed by design practitioners as they learn about subjects related to a client's products and services.*" which leaves the questions on end user usually to designer's intuition but not testing the conceptual models. (Winkler, 1997; cited in Strickler, 1999)

Strickler (1999), citing Brinberg and McGrath (1985) states that in the late twentieth century, "*the search for truth*" is not concerned with "*absolute truth*" as conceived by

classical philosophers, but rather with an ongoing engagement in a process for reducing uncertainty about subjects or phenomena. (Brinberg and McGrath, 1985; cited in Strickler, 1999). Strickler (1999) explains this as follows:

> A central premise of this position is that any conceptual model or finding represents only a partial explanation of reality which can be usurped by new findings at any time. In this environment, theory and experiment are interdependent processes in formulating bodies of knowledge that can be said to reduce uncertainty. Theory remains speculative until tested, and collected data cannot be meaningfully analyzed until subjected to the organizing principles of theory. As methods for critical and theoretical investigation in design evolve, a rigorous experimental branch of visual communication research will be necessary for the field to mature. (Strickler, 1999)

Strickler (1999), citing Brinberg and McGrath (1985) states that all research activity occur in three principle domains, not necessarily in this order, which are as follows:

- The substantive domain concerns content that is of interest.
- The conceptual domain concerns ideas that give meaning to content.
- The methodological domain concerns procedures for studying content. (Brinberg and McGrath, 1985; cited in Strickler, 1999)

Strickler (1999) suggests that relations between these domains define three distinct "*study paths*", the experimental, the empirical, and the theoretical, which describe fundamental research orientations. He also states that these paths allow an integrative approach which is which he defines as 'unique' to design research. He explains the paths as follows;

- The experimental path combines concepts from the conceptual domain with methods from the methodological domain to produce a study plan. Concepts and methods subsequently are brought to bear on phenomena in the substantive domain.
- The empirical path combines methods from the methodological domain with substantive phenomena to produce a set of observations to be interpreted with ideas from the conceptual domain.
- The theoretical path combines concepts from the conceptual domain with phenomena from the substantive domain to produce an "*untried theory*," which can then be subjected to selected methods. If individual concepts are combined with particular phenomena, the products are constructs. If larger "*conceptual relations*" are combined with "*patterns of phenomena*" then the products are hypotheses. (Strickler, 1999)

Strickler (1999) also discusses the concept of '*validity*' in social sciences and design. He mentions that the unlike natural sciences, social sciences subject human who are unique individuals with consciousness and will, so active participants to the process. (McCracken, 1988; cited in Strickler, 1999) For this reason Strickler (1999) states that social scientists do not include the '*self-expression*' of the subjects in the study to to "*reduce the perception of risk by the participants and to ensure the protection of their privacy*". However in design research, he states, that this kind of information might hold important information of social motivation and thus although it cannot be assumes to be '*true*', it must be collected.

As the traditional values of scientific inquiry for establishing validity in social research, Strickler (1999) counts precision, realism, and generalizability (Brinberg and McGrath, 1985; cited in Strickler, 1999). He defines them as follows;

- precision is the accuracy of the measurements taken and the extent to which a researcher is able to control variables in the research environment,
- realism refers to social context, or the degree to which the environment in which data are collected reflects normal circumstances under which a behavior occurs,
- generalizability refers to the extent to which data collected from participants in a sample are applicable to members of the larger population under study. (Strickler,1999)

Strickler (1999) also adds that it is an ideal but can never be fully attained as the three values cancel each other. As examples he gives a laboratory experiment where participants can be observed precisely, but loosing realism; on the other hand an ethnographic research where realism is obtained but loosing precision and generalizability or a survey, which can be generalizable as it has a larger sample but then the data gathering and interpreting is not well controlled. For this reason he comments that "*researchers increasingly advocate a pluralistic, or triangulated, approach to data gathering to gain perspective from the competing attributes and limitations of individual methods*."

Strickler (1999) describes several methods for collecting data of social sciences which can be and is adapted to "*user-focused, experimental design research*", which are as follows:

1. Participant observation (ethnographic observation): Observance natural behavior and interactions between participants where the researcher is the main instrument for data collection.

2. Focus group (focus group interviewing): A group conversation guided by a neutral researcher with short list of open questions.
3. Interview: There are three important versions which are the ethnographic interview, long interview and the depth interview, the first two being preferred usually for social purposes and the last, for psychological purposes.
4. Survey Questionnaire: A quantitative method frequently used in combination with other qualitative methods to verify findings. The purpose is usually to measure the degree to which an assumption can be generalized. (Strickler,1999)

Complaining that the literature includes very little information abut how to analyze the result data, Strickler (1999) mentions the points that are agreed on as "*methodological systems for data transcription; methodical sorting and data review; reduction of data; separation and analysis of key ideas; display of phenomenal relationships; and elegance of summary*".

Strickler (1999) concludes, again focusing on visual communications design and emphasizing the interdisciplinary research and suggests to "*look for opportunities to strengthen the experimental branch of the field as an empirical bridge between theory and practice*" to evolve as an academic discipline.

### 3.1.4. Design Methodology, Creativity in Design and Design Strategy in which Experiment Could/Should Integrate

In his book "*Design: History, Theory, and Practice of Product Design*", Bürdek (2005) describes the economic condition for design to develop methods as, after World War II, a major economic upswing began in the industrialized countries of Europe, and in those countries characterized by a market economy, competition quickly intensified to become the international business rivalry known today as globalization. In this situation, he argues, design, too, had to adapt to the changed conditions, when it was not possible to continue practicing the subjective and emotional methods of design which originated in the tradition of the Werkkunst arts and crafts while industry was rationalizing design, construction, and production. He states that it was thus an obvious step for designers to try to integrate scientific methods into the design process so that they could be accepted as serious partners in the sphere of industry.

This is very important when understanding and interpreting the design theory. It means that the economics was the influencing factor of the development of design

methodology. The economics of experimenting will be subjected later in this chapter which will be integrated with this suggestion of Bürdek (2005).

It is important to subject the design methods, considering experimentation in design, to compare them with the methods, principles or outlines of processes. Roozenburg and Eekels (1995), in their book "*Product Design Fundamentals and Methods*" define design methodology as "*the branch of science that critically studies the working procedures*" for designing products in the sense of material artifacts and systems. They state that design methodology provides designers with knowledge on the design process, which they classify as follows;

- models of design and development processes, representing the structure of thinking and action in designing
- the methods and techniques to be used within these processes
- a system of concepts and corresponding terminology.

Roozenburg and Eekels (1995) describe the design methodology as providing methods and rules for designing, which are mostly heuristics, helping but not guaranteeing to find a solution for some problem. They add that heuristics should be used '*sensibly*' and '*knowledgeably*' by interpreting and applying to the experience at hand.

Roozenburg and Eekels (1995) suggest two principles in design methodology, first being "*What is the essential structure of designing?*" and second being "*How should the design process be approached to make it effective and efficient?*". The design methodology that tries to reveal the first question through logical structural analyses and empirical research, as well as identifying the needs for methodical support, they define as "descriptive design methodology". And the answers to the second question can be given by "prescriptive design methodology" which recommends and even demands applications of certain methods to certain design problems. And usually non-designers tent to get interested in descriptive side and the professional designer in prescriptive design methodology but both should be held complementary. (Roozenburg and Eekels, 1995)

Cross (2000) describes the design methods very detailed and clearly in his book '*Design Engineering Methods'*, which he describes shortly as offering a strategic approach and a number of tactics as aids for designing successful products.

Descriptive methods, Cross (2000) defines as describing the sequences of activities that typically occur in designing and prescriptive methods as prescribing a better or more appropriate pattern of activities. In detail, Cross (2000) describes descriptive

models, as identifying the significance of generating a solution concept early in the process, thus reflecting the solution-focused nature of design thinking. This initial solution conjecture is then subjected to analysis, evaluation, refinement and development, he states, and sometimes, the analysis and evaluation show up fundamental flaws in the initial conjecture and it has to be abandoned, a new concept generated and the cycle started again. Putting these four activity types in their natural sequence, the four-stage model of the design process consisting of: exploration, generation, evaluation and communication which involve an iterative feedback loop from the evaluation stage to the generation stage. (French, 1985, cited in Cross, 2000).

And the prescriptive models, Cross (2000) describes as models that are concerned with trying to persuade or encourage designers to adopt improved ways of working, usually offering a more algorithmic, systematic procedure to follow, and are often regarded as providing a particular design methodology. The intention, as Cross (2000) states, is to try to ensure that the design problem is fully understood, that no important elements of it are overlooked, and that the real problem is identified.

Cross cites Jones (1984) to list the stages of the model, commenting that such apparently sensible and rational procedures are not always followed in conventional design practice:

- Analysis: listing of all design requirements and the reduction of these to a complete set of logically related performance specifications.
- Synthesis: finding possible solutions for each individual performance specification and building up complete designs from these with least possible compromise.
- Evaluation: evaluating the accuracy with which alternative designs performance requirements for operation, manufacture and sales, before the final design is selected. (Jones, 1984, cited in Cross, 2000)

Cross (2000) also cites Archer, whose model includes interactions with the world outside. (Archer, 1984, cited in Cross, 2000) For prescriptive models, Cross (2000) also cites the model of Pahl and Beitz (1984) which he calls as more complex but reasonably comprehensive, and one of the guidelines of Verein Deutscher Ingenieure (VDI), which he states that it was criticized by the design-world as it seems to be based on a problem-focused, rather than a solution-focused approach, running counter to the designer's traditional ways of thinking; and lastly the model of

March (1984) which bases on production-deduction-induction, following the philosopher Peirce's concept of abductive reasoning for prescriptive models.

When discussing the design models, it is interesting and necessary to subject cognitive psychology. Finke, Ward and Smith (1992), in their book '*Creative Cognition'* state that in contrast to memory, a topic seldom linked to creativity, problem solving has often been the focus of previous cognitive approaches to creative thinking. The topics they concentrate in particular, they list as induction, the use of algorithms and heuristics, analogical mapping, metacognition, the use of mental models, suspension of expertise, and divergent thinking.

Heuristics is grouped as descriptive models, and prescriptive models as algorithmic and systematic procedures, as mentioned. Finke, Ward and Smith (1992) define algorithms as step-by-step methods or formulas that essentially guarantee a correct solution of the problem, giving the examples of arithmetic rules, mathematical formulas, and production systems that mechanically produce a solution using a set of prescribed operations. And heuristics, they define as general rules of thumb that provide useful shortcuts for solving problems, giving the examples of experts at solving anagrams who know what letter combinations and positions are most likely to produce a solution. They comment that algorithms are simple and reliable and heuristics are useful because of their relative efficiency, however they also add that there are times when established approaches will not suffice, and a novel, creative approach is necessary and also creative strategies for problem solving often require a suspension of one's expertise.

What Finke, Ward and Smith (1992) advocate is the development of cognitive skills related to expert creative thinking in general which would be founded on deeper understandings of the cognitive processes underlying creativity, particularly those that are involved in generating pre-inventive structures, combining existing concepts, and interpreting emergent properties. Such skills, they comment, would be especially helpful in situations where the usual problem-solving rules and heuristics would not apply.

Cross (2000) also comments about the models, suggesting an integrative model that the designer explores and develops the problem and solution together, as in most design situations it is not possible, or relevant, to attempt to analyse the problem from the beginning and in abstract isolation from solution concepts. He states that there is a symmetrical and commutative relationship between problem and solution; and between sub-problems and sub-solutions, and a constant transfer of the

designer's attention backwards and forwards between the problem space and the solution space.

Cross (2000) adds that it is argued, that there are several reasons – four reasons he states, for developing new design procedures. One reason, he states, the increasing complexity of modern design and another reason is that many of the products and machines to be designed today have never existed before, and so the designer's previous experience may well be irrelevant and inadequate for these tasks. A third reason as a related part of the complexity, Cross (2000) indicates the need to develop a team work with many specialists collaborating in and contributing to the design, arousing a need for a clear and organized approach is necessary. And last but not least Cross (2000) also mentions the high risks and costs associated with modern design of complex or mass-produced products, where also the time efficiency is also very important.

After describing the need for developing new design procedures, Cross (2000) discusses the definition of design methods from another point, as being any procedures, techniques, aids or 'tools' for designing; and the most common of them, he states is design-by-drawing. According to Cross (2000), beside the conventional and normal procedures of design, such as drawing, there has been a substantial growth in new, unconventional procedures, some of which seem over-formalized, or merely fancy names for old common-sense techniques, or too systematic to be useful in the rather messy and often hurried world of the design office. Cross states that some of the new design methods are new inventions of rational procedures, some are adapted from operational research, decision theory, management sciences or other sources, and some are simply extensions or formalizations of the informal techniques that designers have always used.

According to Cross (2000), as common principle features of the new methods, they either formalize certain procedures of design or they externalize design thinking. Cross (2000) states that, by formalization, occurrence of oversights, of overlooked factors in the design problem and of the kinds of errors that occur with informal methods are avoided; and also the process of formalizing a procedure tends to widen the approach that is taken to a design problem and to widen the search for appropriate solutions; it encourages and enables you to think beyond the first solution that comes into your head. The latter feature, externalizing design thinking, Cross (2000) describes as trying to get the thoughts and thinking processes out of the head and into the charts and diagrams which is a significant aid when dealing with complex problems, getting a lot of systematic work out of your head and onto

paper also means that your mind can be more free to pursue the kind of thinking it is best at: intuitive and imaginative thinking; it is also a necessary part of team work providing means by which all the members of the team can see what is going on and can contribute to the design process.

Cross (2000) adds that the design methods are not the enemy of creativity, imagination and intuition, at the contrary, they are more likely to lead to novel design solutions than the informal, internal and often incoherent thinking procedures of the conventional design process. Adding that some design methods are, indeed, techniques specifically for aiding creative thought he classifies the general body of design methods into two broad groups as creative methods and rational methods.

Cross (2000) describes the creative design methods as intending to help stimulate creative thinking by trying to increase the flow of ideas, by removing the mental blocks that inhibit creativity, or by widening the area in which a search for solutions is made, and lists as (1) Brainstorming, (2) Synectics, and (3) Enlarging the search space.

Cross (2000) comments that these methods are some techniques which have been found useful when it is necessary for a designer or design team to '*turn on*' their creative thinking. However, he adds that creative, original ideas can also seem to occur quite spontaneously, without the use of any such aids to creative thinking.

Referring the psychologists who have studied accounts of creative thinking from a wide range of scientists, artists and designers, Cross (2000) mentions that these highly creative individuals generally report that they experience a very sudden creative insight that suggests a solution to the problem they have been working on. According to Cross (2000) that sudden illumination, the '*Ah-ha!*' experience often occurs when the individual is not expecting it, and after a period when they have been thinking about something else, however, does not usually occur without considerable background work on a problem. He adds that the key insight is also usually just the germ of an idea that needs a lot of further work to develop it into a proper, complete solution to the problem. Referring to the psychologists who suggest that there is a general pattern to similar kinds of thought sequences as they occur often enough, Cross (2000) states the general pattern is a sequence of recognition, preparation, incubation, illumination and verification, and the definitions are listed as follows;

- '*Recognition*' is the first realization or acknowledgement that *'a problem*' exists

- '*Preparation*' is the application of deliberate effort to understand the problem
- *'Incubation'* is a period of leaving it to mull over in the mind, allowing one's subconscious to go to work
- *'Illumination'* is the (often quite sudden) perception or formulation of the key idea
- *'Verification'* is the hard work of developing and testing the idea (Cross, 2000)

To conclude, Cross (2000) suggests that this process is essentially one of work, relaxation, work, with the creative insight occurring in a relaxation period; and the hard work of preparation and verification is essential. Later in this chapter this subject will be held again, with real examples and comments from the perspective management of design.

Cross (2000) also mentions rational methods which encourage a systematic approach to design have similar aims to the creative methods, such as widening the search space for potential solutions, or facilitating team work and group decision-making, i.e. being not necessarily true that rational methods are somehow the very opposite of creative methods. He suggests that creative methods and rational methods are complementary aspects of a systematic approach to design. He also adds that using any particular design method during the design process will often appear to be diverting effort from the central task of designing, however, this is exactly the importance of using such a method; it involves applying some thought to the way in which the problem is being tackled. He adds that requires some strategic thinking about managing the design process.

Cross (2000) defines a design strategy as describing the general plan of action for a design project and the sequence of particular activities which the designer or design team expect to take to carry through the plan. According to Cross (2000), to have a strategy is to be aware of where you are going and how you intend to get there with the purpose to ensure that activities remain realistic with respect to the constraints of time, resources, etc., within which the design team has to work.

According to Cross (2000), to operate with no explicit design strategy which might be called a random search strategy might also very well be appropriate in novel design situations of great uncertainty, where the widest possible search for solutions is being made. To such novel situations he gives the examples of trying to find applications for a completely new material, or designing a completely new machine such as a domestic robot. To the opposite extreme to random search, Cross (2000)

puts a completely predictable or prefabricated sequence of tried-and-tested actions which would be appropriate in familiar and well-known situations. In practice, he suggests that most design projects require a strategy that lies somewhere between the two extremes, and contains elements of both.

Cross (2000) relates these two extreme strategy styles to design approaches and thinking styles identified by psychologists which he lists, convergent/divergent, serialist/holist and linear/lateral as random search and prefabricated strategies respectively.

Cross (2000) states that the random search strategy represents a predominantly divergent design approach; the prefabricated strategy represents a predominantly convergent approach. Normally, he suggests, the overall aim of a design strategy will be to converge onto a final, evaluated and detailed design proposal, but within the process of reaching that final design there will be times when it will be appropriate and necessary to diverge, to widen the search or to seek new ideas and starting points. The overall design process, he comments that, is therefore convergent, but it will contain periods of deliberate divergence. He adds that convergent thinkers are usually good at detail design, at evaluation and at selecting the most appropriate or feasible proposal from a range of options and divergent thinkers are usually good at concept design and at the generation of a wide range of alternatives.

Serialist and holist thinkers, Cross (2000) defines as, the former preferring to proceed in small, logical steps, trying to get every point clear or decision made before moving on to the next, and pursues a straight path through the task, trying to avoid any digressions; and the latter preferring to proceed on a much broader front, picking up and using bits of information that are not necessarily connected logically, and often doing things out of sequence. And the linear and lateral thinking Cross defines as, the former proceeding quickly and efficiently towards a perceived goal, but may result in getting stuck in a rut, while the latter entailing a readiness to see, and to move to, new directions of thought.

Cross (2000) also adds that there is even some evidence to suggest that there is a fundamental dichotomy between the thinking styles of the two hemispheres of the human brain, the left hemisphere being predominant in rational, verbal, analytic modes of thought, while the right hemisphere being predominant in intuitive, nonverbal, synthetic modes of thought. Therefore he comments that differences in thinking styles appear to be an inherent characteristic of human beings, most people

tending towards a preference for one style rather than another; but no-one being exclusively limited to just one style. Relating these thinking styles to models of design process such as descriptive and prescriptive models, Cross (2000) suggests that they tend to present design as a linear serialistic process and comments that it may be off-putting, and even counterproductive to those designers whose own preferred thinking style tends more towards the lateral and holistic.

Cross (2000) concludes that "*What is needed is a more flexible and strategic approach to designing, which identifies and fosters the right kind of thinking at the right-time, and within the context of the particular design project*." suggesting some simple rules of strategy control as follows:

- Keep your objectives clear
- Keep your strategy under review
- Involve other people
- Keep separate files for different aspects

### 3.2. The Term 'Experiment' in Innovation Literature

The term experiment is gaining importance in innovation culture. With a simple explanation, Thomke (2003) justifies the name of his book '*Experimentation Matters'* as "*Experimentation matters because it fuels the discovery and creation of knowledge and thereby leads to the development and improvement of products, processes, systems, and organizations*."

The re-introduction of the word is described by Tom Peters in the foreword of '*Serious Play'* by Shrage (2000) as follows;

> Truth is Waterman and I were 300 years late to the dance. The scientific method, which helped extract humanity from the Dark Ages, was built what has become the B-school analysis paradigm. It was built on … the *experiment*, in other words, just do it. (Shrage, 2000)

According to Thomke (2003), the reason that experimenting is being issued lately is mainly that the change in economics of experimenting with the technologies available, and that it is now possible to perform more experiments economically and faster toward innovation. That can be also explained as Schrage (2000) puts forward, quantitative differences create qualitative differences; when the cost and quality of the raw material of innovation transforms, the definitions of risks and value creation changes as well. Thomke (2003) describes the change as, "*Never before*

*has it been so economically feasible to ask "what-if" questions and generate preliminary answers. New technologies enable organizations to both challenge presumed answers and pose more questions*."

Experiment is not a new word for companies, as Thomke (2003) states and adds, "*All companies have some experimentation process at work but not everyone organizes that process to invite innovation.*" He quotes from the book '*In Search of Excellence',*

> The most important and visible outcropping of the action bias in the excellent companies is their willingness to try things out, to experiment. There is absolutely no magic in the experiment. It is simply a tiny completed action, a manageable test that helps you learn something, just as in high-school chemistry. But our experience has been that most big institutions have forgotten how to test and learn. They seem to prefer analysis and debate to trying something out, and they are paralyzed by fear of failure, however small. (Peters and Waterman, 1982 cited in Thomke, 2003)

### 3.2.1. How Innovation Literature Defines and Describes 'Experimenting'

Thomke (2003) defines experimenting for innovation shortly as to learn by trying things out; via models, prototypes, controlled environments, and computer simulations, innovators reflect, improvise, and evaluate the many ideas that are generated in organizations.

Thomke (2003) categorizes the experiments as ideal experiment and real world experiment as the sciences does. The ideal experiment he describes as innovators separating an independent variable (the "*cause*") and a dependent variable (the "*effect*") and then manipulating the former to observe changes in the latter. The manipulation under careful observation and analysis gives rise to learning about relationships between cause and effect, which ideally can be applied to or tested in other settings. In the real world experimentation, environments are constantly changing linkages between variables are complex and poorly understood, and often the variables are uncertain or unknown. (Thomke, 2003)

When all relevant variables are known, Thomke (2003) suggests that formal statistical techniques and protocols which are used widely in many fields of process and product optimization today, allow for the most efficient design and analysis of experiments.

However, according to Thomke (2003), the independent and dependent variables themselves are uncertain, unknown, or difficult to measure. He classifies these uncertainties as (1) technical uncertainty, (2) production uncertainty, (3) need uncertainty and (4) market uncertainty. With these uncertainties, he states,

experimentation is much more informal or tentative requiring iterations; innovators making progress through iterative experimentation that is guided by some insight where a solution might lie.

Thomke (2003) describes the process of experimentation as typically beginning by selecting or creating one or more possible solution concepts, which may or may not include the best possible solutions; testing the solution concepts against an array of requirements and constraints. These trials yield new information and learning about aspects of the outcome the experimenter did not (or was not able to) know or foresee in advance, namely the errors. Test outcomes are then being used to revise and refine the solutions under development, and progress is made in this way toward an acceptable result. (Thomke, 2003)

Thomke (2003) defines and summarizes this experimentation process as four-step iterative cycle; (1) design, (2) build, (3) run, (4) analyze. The experiment starts with the design, individuals or teams defining what they expect to learn from the experiment. Hypotheses are formulated based on prior knowledge, reviewing existing data, observations, and prior experiments and generating new ideas through brainstorming. As the second step, (physical or virtual) prototypes and testing apparatus – models – are built. Then as the third step, the experiment is conducted in either laboratory conditions or a real setting. As the last step of the cycle, the result is analyzed, compared against the expected outcome, and the understanding is adjusted of what is under investigation. During this analysis step, most of the learning can happen and forms the basis of experiments in the next cycle. It is possible to disqualify failed experiments from the potential solution space and continue the search by going to step 1 of another cycle. However, in most cases, an error or a failed experiment can help someone to adjust mental, computer, or physical models to reflect what has been observed. Deeper understanding and less uncertainty about cause and effect is gained as a result. Or if the results of a first experimental cycle (steps 1 through 4) are satisfactory or address the hypothesis in question, one stops. However if, as is usually the case, analysis shows that the results of the initial experiment are not satisfactory, the experiment can be modified and "*iterated*" -tried again. These modifications may involve the experimental design, the experimental conditions, or even the nature of the desired solution. (Thomke, 2003)

Thomke (2003) states that in large development projects such as in automotive development, the number of the cycles can be thousands. Even small projects can have many iterations. As projects progress and designs mature, cycles tend to include models of increasing fidelity, or representativeness, gradually moving toward functional

prototypes and pilot vehicles as much as the time and budget constraints of the project allows, which are used to test decisions affecting design appearance, function, structure, and manufacturability. (Thomke, 2003)

Thomke (2003) summarizes the firm-specific conditions as seven factors that influence learning and innovation process across experimentation; (1) fidelity, (2) cost, (3) iteration time, (4) capacity, (5) sequential and parallel strategies, (6) signal-to-noise ratio, and (7) type of experiment. The definitions of the factors are listed in Table 3.5.

**Table 3.5:** Factors that affect Learning by Experimentation (Thomke, 2003)

| Factor | Definition |
|---|---|
| **Fidelity of Experiments** | The degrees to which a model and its testing conditions represent a final product, process, or service under actual use conditions |
| **Cost of Experiments** | The total cost of designing, building, running, and analyzing an experiment, including expenses for prototypes, laboratory use, and so on |
| **Iteration Time (all four steps)** | The time from planning experiments to when the analyzed results are available and used for planning another iteration |
| **Capacity** | The number of same fidelity experiments that can be carries out per unit time |
| **Strategy** | The extent to which experiments are run in parallel or series |
| **Signal-to-Noise Ratio** | The extent to which the variable of interest is obscured by experimental noise |
| **Type of Experiment** | The degree of variable manipulation (incremental versus radical changes); no manipulation results in observation only |

According to Thomke (2003), as experimentation is an iterative process of understanding what doesn't work and what does, it encompasses success and failure, both of which are equally important for learning; besides, the ability to experimenting quickly is also important as rapid feedback shapes new ideas by reinforcing, modifying, or complementing existing knowledge. Thomke (2003) emphasizes the importance of early experimentation as "*Large companies often spend millions of dollars to correct late-stage development problems but underestimate the savings of early experimentation.*"; and suggests that effective experiments are supposed to reveal what does not work early, they realize that the knowledge gained then can benefit the next round of experiments and lead to more innovative ideas and concepts—early "*failures*" can lead to more powerful successes faster.

Tom Kelley (2001), the general manager of one of the worlds leading design firm – IDEO, calls this approach "*Fail often to succeed sooner*." He argues that good companies embrace a culture of mini-failures as defining failure as the flip side of risk taking, and adds, "*If you don't risk, odds are you won't succeed*".

Thomke (2003) also adds that the knowledge of either failure or success itself can be stockpiled, providing a resource that, if not applicable to one set of experiments, can be used for subsequent inquiries. He gives the example of '*Tech Box*' that IDEO maintains, where they stockpill experiments from finished and ongoing projects. A curator in IDEO organizes and manages the content of the Tech Box is for cataloging and electronically documenting materials, objects, and interesting gadgets engineers can rummage through the box and play with an assortment of switches, buttons, and odd materials that were all part of successful or failed experiments which are then used to inspire innovators in new development projects. (Thomke, 2003)

To unlock the potential for experimenting, Thomke (2003) suggests six principles to the firms, which are;

1. Anticipate and Exploit Early Information through "Front-Loaded" Innovation Processes
2. Experiment Frequently but Do Not Overload Your Organization
3. Integrate New and Traditional Technologies to Unlock Performance
4. Organize for Rapid Experimentation
5. Fail Early and Often but Avoid "*Mistakes*"
6. Manage Projects as Experiments (Thomke, 2003)

The principles summarize a mentality for experimenting, but the most important principle concerning the subject of the thesis is the last one, namely '*Managing projects as experiments*' which Thome (2003) describes as a different way of thinking about experimentation. This refers to the more general approach of '*experimental thinking*' beside the other more practical principles.

Shrage (2000) suggests a similar list which he calls '*User Guide*', summarizing the principles he discusses in his book '*Serious Play'* as follows;

1. Ask, Who benefits?
2. Decide what the main paybacks should be and measure them. Rigorously.
3. Fail early and often.
4. Manage a diversified prototype portfolio.
5. Commit to a migration path. Honor that commitment.
6. A prototype should be an invitation to play.

7. Create markets around the prototypes.
8. Encourage role playing.
9. Determine the points of diminishing returns.
10. Record and review relentlessly and rigorously. (Shrage, 2000)

This list focuses more on the practical was of innovative process, which has common principles with the previous one like '*Fail early and often*', similar to '*Fail Early and Often but Avoid "Mistakes*"' or '*Manage a diversified prototype portfolio*', similar to '*Integrate New and Traditional Technologies to Unlock Performance*'.

Shrage (2000) calls the innovation process as "*serious play*" and the prototypes as "*toys*". Thomke (2003) defines prototyping as the mechanism through which experiments are carried out. According to this view and referring Schön (1983) who uses the metaphor of '*playing a game'* for experimenting, Shrage (2000)'s term '*Serious Play*' can also be read as '*Experimentation*'.

### 3.2.2. Experimenting through Prototypes

Hippel (2005) put the relationship of prototypes and experimentation simply as "*Experimentation is often carried out using simplified versions – models - of the product being designed and its intended use environment. These models can be physical or virtual*." The value of using models rather than the real thing in experimentation, he states, is twofold; first, it can reduce the cost of an experiment and second, it can make experimental results clearer by making them simpler or otherwise different than real life.

Shrage (2000) describes his perspective about the prototypes as "*Behavior change matters more than technological changes and the most intriguing perspectives don't come from looking at what these new toys can do, but from using them to see how people and their organizations behave*." He suggests that looking through the model you are experimenting on, and using it as a tool for watching the whole project, gives more insight about the projects evolution, giving the analogy that putting a camera into a flower and watching it's environment gives more insight and information about the flower than just focusing on it and watching it from outsight.

Shrage (2000) describes the relation of the prototypes with the innovation as "*As toys and games for serious play evolve, innovation behavior will evolve right along with them*." He makes the analogy that a new musical instrument may not change the meaning of improvisation, but it will change how a talented musician improvises; similarly, new types of modeling, prototyping, and simulation may not change the meaning of innovation, but they will surely change how organizations innovate.

Thomke (2003) describes the role of the prototypes in the process as facilitator of communication with clients, marketers, experts, and users by ensuring that everyone is discussing the same ideas and concepts. He provokes of using quick-and-dirty prototyping of individual product components to allow for more and faster design iterations. Shrage (2000) also comments that any organization committed to a speed-to-market philosophy inherently commits itself to "*rapid prototyping*" if it has any hopes for success and adds that quick-and-dirty prototypes can turn clients into partners, enabling developers to manage expectations and deal with changing requirements more responsively.

Shrage (2000) emphasizes that the fundamental question isn't, "*What kinds of models, prototypes and simulations should we building*" but, "*What kind of interactions do we want to create?*" For mission-critical measures in the prototyping process he gives the examples of IKEA and Steelcase. As Cost-to-build is explicitly identified as IKEA's single most important criterion, they calculate the manufacturing costs of furniture prototypes down to a fraction of a krone. Steelcase uses his prototyping showroom in New York, to measure the customers' interest in Steelcase systems via their length of stay (Shrage, 2000)

Shrage (2000) categorizes concepts of a product as prototype-driven and specification-driven (spec-driven). He states that small entrepreneurial companies built around a brilliant product concept tend to be prototype-driven whereas companies that need to coordinate large volumes of information while managing a large installed base of users – companies like to be spec-driven. He quotes David Kelley of IDEO who argues that the innovation cultures need to move from spec-driven prototypes to prototype-driven specs, but comments as that is arguable.

### 3.2.3 Example of IDEO

Kelley (2001) describes the value of prototypes as '*We believe in that great old saying, a picture is worth a thousand words. Only at IDEO, we've found that a good prototype is worth a thousand pictures.*'

Thomke (2003) describes the firm IDEO as '*While prototyping and experimentation have been integral to IDEO's success in product innovation, the same is true for continuously evolving its system for innovation'.* He summarizes the prototyping culture of IDEO as following three Rs: rough, rapid and right.

Kelley (2001) describes the prototyping process in IDEO as evaluating and refining the prototypes in a series of quick iterations and not getting too attached to the first few prototypes, as they know that they will change: then planning a series of

improvements, getting input from their internal team, from the client, from knowledgeable people not directly involved with the project, and from people who make up the target market. He adds that they watch for what works and what doesn't, what confuses people, what they seem to like, and they incrementally improve the product in the next round. This process (2001) Kelley describes fits to the experimentation cycle model of Thomke (2003) suggests.

Kelley (2001) also emphasizes the importance of a diversified prototype portfolio and integrating new and traditional technologies as Shrage (2000) and Thomke (2003) suggest. Kelley (2001) states that for new product categories IDEO visualize the customer experience by using composite characters and storyboard-illustrated scenarios; in some cases even make a video that portrays life with the future product before it really exists. He adds that quite often, the visualization takes the form of a computer-based rendering or simulation, though IDEO also builds thousands of physical models and prototypes every year.

### 3.2.4 Users That Experiment

According to Thomke (2003), the difficulty of product design is that the "need" information resides with the customer and the "solution" information lies with the manufacturer. The manufacturer usually collects the customer need information through market research which is costly, time consuming, complex, and changing. Besides, customers don't understand their needs unless they test a prototype and express what does and what doesn't work for them. Thus the way usually followed is that the manufacturer develops the prototype under the raw data gained from the customer and the customers test the prototype and requests corrections. But this learning-by-experimentation cycle is usually repeated until a satisfactory solution is reached which is costly and time consuming. (Thomke, 2003)

Thomke (2003) states many companies abandoned these market researches but instead headed towards equipping the customers with tools to design and develop their own new products, ranging from minor modifications to major new innovations. These user-friendly tools, usually in form of 'toolkit' packages, allow the customers to run what-if experiments themselves deploying new technologies like computer simulations and rapid prototyping. (Thomke, 2003)

The most given example is the operating system Windows 95 that is developed by Microsoft (Shrage, 2000; Thomke, 2003; Hippel, 2005). Shrage (2000) states that the launch of Windows 95 consolidated Microsoft's dominant market position in operating systems and greatly enhanced the company's stock market valuation as one of the

world's richest technology leaders and that the Microsoft executives confirmed that Windows 95 had cost the company "hundreds of millions of dollars" to develop. But the special case was that the world's wealthiest software company had effectively negotiated a billion-dollar subsidy from many of its best customers and developers. Microsoft built “beta versions” of Windows 95, which is a prototype of the final product still amenable to modifications to correct errors and enhance features and sent to 400.000 copies of the beta version to beta sites worldwide, who are the lead customers, organizations and individuals willing to help track bugs and flaws and suggest product enhancements in exchange for receiving the software in advance, influencing its development, and getting help with any problems that might arise. So, Microsoft drew on a technical population at the size of a major city to help to improve the quality and capabilities of its new operating system. (Shrage, 2000)

Thomke (2003) also gives the examples of General Electric and Bush Boake Alien, the first providing customers web-based toolkits for designing their plastics and the latter providing a toolkit that enables the customers to develop their own flavors.

Thomke (2003) describes four important capabilities that must be provided when building a toolkit for experimentation; (1) it must enable users to iterate through the series of iteration steps which are design, build, run and analyze; (2) it must be user-friendly, (3) it must contain libraries of useful components and modules that have been tested, and (4) it must contain information about the capabilities and limitations of the production process that will be used to manufacture the product to ensure that a customer's design will in fact be producible.

What Thomke (2003) calls “experimentation of users”, Hippel (2005) names as “democratization of innovation” meaning that “*users of products and services – both firms and individual consumers – are increasingly able to innovate for themselves*”. Hippel (2005) states that many firms and industries are making fundamental changes in order to adapt, but despite the difficulties, he comments that the shift of innovation to users, democratized and user-centric system of innovation appears well worth striving for.

As one of the incentives that user innovation drives, Hippel (2005) discusses that users rather innovate than buy, because of the enjoyment or learning that the process of innovation brings them. To justify his statement, he indicates the studies on the motivations of volunteer contributors of code to widely used software products and the results as examples, as these individuals being often strongly motivated to innovate by the joy and learning they find in this work (Hertel et al.

2003; Lakhani and Wolf 2005; cited in Hippel, 2005). He adds that it was a surprise to innovation researches to find out that users often “freely reveal” what they have developed meaning voluntarily giving the information and it becoming a public good. He argues that “open source” software development was important to bring the phenomenon to general awareness, adding that there much earlier examples like the eighteenth-century iron industry that Alien (1983) documented (Alien, 1983; cited in Hippel, 2005). As the reason for free revealing he argues the following;

> Innovators often freely reveal because it is often the best or the only practical option available to them. Hiding an innovation as a trade secret is unlikely to be successful for long: too many generally know similar things, and some holders of the "secret" information stand to lose little or nothing by freely revealing what they know. Studies find that innovators in many fields view patents as having only limited value. Copyright protection and copyright licensing are applicable only to "writings," such as books, graphic images, and computer software. (von Hippel, 2005)

Hippel (2005) mentions a detailed study that he accomplished with Lilien, Morrison, Searls, and Sonnack (1992) in the company 3M, when 3M was carrying out both lead user projects and traditional market research based idea generation projects in the same divisions at the same time for a statistical comparison of outcomes. He reports that “*at 3M, lead user idea-generation projects clearly did generate new product concepts with much greater commercial potential than did traditional, non-LU methods*”. And comparing the projects that were created, he comments that all five of the funded 3M lead user projects created the basis for major new product lines for 3M whereas 41 of 42 funded product concepts generated by non-LU methods were improvements or extensions of existing product lines.

Another good examples hat Thomke (2003) describes is the semiconductor industry in 1970s. As it was costly to custom design semiconductors, the chip companies usually served to projects of high volume customers and smaller companies had to use standard chips which was a problem when developing products that were smaller, better in performance, lower in cost, or simply more innovative, so there was a niche for custom chips. At that time, new firms like LSI Logic developed toolkits for both small and large customers to design the specialized chips suitable for their need. Between the 1980s and 2000, serving to a large number of small companies and also a small number of large companies, the market for custom design chips soared “*from virtually nothing to $15 billion*”. (Thomke, 2003)

Another example is GE Plastic who sells resins with specific properties to plastic manufacturers. In 1998, GE Plastic decided to offer company data sheets, engineering expertise, and simulation software that were developed throughout the

thirty years company history, online accessible for their registered customers so that they could use that knowledge and technology to conduct their own trial-and-error experiments to investigate. This enterprise cost approximately $5 million to the company. The reason behind this decision was the fact that GE Plastics was to identify and track potential customers through the web site that use the service and also reach smaller companies that were ignored before so that its market has grown worth the enterprise. (Thomke, 2003)

## 4. CONTENT ANALYSIS FOR THE TERM 'EXPERIMENT'

### 4.1. Aims, Scope and the Research Technique of the Study

In this study, the articles in the periodicals '*Design Issues*' and '*Design Studies*' are subjected to quantitative content analysis, exploring in which contexts and meanings the term "experiment" has been used. The aims of the study can be summarized as, to complete and compare the literature review with the results of the content analysis covering all the usages and contexts of the term 'experiment' in design literature. The findings are compared regarding to time and between the two periodicals and it is checked if there is a correlation between the term '*experiment*' and '*innovation*' as suggested in the literature review.

The reason for '*Design Issues*' and '*Design Studies*' being selected for the content analysis is to cover up the design theory as general as possible by these two important journals of design literature from two different perspectives, the former having a cultural and intellectual perspective, and the latter having a cognition and methodology perspective to values and philosophy in design.

To give brief information about the periodicals, '*Design Issues*' is described in the website of Jstor, the scholar journal archive, as "*the first American academic journal to examine design history, theory, and criticism*" which "*provokes inquiry into the cultural and intellectual issues surrounding design"*. It has been published since 1984, and is currently being published by MIT Press four times a year. The editors in chief are Richard Buchanan and Victor Margolin in most of the issues with contributing editors. The second periodical that is subjected to content analysis, '*Design Studies*' (The International Journal for Design Research in Engineering, Architecture, Products) is described in the website of Science Direct, Elsevier as "*the only journal to approach the understanding of design from comparisons across all domains of application, including engineering and product design, architectural design and planning, computer artefacts and systems design*", which provides a unique forum for the development and discussion of fundamental aspects of design activity and experience, from cognition and methodology to values and philosophy. It has been published since 1979, and is currently being published by Elsevier six

times a year, the editor-in-chief is Nigel Cross. The issues of '*Design Issues*' and '*Design Studies*' are available online through the membership of the Library of Istanbul Technical University.

The periodical '*Design Issues*' is subjected to a content analysis between the time it was started to be published, from Spring 1984, until Summer 2007, the time this study was being completed. The issues were grouped as the issues in 1980s, 1990s and 2000s and are analyzed separately, which are shown graphically in Figure 4.1, Figure 4.2 and Figure 4.3. The periodical '*Design Studies*' is subjected to a content analysis between January 2000 and September 2007. The reason for '*Design Issues*' is being analyzed just covering the 2000s, is because of the technical limitation that the periodical is not available online before 1997 on Science Direct through ITU membership. This analysis is compared to the analysis of 'Design Issues' in 2000s in Figure 4.4, Figure 4.5, and Figure 4.6.

### 4.2. History and Definition of the Research Technique, Content Analysis

In his book '*Content Analysis'*, Krippendorf (2004) describes content analysis, the research technique of this study, as "*a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use*". According to him, as a technique, content analysis involves specialized procedures, is learnable and divorceable from the personal authority of the researcher; and as a research technique, it provides new insights, increases a researcher's understanding of particular phenomena, or informs practical actions. Content analysis is a scientific tool, he adds, it fulfills the requirements of methodological requirements of validity and replicability, which is the most important form of reliability.

According to Krippendorf (2004), contemporary content analysis has three distinguishing characteristics which are as follows;

- contemporary content analysis is an empirically grounded method, exploratory in process, and predictive or inferential in intent.
- contemporary content analysis transcends traditional notions of symbols, contents, and intents.
- contemporary content analysis has been forced to develop a methodology of its own, one that enables researchers to plan, execute, communicate, reproduce, and critically evaluate their analyses whatever the particular results.

Looking at the history of the content analysis, Krippendorff (2004) states that the intellectual roots of content analysis can be traced far back in human history, to the

beginning of the conscious use of symbols and voice, especially writing which has been shaped by the ancient disciplines of philosophy, rhetoric, and cryptography and also has spawned religious inquisitions and political censorship on the part of ruling establishments. More specifically, he states that the first examples of systematic analysis of text are inquisitorial pursuits by the Church in the 17th century. As religions have always been captivated by the written word, he finds it not surprising that the first known dissertations about newspapers were defended in 1690, 1695, and 1699 by individuals pursuing academic degrees in theology.

Krippendorff (2004) states that the term content analysis was first included in Webster's Dictionary of the English Language, in its 1961 edition, defined as "*analysis of the manifest and latent content of a body of communicated material (as a book or film) through classification, tabulation, and evaluation of its key symbols and themes in order to ascertain its meaning and probable effect.*"

Considering the history of communication, Krippendorff (2004) suggests that researchers who are concerned with texts can no longer focus only on symbols or representations, nor can they limit themselves to questions about "*who says what, through which channels, to whom, and with which effects*" (Lasswell, 1960; cited in Krippendorff, 2004) but the popular and simplistic notion of "content" has outlived its explanatory capabilities as well; content, the "*what*" of a communication, an entity that authors think they enter into messages and ship to remote receivers, who remove it for what it is and henceforth share it among others.

According to Krippendorff (2004), the visible increase in the mass production of newsprint, in the 20$^{th}$ century, the mass markets and interest in public opinion it created, the emerged journalism schools, leading to demands for ethical standards and for empirical inquiries into the phenomenon of the newspaper; these demands, plus a somewhat simplistic notion of scientific objectivity, were met by what was then called quantitative newspaper analysis. When other mass media became prominent, he states, researchers extended the approach first used in newspaper analysis—measuring volumes of coverage in various subject matter categories.

According to Krippendorff (2004), the most important and large-scale challenge that content analysis faced came during World War II, when it was employed in efforts to extract information from propaganda, the reasons in the origin being that propaganda was used extensively during World War I (Lasswell, 1927: cited in Krippendorff, 2004), and that the years between the two world wars witnessed the effective use of propaganda by antidemocratic demagogues in Europe. After World War II, he states that

perhaps as the result of the first integrated picture of content analysis provided by Berelson (Berelson, 1952; cited in Krippendorff, 2004), the use of content analysis spread to numerous disciplines such as psychology, anthropology, and history. He also mentions the major conference on content analysis sponsored by the Annenberg School of Communications in 1967, discussions there focusing on many areas such as the difficulties of recording nonverbal (visual, vocal, and musical) communications, the need for standardized categories, the problems involved in drawing inferences, the roles of theories and analytical constructs, what developments content analysts could expect in the near future, but the subject of the use of computers in content analysis permeating much of the conference.

### 4.3. Procedure of the Study

Krippendorff (2004) lists the components to evaluate content analysis step by step, adding, what the components do must also serve as instructions for replicating them elsewhere, each component has a descriptive and an operational state. The steps he lists are as follows;

- Unitizing: relying on unitizing schemes
- Sampling: relying on sampling plans
- Recording/coding: relying on coding instructions
- Reducing data to manageable representations: relying on established statistical techniques or other methods for summarizing or simplifying data
- Abductively inferring contextual phenomena: relying on analytical constructs or models of the chosen context as warrants
- Narrating the answer to the research question: relying on narrative traditions or discursive conventions established within the discipline of the content analyst

Following these steps for describing the procedure of the study, to start with, the units are the articles of the periodicals '*Design Issue*' and '*Design Studies*' in the mentioned periods. The articles subjected to the analysis, searched full text for the term 'experiment'. Other terms which could be related to the subject were not searched to see the sole results for the term 'experiment' and its derivatives, 'experimenting', 'experimentation' and 'experimental'. Another point is that all the articles and editorials are included in the research but the book and exhibition reviews, calendars, announcements and indexes are not included although some of them contains the term '*experiment*', the aim being to unitize the research.

Each sentence with the term '*experiment*' was determined as a sample. These sentences are listed in the Appendix A, Appendix B, Appendix C, and Appendix D, respectively as the '*Content Analysis of Design Issues in 1980s*', '*Content Analysis of Design Issues in 1990s*', '*Content Analysis of Design Issues in 2000s*' and '*Content Analysis of Design Studies in 2000s*'. The Appendices were prepared as tables of each issue of the journals listing the sentences including the term 'experiment' with the data of the article the term is in; the writer, title, page numbers and the issue of the periodical. The sentences are also coded for further information, such as, sentences that are in the notes are marked with a '*n*'; if the term 'experiment' is in two or more following sentences, the following sentence is marked with a '*f*'; if the term is used in a table, it is marked with a *'t*', if the term is in a header, it is marked with a '*h*' and if the term is used in the abstract, it is marked with an '*a*'. The term 'innovation' is also marked in the sentences to check if the design theory suggests a direct relationship with experimenting and innovation.

After sampling the research data, the codes are specified. For one of the research questions, what the usages of experiment are, a list is prepared in the light of literature review, which is as follows;

1. experiment in other fields than industrial design (natural and social sciences, arts, and technology, etc.)
2. experiment in design as defined by Schön (1983), combination of exploratory, hypothesis-testing, move-testing experiments
3. experiments for design research
4. experiment, called together with the term '*innovation*'
5. avant-garde design movement

The contexts are listed as well as in the light of design literature, and it is aimed to be as narrow as to form a classification but as general not to allow interpretation. The list was evaluated after the samples were collected to cover all the contexts of the s. The first six of the contexts are about industrial design, which is also the context of this study, the next six can be considered together with the usage '*fields other than industrial design'*, which is numbered with '*1*' in the list of usages. The list is as follows;

1. design history and cultural studies in design
2. design process (design methodology, design cognition, sketching and modeling, etc. )
3. design education

4. design management
5. user research
6. technological research
7. architecture and urban planning
8. graphic design and visual communication design
9. advertising and new media
10. art
11. mathematics, natural sciences and medicine
12. social sciences
13. engineering

Each sentence with the term '*experiment*' is numbered according to these two classifications of '*Usages*' and '*Contexts*' in the Tables in Appendices. If in a sentence, the term 'experiment' is used more than once, the sentence is marked this many times with each usage and context of the term.

The numbers of the term '*experiment*' is counted for each usage and context forming the statistics which are shown graphically in Figure 4.1, Figure 4.2, Figure 4.3, Figure 4.4, Figure 4.5, Figure 4.5, and Figure 4.6, respectively for "*Content Analysis of 'Design Issues' with the Usages of 'Experiment'*", "*Content Analysis of 'Design Issues' with the Contexts of 'Experiment' – I*", "*Content Analysis of 'Design Issues' with the Contexts of 'Experiment' – II*", "*Content Analysis and Comparison of 'Design Studies' in 2000s and 'Design Issues' in 2000s for the Usages of 'Experiment'*", "*Content Analysis and Comparison of 'Design Studies in 2000s' and 'Design Issues' in 2000s for the Contexts of 'Experiment' – I*", "*Content Analysis and Comparison of 'Design Studies' in 2000s and 'Design Issues' in 2000s for the Contexts of 'Experiment' – II*". The Figures can be seen in bigger scale in the Appendix E.

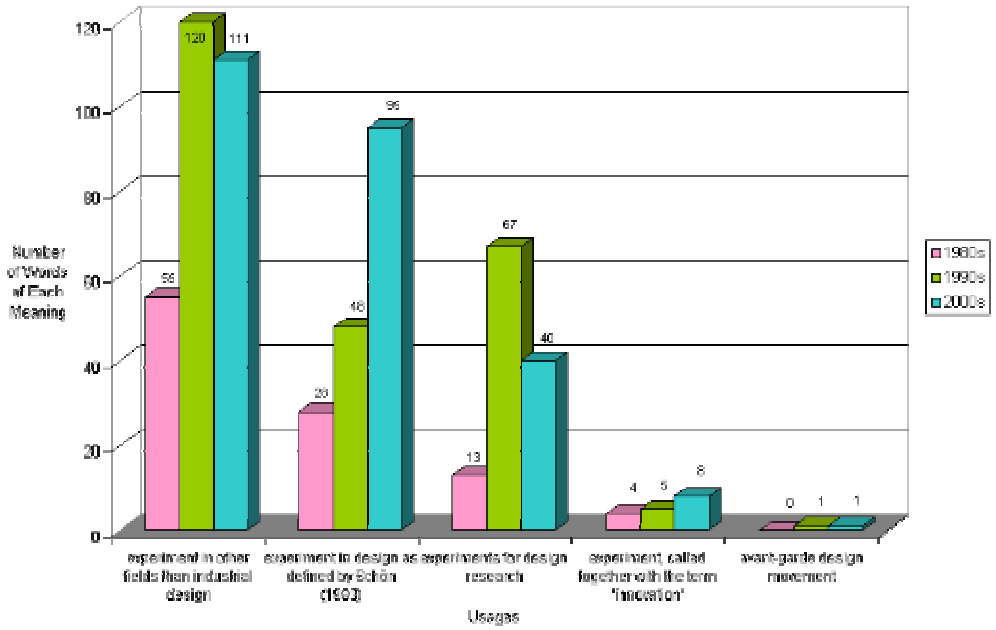


**Figure 4.1:** Content Analysis of 'Design Issues' with the Usages of 'Experiment'

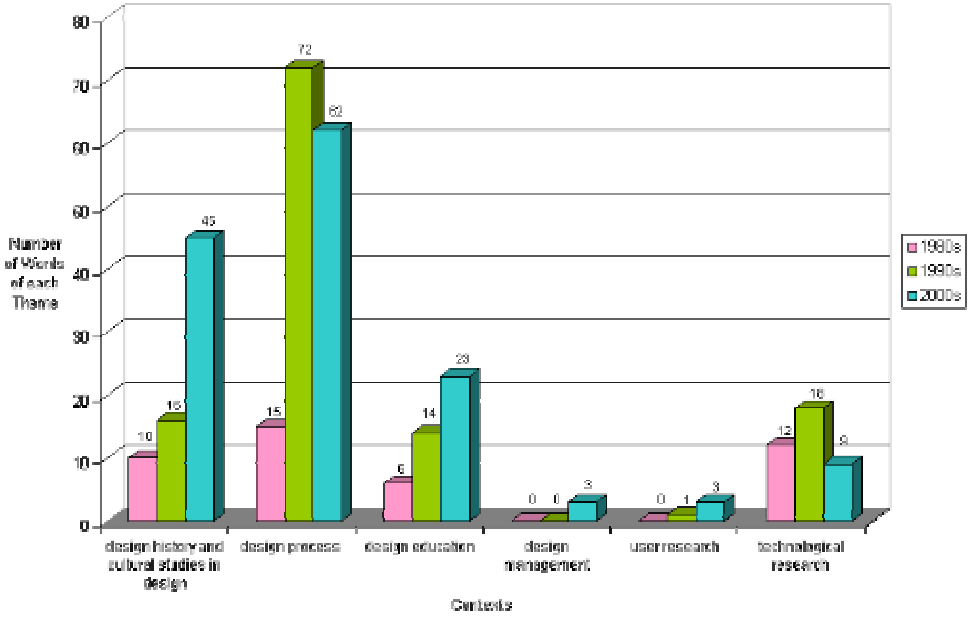


**Figure 4.2:** Content Analysis of 'Design Issues' with the Contexts of 'Experiment' - I

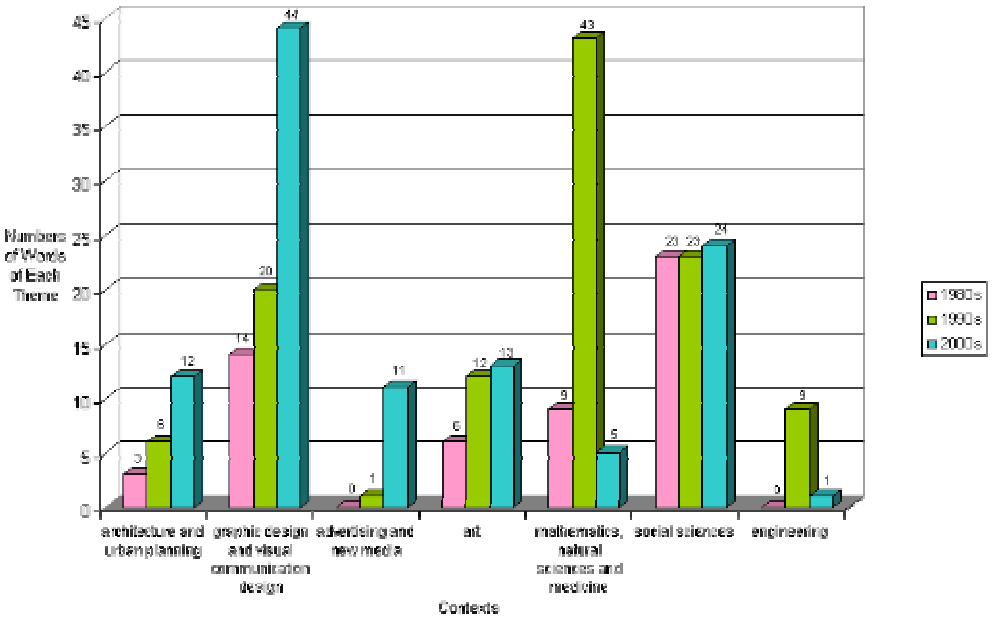


**Figure 4.3:** Content Analysis of ‘Design Studies’ with the Contexts of ‘Experiment’ - II

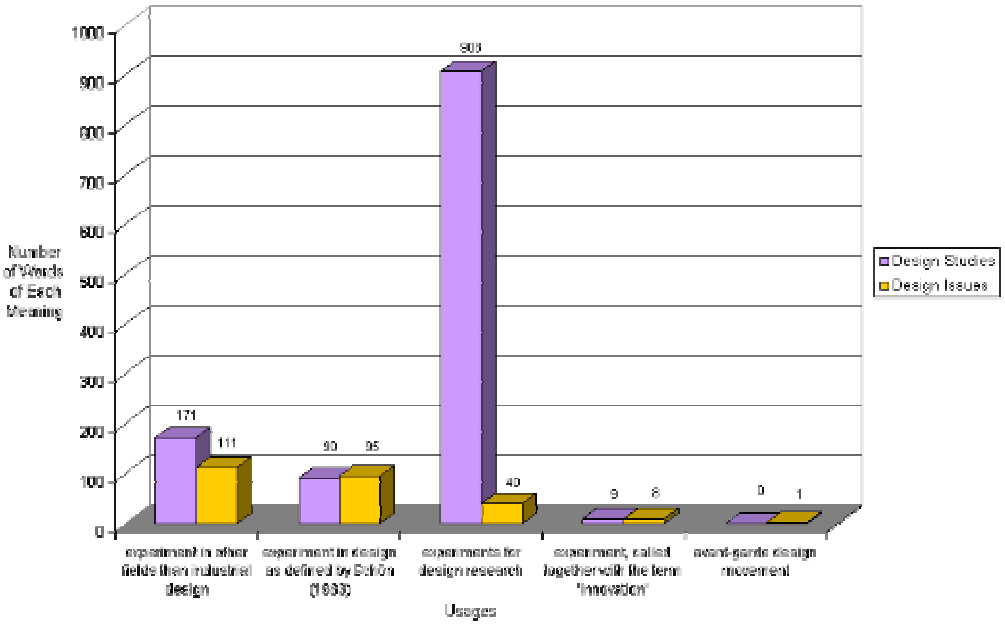


**Figure 4.4:** Content Analysis and Comparison of 'Design Studies' in 2000s and 'Design Issues' in 2000s for the Usages of ‘Experiment’

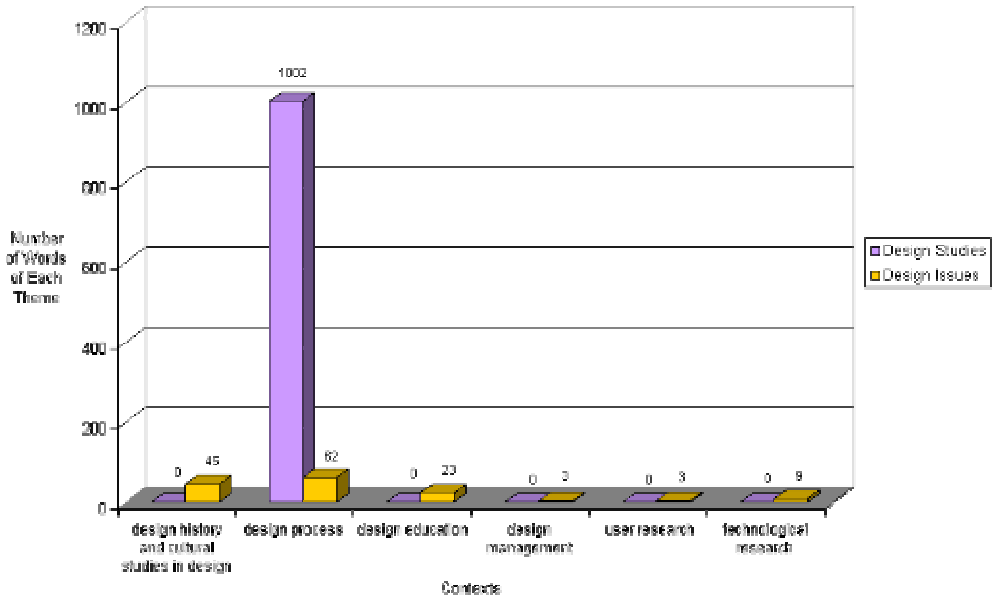


**Figure 4.5:** Content Analysis and Comparison of ‘Design Studies' in 2000s and 'Design Issues' in 2000s for the Contexts of ‘Experiment’ - I

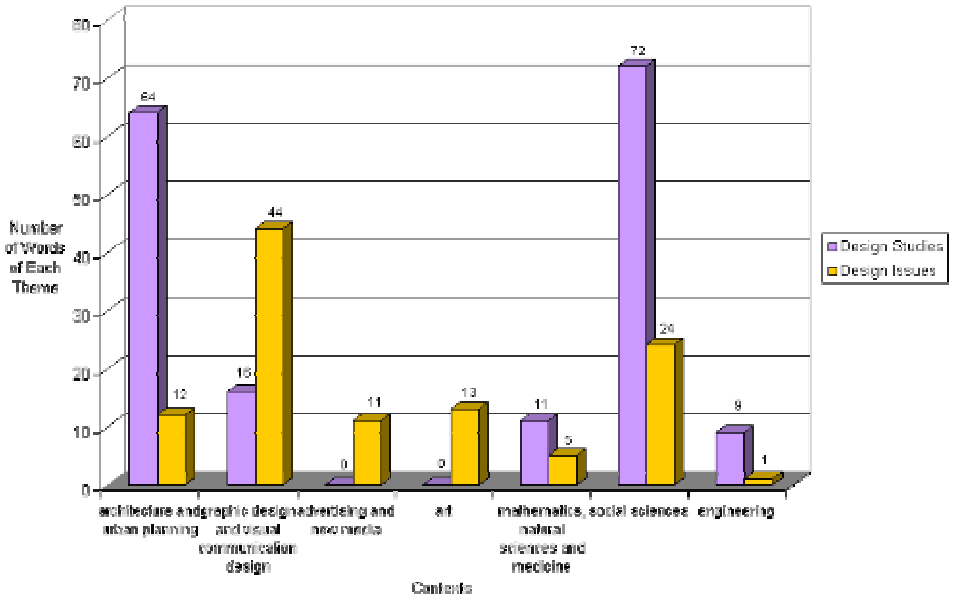


**Figure 4.6:** Content Analysis and Comparison of ‘Design Studies' in 2000s and 'Design Issues' in 2000s for the Contexts of ‘Experiment’ - II

### 4.4. Results of the Study

Figure 4.1, Figure 4.2, and Figure 4.3 are the figures of quantitative content analyses of 'Design Issues' with the comparison of values in 1980s, 1990s and 2000s.

Figure 4.1 shows the quantitative content analysis of '*Design Issues*' regarding to the numbers of term 'experiment' for each usage listed before which provides a comparison of the periods, 1980s, 1990s and 2000s. According to the Figure, in all the time periods, the term '*experiment*' is used mostly mentioning other disciplines rather than industrial design. In the industrial design context, in 1990s the term is used mostly when mentioning experiments for design research, but in 1980s and 2000s the term is mostly used referring to the definition of experiment by Schön (1983) where the values are almost doubling through each time period. This can be interpreted that the importance given to the subject of experimenting is increasing.

Figure 4.2 and Figure 4.3 show the quantitative content analyses of '*Design Issues*' in two parts regarding to the numbers of term '*experiment*' used in the contexts listed before.

Figure 4.2 shows that during all the periods, the term '*experiment*' is used mostly in design process context. Another point is that in 2000s, the usage of the term in *'design history and cultural studies*' context shows a big increase while the usages in '*design process*' and '*technological research*' got lower.

Figure 4.3 shows quantitative content analysis of '*Design Issues*' regarding to the numbers of term 'experiment' used other than industrial design but related contexts. Mentioning the points that draw attention, the contexts with the greatest number in total of all the periods are '*graphic design and visual communication design'*, '*social sciences*', and '*mathematics, natural sciences and medicine'*. This inference is interesting when read together with the values of first seven contexts of design, as design is a new discipline compared to the sciences where experiment is very fundamental and this might suggest that the term '*experiment*' is not just a term the design literature borrows or references, but also is assimilated.

Another interesting point, that '*social sciences*' has interestingly very constant values, 'mathematics, natural sciences and medicine' gets very high in 1990s but than gets much lower in 2000s, and '*graphic design and visual communication design*' increases more than two times in 2000s compared to 1980s and 1990s. '*Engineering*' was mentioned with the term '*experiment*' in 1990s whereas almost none in 1980s and 2000s. Also, '*advertising and new media*' is almost never

mentioned in 1980s and 1990s, but starts to be mentioned almost as much as '*architecture and urban planning*' and '*art*' in 2000s. These could be interpreted as the changing interest of design literature through time if the study were about the contexts of the s in general, but this arouses the question for further studies, comparing this study with a study about changing interest in design literature to see how much they overlap.

In total, the number of usage of the word '*experiment*' in '*Design Studies*' is more than four times bigger than the value in '*Design Issues*'. Checking the ratio of pages of two periodicals, '*Design Studies*' is more than one and a half times thicker in size than '*Design Issues*' between 2000 and today, which doesn't alone justify the statement. The reason might be which was stated before, the perspective of '*Design Studies*' and the importance it gives to the experiments conducted for research.

Figure 4.4 shows the quantitative content analysis of '*Design Studies*' in 2000s regarding to the numbers of term '*experiment*' for each usage listed before in comparison with '*Design Issues*' in 2000s. The first obvious point that draws attention is that the value of '*experiments for design research*' is more than five times bigger than the closest value which again can be read as the perspective of '*Design Studies'*, and the importance it gives to the experimental research.

Figure 4.5 and Figure 4.6 show the quantitative content analysis of '*Design Studies*' in 2000s regarding to the numbers of term '*experiment*' in each context listed before in two parts, both of them being in comparison with *'Design Issues*' in 2000s. Figure 4.5 shows that '*Design Studies*' in 2000s uses the term '*experiment*' only in the context of '*design process*'. This again can be read as the perspective and the scope of '*Design Studies*'.

In Figure 4.6, it can be observed that the word 'experiment' is used mostly in '*social sciences*' and then in '*architecture and urban planning*' contexts in '*Design Studies*' in 2000s, whereas '*graphic design and communication design*' context is not held much with the term as it did in Design Issues; and in the contexts of '*advertising and new media*' and '*art*' not at all.

### 4.5. Discussion and Further Studies

One of he most important results of the study is that the term '*experiment'* is used in such a wide variety of contexts, covering almost all the contexts of industrial design and related fields, which affirm the importance of the subject '*experiment*' in design literature. The Figures about the contexts aroused a further research question, or a

preceding one, a quantitative study on the percentages of the contexts of each in the periodicals which then could be compared with this study. That arouses another question; which other term would intersect the design literature as the term experiment did in this study? Design, method, research..? This again emphasizes the importance of subjecting '*experimental design*' in detail.

Another point is that, considering Figure 4.1, the definition of experiment in design by Schön (1983) which was emphasized in the literature review and was suggested as the most comprehensive definition specific for design literature, covers an important number of the usages of the term "experiment". And the numbers are increasing constantly by doubling the previous, which can be read that the importance given to the subject is also increasing. This is also confirmed by the total numbers of the term '*experiment*' being repeated in 1980s, 1990s and 2000s.

Figure 4.3 shows that natural sciences, social sciences and art have been the interest with the term '*experiment*'. Considering the literature review of this study, where they were issued insisting their fundamental importance, the content analysis, Figure 4.3 shows that the term 'experiment' is issued in architecture, urban planning, graphic design and communication design as well very frequently. This can be interpreted as these design fields assimilated experiment as well which can also be observed in the number of usage of Schön (1983)'s definition. A further question for and qualitative analysis, could be what these fields can learn from each other about experimenting.

# 5. CONCLUSION AND DISCUSSION

## 5.1. Conclusion and Discussion

This study aimed to explore the term ‘experiment’ in design literature and to emphasize and justify the importance of ‘experiment’ in design. Necessary conceptual background is constituted by exploring art and science, throughout the study important correlations have been formed. It was striking to see that the concept of experimentalism did not follow a straightforward path but it has been subjected to discussion and development throughout the history of art and science until recently, and also how and in which circumstances the development of experimentalism from being a mental act to an instrumental physical act in science has took place. The history of social sciences, especially the history of psychology is an important case in the way it is developed experimentally, but also in its own terms and methodology.

The parallelism of the philosophy of Dewey with the education approach of Moholy-Nagy was also interesting as an example of integrated knowledge that was tried to be built in this study as well. Schön’s definition and description was still the most comprehensive approach to experiment in design which creates a grounded base for further discussion. When discussing experiment in design, the subjects such as handling design process as an experiment, the early failure, suggested plans for experimenting etc. are discussed mostly through innovation literature, but it also should be discussed in design research as detailed.

About the design research, it was important what Bürdek (2005) states about the economic reasons for developing the design methodology after the World War II. Now, the economics of experimenting demands to be discussed in the design research which Thomke (2003) puts forward.

Moreover, integrating experiment to the culture of prototyping is inevitable to succeed and open up for users to get involved in the design process as well. It’s promising for both user and manufacturer satisfaction. The fast changing nature of

design demands methodologies for easy adaptation of technology and thus the culture of experimenting should be developed and discussed in design field.

Another point that should be remembered is one of the results that is drawn from the content analysis, that the subject of experiment is included and covers a very wide variety of contexts in design theory which cannot be achieved by another subject very easily, and thus the path of a discussion that is carried over '*experiment*' will help provide an integrated approach in design theory. Also that experiment is subjected in the fields of science and art; it will provide a fertile base for interdisciplinary studies.

### 5.2. Further Research

This study arouses more research questions about experimenting in design. One of them is about the relationship between experimenting and learning. Dewey's experimental approach and Bauhaus' experimental education are subjected in this study. Experiment is a very promising subject about 'learning' which can also be held by experimental researches in design.

Another subject that can be suggested for further research is a study on experiment in the neighbor fields of industrial design which was the focus of the study. Architecture, urban planning, graphic design and especially visual communication design where experimental research gains importance can be subjected in interdisciplinary researches about experiment in design.

**REFERENCES**


**Barnes, B., Bloor, D. and Henry, J,** 1996. *Scientific Knowledge: A Sociological Analysis*. University of Chicago Press, Chicago.

**Barnes, E. G.,** 1950. *A History of Experimental Psychology*. Appleton-Century-Crofts, New York.

**Buchanan, R.,** 1995. "Rhetoric, Humanism, and Design" in *Discovery of Design,* ed. Buchanan, R. and Margolin, V. University of Chicago Press, Chicago.

**Buchanan, R.,** 1992. **"**Wicked Problems in Design Thinking". *Design Issues*, Vol. 8, No. 2. (Spring, 1992), pp. 5-21.

**Buchanan, R. and Margolin, V.,** 1995. "Introduction" in *Discovery of Design,* ed. Buchanan, R. and Margolin, V. University of Chicago Press, Chicago.

**Bürdek, B. E.,** 2005. *Design: History, Theory, and Practice of Product Design*. Birkhauser-Publishers for Architecture, Basel.

**Coles, A.,** 2005. *DesignArt: On Arts Romance with Design*. Tate Publishing, London.

**Cross, N.,** 1995. "Discovering Design Ability" in *Discovery of Design,* ed. Buchanan, R. and Margolin, V. University of Chicago Press, Chicago.

**Cross, N.,** 1999. "Design Research: A Disciplined Conversation". *Design Issues*, Vol. 15, No. 2, Design Research. (Summer 1999), pp. 5-10.

**Cross, N.,** 2000. *Engineering Design Methods: Strategies for Product Design*. Wiley, Chichester.

**Dewey, J.,** 1960 (c1929). *The Quest for Certainty: A Study of the Relation of Knowledge and Action.* Putnam, New York.

**Dewey, J.,** 1980 (c1934). *Art as experience*. Perigee Books, New York.

**Elsevier,** 2007. http://www.elsevier.com/wps/find/journaldescription.cws_home/30409/description#description

**Findeli, A.,** 1999. **"**Moholy-Nagy's Design Pedagogy in Chicago (1937-46)". *Design Issues*, Vol. 7, No. 1. (Autumn, 1990), pp. 4-19.

**Finke R. A., Ward, T. B. and Smith, S. M.,** 1992. *Creative Cognition: Theory, Research, and Applications.* MIT Press, Massachusetts.

**Focillon, H.,** 1934. "The Life Forms in Art" in *Art History and Its Methods,* selection and commentary by Fernie, E. Phaidon Press, London.

**Friedman, K.,** 2003. “Theory Construction in Design Research: Criteria: Approaches, and Methods”. *Design Studies*, Vol. 24, No. 4. (November, 2003), pp. 507-522.

**Gillies, D.,** 1993. *Philosophy of Science in the Twentieth Century: Four Central Themes*. Blackwell, Oxford, UK; Massachusetts, USA.

**Glanville, R.,** 1999. **“**Researching Design and Designing Research’”. *Design Issues*, Vol. 15, No. 2, Design Research. (Summer, 1999), pp. 80-91.

**Gombrich, E. H.,** 1995. *The Story of Art*. Phaidon Press, London.

**Hippel, Eric von,** 2005. *Democratizing Innovation*. MIT Press, Massachusetts.

**Jstor**, 2007. http://0-www.jstor.org.divit.library.itu.edu.tr/journals/07479360.html

**Kelley, T.** 2001. *The Art of Innovation : Lessons in Creativity from IDEO, America's Leading Design Firm*. Currency/Doubleday, New York.

**Krippendorff, K.,** 2004. *Content Analysis: An Introduction to Its Methodology*. Thousand Oaks, California.

**Kuhn, T. S.,** 1977. *The Essential Tension: Selected Studies in Scientific Tradition and Change*. University of Chicago Press, Chicago.

**McGuigan, F. J.,** 1990. *Experimental Psychology: Methods of Research*. Prentice Hall, Englewood Cliffs, N.J.

**Pickstone, J. V.,** 2001. *Ways of Knowing: A New History of Science, Technology, and Medicine.* University of Chicago Press, Chicago.

**Poggioli, R.,** 1968. *Theory of the Avant-Garde*. Belknap Press of Harvard University Press, Cambridge, Massachusetts.

**Preusser, R.,** 1973. “Relating Art to Science and Technology: An Educational Experiment at the Massachusetts Institute of Technology (M.I.T.)”. *Leonardo*, Vol. 6, No. 3. (Summer, 1973), pp. 199-206.

**Roozenberg, N. F. M., Eekels, J.,** 1995. *Product Design: Fundementals and Methods.* John Wiley & Sons, West Sussex.

**Schön, D.,** 1983. *The Reflective Practitioner: How Professionals Think in Action*. Basic Books, New York.

**Shapin, S.,** 1985. *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life.* Princeton University Press, Princeton, N.J.

**Shapin, S.,** 1998. *The Scientific Revolution.* University of Chicago Press, Chicago, IL.

**Schrange, M.,** 1999. *Serious Play.* Harvard Business School Press, Boston, Massachusetts.

**Simon, R.,** 1992. “The Science of Design: Creating the Artificial”. *Design Issues*, Vol. 4, No. 1/2, Designing the Immmaterial Society. (1988), pp. 67-82.

**Strickler, Z.,** 1999. **“**Elicitation Methods in Experimental Design Research**”.** *Design Issues*, Vol. 15, No. 2, Design Research. (Summer, 1999), pp. 27-39.

**Thomke, S.,** 2003. *Experimentation Matters*. Harvard Business School Press, Boston, Massachusetts.

## APPENDIX A: CONTENT ANALYSIS OF DESIGN ISSUES IN 1980s

**Table A.1:** Content Analysis of Design Issues, Vol. 1, No. 1. (Spring, 1984)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 3 | Victor Margolin | Editorial | | There will also be space in the journal for visual material -**experimental** typography, drawings, sketches for objects, and so forth. | **1** | **8** |
| 27-40 | Frances C. Butler | Eating the Image: The Graphic Designer and the Starving Audience | | In this use of the repeat ornamental pattern, graphic designers parallel other composers of sensory stimulation - painters, authors, filmmakers, and musicians - all of whom have **experiment**ed with the return to unfigured or minimally ploted structure in composition. | **1** | **8** |
| | | | | Thus, the process of perception and cognitive pattern making is one of constant interaction of **experimental** stimuli filtered through shifting mental schemata. | **1** | **11** |
| 41-52 | Gert Selle; Peter Nelles | There Is No Kitsch, There Is Only Design! | | Theoretical constructs based on exclusivity, such as the critique of commodity esthetics or more or less relativized postulates of a Socio Design, must in the future be subjected to the test of **experimental** science. | **1** | **11** |
| 64-70 | Antonio Barrese; Angelo Cortesi; Gillo Dorfles; Jonathan de Pas | Scientific Program on the Themes of the 1983 ICSID Congress | h | Italian Design: **Experimentation** with ways of being a designer | **2** | **1** |
| | | | h | Italian Design: **Experimentation** with news ways of "making" design | **2** | **1** |

**Table A.2:** Content Analysis of Design Issues, Vol. 1, No. 2. (Autumn, 1984)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 3-20 | Clive Dilnot | The State of Design History, Part II: Problems and Possibilities | | At Cambridge in the 1930s, I.A. Richards showed, in his famous **experiment**s in practical criticism, that the most highly trained students of English literature could be taught what the canon of literature consisted of, but they could not produce for themselves its implicit variations.[12] | **1** | **10** |
| 26-41 | Paul Shaw | Tradition and **Innovation**: The Design Work of William Addison Dwiggins | | These commissions provided Dwiggins with an excellent opportunity to sharpen his skills and **experiment** with new design ideas. | **1** | **8** |
| | | | | His designs for the latter allowed him to **experiment** with different paper stock and | **1** | **8** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | various color combinations of ink, and the development of Dwiggins's famed stencil method of illustration can be traced in these designs and decoration, as well as his increasing fondness for unusual color harmonies. | | |
| | | | n | 24) For the relationship between Dwiggins's marionette designs and his thinking on the design of newspaper type see Gerard Unger, "**Experimental** No. 223, A Newspaper Face, Designed by W.A. Dwiggins," Quarendo 11 (1981): 4. | **1** | **8** |
| | | | | The remaining faces were all **experimental** efforts in which he attempted to solve various self-imposed problems. | **1** | **8** |
| | | | n | 35) See Paul A. Bennett, "WAD and Linotype," Postscripts on Dwiggins, vol. 2, and Griffith Papers for further details of **experimental** type designs. | **1** | **8** |
| | | | | That is why so much of Dwiggins's meager output as a type designer was in the form of **experimental** faces that were never issued to the public. | **1** | **8** |
| | | | n | 36) Dwiggins, WAD to RR, and Gerard Unger, '**Experimental** No. 223," Quarendo II (1981). | **1** | **8** |
| 70-74 | V. Tatlin; S. Dymshits-Tolstaia; John Bowlt | Memorandum from the Visual Arts Section of the People's Commissariat for Enlightenment to the Soviet of People's Commissars: Project for the Organization of Competitions for Monuments to Distinguished Persons (1918) | | Although Tatlin did not remain in the Moscow Collegium long enough to see the erection of some of the most startling pieces, for example, Korolev's Cubo-Futurist statue to Mikhail Bakunin in September 1919, his program here, with its rejection of tradition and emphasis on freedom of expression, can be viewed as an important stimulus to the upsurge of interest in highly **experimental** sculpture and construction at this time in Moscow and Petrograd. | **1** | **10** |

**Table A.3:** Content Analysis of Design Issues, Vol. 2, No. 1. (Spring, 1985)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 23-32 | Anty Pansera; Anna Venturelli; Antonio C. Mastrobuono | The Triennale of Milan: Past, Present, and Future | | The Triennale spread the modern taste for furniture and industrial production and provided architecture with the opportunity for possible **experimental** statements. | **1** | **7** |
| | | | | After World War II, between 1947 and 1968, the Triennale adhered to the reality still partially expressed by the planning and construction of the **experimental** district QT8 or by attention to the theme of the house as the point where many interests converge. | **1** | **7** |
| | | | | The unsuccessful realization of this **experimental** plan and the return to exhibitions with a more eclectic intent are surely due to the modified political and economic situation of | **1** | **7** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | the nation. | | |
| 53-64 | Abraham A. Moles | The Comprehensive Guarantee: A New Consumer Value | | In reality, through ergonomics and **experimental** esthetics, designers have taken the burden as well as the hazards of demarcating the boundaries of the individual universe in the field of everyday life, thus ensuring at the very least a de facto technical analysis of these issues. | **2** | **2** |
| 65-77 | Sidney Lawrence | Declaration of Function: Documents from the Museum of Modern Art's Design Crusade, 1933-1950 | | After its first few **experimental** years, the Bauhaus achieved forthright modern forms which were the result of four important factors: | **2** | **1** |

**Table A.4:** Content Analysis of Design Issues, Vol. 2, No. 2. (Autumn, 1985)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 3-8 | Maurizio Vitta; Juliette Nelles | The Meaning of Design | | The fate of these attempts has been more or less identical with that of similar **experiment**s carried out for the same reasons in the field of art; the transformation of products into merchandise has equally taken place at an even higher level, as has happened, for example, with conceptual art, arte povera, earth art, and so forth. | **1** | **10** |
| 9-17 | Enric Satué; George Tscherny; Hubert Leckie; Ivan Chermayeff; Rafael Moneo | Super Veloz: A Typographic System for the Small Printer | n | 1) Examples are Helvetica, Gill Sans, Futura (with the various series of Venus, Akzidenz, and Grotesk), Times Roman, Clarendon, Menhart, and Weiss. A. M. Cassandre's **experiment**s with Deberny and PeignOt Bnd ultimately, in a maddened dynamic of consumerism, the appearance of a famous series of geometrical figures also occurred in this period. | **1** | **8** |
| 31-45 | Nigel Whiteley | Pop, Consumerism, and the Design Shift | | Nevertheless, the real debt to Pop is the climate of openness and **experimentation** which it brought into being. | **1** | **10** |
| 50-55 | Luc Vanmalderen | Investigations into the Image | n | 5) The **experiment** was conducted at the Ecole de La Cambre in Brussels. | **1** | **8** |
| 71-72 | Klaus Krippendorf | Comments on Richard Buchanan's "Declaration by Design" | | An operating logic, which assigns functions to each part and suggests how they work together, is to a thing like a syntax is to a sentence, except that it is more tied to physical knowledge, obtainable by **experimentation** with the material world, than to mere cultural conventions. | **2** | **2** |

**Table A.5:** Content Analysis of Design Issues, Vol. 3, No. 1. (Spring, 1986)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 3-21 | John Turpin | The Irish Design Reform Movement of the 1960s | | Initially, Kilkenny was seen as a center for **innovation** and **experiment**, rather than of direct service to manufacturers as clients. | **4** | **6** |
| 28-42 | Beate Ziegert | The Debschitz School, Munich: 1902-1914 | | The essence of the Debschitz School's program and the philosophy of its founders is reflected in its official name: Lehrund Versuch-Ateliers für Angewandte und Freie Kunst (Teaching and **Experimental** Ateliers for Applied and Fine Art). | **2** | **3** |
| | | | f | This name implied not only teaching in the practical sense, but also **experimentation**; it emphasized the completion of products in real materials and, above all, the combination of the applied and the fine arts in one school. | **2** | **3** |
| 54-63 | Svetlana Sylvestrova | Present at the Beginning | | To negotiate with clients, this team had to acquire experience, that is, conduct **experiment**s and gather analytical data. | **2** | **6** |
| | | | | To set up an **experimental** model workshop, it was necessary to find first-rate cabinet makers, and Yu. | **2** | **6** |
| | | | | He gathered highly qualified professionals to work in the new **experimental** workshop, which was subordinate to the AAB. | **2** | **6** |
| | | | | An essential job was performed for the ships by the craftsmen of the **experimental** workshops. | **2** | **6** |
| | | | | They constantly trained their craftsmen at the **experimental** workshops to look for and evaluate the advantages of new technological processes for woodworking. | **2** | **6** |
| | | | | The inventor of this new finish technology, an engineer named Ingber at the AAB **experimental** workshop, insisted on testing this new finishing process. | **2** | **6** |
| | | | | I learned a lot from the craftsmen of our **experimental** workshops, not only a knowledge of the secrets of producing superior wooden structures, but also high respect for the profession. | **2** | **6** |

**Table A.6:** Content Analysis of Design Issues, Vol. 3, No. 2. (Autumn, 1986)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 3-14 | Cheryl Buckley | Made in Patriarchy: Toward a Feminist Analysis of Women and Design | | The theory of modernism has had an enormous impact on design history by emphasizing both formal and technical **innovation** and **experimentation** as the significant features of design. | **4** | **1** |
| | | | | These evaluations are largely nonexistent because design that is not **innovative** and **experimental** has rarely been analyzed by design historians. [44] | **4** | **1** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Another area of design associated with women to have fared badly in the hands of modernist design historians is fashion design, arguably the most extreme manifestation of modernism, in that throughout the twentieth century it has been continuously **innovative** and **experimental**. | **4** | **1** |
| 15-30 | Jack H. Williamson | The Grid: History, Use, and Meaning | | In the sociopolitical realm, socialist, communist, and collectivist writings and **experiment**s placed great emphasis on groups and on relationships between groups, thereby deemphasizing the importance of the autonomous individual. | **1** | **12** |
| 47-58 | Ellen Lupton | Reading Isotype | | Isotype itself, in fact, could not have been consistent, because it was a huge sprawling **experiment**. | **1** | **8** |
| 59-72 | David Brett | Drawing and the Ideology of Industrialization | | 23) For a detailed description and discussion of Schmid's work, see C. Ashwin, "Peter Schmid and Das Naturzeichnen: An **Experiment** in the Teaching of Drawing," Art History Vol. 5, No. 2 (June 1982): 154-165. | **3** | **3** |
| | | | | These ideas were tried out by A.B. Alcott in his **experimental** schools in Boston between 1834 and 1839; but the appeal of the drawing manual was very strong in a country in which the education system was still in an early stage. | **2** | **3** |
| 73-82 | Marco Diani | The Social Design of Office Automation | | The technical overtone that seems to dominate the debates on automation of the office, at least from a quantitative point of view, has largely to do with the tendency of manufacturers to introduce product and system changes at a very fast pace in an increasingly turbulent but rapidly growing market, thereby creating a difficult climate of competition and uncertainty where little space is left for **experimentation** and accumulation of shared knowledge. | **1** | **11** |
| | | | | The consequences of these various systems of unsophisticated office automation now seem clear: after the "great fear" of the social and economic consequences, and after the excessive theoretical visions of sudden and radical changes, very little room was left for **experimental** and alternative uses of the new technologies. | **1** | **11** |

**Table A.7:** Content Analysis of Design Issues, Vol. 4, No. 1/2, Designing the Immaterial Society. (1988)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 38-51 | Tufan Orel; Susan Willis-Altamirano | The Technologies of Self-Fashioning: Beyond Universality and Variance of the Industrial Product | | These actions do not seek to forge an archetypal personality; instead they fashion or model our being, by carrying out **experiment**s and research on the self. | **2** | **2** |
| | | | | They are destined to serve not as objects of cult but, on the contrary, as agents for carrying out **experiment**s on the self. | **2** | **2** |
| | | | | Today, however, the more the user/**experiment**er acts upon herself or himself, the more she or he tries things out on himself (but also makes errors), the more she or he refers | **2** | **2** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | to a personal milieu by considering it as the only existing reality. | | |
| 59-64 | Victor Margolin | Expanding the Boundaries of Design: The Product Environment and the New User | n | 1) Researchers at the Massachusetts Institute of Technology's Media Lab and elsewhere are **experimenting** with "intelligent television," which will significantly enhance the flexibility of program formats. | **3** | **6** |
| 67-82 | Herbert A. Simon | The Science of Design: Creating the Artificial | n | 15) L. A. Hillier and L. M. Isaacson's **Experimental** Music (New York: McGraw Hill, 1959), reporting **experiment**s begun more two decades ago, still provides a good introduction to the subject of musical composition, viewed as design. | **1** | **10** |
| 97-115 | Fred Forest; David Sugarman; Joanna Weston | Communication Esthetics, Interactive Participation and Artistic Systems of Communication and Expression | n | Fig. 1) Second National French TV Channel "A-2" "Tele Choc, Tele Vie" **experiment** of Fred Forest within broadcast of Michel Lancelot. | **3** | **12** |
| | | | | Possibilities for geographical travel opening up more and more rapidly, our capital of information widening, scientific **experiment**s being performed on Time, all of these are causing us to vacillate more than a little in our strongly held convictions on this subject and on a good many others! | **1** | **11** |
| 116-130 | Daniel Simeoni | Language Processes and the Metalinguistic Puzzle | n | 41) "**Experimental** results [. . .] provide persuasive evidence that what we have called mental rotation is in a significant sense an analog simulation of an actual physical rotation." Roger N. Shepard and Lynn A. Cooper, Mental images and their Transformations (Cambridge: MIT Press, 19821, 186. | **1** | **12** |
| | | | | **Experiment**s[46] have long established that teaching the technique of knot-making verbally is impossible without the complement of visual representations. | **1** | **12** |
| 141-151 | Michel Maffesoli; Charles R. Foulkes | Jeux De Masques: Postmodern Tribalism | | What was once **experimental** in the California groups, has become common reality in everyday life. | **1** | **12** |
| 152-167 | Victor Scardigli; Caryn Bensmida | Toward Digital Man? | | But, close analysis of numerous social **experiment**s of products and commercial services identifies three very distinct phases in the process of social diffusion. | **1** | **12** |
| | | | | At the same time, in France, as one example, industrialists and public authorities are convinced that creating a vast domestic market is important to support industry (reasoning developed during the programming of the electronic telephone directory and the Telematic Plan) and to serve as a showcase for exportation (justification for the Biarritz **experiment** of fiber optics and the visiophone - otherwise known as videophone). | **1** | **13** |
| | | | | In the 1970s, the first video materials, and, later, the first local cable television networks gave rise to genuine social **experiment**s: they served as support in the research of alternative lifestyles in a few French villages or neighborhoods and especially in | **1** | **12** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Quebec, Canada. | | |
| | | | | It is, for example, the launching of the ASPASIE **experiment** at Marne-la-Vallee.[20] | **1** | **12** |
| | | | | The so-called social **experiment**s are henceforth urged by public authorities, with the purpose of serving as pre-tests of telematic and audiovisual products (the community of Velizy tested the minitel). | **1** | **12** |

**Table A.8:** Content Analysis of Design Issues, Vol. 5, No. 1. (Autumn, 1988)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 4-17 | Victor Papanek | The Future Isn't What It Used to Be | | **Experiment**s in psychology and psychiatry at Yale University have demonstrated that some smells cause blood pressure changes similar to those achieved through meditation: the scent of spiced apple reduces blood pressure drastically. | **1** | **11** |
| | | | | Dr. Richard Wurtman, a professor of brain and cognitive sciences at Massachusetts Institute of Technology, says, "We are all unwitting subjects of a long-term **experiment** on the effects of artificial lighting on our health." | **1** | **11** |
| | | | | Without giving in to reductionist reasoning, neuroanatomical **experiment**s with rats at the University of California at Berkeley have shown that when a young rat is put in an enriched environment (one with more playmates and toys) its cerebral cortex begins thickening within a few days; whereas, the cortex of a young rat in an impoverished milieu actually shrinks. | **1** | **11** |
| | | | | Approximately 30 years ago, Dr. Abraham Maslow, one of the founders of humanistic psychology, conducted some of the first **experiment**s on the effects that a beautiful environment have on human functioning. | **1** | **12** |
| | | | | The average room had, according to the **experiment**ers, "the appearance of a clean, neat, 'worked-in' office, in no way outstanding enough to elicit any comments." | **1** | **12** |
| | | | | The volunteers were supervised by three examiners (who were themselves unaware of the real objective of the **experiment**). | **1** | **12** |
| 18-29 | Jorge Frascara | Graphic Design: Fine Art or Social Science? | | • More information should be generated through two kinds of research activities: **experimental**, and critical discussion of both present and past work. | **1** | **8** |
| 71-81 | Pauline Saliga | Architecture and Design in American Museums circa 2000 | | It goes through a lot more **experimentation** quickly. | **1** | **8** |
| 87-92 | Fredrik Wildhagen | The Guzzini Memorandum: From the Ethic of Projects to the Project of Ethics | | THE CONDITIONS OF INDIVIDUAL SAFETY INDISPENSABLE FOR MANKIND CALL FOR DUE RESPECT FOR THE RIGHTS AND OBLIGATIONS ARISING FROM HUMANITY'S EXISTENCE, HOWEVER THIS BEBEGUN, CONTINUED, AND ENDED. INFORMATION ABOUT THE ROLE OF BIOLOGY, PHYSICS, CHEMISTRY, PSYCHOLOGY, AND **EXPERIMENTAL** MEDICINE MUST BE TRANSPARENT AND CLEAR. | **1** | **11** |

**Table A.9:** Content Analysis of Design Issues, Vol. 5, No. 2. (Spring, 1989)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| | Reinhart Butter; Klaus Krippendorff | Editorial | | For Smets this theory informs different kinds of inquiries and **experiment**s with design. | **3** | **2** |
| 1-8 | Robert I. Blaich | Philips Corporate Industrial Design: A Personal Account | n | Fig. 3) **Experimental** LCD TV with changeable speakers, 1987. | **3** | **6** |
| | | | n | Fig. 5) **Experimental** hair dryer, 1987. | **3** | **6** |
| 9-39 | Klaus Krippendorff | On the Essential Contexts of Artifacts or on the Proposition That "Design Is Making Sense (Of Things)" | | The list reflects what Ulrich Neisser[7] observed after many **experiment**s of this sort: people do not perceive pure forms, unrelated objects, or things as such but as meanings. | **3** | **2** |
| 51-67 | Reinhart Butter | Putting Theory into Practice: An Application of Product Semantics to Transportation Design | | There is no question that the need to produce full-size three-dimensional representations of an entire truck cab interior in the 10 weeks of one academic quarter did not always leave enough time for educational exercises and **experiment**s oriented specifically toward the refinement of the approach and the development of alternative options. | **2** | **6** |
| 68-85 | S. Balaram | Product Symbolism of Gandhi and Its Connection with Indian Mythology | | Gandhi lived his life as a well-publicized **experiment**. | **1** | **12** |
| | | | | Emphasized actions, continuous **experimenting**, said, "My life is my message." | **1** | **12** |
| | | | n | 7) Mohandas Karamchand Gandhi, An Autobiography or the Story of My **Experiment**s with Truth (Ahmedabad: Navjeevan Publishing Co., 1976). | **1** | **12** |
| 86-99 | Gerta J. F. Smets | Perceptual Meaning | | Fig. 10) **Experimental** subjects describe the Volkswagen as young or old. | **1** | **12** |
| | | | n | 9) J. B. Pittenger, R. E. Shaw, and L. S. Mark, "Perceptual Information for the Age Level of Faces as a Higher Order Invariant of Growth", Journal of **Experimental** Psychology: Human Perception and Performance 5 (1979): 478-93. | **1** | **12** |
| | | | | Various other **experiment**s have been conducted that show an observer is capable of detecting the information contained in relational patterns. | **1** | **12** |
| | | | | Many **experiment**s have been carried out to show that this is so, including the work described earlier on the Tactile Vision Substitution System; but these findings remained isolated data that only began to form a coherent whole when considered within a Gibsonian framework. | **1** | **12** |
| 100-111 | Uday A. Athavankar | Categorization... Natural Language and Design | | The Labov **experiment** also indicates that concept boundaries do not show sharp discontinuities, and they seem movable when context or subjects change. | **3** | **2** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | In the Labov **experiment**, subjects could identify a shape that everyone unmistakably called a cup. | **3** | **2** |
| | | | | For example, the shapes shown in the cup-bowl **experiment** had no natural discontinuities. | **3** | **2** |
| | | | | There is a need for designers to **experiment** with new and simple methods. | **3** | **2** |
| | | | | New methods and approaches are already in an **experimental** stage and show excellent promise. | **3** | **2** |
| 112-123 | Lisa Krohn; Michael McCoy | Beyond Beige: Interpretive Design for the Post-Industrial Age | n | 4) Through **experimental** work with projects from the graduate studios here at Cranbrook Academy of Art we are formulating an alternative design approach to the sign value and potential of the mass-produced object to reflect myth. | **2** | **3** |
| | | | | Concurrently with the design systems movement in the United States in the 1960s, product designers in Italy were beginning to **experiment** with a more conscious use of metaphor and analogy to interpret technology. | **2** | **3** |
| 124-140 | Martin Krampen | Semiotics in Architecture and Industrial/Product Design | | In one **experiment** on door handles, I found that light alloy door handles of plain design were attributed the connotative meaning of simple, sober, clean, linear, slick, unobtrusive, modern, pleasant, economical, cheap, modest, and cold.[13] | **3** | **2** |

**Table A.10:** Content Analysis of Design Issues, Vol. 6, No. 1, Design in Asia and Australia. (Autumn, 1989)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 4-14 | Richard S. Thornton | Japanese Posters: The First 100 Years | | His illustrations, always created over precise drawings, matured from realistic paintings through intricate art nouveau details and work reminiscent of Matisse in the 1930s, to more **experimental** forms that were influenced by the cubists and early Bauhaus artists. | **1** | **12** |
| | | | | Several Japanese posters produced in the early 1930s show the influence of typographic **experiment**s by European graphic designers, such as Herbert Bayer and Jan Tschichold. | **1** | **12** |
| | | | | With leadership from independent art directors and successful designers in such corporations as Shiseido and Suntory and at large department stores, commercial posters became more **experimental** and indicative of individual expression. | **1** | **12** |
| 31-48 | Rajeshwari Ghose | Design, Development, Culture, and Cultural Legacies in Asia | | Designers caught in these debates have **experiment**ed with different approaches. | **2** | **1** |
| | | | | 22) This **experiment**, called the "Golden Eye", was done with the help of Cooper Hewitt Museum, New York, and the Handicrafts and Handlooms Corporation of India LTD., New Delhi, and was coordinated by the Golden Eye Studio. | **2** | **1** |
| | | | | The **experiment** met with only very limited success and aroused a heated debate. | **2** | **1** |
| 49-78 | Shou Zhi Wang | Chinese Modern Design: A Retrospective | | In 1979, however, the government decided to turn this small village into a large **experimental** area of Chinese socialist capitalism, which was a priority of its new | **1** | **12** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | economic reform blueprint. | | |
| | | | | Every new issue and **experiment** raised in the reform was abandoned.[11] | **1** | **12** |
| 79-91 | Matthew Turner | Early Modern Design in Hong Kong | | Although Sunbeam formed an engineering and design department after World War II and **experiment**ed with modern styles, customers in Africa and Asia rejected the slighest changes in pattern, regarding them as inferior imitations. | **2** | **1** |

## APPENDIX B: CONTENT ANALYSIS OF DESIGN ISSUES IN 1990s

**Table B.1:** Content Analysis of Design Issues, Vol. 7, No. 1, Educating the Designer. (Autumn, 1990)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 4-19 | Alain Findeli | Moholy-Nagy's Design Pedagogy in Chicago (1937-46) | n | 2) (…) Sibyl Moholy-Nagy's biography of her husband provides a very lively, although very personal, general framework to this period, Moholy-Nagy: **Experiment** in Totality (Cambridge: MIT Press, 1950, second edition, 1969). | **2** | **3** |
| | | | | Goethe, however, pretended that the solution to a problem lay in the problem itself, in the phenomenon itself, not within the **experiment**er. | **1** | **10** |
| | | | f | The **experiment**er is only there to guide and to help the phenomenon disclose its true nature; in the same way, the teacher should be there only to help the students discover and then master their potentialities, because, according to Moholy-Nagy, "everybody is talented." | **2** | **3** |
| | | | | The **experimental** aspect (in Dewey's instrumentalist sense) of the course of study in Chicago is but one of the numerous examples of the analogy between both pedagogical and methodological models. | **2** | **3** |
| 20-22 | Katherine McCoy | Professional Design Education: An Opinion and a Proposal | | Graduate studies generate research and **experimentation**, often with professional and industrial support, which in turn enrich the profession. | **2** | **3** |
| | | | f | **Experimental** and theoretical ideas are worthless without their effective application to the real needs of professional practice, building a bridge between theory and practice. | **2** | **3** |
| | | | | Graduate programs should be dedicated to advancing the field, to **experimentation** and research that will lead the profession. | **2** | **3** |
| | | | | This model also implies a doctoral level dedicated solely to advanced design research and **experimentation**. | **2** | **3** |

**Table B.2:** Content Analysis of Design Issues, Vol. 7, No. 2. (Spring, 1991)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 25-33 | Charles L. Owen | Design Education in the Information Age | | The charge for the conference's activity will be the establishment of a regional, **experimental** communication channel for designers and planners in the Pacific basin-the first step to an **innovative** global communications channel for design. | **4** | **6** |
| 43-53 | György Haiman | Imre Kner and the Revival of Hungarian Printing | | As an **experiment** they began working together on a yearbook. | **1** | **8** |
| | | | | The result of the **experiment** was a publicity yearbook, the Kner Almanach for 1919, | **1** | **8** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | with ornaments by Kozma. | | |
| | | | | Fig. 2) Kner's first **experiment** in a new book style, 1918. | **1** | **8** |
| | | | | The principles of the major **experiment** conducted in the early 1920s in the revival of tradition were summed up by Imre Kner, Lajos Kozma, and Gy'drgy Kiraly in the 1922 Kner Almanach. | **1** | **8** |
| 54-62 | Takuo Hirano | The Development of Modern Japanese Design: A Personal Account | | The **experiment** in university-business linkage has been successful at Tama Art University and will soon be introduced to other universities. | **1** | **10** |

**Table B.3:** Content Analysis of Design Issues, Vol. 8, No. 1. (Autumn, 1991)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 26-34 | Mihaly Csikszentmihalyi | Design and Order in Everyday Life | | These extravolations from the findings of the natural sciences and mathematics were occasionally confirmed by laboratory **experiment**s on visual perception, but turned out to have little explanatory value in real-life contexts. | **1** | **12** |
| | | | | In the laboratory, one learns readily to agree with whatever the **experiment**er wants you to see. | **1** | **12** |
| 44-56 | Marina M. Mykheeva; Dmitri A. Azrikan; Igor A. Tarakov; Alexey S. Sinelnikov; Andrew Kaspryk | Future-Design: The Design of the Future: The Design of a Neo-Sphere, a Concept for a Prognostic Project | | In questions related to telepathic relations-in all the **experiment**s conducted and the accounts of the participants involved in them-the main problem lies in the impact of the selective process on the transfer of thoughts at a distance. | **1** | **12** |
| | | | | In addition, two more subprograms are foreseen: a social program, which is to include family relations, an exchange of experience, aquatic leisure activities alongside training, as well as a popularization of methodology and other educational tasks; and a scientific program, which is still undeveloped; it requires further research and **experiment**s as well as a further methodological elaboration, including plans to train and teach personnel. | **1** | **12** |
| 57-66 | Yelena Yasen | The Development of Children's Book Illustration in Postrevolutionary Russia | | Before the creation of The Circus, Lebedev had already made his posters, his first children's books, and **experimental** cubist paintings. | **1** | **10** |
| | | | | Ermolaeva's method was in fact a suggestion of a new esthetic ideal, which the | **1** | **10** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | spectator so desired after the endless artistic **experiment**s of the beginning of the twentieth century. | | |
| | | | | Tjersa tried to change his field by illustrating classical literature, which was less dangerous than conducting **innovative experiment**s in children's books. | **5.1** | **2** |
| 74-77 | * | The Munich Design Charter | | We therefore have to work to find the right temporary and **experimental** balance of our environment between these different logics of technology and production, a balance that accords with a rich and emotionally-chargeable view of the artificial environment. | **2** | **1** |

* Signers of the "Munich Design-Charter" as of October 15, 1990:Dieter Rams, Ettore Sottsass, Jr., Javier Mariscal, Andrea Branzi, David Chipperfield, J. Saenz de Oiza, Daniel Weil, Michael Erlhoff; Gillo Dorfes, Ann Marie Boutin, Mai Felip, Alexander Neumeister, Gudrun Neumeister, Marco Piva, Mike Jones, Giuliano Molineri, Cristina Morozzi, Fran~ois Burkhardt, Edouard Bannward, Ezio Manzini, W. Poelman, Alberto Meda, Ruud Nordt, Isao Hosoe, Herbert H. Schultes, Clino Tini Castelli, Anna Mariu Beesch, Remo Buti, Klaus Schmidt, Lapo Binazzi, R. Kemna, Antonio Citterio, Philipp Thonet, Alessandro Mendini, Evelin Moller, Pierluigi Molinari, Uta Brandes, Mario Bellini, Marc Bertheir, Antonio Petrillo, E. van Hinte, Francesco Morace, Winfried Scheuer, Anna Castelli Ferrieri, Ingrid Scheurmann, Denis Santachiura, M. Brandes, Massimo Iosa Ghini, Augustin N. Calabro, Maria Grazia Mazzocchi, Hans J. Neyer, Rodolfo Bonetto, Egon Chemaitis, Stefan Marzano, Siglinde Spanihel, Brigitte Wolf; Peter Zec, Marco Zanini, Giinter Zamp-Kelp, Niko Fritz, Michele De Lucchi, Michael Klar, Paolo Deganello, Jo Eisele, Rolf Fehlbaum, Stephan Ott, Holger Fritzlar, Klaus Achim Heine, Christof Langhof; Richard Linxweiler, Giinter Horntrich, Volker Albus, Andreas Brandolini, Wolfgang Laubersheimer.

**Table B.4:** Content Analysis of Design Issues, Vol. 8, No. 2. (Spring, 1992)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 5-21 | Richard Buchanan | Wicked Problems in Design Thinking | | The consideration that completes the ground for assimilating science to art is the fact that assignment of scientific status in any given case rests upon facts which are **experimental**ly produced. | **1** | **11** |
| | | | | Instead of meaning knowledge of how to make and use artifacts or the artifacts themselves, technology for Dewey is an art of **experimental** thinking. | **2** | **6** |
| | | | | We mistakenly identify technology with one particular type of product-hardware-that may result from **experimental** thinking, but overlook the art that lies behind and provides the basis for creating other types of products. | **2** | **6** |
| | | | | For nearly twenty years, however, a group of architects have aggressively sought to reposition architecture in the context of signs, symbols, and visual communication, yielding the postmodern **experiment** and trends such as deconstructionist architecture. | **1** | **7** |
| | | | | The test, of course, is whether **experiment**s in **innovation** yield productive results, judged by individuals and by society as a whole.[19] | **5** | **12** |
| | | | f | Some **experiment**s have fallen like dead leaves at the first frost, swept away to merciful oblivion. | **1** | **7** |
| | | | f | At present, the results of deconstructionist architecture are mixed, but the **experiment** | **1** | **7** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | will continue until individuals or groups reposition the problems of architecture and shift general attention toward new questions. [20] | | |
| | | | n | 21) Visual **experimentation** is an important part of graphic design thinking, but **experimentation** must finally be judged by relevance and effectiveness of communication. | **1** | **8** |
| | | | | In this sense, Simon's science of the artificial is perhaps closer to what Dewey means by technology as a systematic discipline of **experimental** thinking. | **2** | **6** |

**Table B.5:** Content Analysis of Design Issues, Vol. 9, No. 1. (Autumn, 1992)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 3-4 | Richard Buchanan; John Heskett | Editorial | | Finally, there are examples of **experimentation**: an essay on design education by Mark Salmon and Glen Gritzer, and a typographic **experiment** by graphic designer Christine Celano. | **1** | **8** |
| 21-29 | Ann C. Tyler | Shaping Belief: The Role of Audience in Visual Communication | | The range of argument achieved by varying the combination of formal devices seems limitless, and **experimenting** with formal devices within argument has been a major focus in graphic design. | **1** | **8** |
| 56-74 | Adrian Snodgrass; Richard Coyne | Models, Metaphors and the Hermeneutics of Designing | n | 31)"[T]he development of laws in the social sciences invariably involves methods of statistical reasoning by which a conformance between data and theoretical regularities is established. Here the aim is to ensure that a relationship between the hypothesized occurrence and the real-world occurrence of variables of interest can legitimately be struck under all conceivable conditions." Rowe, Design Thinking, 163, citing Donald T. Campbell and Julian C. Stanley, **Experimental** and Quasi-**Experimental** Designs for Research (Chicago: Rand McNally, 1970). | **1** | **12** |

**Table B.6:** Content Analysis of Design Issues, Vol. 9, No. 2. (Autumn, 1993)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 15-19 | Rudolf Arnheim | Sketching and the Psychology of Design | | Obviously, it starts with an analysis of the given task. In a most concrete case, the designer is asked to work from a given plan such as, in Goldschmidt's **experiment**, the outline of a building for a branch library. | **1** | **7** |
| 20-31 | Robert Jerrard | Person-System Interaction and Designing: Re-Establishing Values | n | 8) Izak Benbasat, Albert S. Dexter, and Paul S. Masulis, "An **Experimental** Study of the Human/Computer Interface," Communications of the ACM 24, no. 11 (November 1981): 752-62. | **1** | **6** |
| | | | | It would appear, according to Izak Benbasat, et al.[8] and Mike Cooley,[9] that there is | **1** | **6** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | generally a paucity of **experimental** work conducted to analyze influences on interdependent variables. | | |
| | | | | In this way, as has been observed in **experimentation** with designers, developing system knowledge has the effect of reducing information requirements. | **3** | **6** |
| 34-43 | Adam Richardson | The Death of the Designer | | Likewise, the early **experimental** work of this type done at Cranbrook had more complex goals in mind but, as so often happens, the popularization of the approach caused much to be lost. | **2** | **1** |
| | | | | While the implementation of these solutions to the current crisis of industrial design will be **experimental**, even problematic, such reassessment is imperative, for the path that industrial design is currently following leads only to its bastardization. | **2** | **1** |
| 64-65 | Victor Margolin | Typography, Book Design, and Advertising in the 1920s: A Collection of Documents | | Raoul Hausmann, the Dada artist who also designed occasional **experimental** journals in the early 1920s, continued to reflect on the problems of photography, typography, and photomontage, and in 1931 published, in a bis z, a summary of these thoughts which we reproduce here. | **1** | **10** |
| 72-76 | G. F. Hartlaub | Art as Advertising (1928) | | The advertising goal, which is just a vague notion in the minds of the client and advertising expert, can be fully carried out; a poster can accommodate the taste of the consumer class and can "imprint" itself on every sense that **experiment** and psychology can verify and yet, as to artistry, still portray a monstrosity. | **1** | **9** |
| | | | | A glance at advertising posts today -at least in Germany and apparently in Switzerland - gives the impression that many people in industry and commerce have lost their joy in artistic "**experiment**s". | **1** | **9** |

**Table B.7:** Content Analysis of Design Issues, Vol. 10, No. 1. (Spring, 1994)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 29-35 | Rudolf Arnheim | The Way of the Crafts | | In a pioneering article, the physicist P.A.M. Dirac has written that "it is more important to have beauty in one's equations than to have them fit **experiment**."[8] | **1** | **11** |

**Table B.8:** Content Analysis of Design Issues, Vol. 10, No. 2. (Summer, 1994)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 3-26 | David Gartman | Harley Earl and the Art and Color Section: The Birth of Styling at General Motors | | Sloan wrote that his plan to offer "better quality" cars "was valid if our cars were at least equal in [technical] design to the best of our competitors in a grade, so that it was not necessary to lead in design or run the risk of untried **experiment**s."[8] | **2** | **6** |
| 27-48 | Ellen Mazur | Alms for Oblivion: The History of | n | 74) A complete early history of the school can be found in T C. Knauff. An **Experiment** | **3** | **3** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Thomson | Women in Early American Graphic Design | | in Training for the Useful and Beautiful. | | |
| 49-68 | Alain Findeli | Ethics, Aesthetics, and Design | | These pedagogical **experiment**s lead me to test a number of hypotheses and models derived from earlier analyses and, in return, to better tackle the most important issues. | **3** | **3** |

**Table B.9:** Content Analysis of Design Issues, Vol. 10, No. 3. (Autumn, 1994)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 3-20 | J. Kevin Byrne; Michael Eckersley; P. Scott Makela; Ellen Shaffer; James Woudhuysen | Three Lies to Live | | This convergence has disposed of most of the drudgeries of early multimedia software efforts and have accelerated **experiment**s in new media centered mostly on entertainment. | **1** | **9** |
| 22-31 | Cinzia Maurizia Giovine; John Cullars | Jean-Marie Gavreau: Art, Handicrafts, and National Culture in Quebec from the 1920s Until the 1950s | | In this climate of general stagnation, Gavreau was forced to continually repeat the same concepts. His unheeded claims and the absence of **experimentation** risked every possibility for constructive debate among the various social parties. | **1** | **12** |
| 52-76 | Jeremy Anysley | Pressa Cologne, 1928: Exhibitions and Publication Design in the Weimar Period | | Lissitzky devised a montage environment, which commented on the role of design in the press and publishing of the new Soviet society in a challenging and **experimental** manner.[2] | **1** | **10** |
| | | | | Similarly, the Berlin exhibition organised by Moholy-Nagy, Wohin geht die Neue Typographic? in 1929, and subsequent Die Fotomontage in 1931 in Berlin and Die Neue Werbung (The New Advertising) in Essen in 1931, all stressed **experimental** photographic culture and new typography.[42] | **1** | **10** |

**Table B.10:** Content Analysis of Design Issues, Vol. 11, No. 1. (Spring, 1995)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 43-65 | Alain Findeli | Design History and Design Studies: Methodological, Epistemological and Pedagogical | | My very brief mention of this very fecund work should also include de Certeau's statement that historical inquiry could and indeed should contribute to the **experimental** validation of theoretical models developed in other disciplines such as sociology, | **1** | **12** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Inquiry | | economics, psychology, and cultural studies. | | |
| 66-70 | Barbara Maria Stafford | An Image of One's Own: Design Discipline vs. Visual Studies | | Our students should be prepared to respond to the diversity of employment opportunities in a shrinking world market, using their distinctive expertise in the multiple facets of visualization to solve real-life problems, as well as engage in imaginative Gedanken-**Experiment**en. | **2.1** | **3** |

**Table B.11:** Content Analysis of Design Issues, Vol. 11, No. 2. (Summer, 1995)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 11-20 | Gui Bonsiepe; John Cullars | The Invisible Facets of the Hfg Ulm | | It was because the necessary practical and **experimental** possibilities scarcely existed in other universities. | **2** | **3** |
| | | | | The formal three-dimensional **experiment**s of Walter Zeischegg on surface transformations owe much to his experiences as a sculptor. | **1** | **10** |
| | | | | Even if the hfg wasn't prepared to relinquish a critical attitude toward industrial production; nonetheless, its disposition was thoroughly pragmatic and thus differed from other critical **experiment**s; particularly of the post-1968 period that mainly restricted themselves to drawings of products and ascribed a critical, if not a revolutionary, function to this. | **2** | **3** |
| 31-61 | Richard Coyne; Adrian Snodgrass | Problem Setting within Prevalent Metaphors of Design | | Ong recounts Luria's **experiment**s among nonliterate cultures in which illiterate but otherwise capable people were presented with a syllogism such as: "In the Far North, where there is snow, all bears are white. Novaya Zembla is in the Far North and there is always snow there. What color are the bears?"[92] | **1** | **12** |

**Table B.12:** Content Analysis of Design Issues, Vol. 11, No. 3. (Autumn, 1995)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| ii | Steven Heller | Dan Friedman 1945-1995 | | This campaign adapted and synthesized the **experimental** typography introduced at Basel, akin to the way in which Russian Constructivism was incorporated by Jan Tschichold into the New Typography of the 1920s; the result was a refreshing image for a conservative corporation. | **1** | **8** |
| | | | f | After the Citibank success, Friedman could easily have made pseudo-**experimental** work for corporate clients but he understood the limitations therein. | **1** | **8** |
| 15-27 | Stuart Walker | The Environment, Product Aesthetics and Surface | | In order to carry out an LCA, the product must exist, or at least be precisely defined; and the data must be available, or attainable through research or **experiment**. | **2** | **6** |

| | | | | | | |
|---|---|---|---|---|---|---|
| 57-61 | Fabian Wurm; John Cullars | Afterword | | He practiced the diagnosis of his times as an **experiment**. | **1** | **12** |
| | | | | Flusser pointed the way, with great publicity, in a bold **experiment** in 1987. | **1** | **12** |

**Table B.13:** Content Analysis of Design Issues, Vol. 12, No. 1. (Spring, 1996)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 5-25 | Tony Golsby-Smith | Fourth Order Design: A Practical Perspective | | As such, they were reversible; this freed people to **experiment** with more vigor. | **2** | **2** |

**Table B.14:** Content Analysis of Design Issues, Vol. 12, No. 2. (Summer, 1996)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 3-21 | Barry Katz | The Arts of War: "Visual Presentation" and National Intelligence | | Through their pioneering **experiment**s in the visual display of information in the propaganda war, in service of the War Crimes trials at Nuremberg and, finally, in the waning months of the organization, in preparation for the founding conference of the United Nations in San Francisco; they left a small but indelible mark on history. | **1** | **12** |
| | | | | For creative energy, he enlisted the aid of Merian C. Cooper, one of the first Hollywood producers to **experiment** successfully with the documentary film, and who now was a captain attached to Army Intelligence.[5] | **1** | **10** |
| | | | | They would be joined, at this early stage, by the inventive Buckminster Fuller, and architects Louis Kahn and Bertrand Goldberg, each of whom had been **experimenting** with prefabricated, mass-produced housing units.[10] | **1** | **7** |
| | | | | Its first product was an **experimental**, one-reel motion picture report; consisting mostly of animated charts; on the status of U.S. Wartime Manpower: How could the nation pull an estimated twelve million men out of the civilian workforce and increase production? | **1** | **10** |

**Table B.15:** Content Analysis of Design Issues, Vol. 12, No. 3. (Autumn, 1996)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 3-13 | Giovanni Anceschi; John Cullars | Visibility in Progress | | I am speaking of his "American lecture"[6], in which he shows the subtlety of his **experimental** theories. | **1** | **12** |

| | | | | | | |
|---|---|---|---|---|---|---|
| 14-34 | Leslie Atzmon | The Scarecrow Fairytale: A Collaboration of Theo Van Doesburg and Kurt Schwitters | | In the same spirit, a group of Dadaists in Zurich, with whom Schwitters corresponded,[10] initiated Cabaret Voltaire in which "**Experimental** poetry, lectures, improvisational dance, and music shared the programs with Dada gestes and a variety of outlandish pranks...."[11] | **1** | **10** |
| | | | | Before they collaborated, they **experiment**ed with typography as both art and message. | **1** | **8** |
| | | | f | Emphasizing typographic formal and contextual relationships, Van Doesburg's and Schwitters's early **experiment**s in typography mainly followed De Stijl and Dada philosophies. | **1** | **8** |
| | | | | Their receptivity to contrasting aspects of Dada and De Stijl energized Van Doesburg's and Schwitters's typographic **experiment**s. | **1** | **8** |
| | | | | Beelden was a series of **experimental** sound poems; a visual hybrid of De Stijl and Dada ideas, as well as of fine art and typography. | **1** | **10** |
| | | | | She described their continuing collaboration; flexible and **experimental**; even as they produced Die Scheuche with typesetter Paul Vogt: "I remember that, after a while, we all got tired and disagreed. | **1** | **8** |
| | | | n | 65) Robert Kahn, "An **Experiment** in Scientific Organization" (Institute for Social Research. University of Michigan, 1993),[5]. | **1** | **12** |
| 77-87 | David W. Booth | Mathematics as a Design Tool: The Case of Architecture Reconsidered | | These functions are obtained by the quantification of relevant areas of experience, and verified through controlled observation and **experiment**. | **1** | **13** |
| | | | n | 14) See, for example, the scientific analysis of the structure of Gothic cathedrals made by the engineer, Robert Mark, in his ***Experiment**s in Gothic Structure* (Cambridge, Mass. MIT Press, 1982) | **1** | **13** |
| | | | | By a series of **experiment**s, he provided himself with the requisite data and obtained the desired measurements. | **1** | **13** |

**Table B.16:** Content Analysis of Design Issues, Vol. 13, No. 1, Designing the Modern Experience, 1885-1945. (Spring, 1997)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 5-14 | Wendy Salmond | A Matter of Give and Take: Peasant Crafts and Their Revival in Late Imperial Russia | | The process might begin, as in other revivals, with artists borrowing raw material from "the folk" (usually in the form of ornament) for their own design **experiment**s, but it rarely stopped there. | **2** | **2** |
| | | | | At the same time, the practical success of her **experiment** in reseeding peasant creativity with carefully chosen and easily reproduced motifs was absolute, as can be seen from the fact that peasants from the Abramtsevo area (and further afield) continued to make her designs well into the Soviet period. | **2** | **1** |
| | | | f | Both as an approach to peasant-inspired design and as a viable production model, this | **2** | **1** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Abramtsevo **experiment** quickly caught on in the 1890s. | | |
| | | | | As long as such concepts as "First World" and "Third World" have currency, as long as "ethnic" cultures continue to attract an increasingly globalized population, the history of last century's craft revivals will make absorbing and relevant reading, as a cautionary tale (The Golden Goose comes to mind) that reminds us where grand **experiment**s in social and cultural engineering can lead. | **1** | **12** |
| 27-38 | Susan R. Henderson | "New Buildings Create New People": The Pavilion Schools of Weimar Frankfurt as a Model of Pedagogical Reform | n | 18) Generally, the peripheral site needed to make the type affordable was not available in most large cities, and may have constrained such **experiment**s elsewhere. | **1** | **7** |
| 39-52 | Dennis P. Doordan | In the Shadow of the Fasces: Political Design in Fascist Italy | | The responses ranged from ringing endorsements of avant-garde **experimentation** to conservative appeals on behalf of classical and traditional artistic vocabularies. [4] | **1** | **10** |
| | | | | Much can be learned by comparing Calzavara's graphic design work on behalf of the regime during the 1930s with earlier avant-garde design **experiment**s in Italy. | **6** | **1** |

**Table B.17:** Content Analysis of Design Issues, Vol. 13, No. 3. (Autumn, 1997)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 29-36 | David Ryan | Enzo Mari and the Process of Design | | There is a long corridor off of which are four or five rooms filled with **experimental** models and prototypes, files, books, and numerous curious objects. | **2** | **2** |
| 52-65 | Mika Pantzar | Domestication of Everyday Life Technology: Dynamic Views on the Social Histories of Artifacts | | Orvar Lofgren from Sweden calls this early period as a period of "happy **experimentation** and a multitude of Utopian schemes." | **2** | **2** |
| | | | | Television, radio, and other forms of new media technology made their breakthrough in an initial phase of enthusiastic passionate **experimentation**, the boom, thereafter, being sustained by bandwagonism. | **2** | **6** |
| 66-81 | John Zukowsky | Design for the Jet Age: Charles Butler and Uwe Schneider | | The Fa 223 was a development of the 1936 FW 61, an **experimental** helicopter (and arguably the first helicopter ever) developed by the Focke-Wulf Aircraft Company that achieved renown for being flown inside the Deutschlandhalle of Berlin's trade fair area by Germany's famous woman test-pilot, Hanna Reitsch, in 1938 (figure 7). | **2** | **6** |

**Table B.18:** Content Analysis of Design Issues, Vol. 14, No. 1. (Spring, 1998)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 1-2 | Richard | Introduction | | Researchers adopt methods that range from **experimental** techniques to critical theory | **3** | **2** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Buchanan; Dennis Doordan; Victor Margolin | | | while practitioners frequently work within the framework of management and organizational thought. | | |
| 3-20 | Richard Buchanan | Branzi's Dilemma: Design in Contemporary Culture | | His voice has remained a presence in the pluralism of contemporary design, emphasizing the continued importance of aesthetics and artistic **experimentation**. | **2** | **2** |
| 40-53 | Robert Jerrard | Quantifying the Unquantifiable: An Inquiry into the Design Process | | These theories are discussed as an aid to the investigation and are utilized in **experimentation**. | **3** | **2** |
| | | | | The conclusion of the paper is an extract of an account of an **experiment** designed to relate such theories and methods to design behavior. | **3** | **2** |
| | | | | 6) D. Bannister, "Personal Construct Theory: A Summary and **Experimental** Paradigm" Acta Psychological[20] ( 962) | **3** | **2** |
| | | | | It is designed as an **experimental** technique which provides an account of an individual's behavior, and it recognizes the individual's need to change his or her concepts in relation to individual interpretation of events. | **3** | **2** |
| | | | | Further to this, such a theory is considered to be content-free in the sense that recognition is given to the individual as an objective **experiment**er who provides subject data for analysis. | **3** | **2** |
| | | | | Indeed, such techniques can provide a basis for the practical application of **experimental** results. | **3** | **2** |
| | | | | Of particular interest is the Sociality Corollary, and Kelly[13] states: "When he construes another person's outlook, and proceeds to build an **experimental** cycle of his own upon that construction, he involves himself, willy nilly, in an interesting way. | **3** | **2** |
| | | | n | 15) K. R. Beittel, "Factor Analysis of Three Dimensions of the Art Judgment Complex: Criteria, Art Objects, and Judges." Journal of **Experimental** Education 32.2 (Winter 1963). | **1** | **12** |
| | | | n | 16) G. Goude, L. Gunnilla, L. Lars, "An **Experimental** Psychological Technique for the Construction of a Characterizing System of Art Painting and an Attempt at Physiological Validation," 33rd Report, Department of Psychology. University of Uppsala, Sweden, June 1966. | **1** | **12** |
| | | | | In general terms, conclusions from this type of **experiment** may be drawn from criteria range and the effect of stimuli. | **3** | **2** |
| | | | | The purpose of Beittel's **experiment** was to: | **3** | **2** |
| | | | | The overall effectiveness of obtaining the grid depends greatly upon the proper presentation of the **experiment**. | **3** | **2** |
| | | | | Second, the **experiment**er should attempt to illustrate previously unknown thought | **3** | **2** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | processes in his or her analysis of the subject. | | |
| | | | h | The **Experiment** | **3** | **2** |
| | | | | A central **experimental** hypothesis may be devised to take into account the fact that recognition of designers personal constructs and, indeed, schemata are improvised judgments and subject to continual development. | **3** | **2** |
| | | | | The formal **experiment** hypothesis is, therefore: "the structure construed from judgments made in design area thinking is largely independent of structures in design artifacts. | **3** | **2** |
| | | | | However, the **experiment** had a great deal of other information of a field research nature associated with it, which related to the experience and cultural background of the subjects. | **3** | **2** |
| | | | f | This information forms the basis of correlation between this **experiment**'s attitude surveys and other data in the conclusion of the work. | **3** | **2** |
| | | | | After initial pilot studies to secure the most accurate method, twelve woven textile designers, each from separate wool manufacturing companies, were asked to take part in the **experiment** over a two-week period. | **3** | **2** |
| | | | | Questions surrounding the formal **experiment** hypothesis (above) can be stated as follows: | **3** | **2** |
| | | | h | Conclusions Regarding the **Experimental** Hypothesis | **3** | **2** |
| | | | | These conclusions relate specifically to the **Experiment** Hypothesis as previously stated. There are two formal conclusions based upon the analysis of results. | **3** | **2** |
| | | | h | **Experiment** Conclusion No. 1. | **3** | **2** |
| | | | | The purpose of the **experiment** was to test the hypothesis and thereby gain insight into the internal representation of design problems in the case of a small sample of twelve designers. | **3** | **2** |
| | | | f | The results of the **experiment** are interesting, and certainly contribute to greater knowledge. | **3** | **2** |
| | | | f | It is, however, realized that interpretation relies heavily on the relative objectivity of both the **experimente**r and the subjects. | **3** | **2** |
| | | | h | **Experiment** Conclusion No. 2. | **3** | **2** |
| | | | | This may reflect the shortcomings of the **experimental** procedure, because criteria were asked for in standard complexities, i.e., ten bipolar constructs per designer. | **3** | **2** |
| | | | | However, senior managers cannot be isolated by the judgments within the **experiment**. | **3** | **2** |
| | | | | It is evident from the **experiment** that certain criteria (beyond those shown in the scatter) are more important than others. | **3** | **2** |
| | | | f | It is clear from this **experiment** that exterior influences were present in the designers' judgments, which would give rise to criteria variation. | **3** | **2** |
| | | | h | Critical Post Observations of the **Experiment** | **3** | **2** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | A critical view of the **experiment** and the conclusions derived from its results isolate certain points which tend to qualify overall value, as well as provide certain directions for future work. | **3** | **2** |
| | | | | 3. Potential weakness of the **experimental** approach may be found in the interpretation of the results although, since the context and range was specific and very carefully controlled, the results are considered secure. | **3** | **2** |
| | | | | This was previously noted in this paper, when Kelly's and Osgood's **experimental** method was reviewed. | **3** | **2** |
| | | | | 5. It is likely that only a small area of design behavior has been isolated, because **experimental** quantitative methods do not allow for the subjects' determination of range of criteria beyond that which is prompted by the samples. | **3** | **2** |
| 54-80 | Michael Punt | Accidental Machines: The Impact of Popular Participation in Computer Technology | | Business interests, and then domestic users, also began to take an interest in these telecommunications **experiment**s. | **1** | **13** |
| | | | | One of the most developed **experiment**s in this area was called "The Aspen Movie Map." | **1** | **13** |
| | | | | At these clubs, the collective imperative of building a small computer for **experimental** purposes overrode individual ambition, and social and professional hierarchies. | **1** | **13** |
| | | | | The Apple II was a machine for the computer enthusiast and the **experimental** programmer. | **1** | **13** |
| | | | | In these **experiment**s, very basic instructions were shown to produce intelligent behavior in swarms of identically programmed robots. | **1** | **13** |
| | | | | **Experimental** practice progressively insisted on sophisticated instrumentation that eliminated the human observer. | **1** | **13** |

**Table B.19:** Content Analysis of Design Issues, Vol. 14, No. 2. (Summer, 1998)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 41-62 | David Fleming | Design Talk: Constructing the Object in Studio Conversations | | D4(Design student no:4): I, we started, decided that we wanted to go with a larger size rather than, the eight and a half by fourteen was small; it was easy to handle but it wasn't large enough to contain all the information, um and make it, make it look pleasing rather than compact and tight with all the information, so we decided to go with the larger paper size; we went up to a ten by twelve page size and we thought we'd work with that, and um, and it seems to be working now, but we still have to **experiment** more with it. | **2** | **2** |
| | | | | D4 (Design student no:4): (…) And um, and it seems to be working now, but we still have to **experiment** more with it, we kind of like the, the feeling of it, because it's | **2** | **2** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | different from their brochures and flyers ( ) that way. | | |
| | | | | Through the interaction between the designers and their professor, problems are encountered and dealt with on the spot, much like the "visual **experiment**s" that Schön found in an architectural review. | **2** | **2** |
| 63-66 | Richard Buchanan | Education and Professional Practice in Design | | While the natural scientist must study his or her subject by creating **experimental** conditions that bring nature into the laboratory, the design researcher has the subject of investigation ready at hand in the work of the studio. | **1** | **11** |
| 67-82 | Paul Betts | Science, Semiotics and Society: The Ulm Hochschule für Gestaltung in Retrospect | | For one thing, the regional government of Baden-Wiirttemberg was less and less willing to subsidize Ulm's theoretical **experimentation** and disinclination toward product design, thus throwing the school into perennial financial crisis. | **2** | **3** |
| | | | | And in light of postmodernism's notorious ideological impasse regarding exactly this issue, the "Ulm **experiment**" may perhaps deserve another hearing. | **2** | **3** |

**Table B.20:** Content Analysis of Design Issues, Vol. 14, No. 3. (Autumn, 1998)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 43-64 | Raimonda Riccini | History from Things: Notes on the History of Industrial Design | | In other words, that devices derived from research and **experimentation** into large-scale industrial machinery may eventually come onto the market for household appliances: from the robots of the automated factory to domestic robots.[71] | **2** | **6** |
| 74-84 | Medardo Chiapponi | Environmental Design and Industrial Design: Integrating Knowledge around Urgent Issues | | The protective belt of a research program is, instead, more flexible and changeable in that its individual elements are subjected to **experimental** verification and must clarify their relationship to the hard core. | **3** | **2** |
| 85-100 | Gabriela Goldschmidt; Maya Weil | Contents and Structure in Design Reasoning | | After briefly describing the **experimental** case on which we base our analyses in this study, we discuss our methodology, which is frequently used for design thinking research, namely verbal report (think-aloud or conversation) protocol analysis. | **3** | **2** |
| | | | | In design as in other fields, most protocol analysis studies are based on "think aloud" **experiment**s in which individuals engage in the investigated activity while they continuously verbalize their thoughts. | **3** | **2** |
| | | | | This is particularly true when the **experiment** involves more than one individual, in which case the protocol consists of natural conversation (as is the case in our example). | **3** | **2** |
| | | | | **Experimental** psychology is well familiar with this problem, which is by no means exclusive to protocol analysis. | **1** | **12** |
| | | | | We wish to thank Kees Dorst, Nigel Cross and Henri Christiaans, who organized the Delft Protocol Workshop and the design **experiment** on which it was based. | **3** | **2** |
| | | | | We are likewise indebted to the three anonymous designers who participated in the **experiment**, and to Xerox PARC and Stanford University's EDRC for their help and support in arranging the design session and in taping the protocols. | **3** | **2** |

**Table B.21:** Content Analysis of Design Issues, Vol. 15, No. 1. (Spring, 1999)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 3-15 | Ellen Mazur Thomson | Thorstein Veblen at the University of Chicago and the Socialization of Aesthetics | | A few philosophers, such as Hugo Munsterburg at Harvard were inspired by the development of **experimental** psychology and undertook to measure aesthetic experience. | 1 | 12 |
| | | | | Evolutionary theory, **experimental** psychology, and anthropological studies, as well as a new approach to sociology and economics, provided the impetus. | 1 | 12 |
| 49-74 | Laurel Fredrickson | Vision and Material Practice: Vladimir Tatlin and the Design of Everyday Objects | | Historians cite a range of influences on Tatlin, including Slavic artisanal traditions, skills learned as a sailor and craftsman, Russian icons, modern **experimental** abstraction, and technological **innovation**s, most notably those in aviation. | 5 | 1 |
| | | | | Both shared an interest in rural Slavic culture, had a similarly lyrical response to nature, and through their **experimental** approach to materials formulated a "humanized technology." [7] | 2 | 6 |
| | | | | Each **experiment**ed with "materials" in his discipline in a manner that complemented and extended the work of the other. | 2 | 6 |
| | | | | The play's overall orientation and set design replicated Khlebnikov's **experimental** approach to language.[39] | 1 | 10 |
| | | | | Thereafter, Tatlin worked in Moscow on his flying machine in the Scientific and **Experimental** Laboratory under Narkompros.[52] | 1 | 13 |
| | | | | Described as a "composite **experimental** research design-centre or design-workshop [with] its own productive base and its own office for publicizing a new sphere of activity," the Section had two divisions.[53] | 2 | 6 |
| | | | | Using a "scientific" **experimental** approach his students tested the: ...different interrelations of materials, trying to find in the material itself preconditions [leading] towards a form [making use] of technical structures as forms for everyday objects and the phenomena of living nature.[57] | 2 | 6 |
| | | | | This unique design derived from Tatlin's approach to transforming traditional objects through **experimental** modern features, while considering the human form.[75] | 2 | 2 |
| | | | | Zhadova maintains that he began **experimental** work four years before beginning construction in 1929.[84] | 2 | 2 |
| | | | | The word Letatlin resembles the poet's **experimental** word constructions, combining two words, Letat' (flight) and Tatlin, to form a third. And its ambitions correspond with the poet's conception of an ideal future city whose buildings would be accessed through flight.[85] | 1 | 10 |
| | | | n | 3) See. for example. George Rickey. Constructivism: Origins and Evolution (New York: Braziller. 1967). 23. Rickey writes that "Tatlin, in Gabo's view, was not a thinker; he had | 1 | 10 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | neither the background nor the training for 'constructive' work; he played with **experiment**s but was clumsy and technically uninformed. | | |
| | | | n | 72) Camilla Gray, The Russian **Experiment** in Art, 1863-1922(London: Thames and Hudson, 1962), 248. | **1** | **10** |

**Table B.21:** Content Analysis of Design Issues, Vol. 15, No. 2, Design Research. (Summer, 1999)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 5-10 | Nigel Cross | Design Research: A Disciplined Conversation | | Similarly, the "ways of finding out," the intellectual skills, can be differentiated: those of science are **experiment** and analysis, those of art are criticism and evaluation, and those of design are modeling and synthesis. | **1** | **11** |
| | | | | Terry Purcell and John Geroy (Design Science, Sydney University, Australia) Design and Other Types of Fixation **Experimental** studies of problem solving in design, aimed at understanding the causes and effects of fixation. | **3** | **2** |
| 11-17 | Alex Seago; Anthony Dunne | New Methodologies in Art and Design Research: The Object as Discourse | | Coming from an art school background in industrial design, and already having been employed as an **experimental** electronic product designer by Sony in Japan, his detachment from more conventional academic research methodologies help render his approach particularly useful as a blueprint for future design research strategies. | **2** | **6** |
| | | | | Dunne's methodological and theoretical stance bears a similarity to contemporary architectural attempts[8] as represented by the work of Kei'iche Irie and Yutaku Saito, to radically redefine relationships between structure, visual perception, and space, and also to the work of the designer/theorists Ezio Manzini and Marco Susani, who express a strong belief in the **experimental** function of contemporary design practice in order to counteract the contemporary obsession with styling for its own sake: | **2** | **2** |
| 18-26 | Susan Roth | The State of Design Research | t | **Experimental** situations | **3** | **2** |
| | | | | Quantitative research attempts to remain objective and neutral through the use of standardized, **experimental** methods and a reliance on mathematical and statistical models. | **3** | **2** |
| 27-39 | Zoe Strickler | Elicitation Methods in **Experimental** Design Research | h | Elicitation Methods in **Experimental** Design Research | **3** | **2** |
| | | | n | 2) Establishment of the Ph D. program at the Institute of Design, Illinois Institute of Technology, represents an important step toward the development of an **experimental** branch of visual communication design. | **1** | **8** |
| | | | | 4) **Experimental** research in the strictest "laboratory" sense involving hypothesis testing, and the control and manipulation of variables, still is relatively uncommon in social scientific research | **1** | **12** |
| | | | | 4) In a more general sense, the term "**experimental**" applies to any form of original | **3** | **12** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | social research in which data are gathered through direct contact with persons identified as representative members of a study population. | | |
| | | | | Recent conceptions of design research as a liberal art and as a social science are not contradictory or competing ideas, but rather two aspects of the same system-the theoretical and **experimental** branches of visual communication design research, respectively. | **1** | **8** |
| | | | f | Just as **experimental** physicists provoke, test, and challenge the work of theoretical physicists, and vice versa, so should theoretical and **experimental** efforts mutually inform and stimulate research in design.[4] | **1**<br>**3** | **11**<br>**2** |
| | | | | But commercial design practice more properly could be understood as the applied branch of the field, with **experimental** research balancing theoretical investigation in graduate programs. | **3** | **2** |
| | | | h | The Interrelation of **Experimental** and Theoretical Research | **3** | **2** |
| | | | | In this environment, theory and **experiment** are interdependent processes in formulating bodies of knowledge that can be said to reduce uncertainty. | **3** | **2** |
| | | | | As methods for critical and theoretical investigation in design evolve, a rigorous **experimental** branch of visual communication research will be necessary for the field to mature. | **1** | **8** |
| | | | | Relations between these domains define three distinct "study paths"-the **experimental**, the empirical, and the theoretical- which describe fundamental research orientations. | **3** | **2** |
| | | | | • The **experimental** path combines concepts from the conceptual domain with methods from the methodological domain to produce a study plan. | **3** | **2** |
| | | | | According to this model, **experimental** research differs from empirical research by the order in which domains are explored. | **3** | **2** |
| | | | f | However, for the purposes of this paper, the term **experimental** will be used interchangeably with the term empirical to refer to original research activity that involves direct collection of data from human subjects. | **3** | **2** |
| | | | | For example, laboratory methods used in **experimental** psychology maximize precision by holding environmental influences constant during data collection, but do so at a considerable loss of realism in observing participants in their natural environment. | **1** | **12** |
| | | | | What follows are descriptions of several methods of data collection from the social sciences that have potential for adaptation to user-focused, **experimental** design research in which existing beliefs are a factor in people's receptivity to communication in the subject area. | **3** | **5** |
| | | | | Recent developments in historical design research and critical/theoretical writing have not been matched by similar growth in **experimental** design research. | **3** | **1** |
| | | | f | If visual communication design is to evolve as an academic discipline (and a respected profession), we need to begin now to look for opportunities to strengthen the | **1** | **8** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | **experimental** branch of our field as an empirical bridge between theory and practice. | | |
| 40-54 | Philippe Gauthier; John Cullars | Technological Intervention and the Malady of Happiness | | Certain **experimental** laboratories exist that recreate natural contexts in which one can observe a user making gestures and actions, as well as bringing together the resources of a given location so as to accomplish a task. [35] | **3** | **5** |
| | | | | From the very earliest age, each person **experiment**s with objects and with situations from which one derives intellectual tools and competencies, according to a process that Piaget[42] has done a great deal to clarify. | **2** | **5** |
| 55-70 | M.-J. Avenier; L. Nourry; Mary Sweeney | Sciences of the Artificial and Knowledge Production: The Crucial Role of Intervention Research in Management Science | | In his exposition of the concept of action-research, M. Liu[l0] essentially proposes to liken this approach to an adaptation of the in situ **experimental** method implemented in a "natural" milieu, the goal being the testing of hypotheses according to a specifically delineated protocol. | **3** | **2** |
| 80-91 | Ranulph Glanville | Researching Design and Designing Research | | In this paper, I look at research, both **experimental** and theoretical, as done, compared with that as reported, and compare this to what is central to the act of design (as I understand it) in order to throw light on the relationship that could hold between research and design. | **3** | **2** |
| | | | | Research is carried out in two main arenas. The first is **experiment**; the second, theory. | **3** | **2** |
| | | | h | **Experiment** | **3** | **2** |
| | | | | **Experiment**s are the main means by which scientists extract knowledge of the world we inhabit.[11] | **1** | **11** |
| | | | f | In the (idealized) scientific **experiment**, we divide systems into distinct, isolated variables. | **1** | **11** |
| | | | | What is left out is the **experiment**er. | **1** | **11** |
| | | | f | Yet how could there be an **experiment** without an **experiment**er? | **1** | **11** |
| | | | f | The answer (based on simple experience: of doing **experiment**s, and of language use and what that implies for action) is straightforward. | **1** | **11** |
| | | | | The **experiment**er chooses to do the **experiment** and sets it up (including determining the variables). | **1** | **11** |
| | | | | That the **experiment**er is influenced by social factors and epistemological outlook does not reduce his or her responsibility: the **experiment**er accepts these social factors, and acts accordingly. | **1** | **11** |
| | | | f | The **experiment**er continues until the system begins to perform as desired or required (for instance, moves the light source/screen/lens to get an in-focus image). | **1** | **11** |
| | | | f | And the **experiment**er determines when enough has been done, i.e., who breaks the circle. | **1** | **11** |
| | | | f | The **experiment**er designs the **experiment** and, if it doesn't work (well enough, in his or her opinion), redesigns it. | **1** | **11** |
| | | | f | The **experiment**er forms the outcome and assembles different observations into a | **1** | **11** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | coherent whole (relating them together). | | |
| | | | f | The **experiment**er may then tie the outcome into theory, modifying that accordingly. | **1** | **11** |
| | | | f | Reacting to changes in knowledge resulting from the **experiment**s, the **experiment**er may rerun the **experiment**, perhaps with a new arrangement of the variables, or in a different place, to check repeatability (i.e., stability). | **1** | **11** |
| | | | | The **experiment**er plays with all aspects of the **experiment** until it produces results of the type desired. | **1** | **11** |
| | | | f | These actions of the **experiment**er are circular. | **1** | **11** |
| | | | | There are circularities in setting up and doing the **experiment**, in evaluating what is found, and in integrating it. | **1** | **11** |
| | | | | The whole process is deeply embedded in circularity, particularly the greatest of all scientific circularities: the active involvement of the **experiment**er (the observer). | **1** | **11** |
| | | | | The traditional relating of (scientific **experimental**) research is highly formalized-like a Russian icon! | **1** | **11** |
| | | | | So, observations are made in and of **experiment**s. | **1** | **11** |
| | | | | The **experiment** just comes into being (no one thinks of it or messes around until it works- i.e., produces the desired type of result (whose desire?). | **1** | **11** |
| | | | f | Results just appear, without anyone adjusting the **experiment** to gain the outcome required, such as moving optical elements to get a sharp focus, and only then taking measurements. | **1** | **11** |
| | | | | The generally promulgated view held by which we account for our research through scientific **experiment** is inaccurate.[18] | **1** | **11** |
| | | | | First, to combine, coordinate, and simplify the findings of **experiment**s by developing generalizing concepts; and, second, to examine these concepts in order to further clarify and develop them, reflecting back extended understandings into theory: and, by suggesting **experiment**s that might be performed, into **experiment**s for verification. | **1** | **11** |
| | | | f | The relationship between theory and **experiment** essentially is circular. | **1** | **11** |
| | | | h | Theory From **Experiment** | **1** | **11** |
| | | | | The first aspect of theory, theory from **experiment**, involves pattern finding. | **1** | **11** |
| | | | h | Theory From Theory (From **Experiment**) | **1** | **11** |
| | | | | The second type of theory is the examination of concepts to clarify (hence develop) these concepts further, reflecting the extended understandings back on the theory and suggesting **experiment**s to be carried out. | **1** | **11** |
| | | | | Sometimes such areas return to **experiment**, but not always. | **1** | **11** |
| | | | | From our (re)new(ed) understanding, we suggest how **experiment** allows us to test our simplification through an interaction in which both we and the personal reality we make for ourselves find confirmation, extension, and modification (and renewal). | **3** | **2** |
| | | | | (Scientific) research (whether **experiment** or theory) is a design activity. | **3** | **2** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | f | We design **experiment**s, but we also act as designers in how we act in these **experiment**s. | **3** | **2** |
| | | | f | We design the experiences and objects we find through **experiment** by finding commonalities (simplification): and we design how we assemble them into patterns (explanatory principles, theories). | **3** | **2** |

**Table B.22:** Content Analysis of Design Issues, Vol. 15, No. 3. (Autumn, 1999)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 3-16 | Sue Clegg; Wendy Mayfield | Gendered by Design: How Women's Place in Design Is Still Defined by Gender | | Simon Frith and Howard Home[13] have characterized the "romantic vision" underlying these courses with their strong art school ideology of individual creativity and **experimentation**. | **2** | **3** |
| | | | | Great care must be exercised in advocating "**innovation**" for, as Liz Farrelly notes, there is no female equivalent of the male atelier **experimental**ist, **innovation** is associated with the exercise of male power. | **5** | **1** |
| | | | q | At one point, we were all going to do the same thing-but as we **experiment**ed with our own artistic styles, we all went our own separate ways. | **2** | **2** |
| 17-33 | Tony Heward | Revivalism and Cultural Shift: British Graphic Design Since 1945 | | In Britain, the critic Herbert Read, in his highly influential Art and Industry (1934) took the "harmony with life" argument a step further when he wrote of the need to integrate the aesthetic **experiment**s of "the abstract artist" into all aspects of life. | **1** | **8** |
| | | | | "At St. Martin's School of Art, according to one who was a student there in 1950-53, all the avant-garde teachers were **experimenting** in Egyptian and Gothic faces, imitating the humors of the Victorian playbill." [21] | **1** | **8** |
| | | | | He described revivals as "indiscriminate eclecticism… mistaken for 'free **experiment**,'" and complained about "graphic design students being briefed to 'do it in art nouveau." [28] | **1** | **8** |
| 45-77 | Dmitry Azrikan | VNIITE, Dinosaur of Totalitarianism or Plato's Academy of Design? | n | 1) VNIITE is discussed briefly in Alexander N. Lavrentiev and Yuri V Nasarov. Russian Design: Traditions and **Experiment**: 192D-799D(London: Academy Editions, 1995). 88-131 | **2** | **1** |
| | | | | The "**experimental** cluster" finalized the process by doing technical documentation, models and prototypes. | **2** | **6** |
| | | | | Viacheslav Koleichuk and Alexander Lavrentiev (Alexander Rodchenko's grandson) created a studio of **experimental** design under Department No. 2's umbrella. | **2** | **1** |
| | | | | Since the VNIITE Design Center, with its large outdoor displays, was opened in fashionable Pushkin Square where the heart of Moscow nightlife and the first anti-Communist gatherings happened at the end of the 1970s, his **experimental** activity got a new motivation and an extensive audience. | **2** | **1** |
| | | | | Boris Shekhov had a wardrobe behind his desk (he did not have an office and always | **2** | **1** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | shared a studio room with ten other designers), and he stored different outfits in this closet -for the **experimental** plant, for lunch, for visits to YuB's office, and many others. | | |
| | | | | When the VNIITE **experimental** plant unsuccessfully tried to find big French curves, he simply drew several free-hand, and the modelmakers copied them in plastic. | **2** | **1** |
| | | | h | Department No. 12: **Experimental** Plant | **2** | **1** |
| | | | | The duty of Kostrov was plan control and **experimental** plant supervision. | **2** | **1** |

## APPENDIX C: CONTENT ANALYSIS OF DESIGN ISSUES IN 2000s

**Table C.1:** Content Analysis of Design Issues, Vol. 16, No. 1. (Spring, 2000)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 3-15 | Carla Keyvanian | Manfredo Tafuri: From the Critique of Ideology to Microhistories | n | 3) For a clear instance of this critique, see Tafuri's analysis of the reasons why the **experiment**s in social housing of the 1920s and '30s in Germany failed Manfredo Tafuri and Francesco Dal Co. Architettura Contemporanea (Milano: Electa, 1976) | **1** | **7** |
| | | | | What comes to the fore, in other words, is the artists' awareness of the "self-referentiality" of architecture and, consequently, their lack of the much extolled "certainty" that supposedly derived from the belief that their architecture was solidly grounded on the models provided by a recuperated tradition, that of an age in which codified norms of proportion had been established once and for all, Tafuri describes the architecture of the Renaissance as expressing a "refined equilibrium between the pursuit of foundations and **experimentation**."[22] | **1** | **7** |
| 59-79 | Kevin G. Barnhurst; John Nerone | Civic Picturing vs. Realist Photojournalism the Regime of Illustrated News, 1856-1901 | | Beginning in the 1830s, in England and the United States, newspaper and magazine publishers began to **experiment** with the use of various kinds of illustrations. | **1** | **8** |
| | | | | This **experimentation** preceded the successful introduction of photography in the form of the daguerreotype in 1839.[3] | **1** | **8** |

**Table C.2:** Content Analysis of Design Issues, Vol. 16, No. 2. (Summer, 2000)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 3-24 | Rob Roy Kelly | Recollections of Josef Albers | | The exercise required a great deal of **experimentation** and refinement. | **2.1** | **1** |
| 25-35 | Charles Traub; Jonathan Lipkin | Creative Interlocutor and Multimedia Dialog | | This story begins in 1948, when Snelson, then an engineering student, attended a summer session at Blackmountain College, the **experimental** school in North Carolina. | **1** | **13** |
| 36-44 | Eladio Rivadulla, Jr.; Jessica Gibbs | The Film Poster in Cuba (1940-1959) | | This last development was the fruit of successful **innovative experiment**s converting opaque pictures into transparent ones, and the reversal of the classical printing sequence, made possible thanks to the design resources happily combined with the printing system. | **4** | **1** |
| 45-61 | Adelaida de | Three Essays on Design | | During that decade, a rather interesting **experiment** was carried out in Cayo Hueso, a | **1** | **7** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Juan; John Cullars | | | poor neighborhood in central Havana that was being rebuilt. | | |

**Table C.3:** Content Analysis of Design Issues, Vol. 16, No. 3. (Autumn, 2000)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 3-18 | Mika Pantzar | Consumption as Work, Play, and Art: Representation of the Consumer in Future Scenarios | | Two **experiment**s from America include a vacuum cleaner which switches off when the phone rings, and a robot, "robutler," which serves refreshments but needs the help of a human to pour the drinks into the glasses. [23] | **3** | **6** |
| | | | | After all, life is not SimLife, where "All life is an **experiment**." [29] | **1** | **12** |
| 19-34 | Loretta Staples | Typography and the Screen: A Technical Chronology of Digital Typography, 1984-1997 | | Because Apple was so instrumental in popularizing the technologies that stimulated typographic **experimentation** within the graphic design community during this period, my paper focuses on the Macintosh platform. | **1** | **8** |
| | | | | At the same time, in Los Angeles, April Greiman, a Swisstrained graphic designer, began **experimenting** extensively with digital imaging and typography in her printed work | **1** | **8** |
| | | | | While pixellation characterized the look of these early typographic **experiment**s, blurring and antialiasing characterized the later look of digital typography. [16] | **1** | **8** |
| | | | | Outside the academy, J. Abbott Miller of the design studio Design/Writing/Research undertook **innovative experiment**s in dimensional typography. | **1** | **8** |
| | | | | Numerous **experiment**s followed that challenged typographic norms. | **1** | **8** |
| 67-79 | Aušra Burns | Emotion and Urban Experience: Implications for Design | | The diversity of these concerns does not signify to me a loss of direction in design, nor a retreat to formal **experimentation**s. | **1** | **7** |

**Table C.4:** Content Analysis of Design Issues, Vol. 17, No. 1. (Winter, 2001)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 54-66 | Dietmar R. Winkler | Modernist Paradigms Never Die, They Just Fade Away | | This century, at its start, acknowledged the sum of good and bad human intentions, conservative and adventurous ideas, constructive and destructive inventions, and the ambitious social engineering and **experimentation** which became, in some instances, culture sustaining and, in others, pernicious. | **1** | **12** |
| | | | | Martin Luther's emancipation of commoners, and Gutenberg's publishing venture and disseminating the resulting of knowledge, finally lead to the American social **experiment** and example-following declarations of independence. | **1** | **12** |
| | | | h | The Social **Experiment** | **1** | **12** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | However, existentialism is a principal energy of the times, and the turn of the century could not define itself without the introduction of new scientific, philosophical, and social ideas, giving rise to, and permission for, energetic **experimentation**. | **1** | **12** |
| | | | | The road to equality is littered with failed **experiment**s. | **1** | **12** |

**Table C.5:** Content Analysis of Design Issues, Vol. 17, No. 2. (Spring, 2001)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 17-31 | Fujita Haruhiko | Notomi Kaijiro: An Industrial Art Pioneer and the First Design Educator of Modern Japan | | The pottery was a success as a place for **experiment**s and education, but a failure as a business, and finally closed in 1882. | **2** | **1** |
| | | | | Instead, they took "**Experiment**s," "Mechanics," and "Analyses." | **1** | **11** |
| | | | | He also tried to use his influence in the interest of Takaoka crafts with his own design **experiment**s. | **2** | **1** |
| 64-80 | Wolfgang Jonas | A Scenario for Design | | The scenario can be considered as an **experimental** stage set for design and planning practice, and a conceptual framework for disciplinary development. | **2** | **2** |
| | | | | Design is not science because it does not offer new explanatory models of reality, but changes reality more or less purposefully, and yet the **experimental** process of research resembles the design process. | **2** | **2** |
| | | | | But it also provides the theoretical basis for the observer in any **experiment**--or the designer in any design-as being involved in a circular, feedback process in which the observer's description and the **experimental** arrangement's behavior interact and modify each other until they are in apparent agreement, allowing predictions to be made (inductively) without the need for any recourse to "truth." | **2** | **2** |
| | | | | The project, as a more or less arbitrarily cut out piece of the continuous flow of time, delivers the **experimental** setting or framework for research. | **2** | **2** |

**Table C.6:** Content Analysis of Design Issues, Vol. 17, No. 3. (Summer, 2001)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 3-14 | Rob Roy Kelly | The Early Years of Graphic Design at Yale University | | Alexey Brodovitch emphasized **experiment**s. | **1** | **8** |
| 26-34 | Oğuzhan Özcan; Lale Akarun | Mathematics and Design Education | | The laboratory session enables the students to visualize the mathematical forms, and to **experiment** with the mathematical form in creating new designs using this visualization tool. | **2** | **2** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | The visualization laboratory module for this topic enables students to **experiment** with placing points and drawing lines on the screen. | **2** | **2** |
| | | | | Different options enable the students to **experiment** with random numbers and special functions to specify these coordinates; encouraging them to create different designs using mathematical formulas. | **2** | **2** |
| | | | | The visualization laboratory module enables students to **experiment** with drawing polygons with specific angles. | **2** | **2** |
| | | | | Visualization laboratory **experiment**s let the students model 2D objects with the selected number of Bezier curve segments. | **2** | **2** |
| | | | | Visualization laboratory **experiment**s enable students to change the position of viewpoint and position of objects, and to see the resulting change in perspective projections of objects. | **2** | **2** |
| | | | | In the visualization laboratory, students **experiment** with parameters to create different forms, and use intersections with each other and with planes to visualize cross sections. | **2** | **2** |
| 40-48 | Claire Hoertz Badaracco | George Salter's Book Jacket Designs, 1925-1940 | | Salter's early jackets completed in Germany for the firm of Fischer demonstrate that he, like Jan Tschichold, had been deeply impressed by the 1923 Weimar Bauhaus exhibition, and earlier **experiment**s by El Lissitzky and Laszlo Moholy-Nagy with the form of the book, including typo-photo (type superimposed on a photo), and the kinetic power that could be conveyed through design, as in Der Tunnel by Bernhard Kellermann (see figure 1). | **1** | **8** |

**Table C.7:** Content Analysis of Design Issues, Vol. 17, No. 4. (Autumn, 2001)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 3-23 | Richard Buchanan | Design Research and the New Learning | | Ten years of experience in what we call "integrated product development," involving collaboration with faculty from engineering and marketing in an **experimental** studio course has played a critical role. | **2** | **3** |
| 32-43 | Tomás Maldonado | Taking Eyeglasses Seriously | | The craftsmen of Venice, the most highly skilled in all of Europe in the 1300s, most probably could have progressed, after a brief period of **experimentation**, to the production of the latter typology, without excessive difficulties. | **2** | **1** |
| 44-50 | Nigel Cross | Can a Machine Design? | | The project was based on getting designers (architects) to attempt a small design project in **experimental** conditions (like the protocol studies and similar studies that have grown up since that time). | **3** | **2** |
| | | | | The designers who participated in these **experiment**s were not told what to expect from the "computer," nor given any constraints on what they might choose to ask of it. | **3** | **2** |
| | | | | I conducted ten such **experiment**s, which lasted about one hour each. | **3** | **2** |
| | | | | The number of messages sent in each **experiment** was quite low, with normally several | **3** | **2** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | minutes elapsing between requests from the designer. | | |
| | | | | Despite this apparently easy pace of interaction, all of the designers reported that they found the **experiment**s hard work and stressful. | **3** | **2** |
| | | | | I also tried a few variations from my standard **experiment**s. | **3** | **2** |
| | | | | I devised **experiment**s in which fully-automatic computer programs, un-aided humans and human designers aided by interactive layout programs tackled the same layout problems. | **3** | **2** |
| 51-71 | Wendy Siuyi Wong | Detachment and Unification: A Chinese Graphic Design History in Greater China Since 1979 | | Figure 2. Chen Fong. Victory. **Experimental** Poster, 1998. | **1** | **8** |
| 72-88 | Carma R. Gorman | Reshaping and Rethinking: Recent Feminist Scholarship on Design and Designers | | For example, rather than displaying the massproduced glasses Francis Higgins designed for the Dearborn Glass Company, Kirkham instead chose to exhibit one of Higgins's studio glass "**experiment**s." [31] | **2** | **1** |

**Table C.8:** Content Analysis of Design Issues, Vol. 18, No. 1. (Winter 2002)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 49-61 | Cal Swann | Action Research and the Practice of Design | | The evidence from the **experiment**s suggested that scientists problem-solve by analysis, whereas designers problem-solve by synthesis; scientists use “problem-focused” strategies and designers use “solution-focused” strategies. | **3** | **2** |

**Table C.9:** Content Analysis of Design Issues, Vol. 18, No. 2. (Spring 2002)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 3-16 | Michael Golec | A Natural History of a Disembodied Eye: The Structure of Gyorgy Kepes’s Language of Vision [1] | | In addition to Helmholtz’s influence, Kepes’s notion of a unified vision borrowed directly from the **experiment**s of gestalt psychology. | **1** | **12** |
| | | | | As examples of radically disintegrative practices, Kepes supplied the image/text **experiment**s of Dada and the surrealist’s dialectic of the conscious and the unconscious of surrealism. | **1** | **10** |
| | | | n | 44) The gestalt psychologist, Wolfgang Köhler, as part of the Prussian Academy Study of Science, conducted **experiment**s on anthropoid apes on the Island of Tenerife. | **1** | **12** |
| 46-56 | Sharon Helmer | Between Word and Deed: The ICOGRADA Design Education | | Often associated with utopian ideals or avant-garde **experiment**s, a manifesto more often than not is received with skepticism. | **5** | **3** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Poggenpohl; Sang-Soo Ahn | Manifesto, Seoul 2000 | | | | |
| | | | | To this end, it must move from being teaching centered to a learning-centered environment which enables students to **experiment** and to develop their own potential in and beyond academic programs. | **2** | **3** |
| 57-64 | Fiona J. Doloughan | The Language of Reflective Practice in Art and Design | | At one level we are dealing here with a problematic which holds for all research projects, that is the relationship between data and analysis of data, and between the creation of an **experimental** situation and commentary on the processes and results of enquiry. | **2** | **2** |

**Table C.10:** Content Analysis of Design Issues, Vol. 18, No. 3. (Summer 2002)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 43-57 | Uday Athavankar | Design in Search of Roots: An Indian Experience | | Constrained by low-profile design activity that does not give adequate opportunity to their passion and creative instincts, some designers have **experiment**ed with design plus limited manufacturing, as well as the marketing of the custom built products. | **2** | **1** |
| | | | | In India, small groups of independent designers are becoming conscious of their cultural roots, and are **experimenting** by developing a new language in architecture, furniture, product, and fashion design. | **2** | **1** |
| 58-61 | Lance Hosey | H A L O communication booth [1] | | The modernist **experiment** did not break down old patriarchal barriers; it reinforced them to a degree never before imagined. | **1** | **12** |

**Table C.11:** Content Analysis of Design Issues, Vol. 18, No. 4. (Autumn 2002)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 3-13 | Jodi Forlizzi; Cherie Lebbon | From Formalism to Social Significance in Communication Design | n | 9) In Zoe Strickler, "Elicitation Methods in **Experimental** Design Research" in Design Issues XV: 2 (Summer 1999): 27, provides a working model for design research related to communication design. | **1** | **7** |
| 14-23 | Simon Jackson | The "Stump-jumpers:" National Identity and the Mythology of Australian Industrial Design in the Period 1930–1975 | n | 23) W. Shaw and Olaf Ruhen, Lawrence Hargrave: Explorer, Inventor & Aviation **Experiment**er (Stanmore, NSW: Cassell, 1977). Leo Port, Brian Murray, and Brian Carroll, Australian Inventors (Stanmore, NSW: Cassell Australia, 1978). | **2** | **1** |
| 31-45 | Laetitia Wolff | Massin in Continuo: A Dictionary Interview with Robert Massin | | Massin, the unclassifiable free thinker. Not a mere dabbler, but rather a passionate amateur who has excelled in graphic design, art direction, book design, typographical **experiment**s, fiction and memoir writing, photography, and musicology, as well as | **1** | **8** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | enlightening professional treatises on design. | | |
| | | | | He edited book series and redesigned major book publisher's logos (NRF, Laffont). He shattered the linear nature of the book by **experimenting** with typographic interpretation (La Cantatrice Chauve), breaking the basic conventions of book layout. | **1** | **8** |
| | | | | The title for the exhibit (Massin In Continuo: A Dictionary) emerged as I was going through fifty years of his work, spanning graphic design, art direction, typographical **experiment**s, fiction and memoirs writing, photography, and musicology, etc. | **1** | **8** |
| | | | | For instance, the L'Imaginaire collection is one of my favorite and most **experimental** designs at Gallimard. I used the metaphor of music variation more than once to describe it. | **1** | **8** |
| | | | | I certainly did not invent expressive typography, but I brought it to a new level, in book length, almost making a new medium out of it. In contrast with my full-time job at Gallimard, which implied a certain restriction, my **experimental** type work was a recess, a release, by breaking graphic and book rules. | **1** | **8** |
| | | | | Massin: My type **experimentation** was clearly a reaction to the overwhelming German-Swiss school, with predominant personalities such as Hollenstein, a Swiss professor of design based in Paris and Frutiger who were very influential in Paris in the '60s, in the art and schooling system, and in the press (e.g., Graphis) | **1** | **8** |
| | | | | LW: Would this **experiment** have been possible without the complicity of the literary masters? | **1** | **8** |
| | | | | LW: How different is your graphic **experiment** with musical scores, such as Edith Piaf's song "La Foule" (1966), or most recently Schoenberg's "Pierrot Lunaire" (2001)? | **1** | **8** |
| 48-53 | Giovanni Anceschi | Introduction to Enzo Paci's Presentation at the 10th Triennial | | At the mythical Bar Jamaica in Brera, as in the most exclusive salons, the future movie star Mariangela Melato would sit next to the proto-cybernetics scientist Silvio Ceccato, the ultra avant-garde painter Piero Manzoni next to the **experimental** writer Germano Lombardi, the journalist Paolo Murialdi next to the musicologist Roberto Leydi, the graphic designer Max Huber next to the model Fleur Jeggy, the architect Vittorio Gregotti next to the electronic poet Nanni Balestrini, and the silversmith next to the mime, the industrialist next to the philosopher. | **1** | **10** |

**Table C.12:** Content Analysis of Design Issues, Vol. 19, No. 1. (Winter 2003)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 5-24 | Alejandro Tapia | Graphic Design in the Digital Era: The Rhetoric of Hypertext | | The new stylistic rules of electronic writing also must be taken into consideration, and its own norms by which its stylistic and cognitive clarity are established. In spite of the **innovation**s and **experimental** procedures which are taking place through computers and their connection to the Worldwide Web, and despite the possibility of digitally | **4** | **1** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | manipulating information, a new canon is being drawn up, a canon that does not contradict the classical discursive sources of the Western world, but is in tune with them. | | |
| 25-35 | Janin Hadlaw | The London Underground Map: Imagining Modern Time and Space | | The era of monopoly capitalism generally is thought to have its beginning in the last quarter of the nineteenth century and extending to World War II, roughly the same period that saw the earliest **experimentation** with electrified urban transportation and the eventual mergers and consolidations of local transit lines into extensive regional networks administered by corporations such as the London Transport Passenger Board (LTPB). | **1** | **9** |
| 57-61 | Kostas Terzidis | Hybrid Form | | The power of computation is in its ability to extend the human mind, and set the stage for **experimentation** into through its mirror image. | **1** | **11** |
| | | | | Most important of all, they lead to the creation of computational schemes, which are available for **experimentation**, analysis, or play across disciplines. | **1** | **11** |
| 72-88 | Gabriela Goldschmidt | The Backtalk of Self-Generated Sketches | | However, when attempting to represent something new, or when **experimenting** with new materials or media, children abandon their conventional representation behavior. [5] | **2** | **2** |
| | | | f | The **experimental** drawing is more concerned with the act of drawing, and when **experimenting**, children are likely to attribute after-the-fact interpretations of their drawings. | **2** | **2** |
| | | | | Later on in childhood, **experimentation** and uncertainty trigger similar inference of representational meaning, as the **experimental** act produces results which are not entirely anticipated. | **2** | **2** |
| | | | n | 7) **Experiment**s with nine-to ten-year-old children who built three-dimensional “models” that represented invented houses for a heroine of a well-known children’s story, yielded similar tendencies (see Goldschmidt, “Development”). | **1** | **12** |
| | | | | The **experiment**er asked what a “town of the past” was, and Naomi replied that they have “lots of tall towers.” | **3** | **2** |
| | | | f | The **experiment**er, who sought to reach a better understanding of the appearance of tall buildings in the scene, asked about them again in the debriefing after the session. | **3** | **2** |
| | | | | She seemed to not comprehend what it is that the **experiment**er could have possibly failed to understand. | **3** | **2** |
| | | | f | Since she could not have inferred her vision of “tall towns” from the photograph, the **experiment**er speculated that she could have been under the influence of a previous “drawing game” played a few hours earlier, in which the source was a painting by Heronimus Bosch that features towers. | **3** | **2** |
| | | | | In the debriefing the **experiment**er asked Naomi: “...both have long hair, right?” | **3** | **2** |
| | | | | The **experiment**er asked Naomi to look at the photo again and asked: “Is it like that in the photo as well?” | **3** | **2** |
| | | | | The **experiment**er asks whether a lot of hair is prettier, and Naomi confirms: “Yes, like in her [W2] opinion.” | **3** | **2** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Naomi did not remember that a few weeks earlier she attempted a portrait of the **experiment**er, who happens to have curly hair. | **3** | **2** |
| | | | | In the debriefing, the **experiment**er returned to this issue and asked why the girlfriend [W2] had a dress with a heart. | **3** | **2** |
| | | | | The **experiment**er wondered: "But the one who is his girlfriend or his wife has a big heart, and the other one has a small heart?" | **3** | **2** |
| | | | f | Naomi came up with an unexpected answer, which she elaborated on when the **experiment**er asked what made her think that the woman was pregnant: | **3** | **2** |
| | | | | It also is possible that it was the **experiment**er's question that triggered the pregnancy response. | **3** | **2** |
| | | | | The desire to **experiment**, and to revise and look for alternatives which the activity of free-hand rapid sketching supported, of course was in perfect harmony with the **innovative** spirit of the renaissance. | **4** | **2** |
| | | | | In each **experiment**, three shapes were drawn from a set of 15. | **3** | **2** |
| | | | n | 22) See, for example, V. Kokotovich and T. Purcell, "Ideas, the Embodiment of Ideas, and Drawing: an **Experimental** Investigation of Inventing" in J. S. Gero, B. Tversky, and T. Purcell, eds., | **2** | **2** |
| | | | n | 25) D. Chambers and D. Reisberg, "Can Mental Images Be Ambiguous?" Journal of **Experimental** Psychology: Human Perception and Performance, 11 (1985): 317–28. | **1** | **12** |
| | | | | Moreover, the expert designer knows from experience what kind of display might prove useful and, without curtailing his or her propensity for **experimentation**, may avoid a cognitively costly search from which no useful outcome may be expected. | **2** | **2** |
| | | | | By using overlays, the designer achieves great flexibility in performing a variety of transformational acts she may choose to exercise and **experiment** with (e.g., shifting, rotating, and flipping over a layer in relation to other layers). | **2** | **2** |
| | | | f | It also supports **experimentation** in that layers may be easily removed (discarded or saved for future reference), should an idea prove futile. [33] | **2** | **2** |
| | | | | Experienced designers do not require an external prompt such as an **experiment**er's question to infer meaning from a sketch: they produce the sketch in order to have a dialogue with it, and the sketch's backtalk is the reward they get for bringing it into being. | **3** | **2** |

**Table C.13:** Content Analysis of Design Issues, Vol. 19, No. 2. (Spring 2003)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 5-16 | Kirsten Strom | Reading Scott Makela: The Subversion of Dyslexic Deconstruction[1] | | Thus, even in an age characterized by the rise of discourses of graphic design and widespread typographic **experimentation**, the classical, or absorptive, paradigm—and the hierarchy it implied— would seem to have held fast to its ground. | **1** | **8** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | To support this latter claim, one might note that such **experiment**s primarily have been theorized in rather simplified terms as "subjective," or as symptoms of a distraction-laden, channel-surfing culture out of control. | **1** | **8** |
| 60-63 | Sherry Blankenship | Cultural Considerations: Arabic Calligraphy and Latin Typography | | Due to continued resistance, the spirit of creative **experimentation** has been ignored. | **2** | **1** |
| 76-80 | Kostas Terzidis | Hybrid Form | | The power of computation is in its ability to extend the human mind, and set the stage for **experimentation** into the unknown. | **2** | **2** |
| | | | | Most important of all, they lead to the creation of computational schemes, which are available for **experimentation**, analysis, or play across disciplines. | **2** | **2** |

**Table C.14:** Content Analysis of Design Issues, Vol. 19, No. 3. (Summer 2003)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 21-36 | Laurent Gutierrez; Valerie Portefaix | Homes for China | | From this evident juxtaposition, there is no doubt that lack of land and a growing population has provided the perfect context with which to **experiment** with new forms of densities. | **1** | **9** |
| | | | | In 1928, the first initiative came from the Union of Contemporary Architects—OSA—which built the Narkomfin Apartment Building, an **experimental** commune house in Moscow. | **1** | **9** |
| | | | n | Figure 1) Bloc 2: Private high rise housing development in Cahi Wan, Hong Kong island. "Lack of land and a growing population have provided the perfect context with which to **experiment** with the forms of density. | **1** | **9** |
| | | | | Unfolded as an **experimental** field, it is the place where the theme applied to the whole development is disclosed. | **1** | **9** |
| 48-58 | Benny Ding Leong in conversation with Hazel Clark | Culture-Based Knowledge Towards New Design Thinking and Practice—A Dialogue | n | 15) The three levels of study referred to hypotheses, theories, methods, and tools: (B) "Macro-relations" led to **experiment**s with the concept of "Relational Analysis," i.e., the methodology which emphases the process of research and the analysis of five key elements (people, place, time, objects, and circumstances or matters identified in the Book of Changes—I Ching—three thousand years ago,) in designing products and services. | **2** | **1** |
| | | | | BL: Chief among these was the Things East-West design exhibition, which was the most comprehensive and systematic of my design **experiment**s. [16] | **2** | **1** |
| | | | n | 16) Thirteen **experimental** designs were shown as the preliminary outcome of five years of research. | **2** | **1** |
| | | | f | Every piece was an **experiment** in the creative conception of traditional cultural | **2** | **1** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | “revitalization” and the application of “cultural integration” strategies. | | |
| | | | | BL: In the Things East West design **experiment**, the intention and motive of cultural integration was to revitalize and renovate the parent (Chinese) culture, to instill it with vitality, and to evolve a new model of product design practice by incorporating methodologies current in contemporary Western culture. | **2** | **1** |
| | | | | BL: Yes, the Double-happiness condiment set was one of my earlier **experimental** pieces that fused the outer (material) level of classical Chinese paper-cutting (applied to the figures) with the mid (behavior) level of Western food culture—the practice of making salt and pepper available at the table to flavor food. (Figure 7) | **2** | **1** |
| | | | f | For Things East West, I evolved a series of **experimental** designs (Figure 8). | **2** | **1** |
| | | | | BL: I have spent five years on the inception of the ideas, practical design **experimentation**, and the construction of the theoretical prototype. | **2** | **1** |
| 59-70 | Ezio Manzini | Hong Kong as “Laboratory of the Future” | | Among the many implications of this new condition of existence, one is particularly interesting to us here: its economic and social **experiment**s are no longer doomed to confinement within the place that generated them, but can easily migrate and influence other parts of the planet. | **2** | **1** |
| | | | | It could be, and in many ways it is already, the best **experimental** field for observing what happens, and what could happen, with the highest density and the highest connectivity within a mixed, non-Western and Western, culture. | **2** | **1** |
| | | | | But if there will be a place in which new **experiment**s in this direction can occur, the place will be Hong Kong. | **2** | **1** |
| | | | f | Even if its business and consumption-oriented way of living appear in opposition to the list of the “good Chinese ideas,” Hong Kong has the potentiality to be a test-field for the most advanced **experiment**s. | **2** | **1** |
| | | | | When and how these **experiment**s will take place, what their results will be, and what influence they will have on other Chinese and non-Chinese regions are crucial questions that cannot be answered here. | **2** | **1** |
| | | | | As yet, the result of these **experiment**s remains open, but the potential is rich. [70] | **2** | **1** |
| 83-93 | Siu King Chung | Redeveloping Design Education in Hong Kong? | n | 29) In the brochure, it is stated: “A section of the exhibition features the students’ interpretations of these rules and principles (Fundamental Design Section); another section features the students’ personal **experiment**s with these rules and principles (Creative Design Section); and the last section shows how these rules and principles are applied to practical problems (Applied Design Section).” | **2** | **1** |
| | | | t | **Experimental** Design | **2** | **1** |
| | | | | The characteristic (like that of traditional art training) is to allow ample Space for **experimentation** and creativity without actually becoming involved in the complicated processes of manufacturing. | **2** | **1** |
| | | | | 33) It was thought that it would be advantageous for students studying in this area to | **2** | **1** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | have ready access to the engineering and technology workshops to do technical processes in their **experiment**s on materials, and in making prototypes of their designs. | | |
| | | | | As for facilities, the suggestion of the Advisory Panel was to establish: a mechanical workshop; an electrical engineering workshop; a tailoring and dressmaking workshop; a dye, roller-print, and weave workshop; a press-print and **experimental** workshop; a timber workshop; a paint workshop, a plaster workshop; and a photography workshop with darkroom. | **2** | **1** |
| | | | | They would not necessarily have been able to conceive course materials and projects relevant to a comprehensive context of industrial production; or it would have been difficult for them to apply creative **experimental** outcomes to specific industrial and commercial settings. | **2** | **1** |

**Table C.15:** Content Analysis of Design Issues, Vol. 19, No. 4. (Autumn 2003)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 3-8 | Dennis P. Doordan | On Materials | | Our modern partnership between science and industry, with the great expansion of research laboratories and **experimental** stations through which it works, is able to meet our needs with reasonable promptness ... so that our repertoire of available resources is far more extensive than any possessed by designers heretofore. [2] | **2** | **9** |
| 9-18 | Bruce Hanington | Methods in the Making: A Perspective on the State of Human Research in Design | n | 1) See, for example, the argument put forth by Strickler regarding suspect reliance by graphic designers on "specialist" design intuition. Zoe Strickler, "Elicitation Methods in **Experimental** Design Research," Design Issues 15:2 (Summer, 1999): 28. | **1** | **8** |
| | | | t | **Experiment**s | **3** | **2** |
| | | | | The **experiment** as a research strategy rarely is used by designers, yet several intentions behind it serve to provide lessons of good practice for all research. | **3** | **2** |
| | | | f | For instance, the **experiment** draws attention to tradeoffs made between control and realism, and argues for rigor in research protocol. | **3** | **2** |
| | | | | Within my own teaching and consulting, the **experiment** is studied as a foundational tool for critical insights in both planning and evaluating research, assessing when and why control over variables is necessary and appropriate, and determining a suitable balance between rigor and relevance. | **3** | **2** |
| 44-56 | James Fathers | Peripheral Vision: An Interview with Gui Bonsiepe Charting a Lifetime of Commitment to Design Empowerment | | However, it was not motivated by this abortion of one of the most influential **experiment**s in design education in the second half of the last century. | **3** | **3** |
| 57-71 | Sarah Teasley | Furnishing the Modern Metropolitan: Moriya Nobuo's | n | 55) The promotion of a lifestyle based on chairs for increased efficiency in the home remained part of these new design movements, and some chairs did take off—desk sets | **2** | **9** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Designs for Domestic Interiors, 1922–1927 | | for children are a good example—but production remained largely **experimental**. | | |

**Table C.16:** Content Analysis of Design Issues, Vol. 20, No. 1. (Winter 2004)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 10-11 | Victor Margolin | Introduction 1984 | | There will also be space in the journal for visual material—**experimental** typography, drawings, sketches for objects, and so forth. | **1** | **8** |
| 16-29 | Nigan Bayazit | Investigating Design: A Review of Forty Years of Design Research | n | 50) M. Langfort, Personal Hygiene Attitudes and Practices in 1000 Middle-Class Households (Ithaca, New York: Cornell University Agricultural **Experiment** Station, New York State College of Home Economics, 1965). | **1** | **7** |
| | | | | One of the first social research studies was conducted at the Cornell University Agricultural **Experiment** Station on one-thousand army personnel to investigate hygienic behaviors and attitudes. [50] | **3** | **1** |

**Table C.17:** Content Analysis of Design Issues, Vol. 20, No. 2. (Spring 2004)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 4-17 | Federico Freschi | Form Follows Façade: The Architecture of W. H. Grant, 1920–1932 [1] | | Although this conflation of art nouveau and classical styling has important implications for the later development of Grant's mature style, in its original context, it provided an interesting counterpoint to the pre-eminence of Herbert Baker's contemporary arts and crafts inspired **experiment**s with the Cape Dutch vernacular. | **1** | **7** |
| | | | | The nearby Rhodes Building of 1902 and the National Mutual Life Building of 1905, for example, implicitly emulated the empirical response to climate and context generated by Baker's arts and crafts inspired **experiment**s with the Cape Dutch vernacular. | **1** | **7** |
| 34-50 | Marian Sauthoff | Walking the Tightrope: Comments on Graphic Design in South Africa | | The aesthetics of "cultural mixing" perhaps are best exemplified by the local magazine i-jusi, [6] an open and **experimental** design platform first published in 1995. | **1** | **8** |
| | | | | The refinement of the **experimental** approaches adopted in i-jusi, and the crafting of a South African graphic idiom to meet specific communication and business objectives, mark the attitude and design strategies of a growing number of South African designers. | **1** | **8** |
| | | | | Coupled to aggressive digital **experimentation**, this attitude acknowledges the complexity of the emerging social and political climate within a specific urban environment. | **1** | **8** |
| | | | | **Innovative** practices in the magazine have tended to be interpreted as a pragmatic or | **4** | **1** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | **experimental** redirection of formal design production. | | |
| | | | | It typifies design **experimentation** in thinktank and scenario situations that foster a broad vision, **innovation**, connectivity, and inter- and cross-disciplinary participation centered around identified themes and alternative solutions to specified problems. | **4** | **1** |

**Table C.18:** Content Analysis of Design Issues, Vol. 20, No. 3. (Summer 2004)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 13-24 | Dean Nieusma | Alternative Design Scholarship: Working Toward Appropriate Design | | Discussing alternative housing **experimentation**, for instance, Wajcman argues, "The failure of this **experiment** in architectural solutions to the problems of women's domestic oppression... demonstrates that new, egalitarian architectural forms cannot simply be superimposed on a preexisting social order and be transformative in themselves." [30] | **1** | **7** |
| 25-39 | Todd Cherkasky | Design Style: Changing Dominant Design Practice | | In addition, the marginal design style works to limit the role of the automobile, combine land uses, and **experiment** with health-conscious and environmentally sound building materials and methods. | **1** | **7** |

**Table C.19:** Content Analysis of Design Issues, Vol. 20, No. 4. (Autumn 2004)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 57-67 | Anthony Crabbe | Contract Research in Design | | This diligent way also may involve a more complex "investigation and **experimentation** aimed at the discovery and interpretation of new facts, revision of accepted theories or laws in the light of new facts, or practical application of such new or revised theories or laws." [3] | **2** | **2** |
| | | | n | 12) J. Eysenck and G.D. Wilson, The **Experimental** Study of Freudian Theories (London: Methuen, 1973), 1–13. | **1** | **12** |
| 76-85 | Chris Rust | Design Enquiry: Tacit Knowledge and Invention in Science | | Through working with designers and scientists, and observing other such collaborations, I have come to the conclusion, a "passionate belief" if you like, that the ability of designers to imagine new scenarios, and to create a practical environment for us to experience them by producing **experimental** artifacts, is a valuable aid for scientists who want to identify ideas that merit investigation. | **1** | **11** |
| | | | | To illustrate this, I would like to give an example from research that included the **experimental** use of creative design practice, and resulted in the accumulation of artifacts that had been produced or employed in the research. | **3** | **2** |

**Table C.20:** Content Analysis of Design Issues, Vol. 21, No. 1. (Winter 2005)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 3-17 | T. W. Allan Whitfield | Aesthetics as Pre-linguistic Knowledge: A Psychological Perspective | | Furthermore, it approaches aesthetics from perhaps the unusual standpoint of **experimental** psychology; that is, from a vantage point in which theory construction must be subject to **experimental** verification. | **1** | **12** |
| | | | | The dominance of behaviorism and later cognitivism relegated aesthetics to obscurity, despite its illustrious beginnings in 1876 as the second published area of **experimental** psychology. | **1** | **12** |
| | | | | While a number of studies within **experimental** psychology provided support for Berlyne's theory, by the 1970s, a growing body of results was inconsistent. | **1** | **12** |
| | | | f | Most of the research supporting Berlyne's model derived from studies involving people's responses to stimuli that normally only would be encountered in an **experimental** situation; for example, dot patterns and random polygons, the type of atomistic material then favored in **experimental** psychology. | **1** | **12** |
| | | | f | While Berlyne's model achieved success in explaining the results of **experiment**s using such stimuli, it had difficulty with research that involved responses to real-world objects such as paintings, buildings, and furniture. | **1** | **12** |
| | | | n | 16) C. Martindale and K. Moore, "Priming, Prototypicality, and Preference," Journal of **Experimental** Psychology: Human Perception and Performance 14 (1988): 661–670. | **1** | **12** |
| | | | n | 21) T. W. A. Whitfield, "Predicting Preference for Familiar, Everyday Objects: An **Experimental** Confrontation between Two Theories of Aesthetic Behavior," Journal of Environmental Psychology 3 (1983): 221–237. | **1** | **12** |
| | | | n | 26) L. W. Barsalou, "Ideals, Central Tendency, and Frequency of Instantiation as Determinants of Graded Structure in Categories," Journal of **Experimental** Psychology: Learning, Memory, and Cognition 11 (1985): 629–654. | **1** | **12** |
| | | | | If little else, research in **experimental** psychology has demonstrated conclusively that people will, when presented with the most disembodied of stimuli (colors, lines, polygons, etc.), make aesthetic judgments. | **1** | **12** |
| | | | | The pictogram previously seen was more likely to be preferred, even though subjects in the **experiment** could not remember seeing it. | **1** | **12** |
| 32-40 | Carl Mitcham | Thinking Re-Vernacular Building | n | The other two volumes: A Pattern Language: Towns, Buildings, Construction (New York: Oxford University Press, 1977); and The Oregon **Experiment** (New York: Oxford University Press, 1975). Roger Scruton in The Classical Vernacular: Architectural Principles in an Age of Nihilims (New York: St. Martin's Press, 1994) nevertheless finds Alexander's project excessively rationalist. | **1** | **7** |
| 41-62 | Barbara | Before the New Bauhaus: From | | Although the University at first offered neither practical courses in art nor courses in art | **1** | **12** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Jaffee | Industrial Drawing to Art and Design Education in Chicago | | history, it did make manual training, along with cooking and sewing, the basis of regular instruction for very young children at the **experimental** school opened by the young John Dewey, professor and head of philosophy and pedagogy in 1895. | | |
| 63-80 | Thomas Leslie | The Pan Am Terminal at Idlewild/Kennedy Airport and the Transition from Jet Age to Space Age | | While airlines had previously **experiment**ed with advertising and identity to distinguish themselves from one another, the extraordinary efforts of Pan Am in the 1950s indicate the anxiety of the corporation to apply an all-encompassing gloss to what, at least for some, was a disorienting new mode of travel. | **1** | **9** |

**Table C.21:** Content Analysis of Design Issues, Vol. 21, No. 2. (Spring 2005)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 28-47 | Andrew M. Shanken | From the Gospel of Efficiency to Modernism: A History of Sweet's Catalogue, 1906–1947 | n | 71) L. V. Brooks, "An **Experiment** in Sweet's Advertising" (April 30, 1942), Sutnar Papers, Box 10, Folder 5. | **1** | **9** |
| | | | | "In trying this **experiment**," he concluded, "we are consciously violating all past theories of advertising—that you must address yourself to an eleven-year[-old] mentality; that your advertisement should show in three seconds what it is about." [78] | **1** | **9** |
| | | | | They're cheap, ephemeral, and easy to change from one printing to the next, which makes them more susceptible to **experimentation** than their more cumbersome three-dimensional masters, buildings. | **1** | **9** |
| 48-62 | Michael Punt | What the Film Archive Can Tell Us About Technology in the Post-digital Era | | Add to this the Lumières' obsession with carbon chemistry and their poly-dimensional approaches to **experiment**s with three-dimensional and color photography, the cinématographe begins to take on the character of a technology whose meaning in relation to entertainment is shaped not by its inventors, but in the course of its entry into a particular public arena and appropriation by audiences and exhibitors. | **1** | **10** |
| | | | | Full (scientific) descriptions of the cinématographe had been in the public domain from at least as early as August 1895, and similar devices had been featured in popular science journals in the previous years. (Indeed, it is fair to assume that anyone sufficiently interested to pay to be astonished by the cinématographe hardly would have missed some of the hundreds of diversions and **experiment**s that are said toinform the prehistory of the cinema). | **1** | **10** |
| | | | | Public demonstrations of telepathy ranged from the scientifically controlled **experiment** to the "turn" in a variety show. The former stage medium and one-time secretary to Edmund Gurney of SPR, G. A. Smith began making films in Brighton some time after he was exposed as a fraud. [3] | **1** | **10** |

**Table C.22:** Content Analysis of Design Issues, Vol. 21, No. 3. (Summer 2005)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 25-48 | Birgit Helene Jevnaker | Vita Activa: On Relationships between Design(ers) and Business | | This philosophy is rooted in **experimentation** and, since the 1970s,[49] designers, inventors, and middle managers supporting and even fighting for the new and unconventional design approach have proactively enacted and tried to make sense of the user's sitting problems. [50] | **2** | **6** |
| 49-66 | Sherwin Simmons | Ernst Neumann's "New Values of Visual Art": Design Theory and Practice in Germany at the Turn-of-the-Century | | Paul Westheim praised him as a leader of artistic printmaking, known for his **experimentation** and **innovative** teaching, and also as the creator of distinctive posters, such as his large advertisement (figure 1) for an appearance of the dancer Sarharet in 1903 at the Wintergarten in Berlin. [2] | **4** | **1** |
| 67-81 | Loe Feijs and Frithjof Meinel | A Formal Approach to Product Semantics with an Application to Sustainable Design | | Guenand and Capell Zapata [14] [Guenand etal.] investigated **experimental** methods to evaluate product semantics. | **2** | **2** |

**Table C.23:** Content Analysis of Design Issues, Vol. 21, No. 4. (Autumn 2005)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 1-3 | Martha Scotford | Introduction: Indian Design and Design Education | | Poonam Bir Kasturi, an educator experienced in consultation to craft practices, disputes some of the myths associated with "contemporizing" craft, and addresses the future through example: collaborations that include broad creativity training (reflection, critical thinking, and **experimentation**); bringing student groups to talk and work with craftspeople (another form of the fieldwork mentioned by Balaram); careful choices of new markets to maintain makers' identity and to avoid the social destabilization of craft communities. | **2** | **3** |
| 4-10 | Ashoke Chatterjee | Design in India: The Experience of Transition | | His "**experiment**s with truth" began in Ahmedabad, **experiment**s intended to bring freedom to his subjugated people and to build a society that could "wipe every tear from every eye." | **1** | **12** |
| 11-22 | Singanapalli Balaram | Design Pedagogy in India: A Perspective | | As caste-based craft learning began to suffer due to the onslaught of industrial production, Gandhi himself and other Indian intellectuals started **experimental** schools and **innovative** pedagogy. | **4** | **3** |
| | | | | Notable among others was Nobel laureate poet Rabindranath Tagore, who established in Bengal his Santiniketan, an **experimental** university for arts, crafts, and design. | **2** | **3** |
| | | | | Much of the design education in India is project-based; students are encouraged to take an empirical, intuitive approach to design problems and to **experiment** freely with new forms, new materials and processes, and to develop original, creative thinking. | **2** | **3** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Similar **experiment**s continue at India's design institutions with materials such as palm leaf, jute fiber, and bamboo; all abundant in India. | **2** | **3** |
| 68-77 | Poonam Bir Kasturi | Designing Freedom | | I used design and art pedagogy to "teach" creativity, reflection, critical thinking, analysis, exploration, and **experimentation**. | **2** | **3** |
| | | | | 3. Also, a school is a space where multiple stakeholders can converge, and since its primary function is learning, the environment is right for **experimenting**, investigating, and making mistakes. | **2** | **3** |
| 78-93 | Gaurav Mathur | Signboards as Mirrors of Cultural Change | | The boom in the local cinema industry, now known as "Bollywood," also provided the painters with much work, and gave them an opportunity to **experiment** and develop a unique visual language. | **1** | **10** |
| 94-105 | Nina Sabnani | The Challenges of a Sleeping Giant | | Animation didn't come to India in a significant manner until the 1950s, although there were pioneer filmmakers such as Dadasaheb Phalke, Gunamoy Banerjee, Jehangir Bhownagery, and Mandar Mallick,[1] to name a few who had **experiment**ed with animation. | **1** | **10** |
| | | | | In the late '50s, the Films Division made some really interesting films that **experiment**ed with the miniature painting style as in Radha and Krishna and the Ajanta fresco style as in The Banyan Deer. 2 | **1** | **10** |
| | | | f | The unit soon began to **experiment** with social awareness themes. | **1** | **10** |
| | | | | They can **experiment**, explore, and push the envelope, the results of which can feed the industry. | **1** | **10** |
| | | | f | The schools can become laboratories for **experimentation** with content, structure, and styles. | **1** | **10** |

**Table C.24:** Content Analysis of Design Issues, Vol. 22, No. 1. (Winter 2006)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 3-19 | Silvia Fernández | The Origins of Design Education in Latin America: From the hfg in Ulm to Globalization[1] | | The Di Tella Institute depended on the Center for Visual Arts (CAV), directed by Jorge Romero Brest, with the aim to promote initiatives and the works of artists with **experimental** character. | **1** | **10** |
| | | | | The development of design education in Peru is described by Teresa Gianella-Estrems, who was involved from the beginning:<br>(…)<br>The experiences of industrial design in the 1970s (the **experimental** housing project PREVI, first and second stage) received this impact; in the last period of the first stage of PREVI worked a foreign expert—an industrial designer of the post-Maldonado ulm worked there. | **1** | **9** |
| | | | n | **Experiment** mit Zeitzünder. Hochschule für Gestaltung Ulm. 1955–1968 (Munich: | **2** | **3** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Edition Disegno 1 [video-film], Schubert Filmproduktion, 1999). | | |
| | | | n | Jacob Heiner, "HfG Ulm: A Personal View of an **Experiment** in Democracy and Design Education," Journal of Design History 13: 4 (1988) (The Design History Society, Oxford University Press). | **2** | **3** |

**Table C.25:** Content Analysis of Design Issues, Vol. 22, No. 2. (Spring 2006)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 3-18 | John M. Carroll | Dimensions of Participation in Simon's Design | | He loved the **experiment**s on games such as number scrabble that showed the superiority of conceptually distinct, but logically identical, representations. | **2** | **2** |
| 35-55 | Genevieve Bell | Satu Keluarga, Satu Komputer (One Home, One Computer): Cultural Accounts of ICTs in South and Southeast Asia | | Some households have augmented their use of e-mail, with instant messaging, and some are starting to **experiment** with voice-over-IP. [25] | **3** | **6** |
| 77-87 | Gérard Mermoz | The Designer as Author: Reading the City of Signs— Istanbul: Revealed or Mystified? | | The "City of Signs" **experiment** is particularly relevant because it moves the graphic design debate away from polemics, and onto the concrete ground of "critical design practice." [4] | **1** | **8** |
| | | | | By "aesthetic," I do not mean concerns about "seductive forms" and/or naive "self-expression" (the alleged attributes of "graphic **experimentation**," from Neville Brody to David Carson), but the complex set of possibilities which arise from the purposeful interaction between forms, ideas, and signs, and their interpretation. | **1** | **8** |
| | | | | This is quite different from those approaches in graphic design which, from Neville Brody to David Carson, have interpreted **experimentation** as a combination of formal play and self-expression. | **1** | **8** |

**Table C.26:** Content Analysis of Design Issues, Vol. 22, No. 3. (Summer 2006)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 4-17 | Kees Dorst | Design Problems and Design Paradoxes | | B. They include **experiment**s and simulation techniques. | **3** | **2** |
| 18-28 | Seçil ¸ Satir | German Werkkunstschules and the Establishment of Industrial Design Education in Turkey | | When the State School of Applied Fine Arts was established, it was a three-year educational institute similar to the Werkkunstschules in Germany, where **experimental** workshops were very important. | **2** | **3** |
| | | | | When Özisik started, he set up a "wood **experiment** workshop," [5] where he lectured on wood workmanship and its applications. | **2** | **3** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Also, there were **experiment**s with various materials. | **2** | **3** |
| | | | | They continued their teaching "to systemize a formalized Bauhaus instruction," where the definition of traditional art was classified as both handicrafts and industrial design, and rested upon the fundamental definitions of form developed at the Bauhaus, until the establishment of the Hochschule für Gestaltung Ulm in 1955, which included programs in the sciences, the theory of communication, sociology, the basic connections of shaping theory, systematical shaping **experiment**s, and specially developed designing methodology. [10] | **2** | **3** |
| | | | | Immediately following the preparatory class, the term was supplemented by **experiment**s with colors and form, and included musical training as an important part of strengthening a student's personal training. | **2** | **3** |
| | | | f | "**Experimental** Product Design" was a very important course for the departments, and worked in tandem with the contemporary facilities of handicraft and industrial design sectors. | **2** | **3** |
| | | | f | The course content consisted of the structure of the form (with samples and **experimental** parts), as well as construction work and form analyses. | **2** | **3** |
| | | | | These included naming the first five departments after the most distinctive five departments in the Werkkunstschules, starting instruction with the Basic Art Training course, and the initiation of "**experimental** workshops." | **2** | **3** |
| 29-41 | Elisa Giaccardi | Collective Storytelling and Social Creativity in the Virtual Museum: A Case Study | | The opportunities given to the museum by information and communication technologies require an investigation of the contemporary role of the museum, and then a challenge to this role through the production of **innovative** visions and **experimentation**s. | **4** | **1** |
| 48-65 | Nader Vossoughian | Mapping the Modern City: Otto Neurath, the International Congress of Modern Architecture (CIAM), and the Politics of Information Design | | A student of turn-of-the-century German sociology—the writings of Georg Simmel, Ferdinand Tönnies, and the Social Policy Association [Verein für Sozialpolitik]—he was a key player in the socialist uprisings in Munich in 1919, as well as Vienna's settlement movement during the early 1920s. In 1925, he gained funding from the Vienna municipality to open the Museum of Society and Economy, which still represents one of the most **innovative** cultural **experiment**s of the twentieth century. | **4** | **1** |
| | | | | Moholy-Nagy held a relatively favorable view of quantitative and empirical research methods in general, albeit with reservations. In 1922, he and his wife, Lucia, began **experimenting** intensely with photograms, a camera-less form of photography that involved projecting light onto a photosensitive surface. [19] | **1** | **10** |

**Table C.27:** Content Analysis of Design Issues, Vol. 22, No. 4. (Autumn 2006)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 1-3 | Bruce Brown; | Introduction | | Jubert argues that France "largely avoided the graphic design revolution, the new | **2** | **1** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Richard Buchanan; Dennis Doordan; Victor Margolin | | | typography movement, and the Bauhaus **experiment**s," and she investigates why. | | |
| 4-26 | Carma R. Gorman | Henry P. Glass and World War II[1] | n | 87) (…) The side chairs are Armour Institute of Technology's **experimental** models, black and shiny." | **2** | **6** |
| 35-47 | Barbara Predan | Design Theory in Slovenia: Mapping the Field | | After this program had been in operation for a year, Majda Dobravc, in an article entitled "The Training of Industrial Designers," observed, "This **experimental** year is significant for another reason, as well; it is intended to serve as the basis for the development of a design studies program in architecture, which we have never had before. | **1** | **7** |
| 66-80 | Roxane Jubert | The Bauhaus Context: Typography and Graphic Design in France | | With its spatio-temporal situation and its goals, the Bauhaus was able to imbue itself with European "isms" and set itself up as an **experimental** laboratory. | **1** | **8** |
| | | | | Off to the side of that Central European effervescence spread by the changes in graphic design and typography, France followed the **experiment**s with a certain reserve. | **1** | **8** |
| | | | | Charles Peignot, who took on the artistic direction of the establishment in 1923, notably used some **experimental** type fonts by Cassandre and founded the journal Arts et Métiers graphiques [The Arts and Graphic Professions] in 1927. 12 | **1** | **8** |
| | | | | Yet, he did not make the case for the Bauhaus's typographical **experiment**s, which would have been a challenge to the eyes of the French. | **1** | **8** |
| | | | | These diverse testimonials prove that France was well aware around 1929–30 of the **experiment**s at the school in Dessau—as well as Central European New Typography. | **1** | **8** |
| | | | | Renner was not a member of the Bauhaus, but the first sketches of his alphabet revealed preoccupations that were very close to those of its members; geometric forms constituted the first visible structure of its character, just as with the then unpublished **experimental** alphabets of Bayer (Universal), Josef Albers (stencils and combinatory writing [Kombinationsschrift]), 25 and Joost Schmidt. | **1** | **8** |
| | | | | Upon crossing the border and becoming "Europe," 27 Futura lost the expression of its projection into the future—the reflection of utopias and Central European **experimental** fumblings that France kept at a distance. | **1** | **8** |
| | | | | In such a context, how can we imagine that the much more radical **experimentation** of the Bauhaus movement could find a favorable reception in France? | **1** | **8** |
| | | | | For the European actors of the new typography, the association of type and photography offered new perspectives. Moholy-Nagy forged the notion of the "typophoto" in 1925, having begun to **experiment** with the two modes of expression in the early 1920s. [36] | **1** | **8** |
| | | | | In Germany, at the Bauhaus as elsewhere, the heat of the moment and interdisciplinary | **1** | **8** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | research stimulated the approach to all kinds of graphic and typographic objects: visual identities, books and journals, posters, the alphabet, **experimental** compositions, and other aspects of typography such as the inscription of text in space (volume, perspective, architecture, etc.). | | |
| | | | f | From 1925 onwards, the members of the Bauhaus took up the concept of **experimental** alphabets, which transformed their ideals. | **1** | **8** |
| | | | n | 38) Dating, respectively, from 1929, 1930, and 1937, the typefaces Bifur, Acier, and Peignot were produced by the Deberny & Peignot Foundry. These inventions came slightly later than the Bauhaus **experiment**s, which did not go beyond the planning stage and of Futura type. | **1** | **8** |
| | | | | At virtually the same moment in 1926, Cassandre opted for another alternative: "I don't know if **experimental** science has just decided against capital letters in favor of 'lowercase' [...] But I remain resolutely attached to capital letters. My architectural conception of the poster must necessarily orient my preferences [...] toward the primitive letter, the lapidary letter, [...] the true, the substantially monumental." [42] | **1** | **8** |
| | | | n | 40) (…) Questioning the omnipresence of the capital letter in the German language goes back to 1822 with Jacob Grimm's Deutsche Grammatik and other proposals of that nature—including the proposal of a single alphabet, suppressing upper case—were made at the beginning of the twentieth century, before the **experiment**s of the Bauhaus. | **1** | **8** |
| | | | | Many things seem to affirm, in one way or another, that France largely avoided the graphic design revolution, the new typography movement, and the Bauhaus **experiment**s. | **1** | **8** |
| | | | | The typography and graphic design of the Bauhaus, if they satisfied a number of internal realizations or exterior commissions and were very influential on their environment, first of all, they were a part of the desire for **experimentation**. [61] | **1** | **8** |

**Table C.28:** Content Analysis of Design Issues, Vol. 23, No. 1. (Winter 2007)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 3-17 | Kristina Niedderer | Designing Mindful Interaction: The Category of Performative Object | | In reviewing current design developments, only a small number of **experimental** design projects could be identified to explicitly explore interaction (two of which I will discuss in the following sections). | **2** | **2** |
| 18-27 | Artemis Yagou | City Lights: A Detail of Greek Interwar Modernism | | We observe morphological **experimentation**s on the proportions of the rectangular shape, as well as variations based on other geometric shapes (e.g., squares, polygons, and even circles). | **2** | **1** |

**Table C.29:** Content Analysis of Design Issues, Vol. 23, No. 2. (Spring 2007)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 17-30 | Javier Gimeno Martínez | Women Only: Design Events Restricted to Female Designers During the 1990s | | As I will argue, only an "**experimental**" allure could link these two concepts. | **3** | **1** |
| 31-39 | Emmanuel Bankole Ojo | Printing Contemporary Handwoven Fabrics (Aso-oke) in Southwestern Nigeria | | Aladire **experiment**ed with different folkloric motifs that were to form the nucleus of reproduction techniques in Nigeria. | **2** | **2** |
| | | | | As a shift from the conventional method of fabric decoration, this research effort conducted **experiment**s to print patterns and designs in traditional and geometric motifs on Aso-oke stripes through the silkscreen process. | **2** | **2** |
| | | | | The **experiment** marked the beginning of "change and tradition" in the emerging competition in local and international markets. | **2** | **1** |
| | | | n | Figure 7) Woven and printed samples of Aso-oke (results of studio **experiment**s). | **2** | **2** |
| | | | | Figure 9) More patterns and design (studio **experiment**s). | **2** | **2** |
| | | | | The fieldwork and studio **experiment**s conducted by the author reveal the prominence of Aso-oke as a purely Yoruba traditional cloth, and as the artistic efforts and dynamism of their cottage weaving industry. | **2** | **5** |
| 46-54 | Jennifer Whyte | Evolutionary Theories and Design Practices | n | 40) Manolya Kavakli and John Gero, "Difference between Expert and Novice Designers: An **Experimental** Study" in Human Behaviour in Design: Individuals, Teams, Tools, Udo Lindemann, ed. (Berlin: Springer, 2003). | **3** | **2** |
| 55-65 | Charles-Edouard Jeanneret (Le Corbusier) | Étude sur le mouvement d'art decoratif en Allemagne (A Study of the Decorative Arts Movement in Germany) | | **Experiment**s have been done there; effective struggles have taken place there; masonry has been raised; and the halls, with their storied walls, tell of the triumph of order and of tenacity. | **1** | **7** |

**Table C.30:** Content Analysis of Design Issues, Vol. 23, No. 3. (Summer 2007)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 16-29 | Adam Kallish | "Feeding the Lion:" One Internal Design Group's Odyssey | | 1 (…) However, the integration of its services is still being **experiment**ed with—20 years after it was purchased—and is addressing many of the key issues listed in this article. | **2** | **4** |
| | | | h | The Reinvention **Experiment** | **2** | **4** |
| | | | | The Design Unit, like all other areas, was deactivated and strewn to the four winds; | **2** | **4** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | closing an interesting seven-year **experiment** in upgrading design services in a demanding business environment. | | |
| 30-45 | Anthony Faiola | The Design Enterprise: Rethinking the HCI Education Paradigm | | For example, Barnard, May, Duke, and Duce [11] outline a dynamic shift away from theorizing and **experimentation** with product concept modeling found in the pure science of cognitive psychology and toward the "boundless domain." | **2** | **2** |
| 46-61 | Paul Atkinson | The Best Laid Plans of Mice and Men: The Computer Mouse in the History of Computing | | He wrote a project proposal and received a grant from NASA in 1963 to **experiment** with "light pens, tracking balls, and other kinds of gadgets." [2] | **2** | **6** |
| | | | f | During one **experiment**, "the subject would sit there poised and ready and, at some arbitrary time, the computer would put up in an arbitrary place an arbitrary size three by three array of objects, and he had to hit the space bar, access the device, and click on the objects. | **3** | **5** |
| | | | | During these **experiment**s, Engelbart recalled his student days when there was a requirement to try and calculate the area of an irregular shape created by plotted points on a chart. | **3** | **5** |
| | | | | This prototype then became one of the devices in the selection **experiment**s, "and it just happened to win everything." [4] | **3** | **1** |
| | | | | Engelbart states that: "I didn't give it a name when I was doing all these **experiment**s. | **3** | **1** |
| | | | | The initial application of the mouse (other than in the selection **experiment**s) was as one element of a more complex computer interface system designed for use with a text-based operating system—not an icon-driven one. | **2** | **1** |
| | | | | First of all, through an **experimental** high-end computer system called the "Alto" designed in 1972, and later through the "Star" computer released in 1981 (Figure 4). | **2** | **6** |
| | | | | Technically, this was justified by a number of ergonomic tests. Following Engelbart's NASA-funded **experiment**s, Bill English moved to Xerox PARC. | **2** | **6** |
| | | | f | He wanted to conduct more **experiment**s to be sure the mouse was still the optimal selection device. | **2** | **6** |
| | | | f | Stuart Card helped with these **experiment**s, and referred to a phenomenon known as Fitts's Law in his tests, a rule that states that the time taken to point to a target goes up as a logarithm of the ratio between the distance and the size of the target. | **2** | **6** |
| 62-69 | Michael A. R. Biggs and Daniela Büchler | Rigor and Practice-based Research | | The 2005 legislation, "Research for a Better Life," was the response to a three-year period of **experimental** ring-fenced funding in areas of national interest. | **3** | **1** |
| | | | f | In 2006, this **experimental** period was itself the subject of a quality review that included input from international visiting professors funded by Vetenskapsrådet. | **3** | **1** |
| 70-85 | Owain Pedgley and | Integration of Design Projects within a Ph.D. | | Physics Ph.D. students, for example, would very likely be involved in undertaking physics **experiment**s. | **1** | **11** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Paul Wormald | | | | | |
| | | | t | Designing and modelling **experiment**s with professional and student designers using three modelling | **2** | **3** |
| 86-87 | Fenggen Qian | International Conference on the Cultural Industry and the Education of Art and Design: The Future of Design Education in Different Cultural Contexts | | Freeman Lau discussed the significance of new **experiment**s in Hong Kong laboratory-based education of arts and design, which actually contributed to the branding of Hong Kong by linking the region to the world. | **3** | **3** |

## APPENDIX D: CONTENT ANALYSIS OF DESIGN STUDIES IN 2000s

**Table D.1:** Content Analysis of Design Studies, Vol. 21, Issue 1. (January, 2000)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 59-74 | S. Sivaloganathan, T. M. M. Shahin, M. Cross and M. Lawrence | A hybrid systematic and conventional approach for the design and development of a product: a case study | | Inferences are then made about the individual concepts by **experimenting** with conceptual models. | 2 | 2 |
| | | | | Some of these tests may include building and **experimenting** with computer models and relating the results with the results obtained from the prototype. | 2 | 2 |
| | | | | (4) Requirement of properties. Here again the data is important. But the absence of it is not crucial because estimates can be made from **experimentation**. | 2 | 2 |
| | | | | The conventional approach on the other hand permits the use of limited data and uses physical modelling and **experimentation** as the principal tools for developing the design. | 2 | 2 |

**Table D.2:** Content Analysis of Design Studies, Vol. 21, Issue 2. (March, 2000)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 119-144 | Simeon J. Simoff and Mary Lou Maher | Analysing participation in collaborative design environments | n | 12 Maher, M L, Cicogniani, A and Simoff, S J 'An **experimental** study of computer mediated collaborative design' International Journal of Design Computing Vol 1 (1997a). | 2 | 2 |
| | | | n | 13 Maher, M L, Simoff, S J and Cicognani, A 'Observations from an **experimental** study of computer-mediated collaborative design' In Maher, M L, Gero, J S and Sudweeks, F (eds) Formal aspects of collaborative CAD Preprints of the TFIP WG 5.2 Workshop on Formal Aspects of Collaborative Computer-Aided Design, Jenolan Caves, Australia (1997c) pp 165–185 | 2 | 2 |
| | | | | The initial step in this approach is similar to the initial data-driven coding of the two-step coding schema used for the analysis of the documented designs in computer-mediated collaborative design **experiments**[12,13]. | 2 | 2 |
| 187- | David Latch | Supporting collaborative design | n | 12 Laughlin, P R and McGlynn, R P 'Collective induction: mutual group and individual | 1 | 12 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 204 | Craig and Craig Zimring | groups as design communities | | influence by exchange of hypotheses and evidence' Journal of **Experimental** Social Psychology Vol 22 No 11 (1986) pp 567–589 | | |
| | | | | As part of the development process, they were minimally required to research the problem given to them, **experiment** with abstract solutions, and, in the end, produce a fairly detailed specification of their final solution. | 2 | 2 |
| | | | | Like any multi-dimensional design problem, this one calls for more exploration and **experimentation**, and a concerted effort to get beyond concepts associated with traditional studio presentations. | 2 | 2 |
| 205-220 | John Haymaker, Paul Keel, Edith Ackermann and William Porter | Filter mediated design: generating coherence in collaborative design | n | 9 Kolarevic, Schmidt, Hirschberg, Kurman, and Johnson An **experiment** in design collaboration, Acadia '98 Association for Computer-Aided Design in Architecture (1998) pp 91–98 | 1 | 7 |
| | | | n | 11 Porter, W L 'Notes on the inner logic of designing: two thought **experiment**s' Design Studies Vol 9 No 3 (1988) pp 169–180 | 3 | 2 |

**Table D.3:** Content Analysis of Design Studies, Vol. 21, Issue 3. (May, 2000)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 223-238 | Michael A. Busseri and Jason M. Palmer | Improving teamwork: the effect of self-assessment on construction design teams | | This paper reports the results of one such **experiment**—exploring the importance of team assessment and its effect on designers' perceptions of satisfaction and team performance. | 3 | 2 |
| | | | | This study was designed to test two **experimental** hypotheses. | 3 | 2 |
| | | | | This study was unique not only in its attempt at controlling some of the **experimental** conditions (which allowed for some inferences to be drawn), but also in defining tight research hypotheses. | 3 | 2 |
| | | | h | 2.2.1 **Experimental** teams | 3 | 2 |
| | | | | The design teams worked through two tasks—one task under **experimental** conditions, another under control conditions. | 3 | 2 |
| | | | f | Group A worked through the **experimental** then the control condition, while Group B began with the control condition. | 3 | 2 |
| | | | f | This **experimental** design (known as AB–BA) made the effect of the **experimental** condition easier to distinguish from confounding effects arising from group-specific factors, or from the order to which groups were assigned conditions and tasks. | 3<br>3 | 2<br>2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | h | 2.2.2 **Experimental** protocol | 3 | 2 |
| | | | | Each member of Group A (**experimental** condition) was given a new sheet of paper containing specific assessment criteria (see Appendix B: Assessment sheets). | 3 | 2 |
| | | | | The above procedure was repeated exactly, except that each team members was given a (different) second design brief (see Appendix A—Task B), and Group A did the room assessment (control condition), while Group B did the team assessment (**experimental** condition). | 3 | 2 |
| | | | | We tested the effects of: profession (architect, engineer, surveyor, or 'other'), gender (male, female), and design task (task A, task B) on subjects' ratings of their team (under **experimental** vs. control conditions). | 3 | 2 |
| | | | f | Index scores were then submitted to a 2 ´ 2 ANOVA of condition (**experimental** vs. control) and group (Group A vs. Group B). | 3 | 2 |
| | | | f | In support of our hypothesis, a main effect of condition was found [$F(1,15) = 5.97$, $P = 0.022$], in which index scores in the **experimental** condition ($M = 5.61$) were significantly greater than scores in the control condition ($M = 4.83$). | 3 | 2 |
| | | | | For five items, the main effect of the **experimental** condition reached statistical significance [all $Fs(1,15) > 3.00$, all $Ps < 0.05$], while the interactions with group (team A vs. team B) were nonsignificant [$Fs < 1$]. | 3 | 2 |
| | | | f | Compared to responses from the control condition, participants in the **experimental** condition gave significantly higher ratings for the following items: | 3 | 2 |
| | | | f | item 1—the team's design (Ms for **experimental** and control conditions, respectively = 5.4, 4.0) | 3 | 2 |
| | | | | For 14 of the 15 participants, ratings improved in the **experimental** condition. | 3 | 2 |
| | | | f | Averaged across all subjects, the index score under **experimental** instructions was 0.8 units (on the 7-point Likert scale) greater than the same measure from the control condition (improvement scores varied from 0.1 to 1.9 on the 7-point scale). | 3 | 2 |
| | | | | The d score can range from 0 (indicating no difference in effect size between **experimental** and control conditions) to 1 (indicating an effect size of one standard deviation between **experimental** and control conditions). | 3<br>3 | 2<br>2 |
| | | | | Taken together, the raw change scores and the effect size results suggest that the positive effect in the **experimental** condition was moderately large in standardised terms, and was not specific to just a few participants. | 3 | 2 |
| | | | | In the **experimental** condition (i.e. when the teams were assessing their performance), 67% of the 15 comments were coded as positive—twice as many as were negative (10 positive and five negative comments, respectively, with no neutral comments). | 3 | 2 |
| | | | | In the control condition, designers refrained from sketching anything until near the end of the task, whereas in the **experimental** condition some members sketched almost continuously. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | h | **Experimental** condition | 3 | 2 |
| | | | f | In the **experiment** condition, team members were each given a copy of the following instructions: | 3 | 2 |
| 277-291 | Chiu-Shui Chan | Can style be measured? | | The results of psychological **experiment**s[30] exploring the definition of style suggest that if a feature appears in three products, it can be registered as a common feature. | 1 | 12 |
| | | | | A psychological **experiment** in applying geometrical and topological distortions to change the feature's shape for studying recognisability of stylistic features has yielded some interesting findings30. | 1 | 12 |
| | | | f | The **experiment** applied computer images of the Little House designed by Wright (1903) as stimuli. | 1 | 12 |
| | | | | The expert is a faculty member who had studied Wright's style in his Ph.D. dissertation and was teaching architectural history at the time the **experiment**s were conducted. | 1 | 12 |
| | | | | In the same **experiment** conducted in the same study, images with topological changes were used as stimuli (see Figure 3). | 1 | 12 |
| | | | | An **experiment** conducted in the same study by Chan[30] suggested that three is the minimum critical number of common features for defining a style. | 1 | 12 |
| | | | f | In that **experiment**, Wright's side elevation of Little House (1903) with six recognisable features was used for the stimulus. | 1 | 12 |
| | | | | Results of the **experiment**s demonstrated that the styles of Wright and Meier were identified without any mistakes, whereas Moore's style elicited some confusion. | 1 | 12 |
| | | | | The original concept of this theory of style measurement was developed and justified by several **experiment**s conducted in the author's dissertation work, 'Psychology of Style in Design,' at Carnegie Mellon University. | 1 | 12 |
| | | | n | 6 Additional **experiment**s using other buildings and styles with similar results would solidify the assertion about the set of common features being key for style identification. | 1 | 12 |

**Table D.4:** Content Analysis of Design Studies, Vol. 21, Issue 4. (July, 2000)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 315-317 | Peter Jagodzinski, Fraser Reid and Phil Culverhouse | Editorial | | These characteristics confound the basic premises of scientific method which require proof of hypothesis by **experiment** and repeatability. | 1 | 11 |
| | | | | The advantages and disadvantages of naturalistic investigations over **experimental** and reductionistic approaches were also debated. | 1 | 11 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 403-421 | Linden J. Ball and Thomas C. Ormerod | Applying ethnography in the analysis and support of expertise in engineering design | a | We also discuss how the outcomes of applied ethnography can be applied to i) the design of a computerbased design support tool and ii) the development of controlled **experimental** studies that retain sufficient ecological validity to capture realistic design expertise. | 3 | 2 |
| | | | | In subsequent sections of the paper we describe how we have employed ethnographic methods in two contexts: first in studying the processes of design re-use in a major aeronautics company in order to inform the development of a design-support tool, and second, in collecting materials for subsequent cognitive **experimental** research into design expertise in a major software development company. | 3 | 2 |
| | | | | First, the complex, ongoing and multi-faceted nature of commercial design projects excludes the use of **experimental** research methods since such factors do not readily lend themselves to **experimental** control. | 3<br>3 | 2<br>2 |
| | | | | Second, the fact that much real-world design is situated within a rich and dynamic social context not only adds new complexities to any attempt to achieve **experimental** rigour, but also obviates the use of non**experimental** techniques such as verbal protocol analysis[8] which are solely geared toward understanding individual behaviours in socially-impoverished contexts. | 3<br>3 | 2<br>2 |
| | | | h | 4 Using applied ethnography in supporting naturalistic **experimentation** | 3 | 2 |
| | | | | Examples of the successful use of an interventionist **experimental** methodology to explore natural practices and expertise in design are few and far between. | 3 | 2 |
| | | | | Attempts to use **experimental** methods to explore design immediately confront the problem of ecological validity[27]; put succinctly, the methods used to study performance in any domain must maintain a sufficient degree of authenticity that the researcher can have confidence in the generalisation of their findings beyond the controlled conditions of the laboratory. | 3 | 2 |
| | | | | In the face of the problem of ecological validity, one might question whether controlled **experimentation** has any role to play in design research. | 3 | 2 |
| | | | | This role is perhaps best illustrated in the use of controlled **experimentation** for functionality and usability testing of products and prototypes[28]. | 3 | 2 |
| | | | | The big pay off from controlled **experimentation** is that it offers a high degree of objectivity in observation and interpretation. | 3 | 2 |
| | | | | When one needs assurance (as in the case of testing whether a product, component or process satisfies a requirements specification), then controlled **experimentation** meets this need. | 3 | 2 |
| | | | | Ethnographers might raise a number of arguments against this criticism, for example by pointing to the skilled nature of ethnography, the potential for achieving validation through intensive observation, and possibly even the false assumptions that underlie claims of objectivity in controlled **experimentation**. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | This is made possible in our research because applied ethnography plays a unique role in enhancing the ecological validity of controlled **experimentation** in design research. | 3 | 2 |
| | | | h | 4.1 Sorting—an **experimental** method that benefits from ethnography | 3 | 2 |
| | | | f | One **experimental** technique that has been used to some effect in exploring design expertise, but that suffers from problems of low ecological validity, is the sort method[29]. | 3 | 2 |
| | | | n | 35 Barsalou, L W 'Ideas, central tendency, and frequency of instantiation as determinants of graded structure in categories' Journal of **Experimental** Psychology, Learning, Memory and Cognition Vol 11 (1985) pp 629–654 | 1 | 12 |
| | | | | The method originates in **experimental** research into human memory and the mental representation of conceptual categories[30]. | 1 | 12 |
| | | | h | 4.2 Combining ethnography and **experimentation**: an example | 3 | 2 |
| | | | | However, a brief description of the study illustrates the combination of applied ethnography with controlled **experimentation**. | 3 | 2 |
| 423-432 | Graham Button | (Discussion) Viewpoint: Ethnographic approaches to the study of engineering design: debate and discussion | | You don't put them in to some sort of **experimental** situation. | 2 | 2 |
| | Hugh Thomas | | | Isn't observation a fundamentally much less powerful way of getting at cause and effect relationships at work than **experimentation**? | 1 | 12 |
| | | | f | I come from an **experimental** psychology background, and it seems to me that observation is also a very labour intensive activity. | 1 | 12 |
| | Fraser Reid | | | I also come from a more **experimental** background, as a psychologist. | 1 | 12 |
| | | | f | What does concern me, is that there are limits to what is achievable with **experimental** knowledge and what is strikingly omitted are things that are not available to the participants to comment upon. | 1 | 12 |

**Table D.5:** Content Analysis of Design Studies, Vol. 21, Issue 5. (September, 2000)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 433-436 | Gabriela Goldschmidt, William Porter | Editorial | | The methodologies used by the authors in the research presented here are diverse, and range from classical laboratory **experiment**s in the psychological tradition to protocol analysis, observation, and theory based on observation. In the 1994 Delft Protocol Analysis Workshop (2nd DTRS) participants asked themselves what methodologies were appropriate for the study of design thinking. | 1 | 12 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Its contribution lies in the explicit design context in which the **experiment**s are carried out. | 3 | 2 |
| | | | | Van der Lugt's paper reports on his **experimental** work in which different methods for enhancing creative problem-solving in design groups are compared and evaluated. | 3 | 2 |
| | | | f | The **experimental** conditions vary the use of sentential and sketch tools for idea generation and development by participants along several meetings. | 3 | 2 |
| 437-449 | Vasilije Kokotovich and Terry Purcell | Mental synthesis and creativity in design: an **experimental** examination | t | Mental synthesis and creativity in design: an **experimental** examination | 3 | 2 |
| | | | a | This research examined design issues of creativity, mental synthesis, and drawing by conducting two **experiment**s. | 3 | 2 |
| | | | f | These **experiment**s compared and contrasted 3D designers, 2D designers, and Non-designers. | 3 | 2 |
| | | | f | The first **experiment** investigated if designers were more creative than nondesigners when given creative mental synthesis tasks. | 3 | 2 |
| | | | | The second **experiment** investigated the relationship between drawing and creative mental synthesis. | 3 | 2 |
| | | | n | 10 Thompson, A and Klatzky, R L 'Study of visual synthesis: integration of fragments into forms' Journal of **Experimental** Psychology: Human Perception and Performance Vol 4 No 2 (1978) pp 244–263 | 1 | 12 |
| | | | | The first **experiment** to be reported explores this straightforward hypothesis. | 3 | 2 |
| | | | | In order to test the importance of drawing in creative mental synthesis they conducted **experiment**s modeled after Finke and Slayton[11]. | 3 | 2 |
| | | | | Both the **experiment**ers and the subjects held the belief that using pencil and paper to help construct patterns should be easier or more effective than using mental imagery alone. | 3 | 2 |
| | | | | The participants in these **experiment**s were university students drawn from the general university population. | 3 | 2 |
| | | | | The second **experiment** to be reported investigates the issue of the role of drawing by systematically controlling when the drawing activity occurs and by comparing the performance of designers with non-designers. | 3 | 2 |
| | | | h | 2 **Experiment** 1 | 3 | 2 |
| | | | h | 2.1 **Experimental** design | 3 | 2 |
| | | | | The first aspect of the **experimental** design of the first **experiment** therefore is the use of the two versions of the task with separate groups of industrial and graphic designers and non-designers. | 3<br>3 | 2<br>2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | h | 2.2 Results and discussion of **experiment** 1 | 3 | 2 |
| | | | | The results of the **experiment** are presented as the frequency of creative responses as a function of the type of problem (involving 2D or 3D forms) and participant group (industrial designers, visual communication or graphic designers and non-designers). | 3 | 2 |
| | | | h | 3 **Experiment** 2 | 3 | 2 |
| | | | h | 3.1 **Experimental** design and method | 3 | 2 |
| | | | | The results of the first **experiment** reported above demonstrated that the creative mental synthesis task does differentiate between non-designers and designers and between designers of different disciplines in terms of their creative output. | 3 | 2 |
| | | | f | In this second **experiment** subjects with the same three backgrounds as in the first **experiment** (industrial design, visual communications and non-designers) were used with similar numbers of subjects (20) from each discipline. | 3<br>3 | 2<br>2 |
| | | | f | In addition the same number of judges (5) from each discipline were used in this **experiment**. | 3 | 2 |
| | | | T<br>h | Given that we have shown in the first **experiment** differences between design disciplines and between designers and non-designers in creative output, it is possible to test this hypothesis by repeating our first **experiment** and comparing performance of the three groups when they are allowed to draw during the process of developing a form with their performance, and when they have to perform the task using mental synthesis only. | 3<br>3 | 2<br>2 |
| | | | | Essentially the procedures in this **experiment** were quite similar to those of the 3D tasks in the first **experiment** (modeled on Finke[12]). | 3<br>3 | 2<br>2 |
| | | | | With the exception of being told to use drawing to develop the invention instead of closing their eyes and using only 'mental imagery', the procedures were the same as in **experiment** 1. | 3 | 2 |
| | | | | The procedures were as those in the first **experiment**. | 3 | 2 |
| | | | h | 3.2 Results and discussion of **experiment** 2 | 3 | 2 |
| | | | f | Table 3 presents the results of this **experiment** with the frequency of synthesized forms judged to be creative, being presented as a function of subject group and task within each strategy. | 3 | 2 |
| | | | | Given that the 3D task was used, it would be expected, on the basis of **experiment** 1, that the industrial designers would produce more creative forms than the visual communication group with the non-designers performing poorly and this is clearly demonstrated in the row totals. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | The direct comparison between the two **experiment**s in terms of the task performed involves Strategy B, Task 1 where the results clearly demonstrate the expected pattern. | 3 | 2 |
| | | | | In the discussion of the design of **experiment** 2 we argued that the absence of any beneficial effect of drawing in Andersen and Helstrup's[13] **experiment** could be due to their use of subjects who had not been trained to use drawing in the way required and that designers should be able to benefit from drawing because they had developed this skill. | 3<br>3 | 2<br>2 |
| | | | | This did not occur in the **experiment** as is apparent in the results for Strategy A, Tasks 1 and 2. | 3 | 2 |
| | | | | The first **experiment** demonstrated that senior design students do produce more creative forms in a mental synthesis task than non-designers from a discipline (law) where the focus is on verbal concepts. | 3 | 2 |
| | | | | As a result these outcomes of the **experiment** demonstrate that the creative mental synthesis task appears to provide an interesting methodology for empirically examining issues that have been thought to be important in the design literature. | 3 | 2 |
| | | | | The results of the second **experiment** further indicate how the methodology can provide insights into design processes. | 3 | 2 |
| 451-464 | P. A. Rodgers, G. Green and A. McGown | Using concept sketches to track design progress | | Figure 5 shows a typical page from the sketchpad of one of the students involved in the **experiment**. | 3 | 2 |
| | | | | In Goel's[16] **experimental** work, subjects 'individuated' the output by drawing rectangles around each separate drawing and in some cases would number them in sequence. | 3 | 2 |
| 465-481 | Stephen A. R. Scrivener, Linden J. Ball and Winger Tseng | Uncertainty and sketching behaviour | n | 13 Novick, L R and Tversky, B 'Cognitive constraints on ordering operations: the case of geometric analogies' Journal of **Experimental** Psychology: General Vol 116 (1987) pp 50–67 | 1 | 12 |
| | | | n | 17 Tversky, B and Hemenway, K 'Objects parts and categories' Journal of **Experimental** Psychology: General Vol 113 (1984) pp 169–193 | 1 | 12 |
| | | | | If this descriptive analysis is confirmed **experimental**ly, Non Part by Part production may prove a useful metric of uncertainty in form making. | 3 | 2 |
| 483-503 | Ellen Yi-Luen Do, Mark D. Gross, Bennett Neiman and Craig Zimring | Intentions in and relations among design drawings | | Blackwell's 'Diagrams about thoughts about thoughts about diagrams'[3] reviews work in **experimental** psychology (e.g., 4–6) that understands a diagram as a notation that provides information and clues about intention in a visual form. | 1 | 12 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | n | 9 Van Sommers, P Drawing and Cognition—Descriptive and **Experimental** Studies of Graphic Production Processes, Cambridge University Press, Cambridge, UK (1984) | 3 | 2 |
| | | | n | 25 Porter, W 'Notes on the inner logic of designing: two thought-**experiment**s' Design Studies Vol 9 No 3 (1988) pp 169–180 | 3 | 2 |
| | | | | Schooler and Engstler-Schooler's **experiment**s indeed demonstrate that verbal reasoning interferes with visual reasoning in visual memory tests[22]. | 3 | 2 |
| | | | | Porter and Schön carried out a speculative account of a design process as a 'thought-**experiment**'[25] to account for the underlying logic of designing. | 3 | 2 |
| | | | | Two undergraduate architecture students and two instructors participated in the **experiment**. | 1 | 7 |
| | | | | The **experiment** revealed several patterns of design drawing behavior: first, the four participating designers employed drawing conventions common among themselves and with the 62 architecture students who participated in the pilot diagramming study. | 1 | 7 |
| | | | | What began as a thought **experiment** resulted in a repertoire of plausible interpretations to account for what might have actually happened in the design process. | 3 | 2 |
| | | | | We found this unorthodox approach plausible for several reasons: first, these drawings came from a real design project carried out over a period of years, rather than a controlled **experiment** done over the course of an hour or so. | 3 | 2 |
| | | | | The participation of the four designers in the design **experiment** is greatly appreciated. | 3 | 2 |
| 505-522 | Remko van der Lugt | Developing a graphic tool for creative problem solving in design groups | a | This paper describes four creative problem solving meeting **experiment**s in which graphic variations on the brainstorming technique were explored. | 3 | 2 |
| | | | | In order to investigate this, we have carried out four design group **experiment**s, consisting of creative problem solving meetings regarding a typical design assignment. | 3 | 2 |
| | | | f | Through variations in the utilization of visual expression in the meetings, the **experiment**s explore graphic variations of existing creative problem solving tools, and the functioning of visual expression in creative problem solving meetings in product design. | 3 | 2 |
| | | | f | The **experiment**s also contribute to developing a method for processing the **experimental** data. | 3<br>3 | 2<br>2 |
| | | | f | In this paper we focus primarily on discussing the methodological approach to the processing of the **experimental** data. | 3 | 2 |
| | | | h | 2 A four-meetings **experiment** with visual creative problem solving | 3 | 2 |
| | | | f | This exploratory research project consisted of a series of four **experiment**s. | 3 | 2 |
| | | | h | 2.1 **Experiment** description | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Tool development has been the main reason for varying the tools in the other steps of the **experiment**s. | 3 | 2 |
| | | | | The **experimental** matrix (Table 1) shows the variations applied. | 3 | 2 |
| | | | Th | Table 1 **Experimental** matrix | 3 | 2 |
| | | | | The linkography method is adjusted in order to make it applicable to our creative problem solving meeting **experiment**s. | 3 | 2 |
| | | | | Three raters took part in our **experiment**, and their agreement varied between K = 0.55 and K = 0.66, which according to Fleiss[29] signify a fair to good agreement beyond chance. | 3 | 2 |
| 539-567 | Masaki Suwa, John Gero and Terry Purcell | Unexpected discoveries and S-invention of design requirements: important vehicles for a design process | | He did an **experiment** in which subjects looked at a geometrical shape and generated as many interpretations of the shape as possible. | 3 | 2 |
| | | | | In the **experimental** group, every time he or she generated an interpretation, the subject was presented with a nonsense sentence, and was told to select one word from the sentence and to generate a new interpretation of the shape in a way associated with the concept of the word. | 3 | 2 |
| | | | | Supporting evidence for this comes from the **experiment**s in which 'problem-finding' behaviours of art students in a drawing task were studied[2]. | 3 | 2 |
| | | | | Further, there was a strong correlation between their 'problem-finding' tendency in the **experimental** task and the degree of success in later years as professional artists. | 3 | 2 |
| | | | f | These **experiment**s compared and contrasted 3D designers, 2D designers, and Non-designers. | 3 | 2 |

**Table D.6:** Content Analysis of Design Studies, Vol. 21, Issue 6. (November, 2000)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 569-588 | Michael Tovey and John Owen | Sketching and direct CAD modelling in automotive design | | Although convincing Prelude-like images were produced, a more controlled **experiment** was needed. | 3 | 2 |
| 589-606 | Terry Liddament | The myths of imagery | | The centre-ground tends to be occupied by **experimental** psychology, with the extremes of the territory bounded on the one hand by work in the fields of the cognitive (merging into work in artificial intelligence) and on the other hand by work in the more speculative areas of philosophical psychology, epistemology, and metaphysics. | 1 | 12 |
| | | | | 'Seeing', for example, as the early empiricists stressed, implies a certain passivity it's | 1 | 12 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | true, but 'looking' on the other hand involves an often quite strenuous activity, and to 'perceive' with shrewdness or insight, for example when looking (say) at the outcome of some **experimental** procedure, is often regarded as a highly 'creative' act. | | |
| | | | | That is, it is assumed that such 'experience' is taken as a datum against which a range of **experimental** procedures can be tested. | 1 | 12 |
| | | | | If we consider the **experiment**s with subjects' supposed powers to 'rotate' and otherwise 'manipulate' mental images, then what we should note is that if one talks here of movements' such as 'rotating' something in the 'imagination' or the 'mind's eye' then one hasn't as yet given a clear meaning to terms such as 'rotating' in such cases. | 1 | 12 |
| | | | | Thus, in the case of the **experimental** scenario enacted by empirical psychology in the investigation of mental phenomena such as 'rotating images' the wrong move has already been made, since the concept 'to rotate' is presupposed as having an unproblematic application in this scenario, whereas it is this application here which is the very point at issue. | 1 | 12 |
| | | | f | We could say: there is an **experimental** procedure here, but it makes no connection with the problem since method and problem pass one another by. | 1 | 12 |
| | | | f | In addition, such **experimental** 'procedures' appear to violate basic empiricist **experimental** tenets of repeatability and objectivity; it isn't clear just what 'repeatability' can mean here since there seems no way of determining what would constitute the 'same' in different cases, and the 'results' would also appear to be unavoidably subjective, based only on the reports of subjects and not amenable to any independent criteria of assessment. | 1<br>1 | 12<br>12 |

**Table D.7:** Content Analysis of Design Studies, Vol. 22, Issue 1. (January, 2001)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 5-26 | Darren W. Dahl, Amitava Chattopadhy-ay and Gerald J. Gorn | The importance of visualisation in concept design | a | Two **experiment**s are presented that test the propositions that flow from the proposed model. | 3 | 2 |
| | | | | We draw on a visualisation typology from **experimental** psychology that distinguishes between visualisation that is based in memory and visualisation that is based in imagination. | 1 | 12 |
| | | | n | 5 Perky, CW 'An **experimental** study of imagination' Journal of Psychology Vol 21 | 1 | 12 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | (1910) pp 422–425 | | |
| | | | | We take an **experimental** approach and use two separate studies to test these propositions. | 3 | 2 |
| | | | f | The paper concludes with a discussion of the implications of our **experimental** findings. | 3 | 2 |
| | | | | Empirical support can be drawn from **experiment**s that have investigated the phenomenon of design fixation[12]. | 3 | 2 |
| | | | f | In these studies, **experimental** subjects are asked to come up with new product designs, with some subjects, in what are called fixation groups, receiving example solutions to assist in concept design. | 3 | 2 |
| | | | h | 2 **Experiment** 1 | 3 | 2 |
| | | | f | Two factors (visualisation type and customer incorporation in visualisation) were manipulated in a between-subjects **experimental** design. | 3 | 2 |
| | | | | Thus, the **experiment** had seven different **experimental** cells [(2 imagery type ´ 3 customer incorporation) + 1 control = 7]. | 3<br>3 | 2<br>2 |
| | | | | Previous research in product design has used engineering students as **experimental** subjects[12]. | 3 | 2 |
| | | | | Based on informal discussions with seniors, a car jack was chosen as the product for the first **experiment**, as seniors reported having difficulty using those currently available. | 3 | 2 |
| | | | | Hence, to obtain the best evaluation of the designs produced in the **experimental** conditions a sample of elderly judges (age 60 + ) were recruited from local senior citizen centres. | 3 | 2 |
| | | | | The ANOVA results for the memory image use scale showed no significant differences between the **experimental** conditions (all P's > 0.10). | 3 | 2 |
| | | | | Figure 1 **Experiment** 1: customer images experienced | 3 | 2 |
| | | | | As above, two-way analysis of variance and t-test comparisons were used to test for differences between the **experimental** conditions. | 3 | 2 |
| | | | | However, a t-test comparing the control condition with the manipulated conditions indicated that the designers in the control condition rated design task difficulty higher [means: control condition = 4.20, **experimental** conditions = 3.34; t (138) = 2.48, P < 0.01]. | 3 | 2 |
| | | | | Additionally, a t-test comparing the control condition with the manipulated conditions also indicated no significant differences [means: control condition = 5.54, **experimental** conditions = 5.89; t (138) = 1.25, P > 0.10]. | 3 | 2 |
| | | | f | These null results indicate that the level of attention fostered by the design task was equal across all **experimental** conditions. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Figure 2 **Experiment** 1: difficulty with design task | 3 | 2 |
| | | | | Figure 3 **Experiment** 1: informative value of design task | 3 | 2 |
| | | | | Figure 4 **Experiment** 1: ratings of originality | 3 | 2 |
| | | | | Figure 5 **Experiment** 1: ratings of usefulness | 3 | 2 |
| | | | | A follow-up contrast showed that the customer appeal of the designs produced by those in the imagination visualisation customer incorporation conditions (mean = 3.74) was greater than the customer appeal of the designs for all the other **experimental** conditions combined [mean = 3.19; F (1,138) = 11.63, P < 0.001] (see note 3). | 3 | 2 |
| | | | f | When done separately, contrasts between the imagination visualisation customer incorporation conditions and the other **experimental** conditions were all significantly different (all P's < 0.05). | 3 | 2 |
| | | | | Figure 6 **Experiment** 1: ratings of customer appeal | 3 | 2 |
| | | | h | 3 **Experiment** 2 | 3 | 2 |
| | | | | The second **experiment** attempted to test the generalisability of the findings pertaining to the output of the design process obtained in **Experiment** 1. | 3<br>3 | 2<br>2 |
| | | | f | In the first **experiment**, we had chosen a target customer segment very different from the designer, namely seniors. | 3 | 2 |
| | | | f | In the second **experiment**, we wanted to examine whether decreasing the difference between the designer and the segment for whom they were designing, attenuated the effect of the customer incorporation manipulation. | 3 | 2 |
| | | | | Thus, we chose a sample of young women (age 20–24), since all the designers in the sample used in the second **experiment** were young men. | 3 | 2 |
| | | | | In the second **experiment** we also used a different product from the one used in first **experiment**, a decision driven by a concern for generalisability. | 3<br>3 | 2<br>2 |
| | | | f | **Experiment** 2 used a between-subjects **experimental** design with two levels of visualisation type (memory visualisation and imagination visualisation) and two levels of customer incorporation (no customer incorporation and customer incorporation) as two independent factors. | 3<br>3 | 2<br>2 |
| | | | | The methodology used in the second study followed that used in the first **experiment**. | 3 | 2 |
| | | | f | The differences in the second **experiment**, identified above, involved the product chosen for the design task (umbrella) and the target customer for the design task (young women age 20–24). | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | f | Given the thrust of this **experiment**, the design process was not evaluated; only an evaluation of the designs produced was conducted. | 3 | 2 |
| | | | f | The dependent measures used to evaluate the designs in the second **experiment** were identical to those used in the first **experiment**. | 3<br>3 | 2<br>2 |
| | | | | Similar to **Experiment** 1, statistical analysis, using analysis of variance (a 2 ´ 2 ANOVA) and follow-up contrasts was conducted to verify the predicted relationships. | 3 | 2 |
| | | | | As in **Experiment** 1, the most original designs were produced when visualization based in imagination was used. | 3 | 2 |
| | | | | Figure 7 **Experiment** 2: ratings of originality | 3 | 2 |
| | | | | Figure 8 **Experiment** 2: ratings of usefulness | 3 | 2 |
| | | | | The follow-up contrast between the imagination visualization customer incorporation condition (mean = 3.69) and all of the other **experimental** conditions combined was significant [F (1,71) = 4.71, P < 0.05, mean = 3.30]. | 3 | 2 |
| | | | | Furthermore, the significant effects for originality and usefulness that replicate the findings of **Experiment** 1 provide additional support for the hypothesised relationships. | 3 | 2 |
| | | | | Figure 9 **Experiment** 2: ratings of customer appeal | 3 | 2 |
| | | | | Additionally, given our **experimental** approach, we had to make choices about the variables to include and were not able to study all of the variables upon which our results might potentially be contingent. | 3 | 2 |
| | | | n | 2 For all statistical analyses, to obtain a better estimate of within cell error, the data from all **experimental** conditions is utilised[25]. | 3 | 2 |
| 27-45 | Chun-Heng Ho | Some phenomena of problem decomposition strategy for design thinking: differences between novices and experts | h | 2 The **experimental** framework | 3 | 2 |
| | | | | During the **experiment**, they were asked to think aloud. One camera was used to record their sketches and verbal data at the same time. | 3 | 2 |
| | | | | Two subjects were involved in the **experiment**. | 3 | 2 |
| | | | | Before the **experiment**, he had received only one semester of academic training in the field of industrial design. | 3 | 2 |
| 47-66 | Pirita Seitamaa-Hakkarainen and Kai Hakkarainen | Composition and construction in experts' and novices' weaving design | h | 1.1 Participants and **experimental** tasks | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | In the **experiment**, participants were asked to complete an already started weaving design idea of his or her own. | 3 | 2 |
| | | | f | They were asked initially to think what product they would like to design or develop during the session a day before the **experimental** session. | 3 | 2 |
| | | | | The **experiment** was arranged individually for each of the participants following a similar procedure. | 3 | 2 |
| | | | | Further, in order to increase the reliability and validity of protocol analysis the protocols were crossreferenced with the observed activities seen in the videorecording (divided into 5-min segments) as well as with the notes and sketches produced during the **experiment**. | 3 | 2 |
| | | | | Plans for **experimenting** at the beginning of the warp, or sampling weave structures in order to test warp set, warp or weft floats were regarded to represent this category. | 2 | 2 |
| | | | | Each participant produced several alternative designs during the **experiment**, usually two or three. | 3 | 2 |
| | | | | As many as 435 protocol statements out of all 538 statements produced in the **experiment** were related to visual design. | 3 | 2 |
| | | | | A solution in Alternative 2 led to development of the design by **experimenting** with color and pattern design in Demonstration 2a (Demo 2a) which was based on a consideration of the mirror image of the previous color and pattern (Alt 2). | 2 | 2 |
| | | | f | On the basis of this **experimentation** (Demo 2a) the participant decided to elaborate in Alternative 3. Alternative 3 was articulated in a more detailed way, and the one side of the carpet was solved. | 2 | 2 |
| | | | | The **experiment** indicated that the thinking-aloud method can be productively applied to research in the area of weaving design. | 3 | 2 |
| | | | | A methodological limitation of the study was that the **experimental** task captured only a part of a long-standing weaving-design process; transition from the first design idea to the production may take several weeks, whereas this study, of necessity, focused only on 1 h of intensive designing. | 3 | 2 |
| 87-99 | Fiona McLachlan and Richard Coyne | The accidental move: accident and authority in design discourse | | Appeals to the accidental move are gaining currency amongst certain designers through increasing **experimentation** using the computer, bolstered by the philosophies of chaos theory, evolutionary systems, and a movement that Farrelly called (in the 1980s) the New Spirit, exemplified in the work of the Viennese architectural design co-operative Coop Himmelb(l)au[2]. | 2 | 2 |
| | | | | Much contemporary design **experimentation**, of the kind put forward by Coop Himmelb(l)au, and the surrealist on whom they draw, takes place in this theoretical context. | 2 | 2 |

**Table D.8:** Content Analysis of Design Studies, Vol. 22, Issue 2. (March, 2001)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 141-155 | Hamdi A. Bashir and Vince Thomson | Models for estimating design effort and time | | Figure 2 Results of **experiment**s where individuals performed similar design tasks with different levels of complexity | 3 | 2 |
| 169-191 | Sebastian Macmillan, John Steele, Simon Austin, Paul Kirby and Robin Spence | Development and verification of a generic framework for conceptual design | | During the course of the case study period an **experimental** session was held, which took the form of a 'Designing Together Workshop', in which the real-time conceptual design activity of three individual teams was observed and recorded as they worked on an artificially constructed design problem. | 3 | 2 |
| | | | | The observations made during both the case study and **experimental** investigations, as will be described in section 4, highlighted the fact that generic activities were apparent across the projects. | 3 | 2 |
| | | | | Additionally, the problem areas that were described acted as a means of categorizing unclassifiable design time during the observation of the two subsequent **experimental** workshops. | 3 | 2 |
| | | | | This first **experimental** session provided the opportunity to gain an appreciation of the similarities and differences in the activities undertaken during the design of a building component. | 3 | 2 |
| | | | | It was recognised that, without defining the activities of the framework, it would be impossible for it to be implemented in either a live design project or an **experimental** workshop; two exercises that would enable validation of the framework and lead to its subsequent improvement. | 3 | 2 |
| | | | | As such, it was decided that an initial validation of the model could be achieved to an acceptable level by applying the framework in an **experimental** environment; details of which are provided elsewhere[33]. | 3 | 2 |
| | | | | The next stage of the research employed an **experimental** approach as a means of validating the preliminary conceptual design framework[33]. | 3 | 2 |
| | | | | It allowed a cause-and-effect **experiment** to be undertaken to provide hard evidence concerning; i) the validity of the framework phases and activities; ii) the applicability of the design framework in practice; and iii) its effect on team performance and effectiveness. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 193-209 | Lamine Mahdjoubi and John Wiltshire | Towards a framework for evaluation of computer visual simulations in environmental design | n | 6 Jenkins, A M MIS design variables and decision-making performance: a simulation **experiment** Umi Research Press, Michigan (1983) p 1 | 3 | 2 |
| | | | | The **experimental** simulations were often manipulated according to the level of detail/texture, scale or sometimes by distorting the colour-contrast to measure their effects on response equivalence. | 3 | 2 |
| | | | | Yet other **experimental** research has produced mixed results. | 3 | 2 |

**Table D.9:** Content Analysis of Design Studies, Vol. 22, Issue 3. (May, 2001)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 211-232 | Simon Austin, John Steele, Sebastian Macmillan, Paul Kirby and Robin Spence | Mapping the conceptual design activity of interdisciplinary teams | | This paper describes an **experimental** workshop involving fifteen design professionals in which conceptual design activity was tracked, and subsequently mapped, in order to test and validate a tentative design framework (phase and activity model). | 3 | 2 |
| | | | | An **experimental** session was held in a bid to both verify the framework structure and ensure that its components were subjected to rigorous testing in a live design environment. | 3 | 2 |
| 233-254 | J. S. Busby | Error and distributed cognition in design | n | 5 Dwarakanath, S and Wallace, K M 'Decision-making in engineering design: observations from design **experiment**s' Journal of Engineering Design Vol 6 (1995) pp 191–206 | 1 | 13 |
| | | | | Without this systematic knowledge of error in organised design processes, specifically, it is hard to know how much of the failure that occurs in the design process is an acceptable part of planned **experimentation**, and how much is avoidable, hazardous and damaging to organizational survival. | 2 | 2 |
| 255-281 | R. Hanna and T. Barber | An inquiry into computers in design: attitudes before–attitudes after | a | A group of students took part in an **experiment** to design a studio for a graphic designer on the computer. | 3 | 2 |
| | | | a | Prior to the **experiment** a literature search was carried out to explore some widely researched design issues such as sketching, design creativity, and computer-aided design. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | However, despite what these technological changes offer in terms of opportunities as well as exciting intellectual challenges, their impact on the architectural design process has not been fully investigated through active research **experimentation** using classical research models. | 3 | 2 |
| | | | | Recent work on the Electronic Cocktail Napkin, 'an **experimental** computer-based environment for sketching and diagramming in conceptual design'[31], is evidence that CAD programs can be written in ways to make them useful for sketching and creative design. | 3 | 2 |
| | | | | However, despite the existence of a few individual **experiment**s on computer-aided sketching, they have made little impact on the development of commercial CAD packages, most of which continue to retain very basic and under-developed sketching routines. | 3 | 2 |
| | | | | Introduced by Newell and Simon[32], and adopted by many investigators, protocol analysis involves setting up quasi-laboratory **experiment**s to record the behaviour of the designer using video-tape (Delft–XeroxPARC workshops, Akin and Lin)[33], audio-tape (MIT Branch Library Design)[34], sketches on paper, etc. | 3 | 2 |
| | | | | An on-line computer program, capable of solving the problems, ran and monitored the **experiment** and compared the subjects' solutions with the computer-generated optimal solution. | 3 | 2 |
| | | | | The 'performance–analysis' area of CAAD has also made significant progress and now offers applications for visual modelling of the acoustic behaviour of sound waves within enclosures, and the visual simulation of air movement using Computational Fluid Dynamics programs, which are fascinating areas for design **experimentation** and appraisal. | 3 | 2 |
| | | | | In order to examine further some of the issues highlighted by the literature, this research conducted a design **experiment** using a CAD program as the sole design medium. | 3 | 2 |
| | | | | Mackintosh school, all of whom had expressed a strong interest and desire to participate voluntarily in this **experiment**/design workshop. | 3 | 2 |
| | | | | The feedback from the pilot group **experiment** was helpful in revising some aspects of the 'main' group **experiment** including CAAD's teaching, length of practice sessions and the lucidity of the questionnaire. | 3<br>3 | 2<br>2 |
| | | | | Fifteen second-year students volunteered to take part in the **experiment** and use the computer in the design of the studio. | 3 | 2 |
| | | | | To increase the 'validity' of this research and move beyond 'internal' validity to 'external' validity, the **experiment** has to be repeated for a larger sample. | 3 | 2 |
| | | | | Before the **experiment** students' response to this issue was different from that after the **experiment**. | 3<br>3 | 2<br>2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | V3—CAD helps design cognition—also showed a significant difference in attitudes between the two **experimental** conditions (t = 6.5, significance = 0.000 < 0.05). | 3 | 2 |
| | | | | Finally, it is important to mention that literature on research design of 'classical **experiment**s' advocates the use of a 'control' group to overcome the problem of internal 'invalidity' of research. | 3 | 2 |
| | | | | However, for a control group to have any value, the **experimental** and control subjects have to be kept separate to 'reduce the possibility of diffusion or imitation of treatments'[50]. | 3 | 2 |
| | | | f | The condition of 'separation' between groups could not be met by the research **experiment** due to the context within which it took place. | 3 | 2 |
| | | | f | In a design studio setting it was difficult, if not impossible, to separate a group of students from their colleagues for the duration of the **experiment**. | 3 | 2 |
| | | | | With this in mind, this research set out with the intention of applying 'classical' research methods and statistical techniques to analyse a 'design **experiment**', which is highly intuitive. | 3 | 2 |
| | | | | Also, **experimental** research is needed in architectural offices, where the context is different and the subjects are experienced architects whose design knowledge/experience is greater than that of our 'novice' students. | 3 | 2 |
| 283-295 | John S. Gero and Hsien-Hui Tang | The differences between retrospective and concurrent protocols in revealing the process-oriented aspects of the design process | | Protocol analysis 1, 2 has become the prevailing **experimental** technique for exploring this understanding of designing3. | 3 | 2 |
| | | | | This paper describes an **experiment** to examine the similarities and differences between the results produced by these two approaches in an attempt to distinguish the advantages of each method. | 3 | 2 |
| | | | | In this study we combine both methods and utilize both protocols with a single subject in an extended **experiment**. | 3 | 2 |
| | | | h | 2 The **experiment** | 3 | 2 |
| | | | | The **experiment** was set up in one of the subject's studios. | 3 | 2 |
| | | | | The results of the **experiment**s indicate some differences between the two types of protocols. | 3 | 2 |
| | | | | In all our **experiment**s the lengths of retrospective protocols are longer than concurrent protocols, but this does not directly indicate that retrospective protocols could reveal more information than concurrent protocols. | 3 | 2 |
| | | | n | 16 Berry, D C and Broadbent, D E 'On the relationship between task performance and associated verbalizable knowledge' The Quarterly Journal of **Experimental** Psychology | 1 | 12 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Vol 36A (1984) 209–231 | | |
| | | | | The reported study here could be regarded as a similar **experiment** in complex cognitive activities. | 3 | 2 |
| 297-315 | Rachael Luck, Hans Haenlein and Keith Bright | Project briefing for accessible design | | He observed three generic models: empirical, **experimental**, and scenario-based, theoretical models. | 2 | 2 |
| | | | | In contrast, **experimental** models involve immediate feedback from live users, either a representative sample of the actual user population, or the designer and/or colleagues acting out usage. | 2 | 2 |
| | | | f | It was generally agreed by design practitioners that **experimenting** on the designed product with live users is an essential part of the design process and did not believe that live users could be replaced by man-made hardware or software user models. | 2 | 2 |

**Table D.10:** Content Analysis of Design Studies, Vol. 22, Issue 4. (July, 2001)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 319-346 | Chiu-Shui Chan | An examination of the forces that generate a style | | The data are verbal reporting data obtained while an invited subject is working on an **experiment** and responds orally to an instruction or probe. | 3 | 2 |
| | | | | (1) (…) In design, studies were done on running controlled **experiment**s for identifying the mental operators and representations applied in the design processes[29,31], or exploring cognitive behavior through developing cognitive models that best fit the **experimental** data[32,33]. | 3<br>3 | 2<br>2 |
| | | | | (3) Introspective verbalization is the response to **experiment**er probes or retrospective answers to questions about prior behavior. | 3 | 2 |
| | | | | Thus, it is costly to conduct multiple **experiment**s observing common generic patterns of a design. | 3 | 2 |
| | | | | It is fair, however, to treat an initial **experiment** as a pilot study which can be repeated by other scholars to further test the validity of findings. | 3 | 2 |
| 347-364 | Manolya Kavakli and John S. Gero | Sketching as mental imagery processing | | As pointed out by Finke et al.[6], **experimental** studies reveal that mental images can exhibit a variety of perceptual-like properties. | 3 | 2 |
| | | | | 10 Farah, M J 'Psychological evidence for a shared representational medium for mental images and percepts' Journal of **Experimental** Psychology: General 114 (1985) 91–103 | 1 | 12 |
| | | | | 12 Finke, R A and Kurtzman, H S 'Mapping the visual filed in mental imagery' Journal **Experimental** Psychology: General 110 (1981) 501–517 | 1 | 12 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | 13 Podgorny, P and Shepard, R N 'Functional representations common to visual perception and imagination' Journal of **Experimental** Psychology: Human Perception and Performance 4 (1978) 21–35 | 1 | 12 |
| | | | | We need to carry out more **experiment**s to corroborate these results, so as to achieve adequate statistical validity of our conclusions in general. | 3 | 2 |
| | | | | Considering that the same amount of time was given to both participants in our **experiment**, the expert's design protocol is 2.84 times as rich as the novice's in terms of actions. | 3 | 2 |
| | | | | We found support for the systematic expansion in the experts' design protocols in the **experimental** findings of Adelson and Soloway[34]. | 3 | 2 |
| | | | | This did not occur in the **experiment**s conducted by Kosslyn et al.[28]. | 3 | 2 |
| | | | n | 30 Weber, R J and Harnish, R 'Visual imagery for words: The Hebb test' Journal of **Experimental** Psychology 102 (1974) 409–414 | 1 | 12 |
| | | | | There have been a large number of **experimental** studies on the time it takes to assemble a mental image and to recognize the resulting pattern or form. | 3 | 2 |
| | | | | Our **experiment** showed that there is a considerable difference (65 vs 41%) in paying attention to the relations between the expert and the novice designers, as shown in Table 8, while the novice's attention mainly focuses on implicit spaces (14 vs 34%). | 3 | 2 |
| | | | | According to the **experimental** findings of Adelson and Soloway[34, 35], experts are better able to form overviews, but thereafter they take longer to develop their understanding and representations, and they more fully consider interactions among functions or components of a system. | 3 | 2 |
| | | | f | Our **experimental** results also indicate that, as shown in Table 7, there is a considerable difference in revisited functions between the expert and the novice (42 vs 33%). | 3 | 2 |
| | | | n | 37 Chambers, D and Reisberg, D 'Can mental images be ambiguous?' Journal of **Experimental** Psychology: Human Perception and Performance 11 (1985) 317–328 | 1 | 12 |
| | | | n | 39 Bower, G H and Glass, A L 'Structural units and the red integrative power of picture fragments' Journal of **Experimental** Psychology: Human Learning and Memory 2 (1976) 456–466 | 1 | 12 |
| | | | | The novice designer in our **experiment** revisited the thought of a function less than the expert (42 vs 33%), as shown in Table 7. | 3 | 2 |
| | | | n | 42 Segal, S J and Fusella, V 'Influences of imaged pictures and sounds on detection of visual and auditory signals' Journal of **Experimental** Psychology 83 (1970) 458–464 | 1 | 12 |
| | | | | This could also explain the poorer performance of the novice designer in our **experiment**. | 3 | 2 |
| 377-394 | Karen Yair, Mike Press | Crafting competitive advantage: Crafts knowledge as a strategic | | Within the project team, a climate of **experimentation** and openness contrary to that of the production line could be cultivated[25, 26] and initiatives originating from any | 2 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | and Anne Tomes | resource | | hierarchical strata encouraged[26]. | | |
| | | | | Peters and Waterman[31] recommend the use of three-dimensional objects as a means of encouraging 'reflective **experimentation**': | 2 | 2 |
| | | | | By embodying progression, active management participation was encouraged[26] alongside the climate of **experimentation** acknowledged as common to **innovative** companies[31]. | 4 | 4 |
| | | | | It appears that the dialogue identified as crucial in the stimulation of organizational learning cannot be established within a culture where priorities for efficiency impede creative **experimentation**. | 2 | 2 |

**Table D.11:** Content Analysis of Design Studies, Vol. 22, Issue 5. (September, 2001)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 397-408 | Stephen Emmitt | Observing the act of specification | | Two approaches were considered, setting up an **experiment** and direct observation in an architect's office. | 1 | 7 |
| 425-437 | Jeffrey B. Dahmus, Javier P. Gonzalez-Zugasti and Kevin N. Otto | Creativity in the design process: co-evolution of problem–solution | h | 1.2 The **experimental** procedure | 3 | 2 |
| | | | f | A special condition in the **experiment** was the manner in which information was provided to the designers. | 3 | 2 |
| | | | | If a designer wanted to know something, they asked the **experimenter** (who was sitting nearby), who would then hand over the appropriate sheet. | 3 | 2 |
| | | | | If the information was not available on the sheets, or if the designer's question related to a detail of a sheet, the **experimenter** answered the question. | 3 | 2 |
| | | | f | The **experiments** were conducted as 'think-aloud' protocol studies[9,10]. | 3 | 2 |
| | | | | Figure 5 represents what we observed in our **experiments**. | 3 | 2 |
| 439-471 | Frances M. T. Brazier, Catholijn M. Jonker, Jan Treur and Niek J. E. | Compositional design of a generic design agent | | Within the context of parametric design several **experiments** with Propose-and-Revise have been performed by 49. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Wijngaards | | | | | |
| | | | n | 60 Chavez, A, Dreilinger, D, Gutman, R and Maes, P 'A reallife **experiment** in creating an agent market place', in Proceedings of the Second International Conference on the Practical Application of Intelligent Agents and Multi-Agent Technology PAAM'97, The Practical Application Company Ltd, Blackpool (1997) pp 159–178 | 1 | 13 |

**Table D.12:** Content Analysis of Design Studies, Vol. 22, Issue 6. (November, 2001)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 473-491 | Anne Römer, Martin Pache, Guido Weißhahn, Udo Lindemann and Winfried Hacker | Effort-saving product representations in design—results of a questionnaire survey | n | 22 Baddeley, A D 'Exploring the central executive' Quarterly Journal of **Experimental** Psychology Vol 49A (1996) 5–28 | 1 | 12 |
| | | | n | 23 Shah, P and Miyake, A 'The separability of working memory resources for spatial thinking and language processing: an individual differences approach' Journal of **Experimental** Psychology: General Vol 125 (1996) 4–27 | 1 | 12 |
| | | | n | 25 Engle, R W, Tucholski, S W, Laughin, J E and Conway, A R 'A working memory, shortterm- memory and general fluid intelligence: A latent-variable approach' Journal of **Experimental** Psychology: General Vol 128 No 3 (1999) 309–331 | 1 | 12 |
| | | | | The actual effects of external representations on time and quality remain to be seen from **experiment**s. | 3 | 2 |
| 519-542 | E. Jones, N. A. Stanton and D. Harrison | Applying structured methods to Eco-**innovation**. An evaluation of the Product Ideas Tree diagram | | The main aim of the **experiment** was to assist in the development of the PIT diagram as well as providing insights into better ways of testing such a recording tool. | 3 | 2 |
| | | | | Also shown are the key-starting points for Eco-**innovation** used in this **experiment**. | 4 | 2 |
| | | | h | 3.2 **Experiment** design | 3 | 2 |
| | | | | Table 1 shows how these two factors were crossed yielding the four **experimental** conditions. | 3 | 2 |
| | | | | The 20 final year students taking part in this **experiment** were recruited by personal invitation one week before the workshop was held. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | The authors were satisfied that the groups were adequately homogenous for this **experiment**. | 3 | 2 |
| | | | | Table 3 shows which of the four overheads each group received in accordance with the four **experimental** conditions. | 3 | 2 |
| | | | | The qualitative data in this study has been invaluable for providing insights into the methods used in this **experiment** as well as providing explanations for the unexpected results in the quantitative data. | 3 | 2 |
| | | | h | 5.1 Evaluation of the **experimental** hypotheses | 3 | 2 |
| | | | | A high number of participants were trained in (ESD) (see Table 2) and had, by coincidence, completed their final exam in ESD on the morning of the **experiment**. | 3 | 2 |
| | | | | This **experiment** did show that all groups with some methods (E,noR), (noE,R) and (E,R) had very low proportions of destructive interactions (G). | 3 | 2 |
| | | | | This **experiment** used a typical brainstorm sequence of activities: individual brainstorm on post-it notes, grouping ideas, and team generating ideas. | 3 | 2 |
| | | | | In future **experiment**s the PIT diagram would not be tested using a typical brainstorm sequence of activities. | 3 | 2 |
| | | | | In future **experiment**s the data could be collected by trained observers or recordings could be analysed to provide more reliable data. | 3 | 2 |
| | | | | Since conducting this **experiment**, the same dishwashing task was set to a different group of participants, in a less controlled environment. | 3 | 2 |
| | | | | The quality of ideas that came out of this 20 min session were very similar to those recorded in this **experiment**, which took over an hour. | 3 | 2 |
| | | | | In future **experiment**s: the participants will be trained in the use of the tool to ensure full understanding, the spectrum of ideas will be assessed; and the criteria for judging environmental relevance will be developed further. | 3 | 2 |
| 557-582 | Tek-Jin Nam and David Wright | The development and evaluation of Syco3D: a real-time collaborative 3D CAD system | a | This paper also reports on a usability **experiment** with two versions of the system, one with the Shared Stage module and the other without, and discusses the issues raised from the development and **experiment**s with the real-time collaborative 3D CAD system. | 3<br>3 | 2<br>2 |
| | | | n | 6 Maher, M L, Simoff, S J and Cicognani, A 'Observations from an **experimental** study of computer-mediated collaborative design', in M L Maher, J S Gero and F Sudweeks (eds) Formal Aspects of Collaborative CAD, University of Sydney (1997) pp 165–186 | 3 | 2 |
| | | | n | 32 Ishii, H, Kobaysshi, M and Grudin, J 'Integration of interpersonal space and shared workspace: clearboard design and **experiment**s', in S Greenberg, S Hayne and R Rada (eds) Groupware for Real-time drawing: A Designers' Guide (1995) pp 96–125 | 3 | 2 |

**Table D.13:** Content Analysis of Design Studies, Vol. 23, Issue 1. (January, 2002)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 5-23 | S. C. Stumpf and J. T. McDonnell | Talking about team framing: using argumentation to analyse and support experiential learning in early design episodes | t | Conduct an **experiment**: (generate)– conjecture–test | 3 | 2 |
| | | | t | Drawings with which to **experiment**, completed designs which prove the hypothesis | 3 | 2 |
| | | | | Surprise at the outcome of these **experiment**s allows the designer to surface her understanding of the situation and develop a new framing of the situation or new moves. | 3 | 2 |
| | | | | A coding scheme and notation has been developed by Valkenburg and Dorst[12, 13], based on the notion that individual designers selectively attend to the design environment in order to form a problem situation (naming and framing), develop a solution out of local **experiment**s (moving) and evaluate the outcome of these local **experiment**s (reflecting). | 3<br>3 | 2<br>2 |
| | | | | Our **experiment**s with showing micro-level detail (like that shown in Figure 1, but displayed through a visualisation tool) and macro-level detail (at the level of detail shown in Figure 2) suggests that there is no single appropriate level of detail that is useful for team or individual reflection. | 3 | 2 |
| 25-40 | Manolya Kavakli and John S. Gero | The structure of concurrent cognitive actions: a case study on novice and expert designers | | In the mental imagery **experiment**s conducted by Kosslyn et al[5], there was also a wide range of correlations in the performance of the tasks. | 3 | 2 |
| | | | | Because of the limited number of designers analysed in this research study, we do not intend to draw general conclusions from the **experimental** results. | 3 | 2 |
| | | | | Our **experimental** results show that although the novice's cognitive activity started at a peak, it dropped continuously until the end of the design session; whereas the expert's cognitive activity rose continuously during the design session. | 3 | 2 |
| | | | | According to our **experimental** findings, there are concurrent cognitive actions in both design protocols and the cognitive activities of the designers in certain categories seem to be parallel to the drawing production on the pages they produced. | 3 | 2 |
| | | | | We also found evidence for a similar systematic expansion in the experts' design protocols in the **experimental** findings of Adelson and Soloway[12]. | 3 | 2 |
| 67-84 | Shih-Wen Hsiao and H. C. Huang | A neural network based approach for product form design | a | Computer modeling, fuzzy set theory and semantic difference method are applied to set up an **experiment**. | 3 | 2 |
| | | | f | The **experimental** results are analyzed by applied back-propagation neural network, which establish the relationships between product–form parameters and adjective image | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | words. | | |
| | | | n | 2 Burr, D J '**Experiment**s on neural net recognition of spoken and written text' IEEE Trans. On ASSP Vol 36 No 7 (1988) 1162–1168 | 3 | 2 |
| | | | | To present the product model clearly, we use Solid Works to construct 3D geometric model of a part and a whole product model for **experiment**. | 3 | 2 |
| | | | h | 3.6 **Experiment** implementation | 3 | 2 |
| | | | | The format of the **experiment** data is shown in Table 2. In this table, each row records the data for a sample. | 3 | 2 |
| | | | Th | Table 2 Data format of the **experimental** data | 3 | 2 |
| | | | | The first 40 **experimental** data of form-images in Table 2 are input to the back-propagation neural network as the training cases to train the network and the last 8 data are used as test cases. | 3 | 2 |
| | | | | (1) The **experiment** interface for establishing the relationship between product forms and their images; | 3 | 2 |
| | | | h | 4.1 The **experiment** interface | 3 | 2 |
| | | | | Three parts are contained in the **experimental** program including setting the configuration parameters, constructing the configurations, and evaluating the image scores of the product. | 3 | 2 |
| | | | | **Experimentation** procedure: | 3 | 2 |
| | | | | To solve this problem, an **experiment** was performed to establish the relationship between product forms and their images in this study. | 3 | 2 |
| | | | f | Then a back-propagation neural network was used to analyze the relationship between the configuration parameters and their image feelings based on the **experiment** results. | 3 | 2 |
| 85-102 | H. Kim, O. M. Querin and G. P. Steven | On the development of structural optimisation and its relevance in engineering design | | The computer simulation assists in evaluation of the design's real-time behaviour, which otherwise would have required one or more **experimental** tests. | 3 | 2 |

**Table D.14:** Content Analysis of Design Studies, Vol. 23, Issue 2. (March, 2002)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 113-133 | Peter Lloyd | Making a drama out of a process: how television represents designing | | An explanation for this might be that the prototype phase could be characterised as one of active collaboration, **experimentation**, and above all learning (not only about the product but about the other people involved). | 2 | 2 |
| 135- | Rivka Oxman | The thinking eye: visual re- | a | An empirical **experiment** from the domain of architecture is presented. | 1 | 7 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 164 | | cognition in design emergence | | | | |
| | | | | For example, in the **experiment** we present below, one of the participants described the following: 'I can anticipate "focal" emergence (e.g. from the center of the formal pattern of spiral shapes) by using knowledge of the prototypical schema: centers and periphery in centrifugal compositions. | 3 | 2 |
| | | | | In an **experiment** conducted by Kosslyn, it was found that a shape is constructed according to how its structural description can be interpreted[19]. | 3 | 2 |
| | | | h | 6 The Re-cognition Annotation **Experiment** | 3 | 2 |
| | | | f | The Re-cognition Annotation **Experiment** was an **experimental** program in the annotation of self-protocols in a process of design emergence. | 3<br>3 | 2<br>2 |
| | | | | In our **experiment**s we have emphasized shape and schema ambiguities per se; this is in contrast to the perceptual ambiguity that is frequently the content of perception in ambiguous hand sketch drawings. | 3 | 2 |
| | | | | Our **experiment**s have indicated that in design emergence, the choice of shapes, as well as their associative manipulations, is dependent upon the existence and operation of high-level cognitive structures such as visual schemas and prototypes. | 3 | 2 |
| 165-185 | Toshiharu Taura, Takahiro Yoshimi and Tomohiro Ikai | Study of gazing points in design situation: A proposal and practice of an analytical method based on the explanation of design activities | a | The method of design **experiment**s that consist of two sessions (design session and explanation session) is proposed and the **experiment** is carried out. | 3<br>3 | 2<br>2 |
| | | | a | Besides the design session, which is the same as in the past standard **experiment**s, in the explanation session, the authors acquire an explanation of design activities, which was recorded in the design session, by means of questions and answers while showing the designer the design process on video. | 3 | 2 |
| | | | | In this study, the authors call these various kinds of information which affects a designer's thinking process 'gazing points in the design situation', and propose a design information model and a new **experimental** methodology to acquire such information. | 3 | 2 |
| | | | | The authors propose the formulation of a design process which can handle the gazing point controlling process, and the verification of the validity of this proposition by means of new design **experiment**s based on the explanation. | 3 | 2 |
| | | | | To date, a number of design **experiment**s have been presented as practical design studies6,7. | 3 | 2 |
| | | | | A design **experiment** consists of 'analyzing design activities by some means after the designing process'8. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Most design **experiment**s have used protocol analysis. | 3 | 2 |
| | | | | This is originally an **experimental** method used in psychology. | 3 | 2 |
| | | | | Moreover, the authors prepare a question plan before the design **experiment** so that the method is more quantitative and repeatable. | 3 | 2 |
| | | | h | 2.4 **Experimental** procedure | 3 | 2 |
| | | | f | The **experiment** was comprised of two sessions, the first of which was the design session which corresponds to standard protocol analysis. | 3 | 2 |
| | | | | The **experiment**ers were given graph paper and white paper, writing tools, simple rulers, a pack of cards, the packaging and references books. | 3 | 2 |
| | | | f | The design **experiment**ers included a person who was an engineer for an electrodevice manufacturer with years of experience (called “Expert” hereafter), and a student who was majoring in mechanical engineering in graduate school (called “Student” hereafter). | 3 | 2 |
| | | | f | The two **experiment**s were carried out independently but one of the authors acted as the analyst in both **experiment**s, staying in the same room with the **experiment**ers throughout the design session. | 3<br>3<br>3 | 2<br>2<br>2 |
| | | | h | 3 Design **experiment** and its analysis | 3 | 2 |
| | | | | Let us explain how the questions and explanations are given in practical **experiment**s, referring to Fig. 4. | 3 | 2 |
| | | | | How to classify the **experimental** data will be explained next. | 3 | 2 |
| | | | h | 3.1 Overview of **experimental** result | 3 | 2 |
| | | | f | Table 2 shows an example of the gazing point observed in the **experiment**. | 3 | 2 |
| | | | | A model of the design process which includes a designer’s gazing point in design situation was formulated, and its validity was confirmed using **experiment**s. | 3 | 2 |
| | | | f | In the **experiment**s, in addition to the standard protocol analysis, the designer’s explanations were taken into account. | 3 | 2 |
| | | | f | As a result of the **experiment**s in which there were two different kinds of **experiment**ers, it was determined that (1) there exists a common feature which is generally expected among designers, (2) there also exists another feature which corresponds to the difference of **experiment**ers. | 3<br>3<br>3 | 2<br>2<br>2 |
| | | | | The results also indicate that the analytical method based on explanation, as proposed in this research, is an effective **experimental** method. | 3 | 2 |
| 187-210 | Mao-Lin Chiu | An organizational view of design communication in design | a | This paper provides a basic understanding of the role of organization in design collaboration and how it affects design communication and collaboration by empirical | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | collaboration | | case studies and design **experiment**s. | | |
| | | | n | 2 Maher, M L, Simoff, S J and Cicognani, A‘ Observations from an **experimental** study of computer-mediated collaborative design’ in Proceedings of IFIP’97 conference, University of Sydney, Australia (1997) pp 165– 186 | 3 | 2 |
| | | | n | 3 Branko, K, Schmitt, G, Hirschberg, U, Kurmann, D and Johnson, B ‘An **experiment** in design collaboration’ Automation in Construction Vol 9 (2000) 73–81 | 3 | 2 |
| | | | | This paper examines design collaboration from an organizational view by reporting case studies of design projects in practice and design **experiment**s in university design studios. | 3 | 2 |
| | | | | The following sections will address the organization view, the communication problems, empirical case studies, **experiment**s in collaborative design studios, and issues related to design collaboration. | 3 | 2 |
| | | | h | 4 Design **experiment**s in collaborative design studios | 3 | 2 |
| | | | | In parallel to the empirical studies in practice, the purpose of design **experiment**s was to examine how the communication related to its organization in CDS. | 3 | 2 |
| | | | | These design **experiment**s were undertaken from 1995 to 2000 in several locations and thus create different distributed organizations. | 3 | 2 |
| | | | | The design **experiment**s considered the arrangement of team organization and the site in order to study the relation between the information flow and organization. | 3 | 2 |
| | | | | The analysis of the above cases and **experiment**s in collaborative design raised the questions such as: What kind of model can better describe the collaborative process? | 3 | 2 |
| | | | | The case studies and **experiment**s clearly demonstrate the impact of using new technologies on the collaborative process in design offices as well as studios. | 3 | 2 |
| | | | | This paper provides a basic understanding of the role of organization in design collaboration and how it affects design communication and collaboration by empirical case studies and design **experiment**s. | 3 | 2 |

**Table D.15:** Content Analysis of Design Studies, Vol. 23, Issue 3. (May, 2002)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 219-231 | Louis L. Bucciarelli | Between thought and object in engineering design | | The analytic character of a proper language hardly allows for the kind of **experimentation** and **innovative** thinking that designing requires. | 4 | 2 |
| 245-261 | Greg Bamford | From analysis/synthesis to conjecture/analysis: a review of Karl Popper's influence on design methodology in | | This argument, put simply, is that since mistakes are always possible in observation or **experiment**, however skilful or meticulous we may be, we therefore cannot know anything, in the standard sense of ‘know’[44]. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | architecture | | | | |
| | | | | Anything that could be dreamed up for the treatment of a disease was tried out;' or that medical 'research' once involved the 'most frivolous and irresponsible kind of human **experimentation**, based on nothing but trial and error, and usually resulting in precisely that sequence[49] (my emphasis, p 26), are we to deny their distinctions between medical research then … and now (current failings aside)? | 3 | 2 |
| | | | n | 2 This case is a 'thought **experiment**', but it is based on an account of alterations that were made to such a hospital ward. | 3 | 2 |
| 263-286 | Richard Coyne, Hoon Park and Dorian Wiszniewski | Design devices: digital drawing and the pursuit of difference | | The computer has also spawned a range of speculative, **experimental**, prototypic devices1–5, many of which have not yet found their way into practice. | 2 | 2 |
| | | | | Here we take the development and testing of an **experimental** 'electronic drawing board' as a case study that provides the basis from which we initiate a phenomenology of the design device. | 2 | 2 |
| | | | | According to the empirical method, as expounded by logical positivists and modified by Popper, the device, or instrument, provides a means of testing a proposition or hypothesis, much as an **experiment** is employed. | 1 | 11 |
| | | | | For human subjects it is difficult to provide the necessary (ideal) isolation of conditions, and their knowledge of the **experimental** procedure influences the results. | 1 | 11 |
| | | | | Even 'design methods', which participated in the 'science' of systems theory, typically distance themselves from scientific **experimentation**[13]. | 1 | 11 |
| | | | | Working with the computer also discloses an orientation towards **experimentation** and discovery as modes of working: 'There's many unexpected things appearing in some designs as a result of using the computer. | 2 | 2 |
| | | | | Partly by accident, partly by discovering things, and partly just by **experimenting**' (Franklin). | 2 | 2 |
| | | | | Computing in design discloses new work patterns and practices, that include new modes of organisation, new specialisms, and a certain kind of **experimentation**. | 2 | 2 |
| 287-302 | Peter Kroes | Design methodology and the nature of technical artefacts | | Admittedly, there has been an empirical turn in the philosophy of science since the work of Kuhn, but although this turn has led to more interest in actual research processes, particularly in **experiment**s, the underlying issues remain, as before, issues about the interpretation and justification of scientific knowledge claims. | 1 | 11 |
| 321-331 | Elizabeth Trott | Permanence, change and standards of excellence in design | | Wise reminds us that 'context helps determine the latitude for **experimental** design' (p. 77). | 2 | 2 |
| 345-361 | Terence Love | Constructing a coherent cross-disciplinary body of theory about | n | 4 Kokotovitch, V and Purcell, T 'Mental synthesis and creativity in design: an **experimental** examination' Design Studies Vol 21 No 5 (2000) 437–450 | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | designing and designs: some philosophical issues | | | | |

**Table D.16:** Content Analysis of Design Studies, Vol. 23, Issue 4. (July, 2002)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 363-384 | Neville A. Stanton and Christopher Baber | Error by design: methods for predicting device usability | h | 5 **Experiment** one: semi-structured versus unstructured techniques | 3 | 2 |
| | | | f | **Experiment** one aims to compare the performance of participants using SHERPA and TAFEI with those using heuristic error prediction. | 3 | 2 |
| | | | h | 5.1 Method for **experiment** one | 3 | 2 |
| | | | h | 5.2 Results for **experiment** one | 3 | 2 |
| | | | h | 6 **Experiment** two: SHERPA versus TAFEI | 3 | 2 |
| | | | f | While **experiment** one has suggested that SHERPA and TAFEI out-perform the heuristic technique, in the next **experiment** we wanted to see how practice might improve performance. | 3<br>3 | 2<br>2 |
| | | | | 6.1 Method for **experiment** two | 3 | 2 |
| | | | | As in **experiment** one, the frequency of hits, misses and false alarms were computed and compared with predicted error rates. | 3 | 2 |
| | | | h | 6.2 Results for **experiment** two | 3 | 2 |
| | | | | The results of **experiment** one show that SHERPA and TAFEI provide a better means of predicting errors than an heuristic approach, and demonstrates a respectable level of concurrent validity. | 3 | 2 |
| | | | | The results of **experiment** two show that the test–retest reliability of SHERPA and TAFEI remains fairly consistent over time. | 3 | 2 |
| 385-406 | W. P. Lewis and E. Bonollo | An analysis of professional skills in design: implications for education and research | a | **Experimental** evidence on the design skills and professional behaviour valued by design practitioners and managers is presented and reviewed in the context of an operational model of the design process. | 3 | 2 |
| | | | | An operational model of the design process constructed to provide a conceptual framework for the educational programme was found to be of considerable assistance in the analysis of the **experimental** data. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | (7) **Experimental** evidence on the proportions of total project time allocated by the students to the major stages of the design process has been presented. | 3 | 2 |
| 407-431 | Ömer Akin | Case-based instruction strategies in architecture | | We also wanted to conduct better structured **experiment**s and projects that verify the value of case-based instruction. | 3 | 2 |
| | | | | Three subjects, all practicing architects, and adjunct faculty at the Department of Architecture, Carnegie Mellon University, participated in the **experiment**. | 1 | 7 |
| | | | f | While **experiment** one has suggested that SHERPA and TAFEI out-perform the heuristic technique, in the next **experiment** we wanted to see how practice might improve performance. | 3<br>3 | 2<br>2 |
| | | | | 6.1 Method for **experiment** two | 3 | 2 |
| | | | | As in **experiment** one, the frequency of hits, misses and false alarms were computed and compared with predicted error rates. | 3 | 2 |
| | | | h | 6.2 Results for **experiment** two | 3 | 2 |
| | | | | The results of **experiment** one show that SHERPA and TAFEI provide a better means of predicting errors than an heuristic approach, and demonstrates a respectable level of concurrent validity. | 3 | 2 |
| | | | | The results of **experiment** two show that the test–retest reliability of SHERPA and TAFEI remains fairly consistent over time. | 3 | 2 |

**Table D.17:** Content Analysis of Design Studies, Vol. 23, Issue 5. (September, 2002)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 437-453 | Chengzhi Peng, David C. Chang, Peter Blundell Jones and Bryan Lawson | Exploring urban history and space online: Design of the virtual Sheffield application | | Our **experiment** with the SUCoD application presents an alternative approach to building virtual cities, which previously has been based largely on pre-determined static urban modelling. | 3 | 2 |
| | | | | To simulate some of the functionality of the responsive modelling workshop, we started with a series of preliminary system **experiment**s. | 3 | 2 |
| | | | | In our current development of the SUCoD prototype, we have **experiment**ed with a different approach. | 3 | 2 |
| | | | | However, we have **experiment**ed with an **innovative** design in the virtual Sheffield | 4 | 7 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | application, addressing the requirements for user-centred dynamic retrieval of complex sets of urban data. | | |
| 473-496 | Joachim Stempfle and Petra Badke-Schaub | Thinking in design teams - an analysis of team communication | | Thus, the comparability of design processes of different teams in practice is not possible in a rigid **experimental** sense. | 3 | 2 |

**Table D.18:** Content Analysis of Design Studies, Vol. 23, Issue 6. (November, 2002)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 497-513 | Jean-François Boujut and Pascal Laureillard | A co-operation framework for product–process integration in engineering design | | New organisations, based on concurrent engineering principles, after many years of **experimentation** within various companies and industrial domains, still suffer from a lack of efficiency. | 2 | 2 |
| 533-556 | Shih-Wen Hsiao and M. C. Liu | A morphing method for shape generation and image prediction in product design | | We compared the **experimental** data with the prediction values obtained with the basic gray prediction model and the modified gray prediction model with Fourier residual correction algorithm, respectively. | 3 | 2 |
| | | | | The **experimental** data with 12.5%, 37.5%, 62.5%, and 87.5% in Table 2, however, are taken to verify the prediction accuracies of the basic gray model and the modified gray model. | 3 | 2 |
| | | | th | Table 2 Some **experimental** image values for several forms | 3 | 2 |
| | | | th | Table 3 A comparison between **experimental** data and predicted images | 3 | 2 |
| | | | t | **Experimental** data | 3 | 2 |
| | | | h | 5 **Experimental** verification | 3 | 2 |
| | | | | To verify the accuracy of the predicted image of a morphed new shape, several **experimental** results were compared with the predicted results obtained with the basic gray prediction model and the modified gray prediction with the Fourier residual correction model, respectively, in Table 3. | 3 | 2 |
| | | | | The result shows that the values predicted with basic gray theory deviate somewhat from the **experimental** data. | 3 | 2 |
| | | | | The maximum improved rate for this example reaches 21% and the modified results are very close to the **experimental** results. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Here x(0)(i), xˆ(0)(i) and xˆ(0) f (i) are the **experimental** value, basic GM(1, 1) prediction value, and Fourier modified prediction value, respectively. | 3 | 2 |
| | | | | Some other **experimental** and predicted results are compared in Table 4, in which the error improved rate, R, in comparison between the basic grey prediction values and the Fourier modified prediction results, is defined as (Formula) | 3 | 2 |
| | | | t<br>h | Table 4 A comparison among the **experimental** data, basic GM(1,1) prediction, and Fourier correction result for several forms | 3 | 2 |
| | | | | They are very close to the **experimental** results. | 3 | 2 |
| | | | | In this model, the information for the relationship between product shape and its image is first obtained **experimental**ly with questionnaires. | 3 | 2 |
| | | | | In a comparison of the **experimental** and theoretical results, we see that the theoretical result deviated somewhat from the **experimental** data if obtained with basic gray theory. | 3<br>3 | 2<br>2 |

**Table D.19:** Content Analysis of Design Studies, Vol. 24, Issue 1. (January, 2003)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 1-25 | Mao-Lin Chiu | Design moves in situated design with case-based reasoning | a | A series of similar sites are tested in a design **experiment** to identify the design situations and make case adaptation, and novice and experienced designers are examined in their design moves by case-based reasoning by freehand sketches or computers, respectively. | 3 | 2 |
| | | | | The concept of design moves in situated design, design **experiment**s, protocol analysis, and the discussion are addressed in the following sections. | 3 | 2 |
| | | | f | Therefore, this paper introduces the concept of design moves to describe the design operations with CBR in helping understand design situatedness by the following steps: (1) to propose a descriptive model of design moves in situated design; (2) to conduct a design **experiment**; (3) to study the process by protocol analysis; (4) to analyze the design moves in relation with cases and design situations; and (5) to discuss the implications of the future computer-aided design (CAD) system development for architectural design. | 3 | 2 |
| | | | | Protocol analysis has become the prevailing **experimental** technique for exploring the understanding of the designing18–20. | 3 | 2 |
| | | | | Therefore, the following studies are undertaken to pursue the following issues: (1) to conduct a design **experiment**; (2) to study the process by protocol analysis; and (3) to analyze the design moves in relation with cases and design situations. | 3 | 2 |
| | | | h | 2 Design **experiment** | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | f | The purpose of the design **experiment** is to understand the design operations in situated design by different designers, how the design moves are preceded manually and computationally, and when and where the situated design is occurred. | 3 | 2 |
| | | | | Designers are requested to design a single urban house in various similar sites in a sequenced design **experiment**. | 3 | 2 |
| | | | | The participants in the design **experiment** consist of two experienced designers (architects with at least 10 year working experience, No. 1 and No. 2) and 10 novice designers (master-level graduate students, No. 3–No. 12). | 3 | 2 |
| | | | | The **experiment** is undertaken for examining how these two groups of designers make design moves or learn how to interact with design situations. | 3 | 2 |
| | | | | In the **experiment**, each participant is required to finish the first part, then the second part. | 3 | 2 |
| | | | | Figure 4 The design **experiment** environment | 3 | 2 |
| | | | | In the first part of the **experiment**, designers study the geometric condition of the sites, the characteristics of the case, and the possibilities of design moves. | 3 | 2 |
| | | | | The aforementioned retrospective report of design **experiment** provides a basic understanding of the design moves in situated design by a pair-wise comparison approach. | 3 | 2 |
| | | | | The findings in the design **experiment** provide the foundation for the following discussion | 3 | 2 |
| | | | | The use of different design tools in design **experiment**s indicates two aspects of design studies: design operations and observation. | 3 | 2 |
| | | | | While the descriptive model of design moves in situated design facilitates our understanding of the process, the observation of design **experiment**s reveals that the descriptive model is a general model of low-level behaviors, and should be further developed into a situation-specific model. | 3 | 2 |
| | | | f | Meanwhile, the study is based on a design **experiment** with limited site conditions in house design, and the complexity of design operations in situated design needs more in-depth studies. | 3 | 2 |
| | | | | This research is supported by the Taiwanese National Science Council under the grant NSC-88-2211-E-006-054. The author is grateful to the assistance by Ying-Chao Kuo, Pei-Yen Wang, Ying-Tzu Lin, and all designers participated in the **experiment**. | 3 | 2 |
| 27-50 | Zafer Bilda and Halime Demirkan | An insight on designers' sketching activities in traditional versus digital media | | The change of media in the **experiment** enabled us to compare the problem solving behavior in different media and the effect of learning. | 3 | 2 |
| | | | | It is not claimed that these categories cover all the possible goals and actions of the designer in the interior space planning problem-solving process, but it was possible to decompose all the design sessions in the **experiment** in terms of those categories. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | h | 2 The **experiment** | 3 | 2 |
| | | | | The **experiment** was conducted in two settings, an office and a CADlab. In the CADlab, a second monitor and a video recorder were connected to the PC to record the digital design process. | 3 | 2 |
| | | | | The Design Apprentice (www.designapprentice.com) software used in the **experiment** is an easy to use commercial software, developed especially for interior space planning tasks. | 3 | 2 |
| | | | | The first phase of the **experiment** consisted of a two-week training programme aiming to provide all subjects with equal proficiency in using the Design Apprentice software. | 3 | 2 |
| | | | | The participants were not asked to report concurrently what was going on in their minds, so they were not interrupted by the **experiment**er. | 3 | 2 |
| | | | | In the **experiment**, the first and the third design sessions employed the same design problem, thus the third session was a second opportunity of the designer to work on the same problem. | 3 | 2 |
| | | | | The authors would like to thank Prof. John Gero for his valuable guidance to the idea of this research on design cognition and for his insightful comments on the design of the **experiment**. | 3 | 2 |
| 101-108 | Hossam A. Gabbar, Kazuhiko Suzuki and Yukiyasu Shimada | Plant object-orientated model formalization — case study: HDS plant design | | The HDS continuous plant has been considered as a case study for validation and **experiment** on the modeling methodology. | 3 | 2 |

**Table D.20:** Content Analysis of Design Studies, Vol. 24, Issue 2. (March, 2003)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 111-134 | Jami J. Shah, Steve M. Smith and Noe Vargas-Hernandez | Metrics for measuring ideation effectiveness | a | These studies include highly controlled lab **experiment**s by cognitive psychologists, as well as **experiment**s in simulated design environments carried out by engineering design theorists. | 1<br>1 | 12<br>13 |
| | | | n | 3 Shah, J '**Experimental** Investigation of Collaborative Techniques for Progressive Idea Generatio' in Proceedings of ASME Design Theory and Methodology Conference, Atlanta, GA (1998) | 1 | 13 |
| | | | n | 4 Shah, J, Kulkarni, S and Vargas-Hernandez, N 'Guidelines for **experimental** | 1 | 13 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | evaluation of idea generation methods in conceptual design' Journal of Mechanical Design Vol 122 No 4 (2000) 377–384 5 Zwicky, P Discovery | | |
| | | | n | 28 Ullman, D, Stauffer, L and Dietterich, T 'Preliminary Results on an **Experimental** Study of Mechanical Design' in NSF DTM Conference (1987) | 1 | 13 |
| | | | | Despite several claims and much anecdotal evidence about the usefulness of these methods, little formal **experimental** evidence exists currently to indicate that these methods are effective in engineering design to generate concepts. | 3 | 2 |
| | | | | We need metrics to **experimental**ly evaluate the effectiveness of these methods for different kinds of design problems. | 3 | 2 |
| | | | | The models in cognitive theories are derived from highly controlled lab **experiment**s involving simple and isolated tasks. | 3 | 2 |
| | | | | There is little similarity between conditions for these **experiment**s and design concept generation in the real world. | 3 | 2 |
| | | | | On the other hand, direct **experiment**s using design idea generation methods in their entirety, simulate real world design better but cannot discriminate between necessary and superfluous components21, require a prohibitive number of **experiment**s, and are unable to explain the performance of methods under different conditions. | 3 | 2 |
| | | | | Regardless of the ecological level of the **experimental** studies, one needs metrics for analysing the effectiveness of ideation methods and processes. | 3 | 2 |
| | | | | Several **experimental** methods have been used for studying the design process and/or its associated cognitive activities. | 3 | 2 |
| | | | | There is not much reported on **experimental** studies of specific idea generation methods applied to engineering design, particularly groups engaged in conceptual design (except studies on Brainstorming or 'free form' idea generation). | 3 | 2 |
| | | | | These cognitive theories were derived either from pure conjecture or controlled **experiment**s that use simple tasks. | 3 | 2 |
| | | | | Many of these 'models' or 'theories' are pure conjectures not supported by **experiment**s. | 3 | 2 |
| | | | | In an **experiment** conducted at ASU, generative and exploratory cognitive processes were identified by videotaping designers who were asked to 'think aloud' while they were generating ideas using the C-Sketch method[3]. | 3 | 2 |
| | | | | More importantly, the cognitive processes described by psychologists in cognitive models such as the Geneplore Model40, the Roadmap Theory43 and other models described in[53], are based on controlled **experiment**s that involve simple problems or tasks. | 3 | 2 |
| | | | | The appropriateness of the use of these models in **experiment**s involving engineering problems, that are far more complex by comparison, is subject to speculation. | 3 | 2 |
| | | | | In this **experiment**, subjects were asked to design a link in a mechanism that could | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | transmit intermittent tension/compression and torque through pin joints at either end. | | |
| | | | | The results of **experiment**s are published elsewhere[20,62]. | 3 | 2 |

**Table D.21:** Content Analysis of Design Studies, Vol. 24, Issue 3. (May, 2003)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 199-212 | Richard Coyne | Mindless repetition: Learning from computer games | | There is little scope in computer games for the same **experimentation** that accompanies digital media art and its forays into new modes of interaction and novel conceptions of space. | 3 | 2 |
| 275-294 | Robin S. Adams, Jennifer Turns and Cynthia J. Atman | Educating effective engineering designers: the role of reflective practice | | Schön characterizes a reflective practitioner as one who emphasizes problem-setting (in addition to problem solving) activities, reasons about the problem and solution through **experimentation**, and fluidly engages in a variety of representations (both inscription representations and language representations) to **experiment** with the problem[6]. | 2<br>2 | 2<br>2 |
| | | | | In this process, the designer functions as both a creator developing a solution and an **experiment**er trying to understand the situation he is creating, hence the notion of the designer as having a 'reflective conversation' with the situation. | 2 | 2 |
| | | | | In a verbal protocol **experiment**, subjects are asked to talk aloud while solving a problem. | 3 | 2 |
| | | | | Because the **experiment** was designed to encourage students to ask the administrator for additional information, it was possible to track the kinds of information explicitly brought into the design activity. | 3 | 2 |
| | | | | From a process perspective, Schön talks about how the designer conducts **experiment**s that push the solution forward but then is open to discover irregularities in the situation that suggest further clarification of the problem. | 2 | 2 |
| | | | q | ". . . does not keep means and ends separate, but defines them interactively as he frames a problematic situation . . .. Because his **experimenting** is a kind of action, implementation is built into his inquiry" (p. 68). | 2 | 2 |
| 295-311 | L. L. Bucciarelli | Designing and learning: a disjunction in contexts | | These often emerge in testing of a prototype or bench top **experiment**. | 3 | 2 |

**Table D.22:** Content Analysis of Design Studies, Vol. 24, Issue 4. (July, 2003)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 313-326 | A. Heylighen and I. M. Verstijnen | Close encounters of the architectural kind | a | I.M. Verstijnen, Laboratory of **Experimental** Psychology, Department of Psychology, Katholieke Universiteit Leuven, Tiensestraat 102, B-3000 Leuven, Belgium | 1 | 12 |
| | | | | The **experiment** that is reported in this article examines the conditions under which CBR technology can be useful in architectural education. | 3 | 2 |
| | | | | In a previous **experiment**, we therefore investigated the effects of using cases in studio teaching.[7] | 3 | 2 |
| | | | | Embroidering upon this first study, the **experiment** reported in this article investigates CBR's potential to meet this challenge | 3 | 2 |
| | | | | The tool used in the **experiment** is called DYNAMO, which stands for dynamic architectural memory on-line. | 3 | 2 |
| | | | | Whereas previous papers have focused on the theoretical ideas behind DYNAMO and on the implementation of these ideas as a working prototype,[10] the **experiment** described in the following sections exploits this prototype to investigate the effects of CBD technology on students' design performance. | 3 | 2 |
| | | | | Figure 1 Screenshot of DYNAMO's user interface (at the time of the **experiment**) | 3 | 2 |
| | | | h | 1 **Experiment** | 3 | 2 |
| | | | f | The **experiment** took place in a traditional design studio addressing the issue of reuse. | 3 | 2 |
| | | | | These aspects were selected because of their particular relevance for the **experiment**, the assignment or the design field, i.e. architecture. | 3 | 2 |
| | | | | Like in our previous **experiment**, design[3]—students' score for the third year design course—was selected as additional independent variable. | 3 | 2 |
| | | | | Unlike in our previous **experiment**, hardly any statistical evidence was found that students' background had any impact on their design performance. | 3 | 2 |
| | | | | Yet, although not significant, its influence on the other aspects as well as on the global quality of the projects is generally positive, which supports the findings of our first **experiment**. | 3 | 2 |
| | | | | The fact that, in this **experiment**, cases were provided on a computer is unlikely to have altered that situation. | 3 | 2 |
| | | | c | Perhaps the most surprising finding of our **experiment**, however, is that the effects of using the CBD tool depend heavily on the option (school or library) students had chosen. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | The results of our **experiment** suggest that, as far as student architects are concerned, similarity has an important part in this compromise. | 3 | 2 |
| | | | | Therefore, it might be interesting to repeat our **experiment** with experienced architects and investigate whether the different impact on library and school designers indeed disappears. | 3 | 2 |
| | | | | This article has reported on a recent **experiment** about the effects of cases in architectural design education. | 3 | 2 |
| | | | | Our **experimental** data provide every reason for optimism. | 3 | 2 |
| | | | | If future **experiment**s can confirm these results, they may provide important lessons for architectural education at large. | 3 | 2 |
| 327-339 | B. Lawson, M. Bassanino, M. Phiri and J. Worthingt | Intentions, practices and aspirations: Understanding learning in design | | **Experimentation** and investigation gradually began to take place[11]. | 2 | 2 |
| 375-390 | Liu Xijuan, Wang Yinglin and Jiang Shouwei | A metrics based task analysis model for design review planning | | Cost is measured as all the expense on equipment, salary, resource and **experiment** during the total time. | 2 | 2 |
| 393 | | ANNOUNCEMENT: DESIGN STUDIES AWARD | | The theory is illustrated with an empirical **experiment** from the domain of architectural design. | 1 | 7 |

**Table D.23:** Content Analysis of Design Studies, Vol. 24, Issue 5. (September, 2003)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 437-456 | O. O. Demirbaş and H. Demirkan | Focus on architectural design process through learning styles | | According to this circular process, concrete experience is followed by observation and reflection; this leads to the formulation of abstract concepts and generalisations, and later the implications of concepts in new situations are tested through active **experimentation**[25, 26]. | 2 | 2 |
| | | | | Each individual has a preferred learning style resulting from the tendency to either learn through experiencing called concrete experience (CE) or through the construction of theoretical frameworks that is abstract conceptualisation (AC) combined with the tendency to either learn by doing through active **experimentation** (AE) or through reflection by reflective observation (RO). | 2 | 2 |
| | | | | It is aimed to find out the effects of different learning styles in various stages of design studio education through a design **experiment**. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | h | 3.2 Design **experiment** | 3 | 2 |
| | | | | According to the LSI test, concrete experience (CE), reflective observation (RO), abstract conceptualisation (AC) and active **experimentation** (AE) scores of each participant were established. | 2 | 2 |
| | | | t | Active **experimentation** (AE) | 2 | 2 |
| | | | | After both of the instructors finished the assessment of all students' products for each stage of the design **experiment**, the raw averages of the two scores were calculated for the final performance score. | 3 | 2 |
| | | | | To control this, the means and standard deviations of the scores given by two instructors for the products of each stage of the design **experiment** were calculated and t-tests were conducted. | 3 | 2 |
| | | | | The analysis of variance (ANOVA) tests were conducted in order to find out if the learning styles had any effect on the performance scores in different stages (stage 2, stage 3 and stage 4) of the design **experiment**. | 3 | 2 |
| | | | | This might be the reason of this result, although it was expected that the mean of converging students would be the highest in stage 3, since the converging style is dealing more with abstract conceptualisation and active **experimentation**. | 2 | 2 |
| | | | | In the design **experiment**, stages that had different learning processes were devised for testing the effects of different learning styles on the performances of students. | 3 | 2 |

**Table D.24:** Content Analysis of Design Studies, Vol. 24, Issue 6. (November, 2003)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 473 | Nigel Cross | Editorial to: Common ground | | Blackler, Popovic and Mahar report an **experiment** in the field of interaction design (an inherently interdisciplinary domain) that has relevance for anyone interested in the usability of products. | 3 | 8 |
| 475-489 | Tokio Abe and Patrick Starr | Teaching the writing and role of specifications via a structured teardown process | t | Statistics/design of **experiment**s | 3 | 2 |
| | | | | The phases, tasks and outcomes of Figure 3 have evolved through several take-apart **experiment**s with small groups of students using familiar consumer products such as a stapler, a can opener and an electric drill. | 3 | 2 |
| | | | n | 18 Abe, T 'The teaching **experiment** of the design scheme' The Journal of the Economics Department, Akita Keizai-Houka University Vol 29 (1999) 49–69 | 1 | 12 |
| | | | n | 19 Abe, T 'The teaching **experiment** of the design scheme (2)' The Journal of the Economics Department, Akita Keizai-Houka University Vol 31 (2000) 13–27 | 1 | 12 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | The first take-apart **experiment**[15] focused upon the idea of 'translation' of the customer needs into engineering requirements. The translation task was broken into three parts, which evolved into phases II–IV of Figure 3, and the steps of phase IV evolved from student efforts on two products[16, 17]. | 3 | 2 |
| | | | | This section describes the details of the elements of Figure 3, and the next section discusses selected outcomes produced by students in the most recent **experiment**s. | 3 | 2 |
| | | | h | 2 Analysis of the **experiment** using the phases of Figure 3 | 3 | 2 |
| | | | | In the **experiment**, the students answered the item of materials, the method of assembly and packing. | 3 | 2 |
| 491-506 | A Blackler, V Popovic and D Mahar | The nature of intuitive use of products: an **experimental** approach | | A set of **experiment**s with a digital camera was conducted to test the thesis. | 3 | 2 |
| | | | | The results of these **experiment**s support the thesis. | 3 | 2 |
| | | | | This paper addresses what intuitive use might entail and details an exploratory **experiment** conducted to investigate whether people can use products intuitively, what enables that process to take place and how designers could facilitate it. | 3 | 2 |
| | | | | 23 Schunn, C D, Reder, L M, Nhouyvanisvong, A, Richards, D R and Stroffolino, P J 'To calculate or not to calculate: a source activation confusion (SAC) model of problem-familiarity's role in strategy selection' Journal of **Experimental** Psychology: Learning, Memory and Cognition Vol 23 No 1 (1997) 3–29 | 1 | 12 |
| | | | h | 4 **Experimental** approach | 3 | 2 |
| | | | | A set of **experiment**s was designed to test the thesis that intuitive use of products is based on previous experience with products or systems that have similar features to those on the product. | 3 | 2 |
| | | | f | Relatively few **experiment**s have been done specifically mentioning intuition[13], so there was no established procedure for measuring it. | 3 | 2 |
| | | | | The **experiment** objectives were to establish if relevant past experience of product features increased the speed and/or ease with which people could use those features, and to establish if interface knowledge was transferred from known products to new ones. | 3 | 2 |
| | | | | Five people per group (a total of 20) were needed for this **experiment**. | 3 | 2 |
| | | | f | None of the participants had encountered the camera used in the tests before the **experiment** began, and all participants were volunteers who received no payment in return for their participation. | 3 | 2 |
| | | | | Thus a calm and 'permissive' environment should be provided for **experiment**s concerned with intuition[13]. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | f | Participants were encouraged not to worry about the **experiment** or their performance, and were reminded that the product was being tested, not themselves. | 3 | 2 |
| | | | | The **experiment**er answered questions and reminded participants to think aloud but otherwise did not intervene during the operations. | 3 | 2 |
| | | | | As part of the interview, participants were asked if they had been anxious during the test, either because of the presence of the **experiment**er, the video cameras and other equipment, or for any other reasons. | 3 | 2 |
| | | | | The Fuji 4700 zoom digital camera (Figures 3 and 4) was chosen for use in this **experiment** | 3 | 2 |
| | | | | The variables measured through this **experiment** and the methods and tools used are shown in Table 1. | 3 | 2 |
| | | | | Correct but inappropriate uses are relevant as this **experiment** was focussing on the features of the camera and these uses were correct uses of those features. | 3 | 2 |
| 507-522 | Ken Friedman | Theory construction in design research: criteria: approaches, and methods | | The noun research means, '1: careful or diligent search, 2: studious inquiry or examination; especially: investigation or **experimentation** aimed at the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts, or practical application of such new or revised theories or laws, 3: the collecting of information about a particular subject'3 (p 1002) (See also:4 (p 1224);5 (unpaged);6 (unpaged);9 (unpaged);10 (unpaged);11 (p 2558);12 (unpaged).) | 2 | 2 |
| | | | | Some craft involves **experimentation**. | 2 | 1 |
| | | | | Design will never achieve this goal until it rests on all three legs of science, observation, theorizing, and **experimenting** to sort useful theories from the rest. | 2 | 2 |
| 523-535 | Rachael Luck | Dialogue in participatory design | n | 21 Gill S P 'Dialogue and Tacit Knowledge for Knowledge Transfer' PhD thesis, Department of **Experimental** Psychology University of Cambridge, Cambridge (1994) | 1 | 12 |
| 537-547 | Susan Turner and Phil Turner | Telling tales: understanding the role of narrative in the design of taxonomic software | n | 11 Maher M L Cicognani A and Simoff S J 'An **experimental** study of computer mediated collaborative design' International Journal of Design Computing (1997) | 3 | 2 |
| | | | n | 27 Bartlett, F C Remembering: an **experimental** and social study Cambridge University Press, Cambridge (1932) | 1 | 12 |
| | | | | As early as 1932, Bartlett[27] demonstrated **experimental**ly that stories are reconstructed rather than recalled. | 1 | 12 |

**Table D.25:** Content Analysis of Design Studies, Vol. 25, Issue 1. (January, 2004)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 1-29 | Jay P. | Speaking the Buick language: | | There is an endless list of interesting **experiment**s that can be performed with the | 1 | 12 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | McCormack, Jonathan Cagan and Craig M. Vogel | capturing, understanding, and exploring brand identity with shape grammars | | grammar. | | |
| | | | | Through **experimentation**, not only is **innovation** found, but also the Buick brand becomes more clearly defined for the user. | 4 | 4 |
| 31-50 | Omer Akin and Hoda Moustapha | Strategic use of representation in architectural massing | h | 1.1 **Experimental** set-up | 1 | 7 |
| | | | | Our protocol **experiment** consisted of observing six architects while they designed a three-dimensional massing model. | 1 | 7 |
| | | | | Each session was recorded on videotape and was followed by a brief post-**experiment** questionnaire. | 1 | 7 |
| | | | | 12 Van Sommers, P Drawings and cognition: descriptive and **experimental** studies of graphics production processes Cambridge University Press, Cambridge (1984) | 1 | 8 |
| 51-62 | Stuart Burgess, Damiano Pasini and Kazem Alemzadeh | Improved visualisation of the design space using nested performance charts | | It is interesting to note that the interpretation of the results in Figure 7 is analogous to the interpretation of the results of a design of **experiment**s (DOE) exercise13 because the effect of changing individual parameters can be systematically examined. | 3 | 2 |
| 63-91 | Rivka Oxman | Think-maps: teaching design thinking in design education | | Research in this area generally falls into two broad directions: empirical and **experimental**. | 3 | 2 |
| | | | | It is in this context of the critical research study of new educational models that **experimental** research offers certain advantages as a supplement to empirical tools. | 3 | 2 |
| | | | f | Rather than emphasizing observation of existing teaching approaches, **experimental** research is frequently associated with the study of **experimental** teaching methods. | 3<br>3 | 2<br>2 |
| | | | f | That is, **experimental** methods tend to encourage **experimentation** with learning theories as a basis for cognitive modeling. | 3<br>2 | 2<br>2 |
| | | | f | In research in design education, **experimental** approaches involve theoretical foundations for modeling based upon cognitive theories of thinking, creativity and learning in design. | 3 | 2 |
| | | | | While interesting in itself as a research approach to cognitive modeling, we believe that such **experimental** approaches may also have potential as an educational medium. | 3 | 2 |
| | | | | In a recent workshop on design learning and knowing we have introduced our | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | **experimental** framework. | | |
| | | | | This form of modeling cognitive processes through the dynamics of network structures has proved to be not only a robust modeling medium, but also an excellent tool for **experimental** design research. | 3 | 2 |
| | | | | The objective of this paper is to describe the theoretical foundations of Think-Maps, discuss their implementation in the Web-Pad system, and to describe and assess our pedagogical **experiment**s with this environment. | 1 | 12 |
| | | | | Section 5 will explain how Web-Pad is employed within the Think-Maps framework in a learning **experiment**, and section 6 will conclude with summary and discussion. | 3 | 2 |
| | | | | These cognitive structures have been investigated in design thinking by both empirical and **experimental** researchers. | 3 | 2 |
| | | | | In **experimental** design research computational modeling has been exploited in studying such knowledge structures as rule schemata and typologies19 and design precedents14. | 3 | 2 |
| | | | | Instead of constructing an **experiment** or an object the learner constructs the conceptual structures of domain knowledge. | 3 | 2 |
| | | | h | 5 Teaching Think-Maps: constructing the learning **experiment**s | 3 | 2 |
| | | | | Think-Maps has been used in a teaching and learning **experiment** that is based upon the student's exploration and formulation of knowledge structures in design, and his ability to construct a conceptual mapping in a specific domain. | 3 | 2 |
| | | | | In this research we have explicitly encouraged the creation of precedent knowledge as part of the learning **experiment**. | 3 | 2 |
| | | | | In the present learning **experiment**, the body of concepts has been acquired from specialist texts in this domain. | 3 | 2 |
| | | | | This **experiment** also demonstrates a novel application of conceptual mapping. | 3 | 2 |
| | | | | The **experiment** was carried out among a team of design students in a collaborative setting. | 3 | 2 |
| | | | | The employment of the Web-Pad tool in the Think-Maps **experiment**s is significant, since it provides a representational schema to be shared by all participants and systems mechanisms for collaborative construction, search, and retrieval of knowledge structures. | 3 | 2 |
| | | | | Within the scope of this **experimental** program a detailed learning evaluation process was not undertaken. | 3 | 2 |
| | | | | However, it is our impression that the exposure to design thinking as a specific kind of transferable knowledge made a powerful impression upon the groups of design students who have undertaken this first series of learning **experiment**s. | 3 | 2 |
| | | | | Whether or not the Think-maps approach may be considered of general relevance it | 2 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | pioneers the kind of pedagogical **experimentation** that is highly desirable in order to overcome deficiencies of conventional approaches to design education. | | |
| | | | | This work was supported by a DFG grant from the German government. Professor Bernd Striech and his research team, particularly Architect Oliver Fritz, are acknowledged for their contributions to our research and pedagogical **experiment**s. | 1 | 12 |
| | | | | As always my students are greatly acknowledged for their participation in this pedagogical **experiment**. | 1 | 12 |
| 93-109 | Sidney Newton | Designing as disclosure | a | These elements play together in a reflective process (conversation) of signification and **experimentation**. | 2 | 2 |
| | | | | Understanding, in this form, is (literally) in the action of **experimentation**. | 2 | 2 |
| | | | f | For Schön, controlled **experimentation** (what he terms hypothesis-testing **experimentation**) is only one of the several valid and rigorous forms of reflective **experiment**: "each of which has its own logic and its own criteria of success and failure"[9]. | 2<br>2<br>2 | 2<br>2<br>2 |
| | | | f | These other forms include exploratory **experimentation** (in which what-if questions are posed early in the design process to establish how a situation/problem responds), and move-testing **experimentation** (where any deliberate change or action that affects the problem can be considered as a testing of that move). | 2<br>2 | 2<br>2 |
| | | | f | "Exploratory **experiment** is the probing, playful activity by which we get a feel for things. | 2 | 2 |
| | | | | **Experimentation** is what prompts the situation's back-talk, to effect new appreciation and understanding, which is then made manifest in changed impulsion (motivations and perspectives) and drives the design process forward. | 2 | 2 |
| | | | f | Thus, the design process (reflective conversation) proceeds as an iterative process of articulation and re-articulation of signification and **experimentation**. | 2 | 2 |
| | | | | An individual's own impulsion (through a process of signification, as a metaphor structure sustained through particular connections) services a reflective conversation (of signification and **experimentation**). | 2 | 2 |
| | | | | (2) (…) There have been multiple versions of Figure 6 developed and considered, as there have been multiple episodes (articulation, re-articulation, signification, **experimentation**) in the design conversation. | 2 | 2 |
| | | | | (3) (…) The flow of the design conversation that lead to the particular instance of Figure 6 presented in this paper, has followed precisely that process of signification and **experimentation** being articulated. | 2 | 2 |
| | | | | (2) (…) The lessons of material culture23 strongly suggest that a traditional engagement with design knowledge (through the artefact) is more fundamentally problematic: it removes the articulation of design knowledge one further (and critical) | 2 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | step from the signification and **experimentation** process itself. | | |
| | | | | (3) (…) Figure 6 explicitly recognises that designing demands an awareness of its own functioning through signification and **experimentation**, and from that the fundamentally experiential nature of designing. | 2 | 2 |
| | | | | This conception explicitly recognises that designing is driven by the impulsion of the designer through an iterative process of signification and **experimentation**. | 2 | 2 |
| | | | | The design process feeds on a continuing (iterative) interplay between (**experimentation** with and through) these relationships and their impact on (what they disclose to) our understanding. | 2 | 2 |

**Table D.26:** Content Analysis of Design Studies, Vol. 25, Issue 2. (March, 2004)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 113-153 | Paul Cleveland | Bound to technology—the telltale signs in print | | This access translated into greater freedom in **experimentation** and the pushing of previous boundaries that existed in page layout design. | 2 | 2 |
| | | | | The 'Verbum' publication began publication in 1987 and provided a focus for **experimentation** and dissemination of information related to the use of computers as tools for producing artwork (Figure 7). | 2 | 2 |
| | | | | Vertelney[20] conducted an **experiment** in which an interface problem was put to a graphic designer and a programmer. | 3 | 2 |
| | | | f | The result of this **experiment** was that interface designers consider themselves as potential users when they develop the interface. | 3 | 2 |
| | | | | True creativity requires **experimentation**, abstraction and the convergence of disparate elements, which are at present beyond computer programs, but not the creative designer. | 2 | 2 |
| | | | | The amount of freedom given to the designer to accomplish what used to be considered difficult tasks has led to a great deal of **experimentation** and new image creation which was not possible previously. | 2 | 2 |
| 155-173 | S. Ahmed and K. M. Wallace | Understanding the knowledge needs of novice designers in the aerospace industry | n | 5 Baya, V 'Information handling behaviour of designers during conceptual design: three **experiment**s' Ph.D. Thesis, Stanford University, Palo Alto (1996) | 3 | 2 |
| 175-192 | Chengzhi Peng and Peter Blundell Jones | Reconstructing urban contexts online for interactive urban designs | a | The current **experiment** suggests that SUCoD could be further developed into an online Urban Design Collaboratory. | 1 | 7 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Based on a recent **experiment** in an undergraduate urban design computing course, this paper reports a study on the usability and usefulness of a Web-based dynamic virtual city information system for directly supporting urban investigation and 3D urban design. | 1 | 7 |
| | | | | In developing the system, we were particularly interested in **experimenting** with an alternative methodology that will lift some of the limitations seen in the existing approaches to building 'virtual cities', which have been largely based on static urban modelling. | 1 | 7 |
| | | | | An overall aim of the course is to provide a learning process with which students can interrelate their existing CAD skills with knowledge of urban history and **experiment** with SUCoD in exploring the urban history and spaces online. | 1 | 7 |
| | | | | Reflecting on the Sheffield **experiment**, we envisage the development of an Urban Design Collaboratory supporting urban contextual study and urban design. | 1 | 7 |
| | | | | (1) (…) The Sheffield Urban Study programme has **experiment**ed with a methodology, which demonstrated how a city's history could be studied in a systematic manner. | 1 | 7 |
| | | | | The Collaboratory will serve as a testing ground for **experimenting** with all kinds of **innovative** software tools relating to multidimensional and interdisciplinary urban modelling and design. | 1 | 7 |

**Table D.27:** Content Analysis of Design Studies, Vol. 25, Issue 3. (May, 2004)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 301-325 | Robert B. Stone, Daniel A. McAdams and Varghese J. Kayyalethekkel | A product architecture-based conceptual DFA technique | n | 29 Kurfman, M, Stone, R, Van Wie, M, Wood, K and Otto, K 'Theoretical underpinnings of functional modeling: preliminary **experimental** studies' in Proceedings of DETC2000 DETC2000/DTM-14563, Balitmore, MD (2000) | 3 | 2 |

**Table D.28:** Content Analysis of Design Studies, Vol. 25, Issue 4. (July, 2004)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 351-371 | Henna Lahti, Pirita | Collaboration patterns in computer supported collaborative | | In this paper, we examine the role of collaborative technology in supporting designing based upon results from our first virtual studio **experiment** in using FLE-Tools in a | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Seitamaa-Hakkarainen and Kai Hakkarainen | designing | | university-level design course involving a project with an authentic real-life design problem. | | |
| | | | t | Exploring technical solutions by sewing and **experimenting** | 2 | 2 |
| 373-391 | John S. Gero and Udo Kannengiesser | The situated function–behaviour–structure framework | n | 11 Bartlett, F C Remembering: a study in **experimental** and social psychology Cambridge University Press, Cambridge (1932)(reprinted in 1977) | 1 | 12 |
| | | | | In **experimental** studies of designers, some phenomena related to the use of sketches, which support this idea, have been reported. | 3 | 2 |
| 393-413 | S. Lim, S. F. Qin, P. Prieto, D. Wright and J. Shackleton | A study of sketching behaviour to support free-form surface modelling from on-line sketching | a | This paper presents our **experimental** studies on sketching behaviour, processing and individual preference through questionnaire and sketch observation. | 3 | 2 |
| | | | | The focus of this paper is an identification of the flexibility demands through **experimental** studies. | 3 | 2 |
| | | | | He also added some **experimental** smooth-surface editing operations such as filleting, creasing, and smoothly merging separate meshes. | 3 | 2 |
| | | | | Thus, some essential system functions and features should be determined before the development through **experimental** studies. | 3 | 2 |
| | | | f | Sections 3 and 4 present our **experimental** studies on sketching behaviour, processing and individual preference through questionnaire and sketch observation. | 3 | 2 |

**Table D.29:** Content Analysis of Design Studies, Vol. 25, Issue 5. (September, 2004)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 425-426 | Nigel Cross | Design studies special issue: expertise in design | | Ball, Ormerod and Morley also focus on the domain of engineering design, using **experimental** studies to compare expert and novice performances in the use of analogies in creative design thinking. | 3 | 2 |
| | | | | McDonnell, Lloyd and Valkenburg report an **experiment** in introducing a new approach in product design education. | 3 | 2 |
| 427-441 | Nigel Cross | Expertise in design: an overview | | Thus, the speed of cognitive processes was much higher for the expert, and the expert's rate of cognitive activity continuously rose throughout the **experiment**, whilst the novice's cognitive activity started at a peak and declined continuously. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 443-457 | Bryan Lawson | Schemata, gambits and precedent: some factors in design expertise | | Sadly we have so far been unable to persuade world expert designers to take part in these **experiment**s and Alex has had to make do with comparing first year with sixth year students of architecture! | 3 | 2 |
| | | | | Suffice it say that the **experiment**s ask designers to describe a drawing to another person who cannot see the drawing but must reproduce it from the verbal description. | 3 | 2 |
| | | | | Such an idea dates back at least as far as Bartlett's famous **experiment** in which he asked subjects to recall a formalized Egyptian drawing of a local ornithological species, the Mulak. | 3 | 2 |
| | | | | Bartlett ran the **experiment** for many sequences in England and on each occasion ended up with a drawing of a black cat hardly resembling the geometry of the original drawing but adequately and reliably communicating the feline schema. | 3 | 2 |
| 477-493 | Marian Petre | How expert engineering teams use disciplines of **innovation** | | Exceptional companies accommodate **experimentation**, for example providing parts or facilities for developing hobby projects (such as competitors for Robot Wars or remote-control airplanes) or providing budgets to individuals for open-ended exploration. | 2 | 2 |
| 495-508 | Linden J. Ball, Thomas C. Ormerod and Nicola J. Morley | Spontaneous analogising in engineering design: a comparative analysis of experts and novices | a | We report an **experimental** comparison of analogy use by expert and novice design engineers. | 3 | 2 |
| | | | | Our literature review focuses primarily on laboratory-based **experiment**s of analogical problem solving, as these have been the mainstay of existing research in this area. | 3 | 2 |
| | | | | For example, pioneering **experiment**s by Gick and Holyoak[14,15] demonstrated that providing participants with a source analogue prior to them tackling a superficially different but conceptually similar target problem gave little or no gain over baseline solution rates where no analogue had previously been presented. | 3 | 2 |
| | | | n | 16 Anoli, L, Antonietti, A, Crisafulli, L and Cantoia, M 'Accessing source information in analogical problem-solving' Quarterly Journal of **Experimental** Psychology Vol 54A (2001) 237–261 | 1 | 12 |
| | | | n | 20 Keane, M 'On retrieving analogues when solving problems' Quarterly Journal of **Experimental** Psychology Vol 39A (1987) 29–41 | 1 | 12 |
| | | | n | 23 Sweller, J 'Transfer eects in a problem solving context' Quarterly Journal of **Experimental** Psychology Vol 32 (1980) 233–239 | 1 | 12 |
| | | | n | 24 Blessing, S B and Ross, B H 'Content eects in problem categorization and problem solving' Journal of **Experimental** Psychology: Learning, Memory, and Cognition Vol 22 (1996) 792–810 | 1 | 12 |
| | | | n | 25 Novick, L R 'Analogical transfer, problem similarity and expertise' Journal of **Experimental** Psychology: Learning, Memory and Cognition Vol 14 (1988) 510–520 | 1 | 12 |
| | | | n | 26 Catrambone, R and Holyoak, K J 'Overcoming contextual limitations on | 1 | 12 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | problemsolving transfer' Journal of **Experimental** Psychology: Learning, Memory and Cognition Vol 15 (1989) 1147–1156 | | |
| | | | | These theoretical speculations, however, require empirical assessment, and a major aspect of the study reported below was to evaluate such ideas **experimental**ly. | 3 | 2 |
| | | | h | 2 **Experimental** predictions | 3 | 2 |
| | | | | All participants were paid £15 for their involvement in the **experiment**. | 3 | 2 |
| | | | h | 3.3 **Experimental** design | 3 | 2 |
| | | | f | The **experiment** involved a 2 X 2 mixed between-within participants design. | 3 | 2 |
| | | | | Each participant was also asked to produce a concurrent think-aloud verbalisation during their design work, and was told that the **experiment**er was interested in capturing the initial phase of their typical design activity. | 3 | 2 |
| | | | | It would appear that analogizing is part of the natural behavioural repertoire of industrial designers, and is a form of reasoning that can flourish without directive hints from the **experiment**er that explicitly request the reuse of prior knowledge and experience. | 3 | 2 |
| 527-545 | Vesna Popovic | Expertise development in product design—strategic and domain-specific knowledge connections | n | 18 Adelson, B 'When novices surpass experts: the diculty of a task may increase with expertise' Journal of **Experimental** Psychology: Learning, Memory and Cognition Vol 10 No 3 (1984) 483–495 | 1 | 12 |

**Table D.30:** Content Analysis of Design Studies, Vol. 25, Issue 6. (November, 2004)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 547-577 | Nathan Crilly, James Moultrie and P.John Clarkson | Seeing things: consumer response to the visual domain in product design | n | 48 Berlyne, D E Studies in the new **experimental** aesthetics Hemisphere Publishing Corporation, Washington, DC (1974) | 3 | 2 |
| | | | | 95 Blackler, A, Popovic, V and Mahar, D 'The nature of intuitive use of products: an **experimental** approach' Design Studies Vol 24 No 6 (2003) 491–506 | 3 | 2 |
| 579-605 | Sharon Poggenpohl, Praima Chayutsahakij and Chujit Jeamsinkul | Language definition and its role in developing a design discourse | | With this technical support, sustainable human motivation and engagement together with agreement on project goals are the remaining issues needing **experimentation** and resolution | 2 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 625-655 | Patrick D'Astous, Françoise Détienne, Willemien Visser and Pierre N. Robillard | Changing our view on design evaluation meetings methodology: a study of software technical review meetings | n | 1 Johnson, P M and Tjahjono, D 'Assessing software review meetings: a controlled **experimental** study using CSRS', in International Conference of Software Engineering (1997) | 1 | 13 |
| | | | | The definition of these five characteristics was obtained through an iterative process of **experimentation** and validation of the coding scheme on one typical meeting. | 1 | 13 |

**Table D.31:** Content Analysis of Design Studies, Vol. 26, Issue 1. (January, 2005)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 19-34 | Thomas Kvan and Yunyan Jia | Students' learning styles and their correlation with performance in architectural design studio | | From these foundations, Kolb developed his model of learning as a four-stage cycle (Figure 1) comprising concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active **experimentation** (AE). | 1 | 7 |
| | | | | If the academic field of architecture is inclined to accommodators, students may experience a transition from reflective observation to active **experimentation** during their undergraduate study; in the two programs of this study, there seems to be some indication of this as the percentage of active learners increased from Program 1 (Year Two students), 16.2%, to Program 2 (Year Three students), 20.4%, but we note that this conclusion cannot be confirmed since the students in the two programs were not the same subjects of study here. | 1 | 7 |
| 55-72 | Y.M. Xie, P. Felicetti, J.W. Tang and M.C. Burry | Form finding for complex structures using evolutionary structural optimization method | | It is the objective of the authors of this paper to demonstrate that the method of Evolutionary Structural Optimization (ESO) (Xie and Steven, 1997), developed approximately 100 years after Gaudi's first **experiment**s with hanging models, is a contemporary digital procedure that can produce novel forms of funicular structures. | 2 | 13 |

**Table D.32:** Content Analysis of Design Studies, Vol. 26, Issue 2. (March, 2005)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 101-122 | Remko van der Lugt | How sketching can affect the idea generation process in design group meetings | a | This study consists of four **experimental** idea generation meetings, which explore whether functions of sketching in design activity are also valid for idea generation meetings. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Next, we will discuss the results of an **experimental** study, which consists of four idea generation meetings in which both graphic and written language are used as a means for idea notation. | 3 | 2 |
| | | | | As computers constrict the communication lines available, most research approaches focus on understanding the workspace activity of design groups (Tang and Leifer, 1988; Tang, 1991) and **experiment**s which involve limiting the communication lines available (Bly, 1988; Scrivener and Clark, 1994). | 3 | 2 |
| | | | | Relating to his observations from protocol analysis of eight **experimental** design team meetings, he concludes: 'The process of creating and using drawings conveys information not found in the resulting drawings' (p. 150). | 3 | 2 |
| | | | | In each of four **experimental** meetings both brainsketching and brainstorming with post-its were applied which allowed us to perform a paired comparison analysis of each participant's problem solving behavior (n=20). | 3 | 2 |
| | | | | The two techniques applied in the **experimental** meetings are rather different in nature. | 3 | 2 |
| | | | | Because of the results of an earlier study (Ullman et al., 1990) we could not use an **experimental** design in which only the working medium was altered. | 3 | 2 |
| | | | n | Humphreys, GWand Bruce, V (eds) (1989) Visual cognition, computational, **experimental** and neuropsychological perspectives Lawrence Erlbaum Associates Ltd, Hove, UK | 3 | 2 |
| | | | | Snodgrass, J G and McCullough, B (1986) The role of visual similarity in picture categorization Journal of **Experimental** Psychology: Learning, Memory and Cognition Vol 7 pp 339e345 | 1 | 12 |
| 123-153 | Mark A. Robinson, Paul R. Sparrow, Chris Clegg and Kamal Birdi | Design engineering competencies: future requirements and predicted changes in the forthcoming decade | | Each of these four competencies were divided into more detailed sub-competencies: (1) know self and work with others consisted of examine and evolve self; act ethically; communicate; team; and mentor; (2) solve unstructured problems consisted of access information and knowledge; perform **experiment**s; develop predictive models; and use the engineering design process; (3) lead change consisted of value others; articulate a vision; optimise globally; seize opportunities; **innovate**; and continuously improve; and (4) design, build, and run high value-added systems consisted of develop a manufacturing strategic plan; design and implement manufacturing systems; support the continuous improvement of manufacturing operations; and run manufacturing equipment. | 4 | 2 |
| 191-213 | Kristina Lauche | Job design for good design practice | | That means that for effective design strategies in practice the organisational context becomes highly relevant while it could be ignored in **experimental** studies with student participants. | 3 | 2 |
| | | | | This is the case for any type of design research that considers the organisational context crucial to designing because in real-world companies **experimental** control is virtually impossible to obtain. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | The closest resemblance of **experimental** manipulation would be a longitudinal study of organisational change with some independent measure of good design practice. | 3 | 2 |

**Table D.33:** Content Analysis of Design Studies, Vol. 26, Issue 3. (May, 2005)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 271-317 | Paul Cleveland | How much visual power can a magazine take? | | Eco (1976) points out that in certain cases iconic representations can appear closer to the truth than reality, as was shown in the Ryan and Schwartz (1956) **experiment** where people identified an image as a hand when it was drawn as a cartoon more quickly than when they were shown a photograph of a hand (Chandler, 2000). | 1 | 8 |
| | | | | The precedents for Carson's **experimentation** had its roots in street style magazines such as The Face and i-D. | 1 | 8 |
| | | | | Wired (Figure 9) was one magazine which **experiment**ed with digital technology to produce visual puns on the way the masthead was read. | 1 | 8 |
| | | | | Magazines take on many different formats and they provide a medium for graphic **experiment** and expression within the bounds of editorial responsibility and market penetration. | 1 | 8 |
| | | | h | 2 Visual power and readership spread **experiment** | 1 | 8 |
| | | | | What can be said is that the top right quadrant of Figure 15 represents magazines which use greater **experimentation** and novelty in the layout and design of their contents compared with the bottom left. | 1 | 8 |
| | | | | If the Australian Women's Weekly wished to shrink the readership spread, more **experimentation** with the layout would be possible. | 1 | 8 |
| | | | f | The possible **experimentation** with the visual grammar is more possible in narrow readership spreads without alienating the readership. | 1 | 8 |
| | | | | This **experiment** indicates the differences in the level of visual power present in a group of magazines at any one time. | 1 | 8 |
| | | | t | **Experimental** photographs, type and layout. | 1 | 10 |
| | | | | This meant that **experimentation** with type was usually restricted to the titles and subheadings. | 1 | 8 |
| | | | | Sixty-five undergraduate Design students, 27 males and 38 females, participated in the **experiment**. | 1 | 8 |
| | | | | This rise is evidenced by the amount of **experimentation** shown in the composition and format of the editorial material. | 1 | 8 |
| | | | | The second feature is that possible **experimentation** with the visual grammar is more possible in narrow readership spreads without alienating the readership. | 1 | 8 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | The **experiment** has shown that The Face and Australian Women's Weekly have variations in arousal potential, hedonic tone, and primary cognition which are cyclical in nature. | 1 | 8 |

**Table D.34:** Content Analysis of Design Studies, Vol. 26, Issue 4. (July, 2005)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 325-357 | Cynthia J. Atman, Monica E. Cardella, Jennifer Turns and Robin Adams | Comparing freshman and senior engineering design processes: an in-depth follow-up study | | Appropriate research methods and **experimental** tasks are vital to accomplishing this task. | 3 | 2 |
| | | | | We then describe our previous findings regarding differences between freshman and senior engineers' design behaviour and the **experimental** tasks that we have used. | 3 | 2 |
| | | | | Information is collected from short-term memory while subjects are prompted to 'keep talking' with minimal interference from the **experiment**er. | 3 | 2 |
| | | | | Their observations are drawn from an accumulation of 40 laboratory **experiment**s. | 3 | 2 |
| | | | | While it is unknown how many participants were involved in these 40 **experiment**s, this series of **experiment**s suggests that these findings are consistent for a number of designers attending to a number of tasks. | 3 | 2 |
| | | | | Smith and Tjandra (1998) offer a review of several different models of iteration and compare them to their own **experimental** results. | 3 | 2 |
| | | | | The **experimental** procedure consisted of several steps. The participants solved two practice problems out loud to familiarize themselves with the process of thinking aloud and then solved the ping pong and street crossing problems. | 3 | 2 |
| | | | | - Time Spent (Design Time): total amount of time spent in design activity (this excludes time spent talking to the **experiment** administrator) | 3 | 2 |
| | | | | For this **experiment** our main goal was to determine if our measures (presented in Tables 1 and 5 and in Section 2.4) would yield consistent results with a new study population and different study tasks. | 3 | 2 |
| | | | | Additionally, for the **experiment**er, the implication is that task matters when setting up the **experiment**. | 3 | 2 |
| | | | | The combination of the findings for across-problem differences between the ping pong problem and the street crossing problem with the findings for the differences between | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | the Senior Follow-Up Study and the Playground Study suggests that the **experiment**er must carefully consider the length of the task, the number of problems the participant needs to solve, the context specificity of the task and the complexity of the task. | | |
| | | | n | Smith, R P and Tjandra, P (1998) **Experimental** observation of iteration in engineering design Research in Engineering Design Vol 10 No 3 pp 107e117 | 3 | 2 |
| 359-377 | Thomas van Rompay, Paul Hekkert and Wim Muller | The bodily basis of product experience | a | An **experimental** study involving chairs partly confirmed this prediction. | 3 | 2 |
| | | | | This prediction was tested in an **experimental** study in which chairs were taken as the kind of product to be judged. | 3 | 2 |
| | | | | They were present at two fourth year design classes in which the **experiment** was executed. | 3 | 2 |
| | | | | Figure 1 The 10 chairs used in the **experiment** | 3 | 2 |
| | | | | At the beginning of a session, participants were informed that the **experiment**er aimed at researching product expressions and they were told to base their ratings on their first impression. | 3 | 2 |
| | | | | This order remained fixed during the **experiment**. | 3 | 2 |
| | | | f | During the presentation of the slides, the **experiment**er informed the participants twice, after 60 and 90 s, respectively, of the remaining time of exposure of the particular slide. | 3 | 2 |
| | | | | Although the **experimental** findings do not allow for a systematic discussion of this issue, in the final section of this paper we will speculate about these relations by looking more closely at features of the chairs in relation to their scores on the schema based clusters of expressions. | 3 | 2 |
| | | | | In order to assess the extent to which these speculations are justified, controlled **experimental** studies must be conducted to test predictions about form-schema relations and the speculations brought forward in this section. | 3 | 2 |
| 379-404 | Joan Ernst van Aken | Valid knowledge for the professional design of large and complex design processes | | Professional designing is playing with alternatives. 'Don't marry your first design idea', as Dym (1994) says, but **experiment** (on paper) with the various solution concepts which may be used for your design problem. | 2 | 2 |
| | | | | Experienced individual architectural or engineering designers, or small teams of them, tend to use informal procedures for their design processes, which they have developed over time through their initial professional training and through subsequent **experimenting** and learning. | 2 | 2 |
| | | | | Like the experienced individual designers they also tend to use their customary set-up for their design process, which they have developed over time through **experimenting** | 2 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | and learning, possibly somewhat adapted, if the new design project seems to differ from previous ones. | | |
| | | | | Nevertheless it seems to be worthwhile to do further **experimentation** in practice and further research in process design in order to support the emancipation of process design from traditional, evolutionary determined approaches and to foster the development of more professional approaches. | 2 | 2 |
| 405-438 | P.K. Palani Rajan, Michael Van Wie, Matthew I. Campbell, Kristin L. Wood and Kevin N. Otto | An empirical foundation for product flexibility | | The products considered for this **experiment** range from small-to-medium scale consumer products. | 3 | 2 |

**Table D.35:** Content Analysis of Design Studies, Vol. 26, Issue 5. (September, 2005)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 445-461 | Andy Dong | The latent semantic approach to studying design team communication | | In the following sections, the article describes **experiment**s on languagebased communication e that is, asynchronous and synchronous communication e using latent semantic analysis (LSA). | 3 | 2 |
| | | | | (6) (…) It has been **experimental**ly determined in various research projects that retaining up to the first 300 most significant singular dimensions provides the best approximation of the 'latent semantics'. | 3 | 2 |
| | | | | Our **experiment**s on language-based communication based on the latent semantic approach reveal that the construction of a socially held representation is an emergent phenomenon that is, in part, driven by language-based communication. | 3 | 2 |
| | | | | What is noteworthy about the **experimental** data set is the diversity, in the sense of design methodologies and expertise, of the design teams studied. | 3 | 2 |
| 463-485 | Katja M.M. Hölttä and Kevin N. Otto | Incorporating design effort complexity measures in product architectural design and assessment | n | Kurfman, M, Stock, M E, Stone, R, Rajan, J and Wood, K (2003) **Experimental** studies assessing the repeatability of a functional modeling derivation method Journal of Mechanical Design Vol 125 pp 682e693 | 1 | 11 |
| 535-561 | Gregory J. Smith and John S. Gero | What does an artificial design agent mean by being 'situated'? | | A dialectic view of designing is of **experimenting**, but unlike scientific **experimenting** it deals with worlds that do not yet exist. | 2<br>1 | 2<br>11 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Design **experiment**s occur 'on the spot' (Schön, 1985) as **experiment** and analysis are not separated in time as with scientific **experiment**s are. | 2<br>2<br>1 | 2<br>2<br>11 |
| | | | | The process is one of a designer interacting with an external representation, performing a series of **experiment**s the results of which influence further **experiment**s. | 2<br>2 | 2<br>2 |
| | | | | Instead, in selecting the next action by considering one design domain the task of selecting actions is made tractable and the process is transformed into the design **experimentation** described. | 2 | 2 |
| | | | | The designer synthesises a potential design action, and performs a design **experiment** by sketching and interpretation. | 2 | 2 |
| | | | | Hoffman, R R (1994) Constructivism versus realism, or constructivism and realism Journal of **Experimental** and Theoretical Artificial Intelligence Vol 6 pp 431e435 | 1 | 11 |
| | | | | Morrison, C T (1997) Are we wrong about representation? Journal of **Experimental** and Theoretical Artificial Intelligence Vol 9 No 4 pp 441e469 | 1 | 11 |

**Table D.36:** Content Analysis of Design Studies, Vol. 26, Issue 6. (November, 2005)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 565-592 | Saeema Ahmed | Encouraging reuse of design knowledge: a method to index knowledge | | The researcher may bias the **experiment** by verbal communications or gestures, e.g. nodding when an expected response is observed. | 3 | 2 |
| | | | | Rosenthal, R (1963) The effects of early data returns on data subsequently obtained by outcome-biased **experimenter** Sociometry Vol 26 No 4 pp 487e493 | 1 | 12 |
| | | | | Rosenthal, R (1966) **Experimenter** effects in behavioral research Appleton Century Crofts, New York | 3 | 2 |
| 593-611 | Gabriela Goldschmidt and Dan Tatsa | How good are good ideas? Correlates of design creativity | | Data were collected by an **experimenter** who joined the studio and documented its activities throughout the semester: sessions were taperecorded and later interviews were conducted with all students and with the instructor. | 3 | 2 |
| | | | | The **experimenter** was introduced as an observer; the students knew he was a graduate student conducting research but were not aware of the research objectives. | 3 | 2 |
| | | | | The **experimenter** listed all ideas that were communicated in individual critiques and group discussions. | 3 | 2 |
| | | | | This work, which was extremely labor-intensive (e.g., for the project with the largest | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | number of ideas e 275 e 37 812 links had to be considered), was done by the **experiment**er alone, since no impartial volunteer judges could be asked due to the heavy load. | | |
| | | | | Links were decided by three judges (the **experiment**er and two naı¨ve judges, both expert designers), and were determined by majority (consensus or agreement between two judges). | 3 | 2 |
| | | | | This tendency is noticeable in both the analysis performed by the three judges, and in the analysis undertaken by the **experiment**er. | 3 | 2 |
| | | | | Although we do not regard the **experiment**er's results as decisive, this analysis is the only one to pertain to three echelons of ideas, and therefore it is indispensable. | 3 | 2 |
| | | | | Our results also corroborate van der Lugt's (2003) findings, who found that the most meaningful ideas in his **experiment**s had a significantly higher number of links than other ideas (see Section 1.2). | 3 | 2 |
| | | | t | **Experiment**er | 3 | 2 |
| | | | | We have no definite answer to this question, other than the one given earlier: we have no other way of assessing the work in this real-life **experiment**. | 3 | 2 |
| | | | n | 1. The protocol was generated for the 'Delft protocol analysis workshop' in 1994. The design **experiment** lasted 2 h (Cross et al., 1996). | 3 | 2 |
| 613-624 | Ben Jonson | Design ideation: the conceptual sketch in the digital age | | Limiting CAD to changes or improvements of existing products or systems, which constitute the bulk of designing, may, however, overlook advances in digital technology in which the computer can introduce new practices and promote different ways of working towards **experimentation** and discovery (Coyne et al., 2002). | 2 | 2 |
| 625-647 | N.M. Segers, B. de Vries and H.H. Achten | Do word graphs stimulate design? | a | The research method entails a working prototype, called the Idea Space System (ISS), in an **experimental** setting in which 18 architects participated. | 1 | 7 |
| | | | a | The findings of the **experiment** show that architects appreciate the use of word graphs. | 1 | 7 |
| | | | | In order to test the influence of associations in the design process we chose to create a prototype design system in an **experimental** setting. | 1 | 7 |
| | | | | The outline of the article is as follows: firstly, we describe our research methodology of testing through design tasks with a prototype system in an **experimental** setting; secondly, the design of the **experiment** will be described; thirdly, the results are discussed. | 1<br>1 | 7<br>7 |
| | | | | In design research it is common practice to test assumptions or theories by means of case studies and **experiment**s (Schön, 1983; Rowe, 1987; Valkenburg, 2000; Reymen, 2001). | 1 | 7 |
| | | | | Gero and Purcell (1996) measure fixation in creative processes by comparing a general | 1 | 7 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | list of features with a list of features of each design, produced by the **experimental** and control groups. | | |
| | | | | Figure 1 Set-up of ISS prototype during the **experiment** | 1 | 7 |
| | | | h | 1.2 Design of the **experiment** | 1 | 7 |
| | | | f | The **experiment** is a two-condition (with and without feedback in word graphs) repeated-measures design with two independent variables (task and order of the tasks). | 1 | 7 |
| | | | f | The subjects of the **experiment** are practicing architects. | 1 | 7 |
| | | | | By using randomised blocks (see Table 1) effects caused by standard order in the **experiment** are avoided. | 1 | 7 |
| | | | f | The learning effect of getting used with the system is tackled by providing a tutorial with a small task before the actual two **experiment** design tasks. | 1 | 7 |
| | | | h | 1.3 Means of measurement in the **experiment** | 1 | 7 |
| | | | | The experts had no knowledge of the architects who participated in the **experiment**. | 1 | 7 |
| | | | | To obtain the personal experience of the participating architects, we asked them to fill in a questionnaire after the **experiment**. | 1 | 7 |
| | | | h | 1.4 **Experiment** participants | 1 | 7 |
| | | | | In total 18 architects from practice agreed to participate in the **experiment**. | 1 | 7 |
| | | | | The architects that are invited to participate in the design **experiment** all have had at least one year of experience as an architect in practice. | 1 | 7 |
| | | | f | The participants were not naive about the purpose of the **experiment**. | 1 | 7 |
| | | | f | They were requested not to tell anything about the **experiment** after completion to other architects. | 1 | 7 |
| | | | h | 1.5 **Experiment** procedure | 1 | 7 |
| | | | | He or she got a general introduction to the **experiment** and a tutorial instruction on how to use the system. | 1 | 7 |
| | | | | After a short introduction the architect is asked to make a 'dummy' design just for practising with the system and to remove the first learning effects from the **experiment**. | 1 | 7 |
| | | | h | 2 Results of the **experiment** | 1 | 7 |
| | | | | Mean1 is the mean rating of 12 architects who have indicated not to have done a task like the ones in the **experiment**, while Mean2 is the mean rating of six architects who have indicated to have done a task like (the) one(s) in the **experiment**. | 1<br>1 | 7<br>7 |
| | | | | Although we used randomised blocks in the design of the **experiment**, we still measured that there are learning and order effects in the tasks. | 1 | 7 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | The outcome as a whole is not as positive as we hoped for, but there may be some aspects related to the research method, the **experiment**, and the prototype that may have played a role. | 1 | 7 |
| | | | | Firstly, an **experiment** like this may have produced more subtle answers to the research questions when more than 18 architects would have participated in the **experiment**. | 1<br>1 | 7<br>7 |
| | | | | This may have had some impact on the data from the **experiment**. | 1 | 7 |
| | | | | It must be kept in mind, however, that the danger with a questionnaire is that the architects may have given social-desirable responses: they may have a tendency to give an answer that is in accordance with what is the desirable outcome of the **experiment**. | 1 | 7 |
| | | | | As stated in Section 2, not just the **experiment**, but also the implementation of the prototype triggers questions about the viability of the proposed research method. | 1 | 7 |
| | | | | There are three choices that have influence on the **experiment**: (i) implementation of only semantic associations and not including other types of associations, (ii) the display of word associations as graphs, and (iii) implementation of ISS with a natural and intuitive interface and the feedback on a vertical screen. | 1 | 7 |
| | | | | From the **experiment**s it appeared that the ISS platform still took more learning time than was expected from earlier **experiment**s. | 1<br>1 | 7<br>7 |
| | | | | From the **experiment** and the results we may conclude that already the provision of a natural language ontology to generate associations can be a good aid for architects to generate more ideas during the design process. | 1 | 7 |
| | | | | The authors would like to thank all architects who participated in the **experiment**. | 1 | 7 |
| 649-669 | Maria C. Yang | A study of prototypes, design activity, and design outcome | | Budde et al. (1992) describe a classification system similar to Sommerville, including evolutionary, **experimental**, and exploratory prototypes. | 2 | 2 |

**Table D.37:** Content Analysis of Design Studies, Vol. 27, Issue 1. (January, 2006)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 5-24 | Monica E. Cardella, Cynthia J. Atman and Robin S. Adams | Mapping between design activities and external representations for engineering student designers | | Research in engineering design has also been conducted via questionnaires (Römer et al., 2001), ethnographic studies (Bucciarelli, 1994), observation (Visser, 1990), **experimental** study (Thomas and Carrol, 1979), and the use of electroencephalograph (EEG) records (Göker, 1997). | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Additionally, the participants were able to request more information from the administrator during the course of the **experiment**. | 3 | 2 |
| | | | | **Experiment**ers evaluated participants' final solutions for quality and also assessed the number of stated constraints (out of seven) met. | 3 | 2 |
| | | | t | Reading/looking at information that is provided by the **experiment**er | 3 | 2 |
| | | | | This participant essentially produced no solutions other than those verbally recorded as part of the **experimental** procedure. | 3 | 2 |
| | | | | This brings us to the participant who did not choose to create any representations, and instead relied solely on those provided by the **experiment** administrator. | 3 | 2 |
| | | | | Would the design behavior (both in terms of representational activity and design activity) have been different had the **experiment**er not provided a diagram? | 3 | 2 |
| 25-55 | Yan Jin and Pawat Chusilp | Study of mental iteration in different design situations | a | An **experiment** is conducted to study the effect of design problems and constraints on the behavior of mental iteration. | 3 | 2 |
| | | | | From the model, different types of iteration loops are identified and an **experiment** is conducted to investigate design mental iteration in response to different design situations. | 3 | 2 |
| | | | | Our **experimental** study results indicate the differences of mental iteration in different design situations defined by problem types and constraint conditions. | 3 | 2 |
| | | | | After that, the **experimental** study and the results will be discussed. | 3 | 2 |
| | | | | The majority of the cognitive processes in the Geneplore model have been empirically identified in an engineering design **experiment** (Shah, 1998). | 3 | 2 |
| | | | h | 3 **Experiment** | 3 | 2 |
| | | | | For the **experiment** presented in this paper, we characterize design situations with two factors, i.e., problem types and constraint conditions. | 3 | 2 |
| | | | h | 3.3 **Experimental** design | 3 | 2 |
| | | | f | The design and analysis of the **experiment** were based on Design of **Experiment**s (Montgomery, 2001; Myers and Montgomery, 2002). | 3<br>3 | 2<br>2 |
| | | | f | Our **experiment** employed 22 factorial design. Sixteen participating subjects were equally divided into two groups, Group 1 and Group 2. | 3 | 2 |
| | | | | Subjects in our **experiment** included 1 senior and 15 graduate students of the 2003e2004 academic year at University of Southern California. | 3 | 2 |
| | | | | In our **experiment**, all subjects were tested individually in a quiet room to prevent distraction. | 3 | 2 |
| | | | | Before starting the **experiment**, a brief instruction with a warm-up task was given to the | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | subjects so that they can get used to thinking aloud. | | |
| | | | | There was no time limitation but on average, subjects spent approximately 15 min for understanding the **experiment** procedure, 30 min for a warm-up task, 50 min for solving design problems with a break. | 3 | 2 |
| | | | f | The whole **experiment** sessions were video taped by two cameras: one from the top to capture their sketches and the other from the front to capture their gestures. | 3 | 2 |
| | | | | The creative design problems used in our **experiment** are equivalent to the design between Dym's Class 1 and Class 2 designs (1994), and between Gero's creative and **innovative** design (1991). | 4 | 2 |
| | | | f | The routine design problem used in this **experiment** is more or less equivalent to Dym's Class 3 design (1994) and Gero's routine design (1991). | 3 | 2 |
| | | | f | In our **experiment**, the chosen design problems must be suitable to the subjects, who are senior and graduate students. | 3 | 2 |
| | | | | The creative design problem selected for this **experiment** is: | 3 | 2 |
| | | | | The routine design problem selected for this **experiment** is: | 3 | 2 |
| | | | | The focus of this **experiment** was to observe how subjects think iteratively in the conceptual design phase in different design situations. | 3 | 2 |
| | | | | For our **experiment**, all subjects had limited work experience and little experience of skiing, whereas they knew and had seen gears and transmission systems. | 3 | 2 |
| | | | f | The **experiment**er talked to each subject before the **experiment** to confirm that he/she perceived the selected creative problem as creative design and the selected routine problem as routine design. | 3<br>3 | 2<br>2 |
| | | | | Due to resource limitations, in this **experiment**, the code matching was spot checked by a second operator. | 3 | 2 |
| | | | | Note that the numbers of local iteration loops from the **experiment** are quite low so it does not make much sense to analyze the percentage of each local loop. | 3 | 2 |
| | | | | Because our **experiment** involves multiple dependent variables, multivariate analysis of variance (MANOVA) needs to be performed to reassure that the significances identified from ANOVAs were not false positives or occurred only by chance. | 3 | 2 |
| | | | | Further **experimental** results support this prediction. | 3 | 2 |
| | | | | Therefore, this conclusion can be claimed only to the problems and constraints used in this **experiment**. | 3 | 2 |
| | | | | Further **experiment** and analysis must be carried out if one intends to use the estimated effects for accurate predictions. | 3 | 2 |
| | | | | The result of the **experiment** shows the mean of the percentage of the CR loop is 45.1 in the creative design and 71.5 in the routine design. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | But again, this conclusion can be made to the problems and constraints used in this **experiment** only. | 3 | 2 |
| | | | | This consideration is supported by the **experiment** result. | 3 | 2 |
| | | | | The existence of these mental iteration loops was verified by the protocol data from an **experiment** study. | 3 | 2 |
| | | | | To summarize, the results obtained from this **experiment** study suggest that (1) designers' iteration behavior varies in response to design problem types and constraint conditions, and (2) the variation follows certain patterns as indicated in Table 4. | 3 | 2 |
| | | | | Montgomery, D C (2001) Design and analysis of **experiment**s (5th edn) John Wiley & Son, New York, NY | 3 | 2 |
| | | | | Myers, R H and Montgomery, D C (2002) Response surface methodology: process and product optimization using design **experiment**s (2nd edn) John Wiley & Son, New York, NY | 3 | 2 |
| | | | | Shah, J (1998) **Experimental** investigations of collaborative techniques for progressive idea generation methods, in Proceedings of ASME DETC'98, Atlanta, GA | 3 | 2 |
| | | | | Smith, R P and Tjandra, P (1998) **Experimental** observation of iteration in engineering design Research in Engineering Design Vol 10 pp 107e117 | 3 | 2 |
| | | | | This section illustrates an example of encoding process for verbal protocol analysis in the **experiment**. | 3 | 2 |
| 77-97 | J. Ye, R.I. Campbell, T. Page and K.S. Badni | An investigation into the implementation of virtual reality technologies in support of conceptual design | | Compared to most conventional CAD systems that only employ the mouse/keyboard and 2D screen interaction metaphor, VR-based CAD systems offer more natural and intuitive 3D interfaces for interaction and enhanced design tools for functional **experimentation**. | 2 | 2 |
| 99-122 | Şule Taşlı Pektaş and Mustafa Pultar | Modelling detailed information flows in building design with the parameter-based design structure matrix | | Hirschi, N W and Frey, D D (2002) Cognition and complexity: an **experiment** on the effect of coupling in parameter design Research in Engineering Design Vol 13 pp 123e131 | 3 | 2 |

**Table D.38:** Content Analysis of Design Studies, Vol. 27, Issue 2. (March, 2006)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 123-139 | Johan Redström | Towards user design? On the shift from object to user as the subject of design | | It is somewhat ironic that perhaps the most interesting work on how to pass on questions about use to users has been done in domains that often openly criticise user-centred design, for instance critical and **experimental** design. | 2 | 2 |
| 141-166 | Rachael Luck and | Architect and user interaction: the spoken representation of | | A: of the larger table out of that but we'll **experiment** with that | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Janet McDonnell | form and functional meaning in early design conversations | | | | |
| 183-222 | Marian Petre, Helen Sharp and Jeffrey Johnson | Complexity through combination: an account of knitwear design | | Bartlett, F C (1932) Remembering: an **experimental** and social study Cambridge University Press, Cambridge | 1 | 12 |
| | | | | Gilmore, D J and Green, T R G (1988) Programming plans and programming expertise Quarterly Journal of **Experimental** Psychology Vol 40A pp 423e442 | 1 | 12 |

**Table D.39:** Content Analysis of Design Studies, Vol. 27, Issue 3. (May, 2006)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 225-227 | Rivka Oxman | Special Issue of Design Studies on Digital Design | | Design theory, methodology and techniques: **Innovative experimental** precedents are now emerging from design practice and academic design **experimentation**. | 4<br>2 | 2<br>2 |
| 267-307 | Yu-Tung Liu and Chor-Kheng Lim | New tectonics: a preliminary framework involving classic and digital thinking | | Through **experiment**s on the digitally designed structure, the prototype was adjusted to a more appropriate presentation for the pattern and was made compliant with the structure's logics. | 3 | 2 |
| | | | | This should include cognitive **experiment**s and the participatory observation of all designers who intend to explore the digital medium in both the design and construction stages. | 3 | 2 |
| 325-355 | Larry Sass and Rivka Oxman | Materializing design: the implications of rapid prototyping in digital design | | These issues have been the resultant of early **experimental** and hands-on involvement with RP technologies in research and educational environments. | 3 | 2 |
| | | | | These general design methodological issues have been the resultant of early **experimental** and hands-on involvement with these technologies in research and educational environments. | 3 | 2 |
| | | | | In our work, we have **experiment**ed with these models as rule-based models constrained by material properties and requiring high levels of model detailing and information input. | 3 | 2 |

**Table D.40:** Content Analysis of Design Studies, Vol. 27, Issue 4. (July, 2006)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 439- | Chengzhi | In-situ 3D concept design with a | | By **experimenting** with the Java 3D technology on the SUCoD server platform, we find | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 455 | Peng | virtual city | | that the virtual city models can be turned into 3D digital canvas for designers to engage in concept design. | | |
| | | | h | 1 SUCoD: ongoing development of an **experimental** virtual city server | 3 | 2 |
| | | | | As an **experimental** virtual city server, SUCoD has been developed to explore how 3D city modelling could migrate from developer-centred to user-driven. | 3 | 2 |
| | | | | We have since considered SUCoD an open extensible platform for **experimenting** further interactive functions beyond those of retrieving, uploading and listing. | 3 | 2 |
| 505-524 | Chun-Heng Ho, Charles Eastman and Richard Catrambone | An investigation of 2D and 3D spatial and mathematical abilities | | The cubes rotation task introduced by Shepard and Metzler (1971) is one of the most popular 3D **experimental** tasks and has evolved through many versions. | 3 | 2 |
| | | | h | 1 **Experiment** | 3 | 2 |
| | | | | In order to gain insight to this line of questioning, we designed an **experimental** framework based on Zhang's earlier study (1997) | 3 | 2 |
| | | | | As controls, we adopted two additional puzzles, i.e. a 3D Cube and Number Series puzzles, for the **experiment**. | 3 | 2 |
| | | | f | The **experiment** framework is shown in Figure 5 and will be discussed in more detail later. | 3 | 2 |
| | | | | Figure 5 The **experiment** framework for current study | 3 | 2 |
| | | | | The **experiment** was embedded in a computer program. | 3 | 2 |
| | | | | In order to compare participants' performance in our **experiment**, 28 participants were selected from each type of puzzle: 14 from the first quartile, regarded as the 'good' performance group, and 14 from the last quartile, regarded as the 'bad' performance group. | 3 | 2 |
| | | | | The hardest Cube task in the **experiment** is the locked shape with two axes of rotation to the correct orientation. | 3 | 2 |

**Table D.41:** Content Analysis of Design Studies, Vol. 27, Issue 5. (September, 2006)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 527-548 | Corinne Kruger and Nigel Cross | Solution driven versus problem driven design: strategies and outcomes | | This aspect of design cognition has been observed many times, and can be traced back to Lawson's (1979) formalised problem solving **experiment**s with science and architecture students, from which he categorised their problem solving strategies as either 'problem focused' or 'solution focused', and claimed the latter as being more | 1 | 7 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | characteristic of design-based problem solving. | | |
| | | | | Many studies have relied on **experiment**s and observations with student designers, rather than experienced, practising designers possessing more mature cognitive strategies. | 1 | 7 |
| | | | h | 1.1 **Experimental** procedure | 1 | 7 |
| | | | | The **experiment**s were conducted as 'think-aloud' protocol studies (Ericsson and Simon, 1993; van Someren et al., 1994). | 1 | 7 |
| | | | | We are grateful to Kees Dorst and Henri Christiaans for their work in designing and implementing the original protocol study **experiment**s, to other colleagues who evaluated the qualities of the designs produced, and of course to the designers who acted as the **experiment** participants. | 1 | 7 |
| 549-569 | Gabriela Goldschmidt and Maria Smolkov | Variances in the impact of visual stimuli on design problem solving performance | | Malaga (2000) reported an **experiment** in which participants were asked to generate ideas in response to a specific task, having been shown word, picture, and combined word and picture stimuli. | 3 | 2 |
| | | | | Therefore, we set out to conduct an explorative **experiment** with the general hypotheses that visual stimuli do indeed have a bearing on designers' performance, and that this influence is dissimilar for different types of design problems. | 3 | 2 |
| | | | f | Following a brief survey of the literature we consider most relevant, we report the **experiment** and its results, and discuss what we learned from it. | 3 | 2 |
| | | | | The **experiment**s were repeated several times with slight variations and Finke concluded that imagery is a strong cognitive resource that people can use for inventive thinking. | 3 | 2 |
| | | | | Finke's **experiment**s were repeated, with variations, by other researchers who were also interested in related topics that Finke had left out of his agenda. | 3 | 2 |
| | | | f | Anderson and Helstrup (1993), who like Finke used psychology students as subjects, designed an **experiment** in which a control group was not blindfolded but, on the contrary, was allowed to use paper and pencil and sketch during the 2 min in which they were to synthesize useful objects. | 3 | 2 |
| | | | | Logie and his associates who conducted similar **experiment**s came to similar conclusions, but qualified them to subjects with no prior sketching experience (e.g., Pearson et al., 1999). | 3 | 2 |
| | | | | Verstijnen, who hypothesized that sketching must be of some benefit to those who practice it routinely, like designers, repeated the **experiment**. | 3 | 2 |
| | | | | Athavankar and his associates (e.g., Athavankar, 1996; Athavankar and Mukherjee, 2003) carried out several **experiment**s in which designers and design students were asked to undertake design assignments while blindfolded, a typical design session lasting 1e2 h. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Kokotovich and Purcell (2000) went back to mental synthesis **experiment**s, but used two separate sets of stimuli: two-dimensional shapes and three-dimensional forms (Finke and his associates had carried out mental synthesis **experiment**s with two-dimensional shapes before they moved on to three-dimensional forms; see for example Finke and Slayton, 1988). | 3<br>3 | 2<br>2 |
| | | | | In these **experiment**s sketching had no effect on creativity scores. | 3 | 2 |
| | | | | In his **experiment**s subjects (architects and architecture students) solved ill-defined and well-defined design problems in a room in which some two-dozen black-and-white drawings and photographs were pinned to a large board. | 3 | 2 |
| | | | | Section 3 describes the **experiment** that was carried out toward this end. | 3 | 2 |
| | | | h | 3 The **experiment** | 3 | 2 |
| | | | | An **experiment** was planned to partially answer this question, in which students of architecture and industrial design were asked to solve (at a preliminary level) two different design problems (see Section 3.2), under different conditions. | 3 | 2 |
| | | | | The variability in conditions included the use of sketching during the process versus the use of mental imagery alone, with a final descriptive sketch of the solution (similar to 'mental synthesis' **experiment**s), and work with or without visual displays of one of two types, as described below. | 3 | 2 |
| | | | | The following is a report of the **experimental** setup. | 3 | 2 |
| | | | | All of the **experimental** sessions were conducted in an enclosed, windowless area within a larger space. | 3 | 2 |
| | | | | Subjects were tested individually by an **experiment**er who dispensed problems to the subjects and explained the procedure, but did not intervene in what the subjects did. | 3 | 2 |
| | | | | Before the first **experimental** task was presented, a brief training problem was given, the purpose of which was to accustom subjects to talking out loud. | 3 | 2 |
| | | | f | Following each session a short debriefing interview was conducted, in which the subject was asked to articulate his or her difficulties, if any, during the session, feelings regarding the **experiment**, and a subjective view on the effect of having made sketches or being prevented from sketching. | 3 | 2 |
| | | | f | All graphic output by the subjects was collected and coded for subject identity and **experimental** condition. | 3 | 2 |
| | | | | Thirty-six subjects, 20 males and 16 females aged 21e26 participated in the **experiment**, all students in a Faculty of Architecture. | 3 | 2 |
| | | | h | 3.4 **Experimental** conditions | 3 | 2 |
| | | | | Group 1 worked with no specific visual stimuli, with the exception of the functional furniture used during the **experiment** (desk, two chairs e for the subject and the | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | **experiment**er), and three bare cardboard panels, 100 X 200 cm each, positioned vertically against the walls, as depicted in Figure 3. | 3 | 2 |
| | | | | The sketches in question were made by group 1 and group 2 subjects who had participated in the **experiment** earlier. | 3 | 2 |
| | | | | All design solutions were evaluated by three judges who were blind to the research goals and the **experimental** conditions. | 3 | 2 |
| | | | | Figure 3 **Experimental** environment, no stimuli | 3 | 2 |
| | | | | Figure 4 **Experimental** environment, diverse rich stimuli | 3 | 2 |
| | | | | Figure 5 **Experimental** environment, sketches as stimuli | 3 | 2 |
| | | | | Third, we would like to bring up the effect, or lack thereof, of sketching on the scores obtained in this **experiment**. | 3 | 2 |
| | | | T h | Table 8 Score increments as a function of variance in **experimental** conditions (D/L indicates increase/ decrease with stimuli) | 3 | 2 |
| | | | | We would therefore expect sketching to have a positive effect on the scores in an **experiment** like ours, at least where no stimuli are provided. | 3 | 2 |
| | | | | When sufficiently remote from typical or prototypical designs, external representation, i.e. sketching, is helpful because **experimentation** and evaluation are crucial. | 3 | 2 |
| | | | | Kokotovich, V and Purcell, T (2000) Mental synthesis and creativity in design: an **experimental** examination Design Studies Vol 21 No 5 pp 473e499 | 3 | 2 |
| | | | n | 1. The **experiment** also had a third condition in which subjects were shown displays and asked to try and use them as analogical sources to support their problem solving. | 3 | 2 |
| 571-585 | Alexandre Menezes and Bryan Lawson | How designers perceive sketches | | Investigating this interaction in real-time design is thus particularly full of methodological challenges since it is both implicit and central and thus easily disturbed by any obtrusive **experimental** techniques and not visible to unobtrusive techniques. | 3 | 2 |
| | | | h | 2 **Experimental** design | 3 | 2 |
| | | | f | A total of 60 students at The University of Sheffield School of Architecture were involved in this **experiment**. | 3 | 2 |
| | | | | The **experiment** was divided into 30 sessions. | 3 | 2 |
| | | | | The **experiment** was carried out in a specially prepared room divided into three parts. | 3 | 2 |
| | | | | There is also a workspace (desk, chair and control panel) for the **experiment**er's use. | 3 | 2 |
| | | | f | The **experiment**er controls the video and sound through monitors (Figure 1). | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | All four camera images were combined onto a single screen for the **experiment**er to monitoring the sessions and analyse later. | 3 | 2 |
| | | | | Figure 1 The **experiment**. Image 1 e subject A describing to subject B. Image 2 e subject B listening the description and drawing. Image 3 e both subjects talking about the experience. Image 4 e four cameras recorded the **experiment** | 3<br>3 | 2<br>2 |
| | | | | They were collected from videotapes of the **experiment** and are composed of 30 sessions and 60 descriptions. | 3 | 2 |
| | | | | In the fourth and final **experimental** task (review), the subjects were asked to identify which of the two images they found the more difficult to describe. | 3 | 2 |
| | | | | This conclusion is supported by some comments made in the reflection phase of the **experiment** such as 'easier to associate with pictures, pound, tick and sun'; 'hard, no reference to me, no sense'; 'easy to relate to some thing'; 'hard, more abstract'; 'easier, geometric things'. | 3 | 2 |
| | | | h | 5 Some **experimental** limitations | 3 | 2 |
| | | | | It would be interesting to repeat the **experiment** with students of other subjects. | 3 | 2 |
| | | | | However, our **experimental** design is naturally conservative here. | 3 | 2 |
| | | | | The **experiment** focused exclusively on the mental process involved in the interpretation and verbal description of conceptual sketches. | 3 | 2 |
| | | | | During the **experiment**, the participants were required to remember and to draw by memory what they described. | 3 | 2 |
| | | | | Bartlett, F (1950) Remembering e a study in **experimental** and social psychology Cambridge University Press, London | 1 | 12 |
| | | | | Kokotovich, V and Purcell, T (2000) Mental synthesis and creativity in design: an **experimental** examination Design Studies Vol 21 No 5 pp 437e449 | 3 | 2 |
| 587-613 | Zafer Bilda, John S. Gero and Terry Purcell | To sketch or not to sketch? That is the question | a | In order to test this hypothesis, we conducted think-aloud **experiment**s with expert architects. | 3 | 2 |
| | | | | Athavankar (1997) conducted an **experiment** where an industrial designer was required to design a product in his imagery (with an eye mask on), so that he had no access to sketching and the visual feedback it provides. | 3 | 2 |
| | | | h | 2.1 Design of the **experiment**s | 3 | 2 |
| | | | | This phase is called the **experiment** condition where they receive design brief 01. | 3 | 2 |
| | | | | After at least a month after the **experiment** condition, the three architects are engaged in a design process where they are allowed to sketch. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | The set-up of the study for both **experiment** and control conditions includes a digital video recorder with a built-in or lapel microphone, directed to the designer. | 3 | 2 |
| | | | | In the **experiment** condition, we used a similar approach to that taken by Athavankar (1997); we had the designers engage in the design process while wearing a blindfold, Figure 1(a). | 3 | 2 |
| | | | | The **experimental** procedure for the first condition was: | 3 | 2 |
| | | | | 1. The **experiment**er reads the instructions to the participant explaining that s/he is required to engage in a design activity but that s/he does it while wearing a blindfold and that the blindfolded session will last for 45 min. | 3 | 2 |
| | | | | 2. The **experiment**er explains what the think-aloud method is and asks the participant to do a short think-aloud exercise. The **experiment**er provides feedback about the participant's thinking aloud. | 3<br>3 | 2<br>2 |
| | | | | Table 1 shows a summary of the considerations for the **experiment** and the control conditions. | 3 | 2 |
| | | | t | **Experiment** condition | 3 | 2 |
| | | | | The three architects were able to satisfy the space and client requirements in both **experiment** and control conditions, Figures 4, 5 and 6. | 3 | 2 |
| | | | | This result cannot be generalized to all architects/designers or all phases of design activity due to the small scale of the **experiment**. | 3 | 2 |
| | | | | Some might question the reason for using a blindfold during the **experiment**. | 3 | 2 |
| | | | | In the design of the blindfolded **experiment**, there is a stage where the participant was asked to rapidly draw what s/he held in his/her mind's eye. | 3 | 2 |
| | | | | Meanwhile the **experiment**er was able to intervene and remind them that they are not allowed to make significant changes to the layout. | 3 | 2 |
| | | | f | Thus, the quick sketching period was semi-controlled by the **experiment**er. | 3 | 2 |
| | | | | During the BF condition, participants were frustrated at some stages of the **experiment**s, thus their feedback on the blindfolded exercise was not positive. | 3 | 2 |
| | | | | However, based on our results from these **experiment**s, we propose that 'externalizing' may not be necessary for expert designers, in the early phases of the conceptual designing, for<br>1. A satisfying and reasonable outcome<br>2. Pursuing cognitive activity needed for designing<br>3. Developing a coherent network of ideas/concepts | 3 | 2 |
| | | | n | Baddeley, A D, Emsile, H, Kolodny, J and Duncan, J (1998) Random generation and executive control of working memory Quarterly Journal of **Experimental** Psychology Vol 51A pp 819e852 | 1 | 12 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | n | Hegarty, M (1992) Mental animation: inferring motion from static displays of mechanical systems Journal of **Experimental** Psychology: Language, Memory and Cognition Vol 18 pp 1084e1102 | 1 | 12 |

**Table D.42:** Content Analysis of Design Studies, Vol. 27, Issue 6. (November, 2006)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 633-656 | Kees Dorst and Lambèr Royakkers | The design analogy: a model for moral problem solving | a | We establish the practical merits of the design analogy in a thought **experiment**, solving a moral problem in a manner that is closely modeled on a design method. | 2 | 2 |
| | | | | They include **experiment**s and simulation techniques. | 2 | 2 |
| 685-710 | Ih-Cheng Lai and Teng-Wen Chang | A distributed linking system for supporting idea association during the conceptual design stage | a | The computational mechanism will be elaborated by means of a design **experiment**. | 3 | 2 |
| | | | | Situation is what people encounter in real life or construct during **experiment**s; depending on the situation, people act or react accordingly. | 3 | 2 |
| | | | | To explain how to play in the idea association process using DIM-2, we conduct an **experiment** where three human designers (UALai, UATengwen, and UAKuntai), who are located in different geographical locations, are involved in a brainstorming session. | 3 | 2 |
| | | | | Through the design **experiment** in the DIM-2 environment, we find some advantages that support idea association under real design situations: | 3 | 2 |
| | | | | We are also thankful to the students in Chaoyang University of Technology who participated in our **experiment**s. | 3 | 2 |
| 723-740 | Gül E. Okudan and Susan Mohammed | Task gender orientation perceptions by novice designers: implications for engineering design research, teaching and practice | | These conflicting results can be partly explained by the confounding effect of **experimental** task type on team performance. | 3 | 2 |
| | | | | The **experimental** task for Rogelberg and Rumery's (1996) study was a winter survival exercise. | 3 | 2 |

**Table D.43:** Content Analysis of Design Studies, Vol. 28, Issue 1. (January, 2007)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 5-21 | Andy Dong | The enactment of design through language | | First, **experiment**s on languagebased communication based on the latent semantic approach (Dong, 2005) revealed that the construction of a socially held representation of a designed artifact is an emergent phenomenon that is the effect of aggregated knowledge. | 3 | 2 |
| | | | | Concept formation in group design is an apt **experimental** condition for exposing accumulation because in this situation individual designers aggregate their expertise to produce a coherent basis from which to realize a new concept. | 3 | 2 |
| 23-38 | Hsiao-chen You and Kuohsiang Chen | Applications of affordance and semantics in product design | | Further in depth **experiment**s or case studies are required to investigate user's response to product appearance. | 3 | 2 |
| 39-58 | Jing-Song Huang, Min-Yuan Ma and Chien-Hsu Chen | Research on predicting models of annoyance under the operation of digital hi-tech products | a | With the substantive operating **experiment**, quantitative data is obtained to process artificial neural network training, multiple regression analysis, and Hayashi's Qualification Theory Type I analysis. | 3 | 2 |
| | | | | With the substance operating **experiment**, quantitative data is gained to process artificial neural network training, multiple regression analysis, and Hayashi's Qualification Theory Type I analysis (Tanaka and Wakimoto, 1983). | 3 | 2 |
| | | | | Wallbott and Scherer (1989) think we can evaluate emotions with scientific **experiment**s in terms of outer behavior and self-narrated evaluations that represent physical and psychological states, authors' observations and subjects' self-narrated surveys, respectively. | 3 | 2 |
| | | | | Hick, W E (1952) On the rate of gain of information Quarterly Journal of **Experimental** Psychology Vol 4 pp 11e26 | 1 | 12 |
| 73-101 | Charles L. Owen | Evaluation of complex systems | h | **Experimental** System Evaluation Project Functional Assessment | 3 | 2 |
| | | | h | **Experimental** System Evaluation Project System Assessment | 3 | 2 |
| | | | | From the **experiment**s reported in this paper, several insights can be drawn. | 3 | 2 |

**Table D.44:** Content Analysis of Design Studies, Vol. 28, Issue 2. (March, 2007)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 175-194 | Henri J. Thevenot and Timothy W. Simpson | Guidelines to minimize variation when estimating product line commonality through product family dissection | a | This paper discusses two **experiment**s conducted to investigate the variation that arises when estimating the Product Line Commonality Index (PCI) for a family of products when using data gathered from product dissection. | 3 | 2 |
| | | | f | In the first **experiment**, three main sources of variation were identified: (1) different levels of dissection, (2) omitted components, and (3) different values for the factors used to compute PCI. | 3 | 2 |
| | | | f | In the second **experiment**, guidelines for dissecting subassemblies to the lowest level possible and predefined tables listing material, manufacturing and assembly/fastening schemes were found to significantly reduce variation, leading to more systematic and consistent methods of product family analysis. | 3 | 2 |
| | | | | In order to minimize this variation, guidelines are given in this paper and validated using **experiment**s involving human subjects, where student teams were asked to (1) dissect various product families, (2) collect data from the dissection, and (3) compute the amount of commonality in the product family using the Product Line Commonality Index (PCI) (Kota et al., 2000). | 3 | 2 |
| | | | | This paper is primarily a follow-up to our first **experiment** where sources of variation were identified during product family dissection (Simpson and Thevenot, 2005), and this paper progresses as follows. | 3 | 2 |
| | | | f | Section 1 discusses related research, and Section 2 summarizes the first **experiment** along with recommendations to minimize variation based on our findings from this first **experiment**. | 3<br>3 | 2<br>2 |
| | | | f | Section 3 describes the second **experiment**, which is designed as a follow-up **experiment** to test these recommendations. | 3<br>3 | 2<br>2 |
| | | | f | Section 4 compares the results obtained in both **experiment**s, and Section 5 gives closing remarks and future work. | 3 | 2 |
| | | | | Consequently, their material classification scheme is employed in this paper to provide a material classification scheme for use during dissection as discussed in the second **experiment** in Section 4. | 3 | 2 |
| | | | | Our second **experiment** uses the manufacturing process classification scheme proposed by Swift and Booker (1997) due to its simplicity and varying levels of granularity. | 3 | 2 |
| | | | f | In addition, the classification scheme for assembly/fastening given in Table 3 is | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | proposed for use during the second **experiment** (see Section 3). | | |
| | | | h | 2 **Experimental** method and results from the first **experiment** | 3<br>3 | 2<br>2 |
| | | | f | This paper compares two **experiment**s to show how variation in estimating product family commonality that arises during dissection can be reduced using appropriate guidelines. | 3 | 2 |
| | | | | The following is an overview to provide context for the follow-up **experiment** presented in Section 4; details on this first **experiment** along with its pedagogical implications can be found in Simpson and Thevenot (2005). | 3<br>3 | 2<br>2 |
| | | | h | 2.1 **Experimental** method | 3 | 2 |
| | | | f | The first **experiment** consisted of five teams dissecting and analyzing the three product families shown in Table 4. | 3 | 2 |
| | | | h | 2.2 Summary of results from the first **experiment** | 3 | 2 |
| | | | | The dissection portion of the **experiment** is first analyzed, followed by the computation portion of the **experiment**. | 3<br>3 | 2<br>2 |
| | | | | Figure 2 Sources of PCI variation identified from the first **experiment** | 3 | 2 |
| | | | | The following recommendations are made based on three main findings in our first **experiment**. | 3 | 2 |
| | | | | The second **experiment** described next is designed as a follow up to this first **experiment**, taking into account these recommendations. | 3<br>3 | 2<br>2 |
| | | | h | 3 **Experimental** method and results for the second follow-up **experiment** | 3<br>3 | 2<br>2 |
| | | | h | 3.1 **Experimental** method | 3 | 2 |
| | | | f | Our goal in the second **experiment** was to try to minimize variation due to different values for the fji factors by automating the PCI computation process using three databases of options. | 3 | 2 |
| | | | Th | Table 9 Comparison of the two **experiment**s conducted | 3 | 2 |
| | | | | By making the team choose the different attributes from a predefined list, variation introduced previously during the computation phase were removed, enabling the comparisons between the first and second **experiment** as shown in Table 9. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | f | For example, in **Experiment** 1, working with the raw data, none of the three variation sources are removed while **Experiment** 2 sought to quantify the variation that specifically occurred during computation of the PCI. | 3<br>3 | 2<br>2 |
| | | | f | This second **experiment** consisted of four teams dissecting and analyzing identical sets of the same product family, namely, the Kodak one-time-use cameras, which contains the six products shown in Table 10. | 3 | 2 |
| | | | f | This **experiment** contained more products per family (six instead of four previously) in an effort to increase potential sources of variation between products. | 3 | 2 |
| | | | f | The second **experiment** was conducted in the same laboratory as the first **experiment** with the same tools available. | 3<br>3 | 2<br>2 |
| | | | | 1. Read an overview of the **experiment** and sign an informed consent form. | 3 | 2 |
| | | | Th | Table 10 Products analyzed in the second **experiment** | 3 | 2 |
| | | | Th | Table 11 Team ordering for dissection and analysis during the second **experiment** | 3 | 2 |
| | | | h | 3.2 Results from the second **experiment** | 3 | 2 |
| | | | f | Similar to the first **experiment**, the PCI values computed by each team for each family were subject to variation during dissection (e.g., components forgotten). | 3 | 2 |
| | | | | To analyze the variation due to the components omitted in the analysis, the data were standardized in the same manner as in the first **experiment**. | 3 | 2 |
| | | | | In Section 4, these values are discussed and compared to the ones obtained in the first **experiment**. | 3 | 2 |
| | | | Th | Table 12 Example of spreadsheet for Kodak one-time-use family for second **experiment** | 3 | 2 |
| | | | Th | Table 13 Initial PCI values for the second **experiment** | 3 | 2 |
| | | | | The first comparison is made between the raw data and the corrected data obtained for each **experiment** in order to assess the variation due to omitted components. | 3 | 2 |
| | | | | The second comparison is performed across **experiment**s to assess the variation due to manual computation. | 3 | 2 |
| | | | | For both **experiment**s, the standard deviation is reduced from 10.4 to 7.6 in the first **experiment** (_26.3%) and from 5.8 to 5.5 (_3.8%) in the second **experiment**. | 3<br>3<br>3 | 2<br>2<br>2 |
| | | | | To reduce variation further, the computation phase was automated to the extent possible in the second **experiment**. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | This result is even more remarkable when considering the number of products and replications in the **experiment**: four products and four PCI computations in the first compared to six and eight, respectively, in the second. | 3 | 2 |
| | | | Th | Table 14 'Corrected' PCI values for the second **experiment** | 3 | 2 |
| | | | | Figure 5 Method for comparing **experimental** results | 3 | 2 |
| | | | | Hence, in both **experiment**s, the teams had to decide which components had 'identical' shape and geometry, and as shown in Figures 3 and 4, there was not complete agreement on this, which explains this variation in the PCI value, even in the second **experiment**. | 3<br>3 | 2<br>2 |
| | | | | In this paper, we sought to identify and subsequently reduce the variation in estimating product line commonality that occurs during product family dissection by conducting and analyzing two **experiment**s. | 3 | 2 |
| | | | | In the first **experiment**, we identified three main sources of variation that occurred during product family dissection to calculate the PCI: | 3 | 2 |
| | | | Th | Table 15 Comparison between raw and corrected data for both **experiment**s | 3 | 2 |
| | | | Th | Table 16 Comparison between the two **experiment**s | 3 | 2 |
| | | | | These variation was significantly reduced in the second follow-up **experiment** by providing: | 3 | 2 |
| | | | | Future work suggests repeating the **experiment** on other important metrics for product family redesign, as well as on a wider variety of product families. | 3 | 2 |
| 195-211 | Tung-Jung Sung and Manlai You | A method for establishing an online design audit platform | | After a pilot test performed, the process of formally testing the ODAP began with the recruitment of **experimental** participants. | 3 | 2 |
| | | | | In this section, we will discuss the findings from the **experiment** and the comments made by the participants. | 3 | 2 |

**Table D.45:** Content Analysis of Design Studies, Vol. 28, Issue 3. (May, 2007)

| **Page** | **Writer** | **Paper Title** | | **Sentence** | **Meaning** | **Context** |
|---|---|---|---|---|---|---|
| 243-261 | John M. Carroll and Mary Beth Rosson | Participatory design in community informatics | | However, as the community network evolved, community members and organisations became direct stakeholders in the project through inhabitation: they built web sites and **experiment**ed with **innovative** web-based interaction (Carroll and Rosson, 1996). | 4 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 289-307 | Malgorzata Hanzl | Information technology as a tool for public participation in urban planning: a review of **experiment**s and potentials | a | The paper contains a review of **experiment**s and prototypes of different IT applications: Participatory Planning GIS, 3D models, communication platforms and computer games. | 3 | 2 |
| | | | a | The most cited examples remain **experimental**. | 3 | 2 |
| | | | | Examples of projects of that kind are rare and function more as **experiment**s, not as real practice. | 3 | 2 |
| | | | | An example of an **experiment** with similar functionality is 'Wired Whitehall' (Batty et al., 1998). | 3 | 2 |
| | | | | The trials to move virtual objects independently on property are managed e the idea of **experiment**s is to enable common decisions making in matters of real world development. | 3 | 2 |
| | | | | In the realised systems, these functions remain the most important ones because of the **experimental** character and status of the prototype of systems. | 3 | 2 |
| | | | | Input data are taken from glasses shaped cameras worn by users during the **experiment**, and from static camera to catch hands movements. | 3 | 2 |
| | | | | Researches proceeded in laboratory of Faculty of Architecture of Swiss Federal Institute of Technology in Zurich (Lang and Hovestadt, 2004) concern **experimental** methods of interaction with model using 3D video record of people taking part in meetings. | 3 | 2 |
| | | | | Most of the examples of IT use described in literature are still **experimental**. | 3 | 2 |
| | | | | The potential of **experimental** IT tools like Augmented Reality systems opens utterly new ways of non-professional participation in urban planning. | 3 | 2 |
| | | | n | D'Aquino, P, Le Page, Ch, Bousquet, F and Bah, A (2003) Using self-designed roleplaying games and a multi-agent system to empower a local decision-making process for land use management: the selfcormas **experiment** in Senegal Journal of Artificial Societies and Social Simulation Vol 6 No 3 http://jasss.soc.surrey.ac.uk/6/3/5.html publication 30.06.2003 | 3 | 2 |
| | | | | Hudson-Smith, A, Evans, S, Batty, M and Batty, S (2002) Online participation: the woodberry down **experiment** Centre for Advanced Spatial Analysis, London http://www.casa.ucl.ac.uk/working_papers.htm December 2002 verified 15.08.06 | 3 | 2 |

**Table D.46:** Content Analysis of Design Studies, Vol. 28, Issue 4. (July, 2007)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 343-367 | Zafer Bilda and John S. Gero | The impact of working memory limitations on the design process during conceptualization | | Similarly, mental imagery **experiment**s have emphasized the role and necessity of externalizations for mental synthesis of parts/objects as well as for re-interpretation (Chambers and Reisberg, 1992; Anderson and Helstrup, 1993; Kavakli et al., 1998; Verstijnen et al., 1998; Kokotovich and Purcell, 2000). | 3 | 2 |
| | | | | His **experimental** study resulted in claims that it was possible for an expert designer to develop a product design using his imagery only. | 3 | 2 |
| | | | h | 3 The **Experiment** | 3 | 2 |
| | | | h | 3.1 Design of the **experiment**s | 3 | 2 |
| | | | | The procedures for conducting the **experiment**s are explained and discussed in Bilda et al. (2006). | 3 | 2 |
| | | | | Verstijnen et al. (1998) conducted similar **experiment**s with industrial design students requiring imagery operations such as synthesis, manipulation and inspection of relatively simple figures. | 3 | 2 |
| | | | | In a follow up study, Kokotovich and Purcell (2000) conducted **experiment**s with designers and nondesigners and obtained results similar to Anderson and Helstrup (1993). | 3 | 2 |
| | | | | The examples of testing the visuo-spatial component ofWM are similar to Kosslyn's (1980) **experiment**s such as image maintenance, image scanning, or rotation, where subjects are initially shown the images and then are asked to remember and process the visuo-spatial information they hold. | 3 | 2 |
| | | | | The BF sessions are more similar to the **experiment**s conducted with expert chess players where they were required to hold and process visuo-spatial information for extended periods (Saariluoma, 1998). | 3 | 2 |
| | | | n | Baddeley, A D, Emsile, H, Kolodny, J and Duncan, J (1998) Random generation and executive control of working memory Quarterly Journal of **Experimental** Psychology Vol 51A pp 819e852 | 1 | 12 |
| | | | n | Kavakli, M and Gero, J S (2003) Difference between expert and novice designers: an **experimental** study in U Lindemann (ed) Human behaviour in design Springer pp 42e51 | 3 | 2 |
| | | | n | Kokotovich, V and Purcell, A T (2000) Mental synthesis and creativity in design: an **experimental** examination Design Studies Vol 21 pp 437e449 | 3 | 2 |
| | | | n | Phillips,WA and Christie, D FM(1997) Components of visual memory Quarterly Journal of **Experimental** Psychology Vol 29 pp 117e133 | 1 | 12 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 411-436 | Theodore Zamenopoulos and Katerina Alexiou | Towards an anticipatory view of design | | More importantly, design also involves the capacity to anticipate the correspondence between theories and models, which can only be verified by **experimentation** or the actual realisation of the design artefact. | 2 | 2 |

**Table D.47:** Content Analysis of Design Studies, Vol. 28, Issue 5. (September, 2007)

| Page | Writer | Paper Title | | Sentence | Meaning | Context |
|---|---|---|---|---|---|---|
| 499-512 | Ann Heylighen, Paula Deisz and Ilse M. Verstijnen | Less is more original? | a | The **experiment** reported on here suggests that this choice may have more fundamental implications than is generally assumed. | 3 | 2 |
| | | | | However, the **experiment** presented in this paper may throw a new light on this question. | 3 | 2 |
| | | | | After an overview of related research and theories in cognitive science (Section 2), the paper will describe the setting and procedure of the **experiment**, followed by the methodology and results of the analysis (Section 3). | 3 | 2 |
| | | | f | It concludes with lessons learned from this **experiment** and topics for future research (Section 4). | 3 | 2 |
| | | | | Other evidence that seems to contradict Scott Brown's theory derives from an **experiment** (Lindekens, 2006) in which three architects were given exactly the same architectural design task: while two of them evolved fast to a single option, the third came up with no less than seven completely separate alternatives within the same time. | 3 | 2 |
| | | | | In the first **experiment**, psychology students were asked to create mentally (i.e. eyes closed) a recognisable form with a randomly selected set of three basic 2D shapes (e.g. a circle, a square, the letter J). | 3 | 2 |
| | | | | Based on several repetitions and variations of these **experiment**s, Finke et al. (1992) theorised two phases in creative thinking: a generative phase involving the construction of preinventive forms, i.e. the creative objects subjects came up with, and an exploratory phase in which these preinventive forms are interpreted in meaningful ways. | 3 | 2 |
| | | | | An exception worth mentioning here is the work by Kokotovich and Purcell (2000), who repeated the mental synthesis **experiment**s with two sets of shapes (2D and 3D) and three groups of subjects (students in graphic design, industrial design and law). | 3 | 2 |
| | | | | Therefore we set out to conduct an exploratory **experiment** based on Finke's paradigm with the general hypothesis that the extent to which architects generate alternatives | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | does have a bearing on their design performance. | | |
| | | | h | 3 **Experiment** | 3 | 2 |
| | | | | They participated in the **experiment** as a mandatory part of their class. | 3 | 2 |
| | | | | The **experiment** was announced as 'Playing with figures' and took place in the classroom where students usually had class at that time. | 3 | 2 |
| | | | f | Before the **experiment** started, participants received a document with instructions explaining the procedure of the **experiment** and showing the seven shapes from which sets of three were to be selected during the **experiment** (Figure 1). | 3<br>3<br>3 | 2<br>2<br>2 |
| | | | | In order to motivate the participants the **experiment**er announced that the best performer would win a prize (without specifying 'best' or the prize). | 3 | 2 |
| | | | f | The **experiment** started with the **experiment**er reading out loud the names of three shapes from the first set (see Figure 3). | 3<br>3 | 2<br>2 |
| | | | | A pilot to this **experiment** had shown that 3 min was the optimal time to both cover the peak in production and yet avoid effects of fatigue. | 3 | 2 |
| | | | f | After the 1-min break the **experiment**er named the next set of three shapes (see Figure 3). | 3 | 2 |
| | | | | The entire **experiment** took half an hour. | 3 | 2 |
| | | | | Figure 3 Five sets of three shapes used in the **experiment** | 3 | 2 |
| | | | | Two extra criteriadfusion and spatialityd were added in this **experiment**. | 3 | 2 |
| | | | | The illustrations of the criteria in Figure 6 are taken from the **experiment**. The creation 'little man', for instance, involves modification of the letter C and the circle, and proportional change of the letter L, which results in a total score of 3 for restructuring. | 3 | 2 |
| | | | | Figure 4 Categories for unique combinations. Every circle symbolises an element. Embedded circles symbolise the presence of an element within another. An element is considered to be outside another element if the centre of the former is located at or outside the border of the latter. The planar view was not used in this **experiment** | 3 | 2 |
| | | | | Figure 5 Creations from the **experiment** illustrating the categories in Figure 4 | 3 | 2 |
| | | | | In fact, it seeks to determine if the variables as measured in the **experiment** can be explained in terms of a smaller number of variables, c.q. factors. | 3 | 2 |
| | | | | Figure 6 Illustrations of the criteria for restructuring with creations from the **experiment** | 3 | 2 |
| | | | | Starting from the hypothesis that the extent to which architects generate alternatives somehow impacts their design performance, we have conducted an exploratory | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | **experiment** based on Finke's paradigm (Finke and Slayton, 1988). | | |
| | | | | First of all, in this **experiment** subjects were given only a few minutes to solve Finke's task. | 3 | 2 |
| | | | | Secondly, this **experiment** made use of a relatively simple task, especially compared to the complex tasks architects are confronted with in practice. | 3 | 2 |
| | | | | For one thing, reducing the task to part of the design process may imply serious limitations: in real-world design, solution generation may depend on the formulation and analysis of the design task (Fricke, 1999), neither of which were covered by the **experiment**. | 3 | 2 |
| | | | | Further **experiment**s should therefore investigate whether these results can be confirmed with more complex and more various tasks that better approaches realistic design tasks. | 3 | 2 |
| | | | | The authors would like to thank the 3rd year architecture students for their participation and their professor for allowing us to conduct this **experiment** during his class. | 3 | 2 |
| | | | | Kokotovich, V and Purcell, T (2000) Mental synthesis and creativity in design: an **experimental** examination Design Studies Vol 21 No 5 pp 437e449 | 3 | 2 |
| 535-557 | Arthur E. Stamps | Evaluating spaciousness in static and dynamic media | | Other **experiment**s investigated whether the shape of the space influenced impressions of spaciousness. | 3 | 2 |
| | | | | A pair of **experiment**s investigated the question of how the roughness of boundaries influenced impressions of spaciousness (Stamps and Krishnan, 2006). | 3 | 2 |
| | | | h | 2 **Experiment** 1: static medium | 3 | 2 |
| | | | | The overall research design consists of conducting rigorous empirical **experiment**s. | 3 | 2 |
| | | | | In the present **experiment**s the ratings range from 1 (not spacious) to 8 (spacious). | 3 | 2 |
| | | | | In one pair of **experiment**s, preferences were obtained for the same 13 scenes but using different participants, different locations, different viewing conditions, different viewing orders, and different scaling methods (Stamps, 1992). | 3 | 2 |
| | | | | In another **experiment** on preferences for 35 houses, two sets of responses were obtained from different groups of respondents, in different cities, under different viewing conditions (Stamps and Nasar, 1997). | 3 | 2 |
| | | | | The results again correlated at r = 0.90. Feimer (1984) reported findings from a large (1148 participants) study on effects of **experimental** conditions on evaluations of environments. | 3 | 2 |
| | | | | Accordingly, the present **experiment**s did not control for viewing conditions. | 3 | 2 |
| | | | f | Overall, therefore, the research design was a formal factorial **experiment**, the measuring system was reporting effect sizes, and the measuring instrument consisted of semantic differential ratings. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Use of professional CAD programs is recommended for the following reasons: (a) the resulting environments can be built (no Escher-type geometric impossibilities), (b) the environments can be designed to meet precisely the requirements of scientific **experiment**s, (c) all dimensions are in real-world units, and (d) lighting is also specified in real-world units (cd/m2) that can be rendered with both ray-tracing and radiosity. | 3 | 2 |
| | | | | In this **experiment**, the direction of view was chosen to maximize the amount of visible area. Figures 2 and 3 illustrate these ideas. | 3 | 2 |
| | | | | For scientific readers, the **experimental** design was a factorial of horizontal size (77.5 and 155 m2) by occlusion (absent, present) by light (300 and 600 cd/m2), with three views within each cell (minimum, average, and maximum visible floor area), for a total of nstim =24. | 3 | 2 |
| | | | | This **experiment** addressed the following research questions: (a) How strongly did floor area influence impressions of spaciousness? (b) How strongly did amount of light influence impressions of spaciousness? And (c) How strongly did inclusion of interior partitions influence impressions of spaciousness? | 3 | 2 |
| | | | | Figure 2 (2) If there are partitions, then some of the shape might be hidden from some of the station points. Selection of station points in **experiment** 1 involved creating trial points | 3 | 2 |
| | | | h | 3 **Experiment** 2: dynamic medium | 3 | 2 |
| | | | | The medium for this **experiment** was a virtual reality model in which participants could walk around the environment. | 3 | 2 |
| | | | | Emphasis in this **experiment** was on creating VR models that matched the static color images used in **experiment** 1, and, moreover, doing so in an efficient manner. | 3<br>3 | 2<br>2 |
| | | | | The result of this process was a set of eight VR models, with one model corresponding to each cell in the factorial **experimental** design of horizontal size (small, large) by light (dim, bright) by occlusion (absent, present). | 3 | 2 |
| | | | | Floor area and occlusion had the same effects in both **experiment**s: larger rooms were perceived as more spacious, as were lighter rooms, but the effect sizes were substantially larger when obtained via VR models. | 3 | 2 |
| | | | | The strength of the effect, measured in terms of d, was 0.54 in **experiment** 1 and 0.94 in **experiment** 2. | 3 | 2 |
| | | | | The effect of occlusion d in the present **experiment**s, partitions d deceased the apparent spaciousness of the rooms. | 3 | 2 |
| | | | | The effect sizes were d = 0.46 (more than a street tree) in the first **experiment** and 1.37 (more than a mountain) in the second **experiment**. | 3 | 2 |
| | | | | Effects of lighting on perceived spaciousness were the same in both **experiment**s. | 3 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | For instance, when creating the VR models for **experiment** 2, the design was done by rendering each space from three station points. | 3 | 2 |
| | | | | First, the findings of strong effects of floor area, occlusion, and light on perceived spaciousness means that, in any future research on spaciousness, these factors should either be included in the **experimental** design or controlled out of the **experimental** design. | 3<br>3 | 2<br>2 |
| | | | | Fourth, there might have been a demographic difference in exploration strategies in **experiment** 2. | 3 | 2 |
| | | | | Fifth, the correspondence between responses obtained from static color images and VR models is based on one **experiment**. | 3 | 2 |
| | | | f | Additional **experiment**s would be highly desirable before making any general claim regarding the inter-changeability of the two media. | 3 | 2 |
| | | | | Ishikawa, T and Okabe, A, et al (1998) An **experimental** analysis of the perceptions of the area using 3-D stereo dynamic graphics Environment & Behavior Vol 30 No 2 pp 216e234 | 3 | 2 |

## APPENDIX E: FIGURES

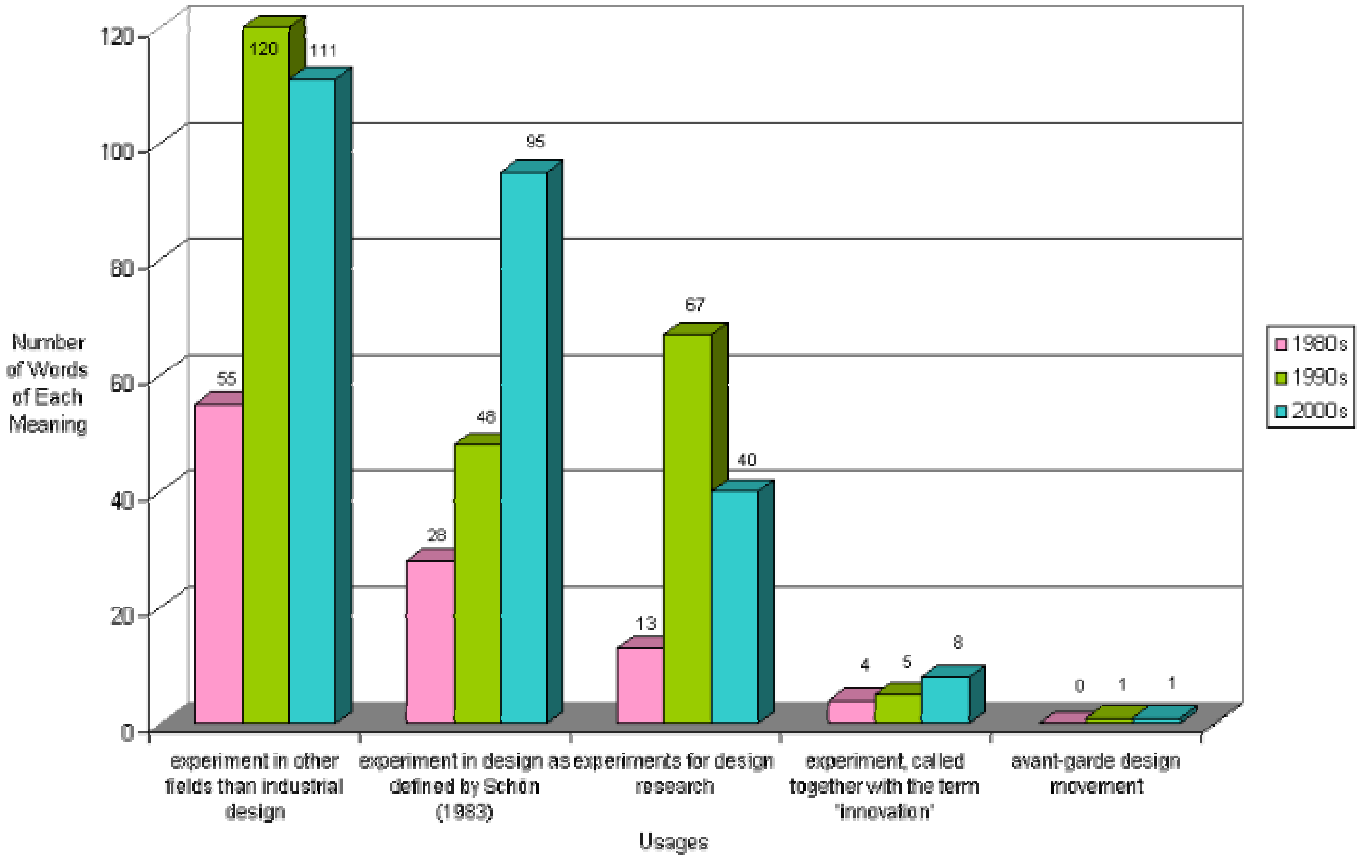


**Figure 4.1:** Content Analysis of 'Design Issues' with the Usages of 'Experiment'

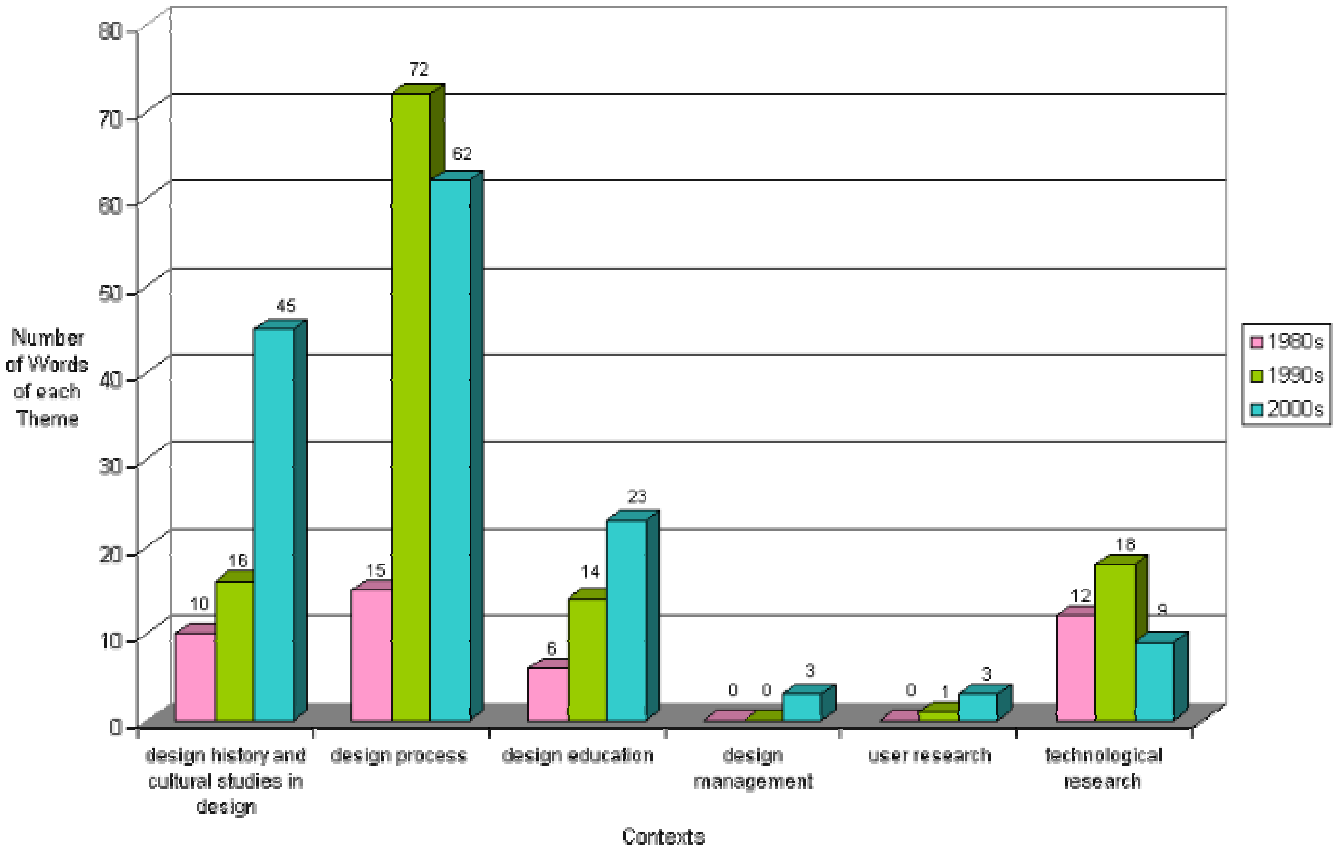


**Figure 4.2:** Content Analysis of 'Design Issues' with the Contexts of 'Experiment' - I

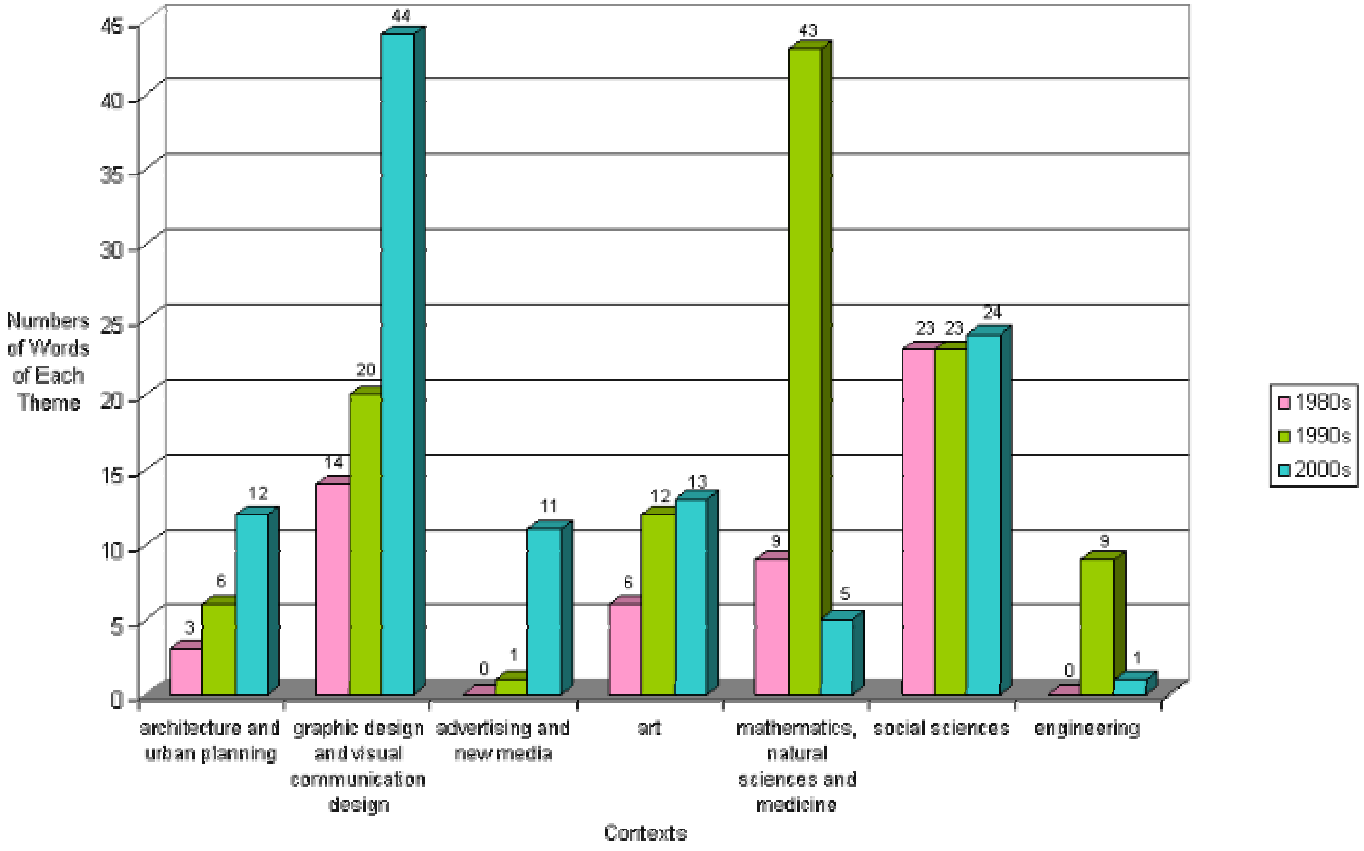


**Figure 4.3:** Content Analysis of ‘Design Studies’ with the Contexts of ‘Experiment’ - II

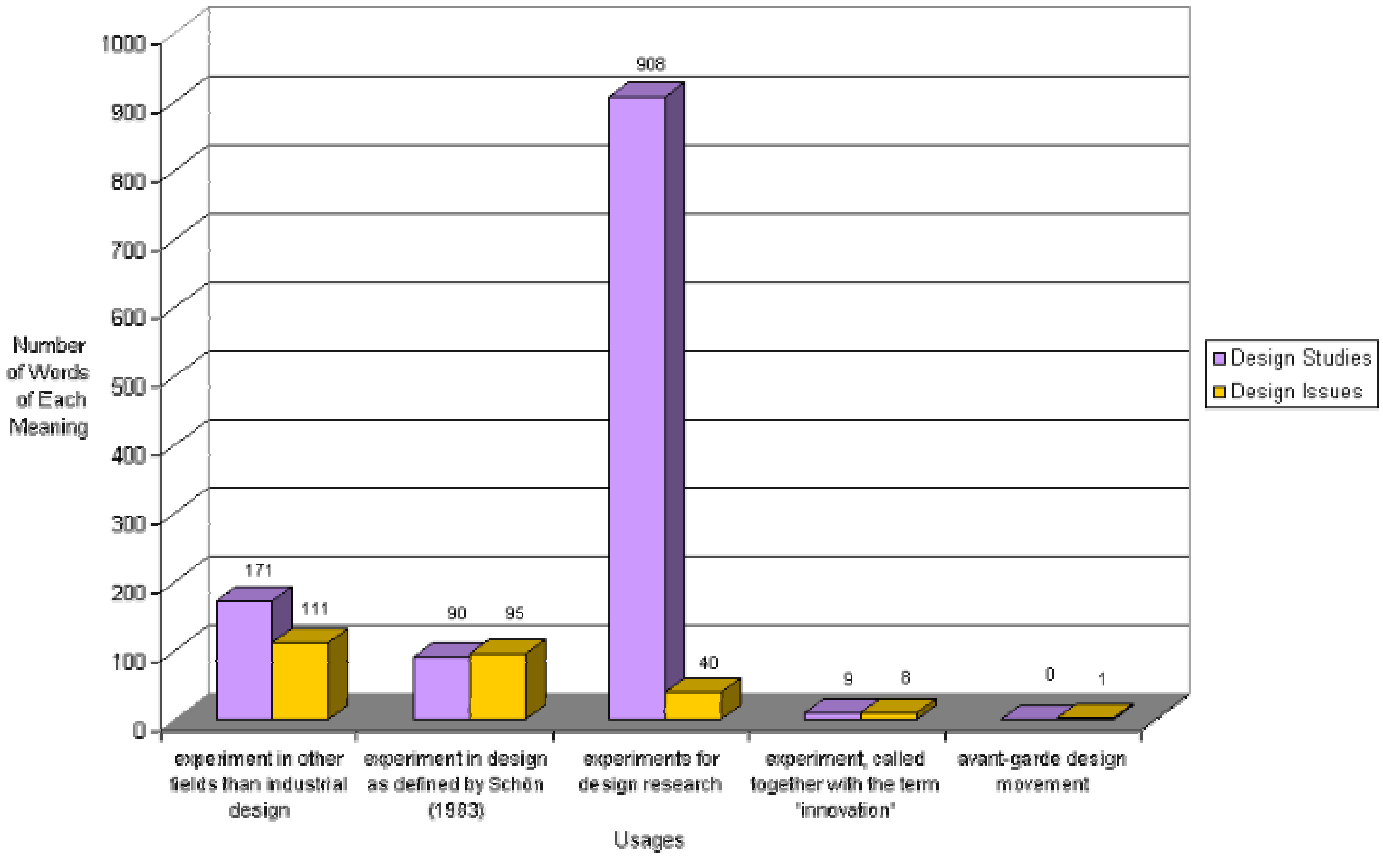


**Figure 4.4:** Content Analysis and Comparison of 'Design Studies' in 2000s and 'Design Issues' in 2000s for the Usages of ‘Experiment’

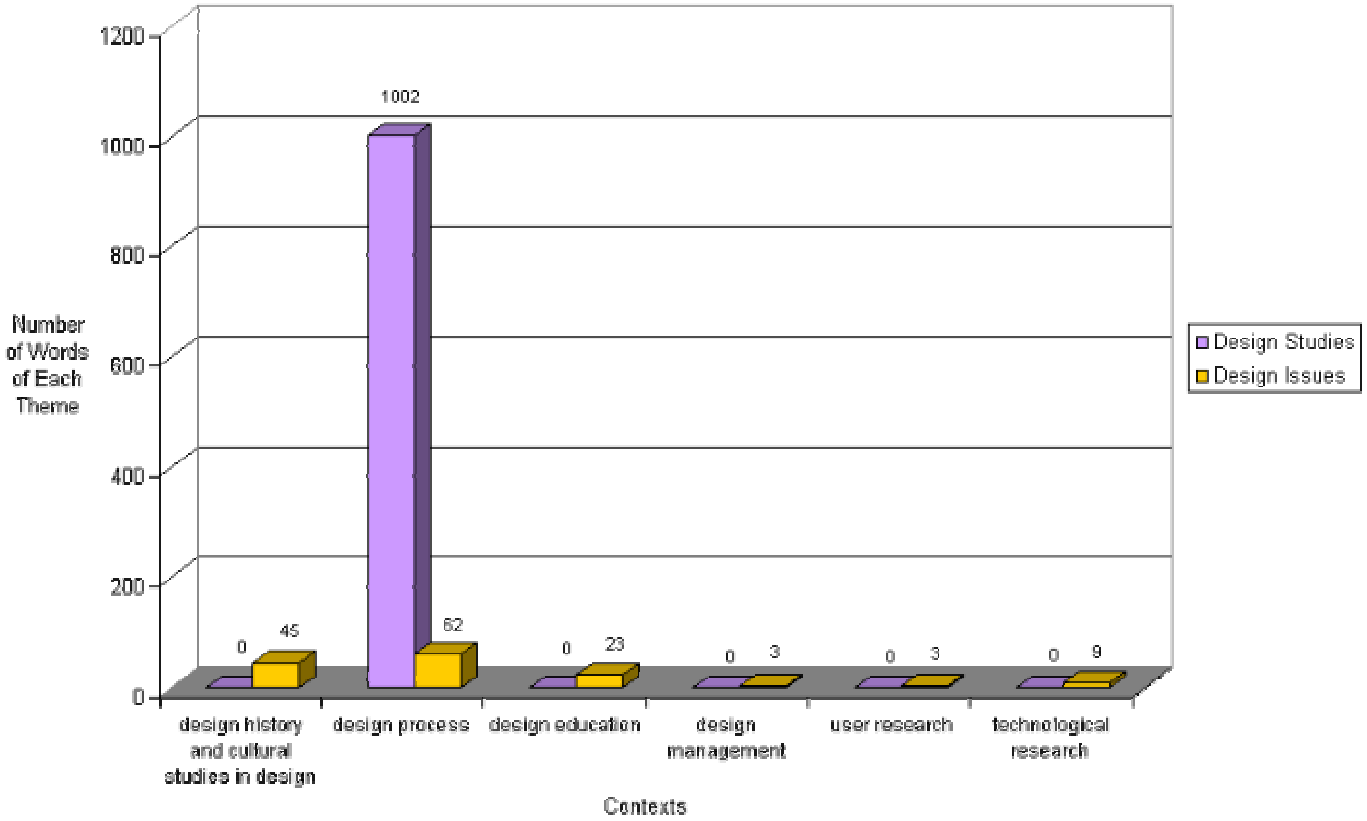


**Figure 4.5:** Content Analysis and Comparison of ‘Design Studies' in 2000s and 'Design Issues' in 2000s for the Contexts of ‘Experiment’ - I

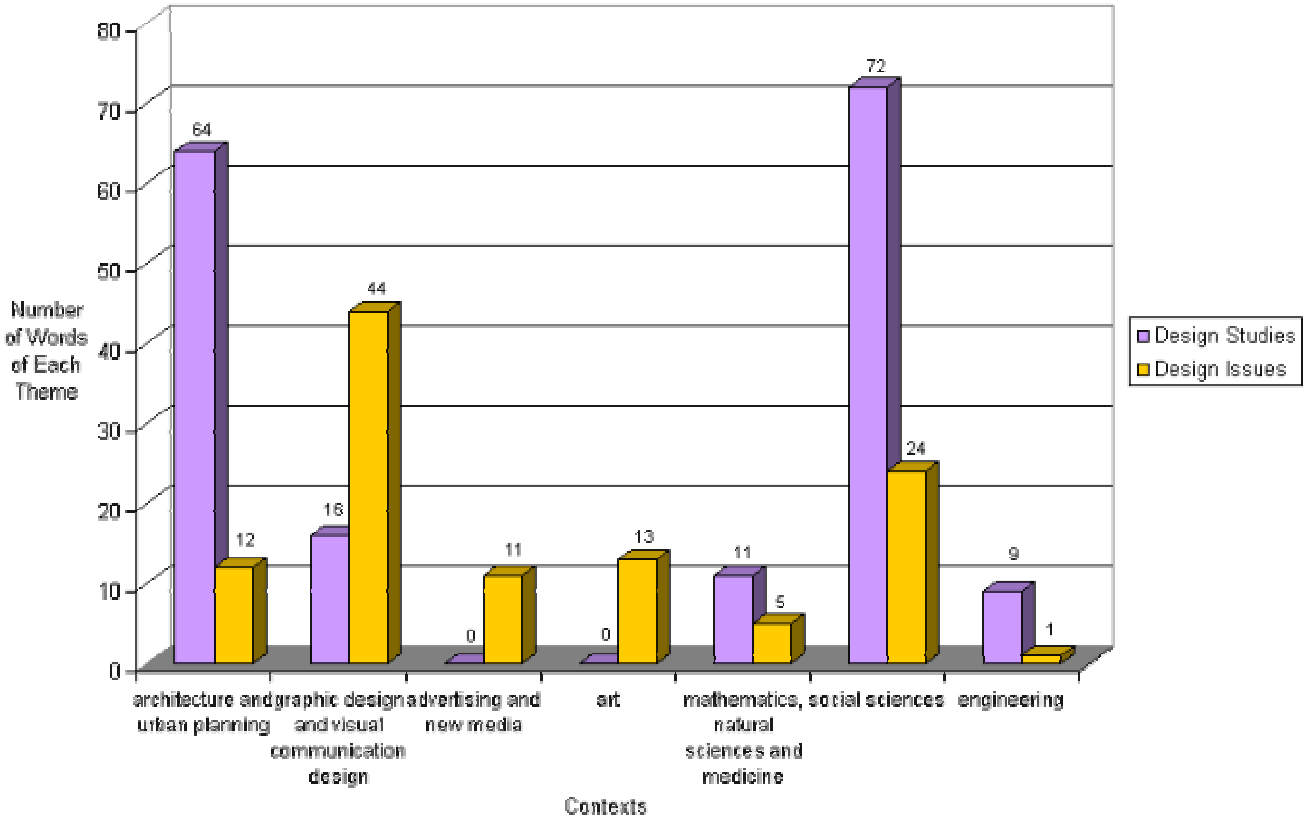


**Figure 4.6:** Content Analysis and Comparison of ‘Design Studies' in 2000s and 'Design Issues' in 2000s for the Contexts of ‘Experiment’ - II

## ABOUT THE AUTHOR

Elif Küçüksayraç was born in Ankara, in 1979. She started her primary education in Ankara and completed in Istanbul. She graduated from Cağaloğlu Anatolian High School in 1997. She received her Bachelor's Degree in Civil Engineering from Boğaziçi University, Department of Civil Engineering in 2002. Between 1998 and 2007 she worked in Geniş Açı Art of Photography Magazine as a writer and between 1999 and 2001 as a member of publishing team. During 2003 she lived in London, England and attended the short course 'Product Design' in Central Saint Martins in London. In 2004 she started her graduate education in Department of Industrial Product Design at Istanbul Technical University. Meanwhile she worked in BAC Design during 2005. Since 2006 January she's been working as a research assistant in the Department of Industrial Design at Istanbul Technical University. In April 2007, she attended SaloneSatellite, Milan Furniture Fair in Italy, and Istanbul Designweek in Istanbul in September 2007 with the exhibition of the project '5 Senses of Istanbul' which was conducted in the Advanced Design Project studio in the Graduate Program of Industrial Product Design at Istanbul Technical University in 2006 Spring Semester, with her design 'Traces'. She was also one of the general coordinators of the exhibition with Prof.Dr. H. Alpay Er and Instr.Dr. Hümanur Bağlı. She also personally exhibited 'Traces' in Designmai Youngsters in Berlin, Germany in Mai 2007.

Her professional interests are Experimental Design, Design Management and Design Research.