INFLUENCES AND MENTAL PROCESSES INVOLVED IN GENERATING CREATIVE PRODUCTS: THEIR IMPLICATIONS FOR LANDSCAPE ARCHITECTS

by

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ABSTRACT

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Creativity is the ability to bring something new into existence consciously with 'something new' being a product resulting from a process initiated by a person (Barron, 1988.) It may be an idea, an artwork of acknowledged greatness, a scientific discovery, the solution to a problem, leadership abilities, or theories and products that are unique and novel (Barron, 1988.)

Influences involved in generating creative products include the social and historical milieu in which creativity is carried out, a culturally defined domain, the creative person's personality, cognitive factors, and motivational characteristics.

The topic of creativity is appropriate for landscape architecture because creative products are generated in this domain. Research on creative processes mostly involves

scientific insight. It includes processes of memory, intelligence, reasoning by analogies, problem solving and problem finding. These processes manifest through convergent, divergent, and analogous thinking tasks.

This thesis tests this hypothesis: If participants' scores are high for a divergent task test, a convergent task test, and an analogous thinking test, then they will also achieve higher scores than the mean score of a testing group on a creative design assessment test. This will prove that landscape architects use the processes involved in scientific insight for creative design. Finding correlations between cognitive processes associated with scientific insight and design abilities of landscape architects, recognizes landscape architecture as a field where inventions, discoveries and novel products occur.

Data was collected through a creative abilities test, and was interpreted through statistical analysis. Although the hypothesis could not be proven irrefutably, correlations were found between some cognitive processes and creative design abilities.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The purpose of this thesis is to determine whether landscape architects use similar cognitive processes when designing landscape architecture projects, to those processes used by persons who generate scientific discoveries, inventions and great works of art. This thesis contributes towards a measuring tool which can recognize creative geniuses in the field of landscape architecture. This research also suggests that the acquisition of knowledge and experience contribute to one's ability to generate creative products in a specific domain. Some researchers believe that too much knowledge can be a dangerous thing. Taylor states that the most creative work in a given area is done by people who are relatively new to a field and who know a fair amount about the field, but not too much (Taylor, 1988.)

In order to investigate the truth of this statement, one must test the creative abilities of landscape architects with different levels of knowledge and experience; however, no such research tool could be found. A creativity test for landscape architects is also needed in order to find possible correlations between cognitive processes associated with 'geniuses' (for example, scientific insight) and creative abilities of landscape architects. Creativity tasks are usually categorized as either

convergent or divergent (Runco, 2007.) Convergent tasks require a single correct response, whereas divergent tasks require producing many different correct answers (Hudson, 1966.) Both tasks depend on knowledge (tacit and academic) and experience (Runco, 2007; Shank, 1988.) One uses divergent thinking when finding and redefining problems (Sternberg, 2003.)

Problem solving ability is a measure of creativity because it employs similar thought processes involved in producing works of acknowledged greatness in art or in science (Wiesberg, 1988) such as forming analogies (Langley and Jones, 1988.) Creative problem solving can use remote analogous relations as the basis for memory search (Wiesberg, 1988.) Creative thought processes, regardless of the problem, involve transformations of the external world and internal representations by forming analogies and bridging conceptual gaps (Tardif and Sternberg, 1988.) Creativity is therefore a memory related phenomenon that centers on mechanisms of indexing and retrieval of information (Langley and Jones, 1988.)

This thesis develops a creative measurement tool for landscape architects. It borrows from existing tests which assess convergent thinking abilities; and divergent thinking abilities by testing remote associations, insight, attribute extraction and analogous thinking abilities. It also adapts a creative design ability test developed for engineers to test creative design abilities of landscape architects. This thesis tests the hypothesis: if participants' scores are high for divergent task tests, convergent task test, and analogous thinking tests, then participants will also get higher scores than the mean score of a testing group on a creative design assessment test.

If the hypothesis is correct, there will be a correlation between the scores of the cognitive processes tested and the creative ability scores. A correlation between cognitive processes associated with creative genius (based on indexing and retrieval of knowledge in memory) will support the notion that learning about the field of landscape architecture contributes to one's ability to generate creative products in the domain. It will also help in recognizing landscape architecture as a field where genius occurs.

This chapter explains what is meant by 'creative products', and it resolves possible confusion regarding the meaning of creativity. It discusses why it is important to understand the influences and mental processes involved in generating creative products. It discusses possible implications that research on creativity have for landscape architecture and gives an overview of the history of research on creativity.

1.2 Creative products

Generating creative products is referred to in psychology as the study of creativity (Sternberg, 2003). The phrase 'generating creative products' is used to describe products that originate from cognitive processes such as reasoning by analogy, finding metaphors and generating analogies. 'Creativity' is sometimes used to describe products which are artistic in nature and produced through skill. Generating creative products, however, is the ability to produce work that is novel (meaning, original and unexpected), that is high in quality, that is useful, and that meet task constraints (Sternberg, 2003.) Consider for a moment two canvasses. One is an original painting by Rembrandt and one is a forgery, and they are completely indistinguishable. Were both

artists equally creative because they used the same skills to produce their paintings? No. Rembrandt's painting is the creative achievement because he introduced some variations in the domain of painting at a certain point in history (for example, the use of light as it reflects off objects), when those variations were novel, and when they were instrumental in revising and enlarging the symbolic domain of the visual arts (Csikszentmihalyi, 1988.) In other words, Rembrandt contributed something new to the world of art.

Similarly, not everything a landscape architect produces is a creative product. Gruber (1988) says that "…because a creative product met a felt or almost felt need, it is reasonable to suppose that others were moving in the same direction. And this is what is often found to be so. If in addition, the move or solution were ready at hand, so that any one of a number of qualified workers in the same vineyard might find it, then it would be a general trend, and would unlikely be called 'creative'" (Gruber, 1988:265.) Some landscape installations are produced by skill alone and seem typical and commonplace. They regurgitate existing knowledge and practices in the same way the forgery simply reproduced Rembrandt's painting. In contrast, some landscape designs solve specific project related problems, and introduce something new to the field whilst being appropriate, aesthetically pleasing and staying within the task constraints. Such solutions, designs and ideas are examples of creative products in landscape architecture.

Research describing creativity as generating creative products broadens the scope of creativity to include novel ideas (Thurstone, 1952), artwork of acknowledged greatness (Weisberg, 1988) scientific discoveries (Langley and Jones, 1988), solutions

to a problems (Metcalf, 1986; Greeno, 1980; Adams, 1979; Weisberg, 1988), leadership abilities (Simonton, 1984; Sternberg 2003), and theories and products that are unique and novel (Reber, 1985.) Since some of these products are synonymous with landscape architecture, we can use such research to help recognize creative contributions in our domain. But even a good idea or an appropriate design solution is not enough for it to be put into the category of creative products.

A creative product attempts to propel a field from wherever it is to wherever the creator believes the field to be (Sternberg, 2003), for example, Freud's contributions with regards to the psychology of personality radically reshaped the domain of psychology during that time (Gardner, 1988.) Since the word 'creativity` can easily be misinterpreted, this thesis discusses different approaches to the study of creativity, offer various definitions of creativity, and orient us briefly with regards to existing research on this topic.

1.2.1 Influences and processes involved in generating creative products

Recognizing art works, scientific discoveries, and novel products as creative products provides a window into the study of creativity but does not explain the origins of novel thoughts. Neither does it explain what influences the creative process or why a person generates creative products in the first place. Barron and Harrington (1985) say that creative persons usually respond to needs for new approaches and new products, and that the new product results from a process. Csikszentmihalyi says that "…we cannot study creativity by isolating individuals and their works from the social and historical milieu in which their actions are carried out. This is because what we call

creative is never the result of individual action alone; it is the product of three main shaping forces. These are: a set of social institutions, or field, that selects from the variations produced by individuals those that are worth preserving; a stable cultural domain that will preserve and transmit the selected new idea or forms to the following generations; and finally the individual, who brings about some change in the domain, a change that the field will consider to be creative" (Csikszentmihalyi, 1988: 325.) In order to research these influences and processes, this thesis will follow the four research approaches to the problem of creativity presented by Mooney (1963) which include, apart from the creative product, also, the creative process, the creative environment, and the creative person.

1.2.2 Implications for the profession of landscape architecture

Landscape architects are designers, problem solvers and problem finders. Hopper states that landscape architecture encompasses the analysis, planning, design, management, and stewardship of the natural and built environments (Hopper, 2007.) Bourassa touches on one aspect of problem solving when he says that design is the problem of fitting form to context (Bourassa, 1991.) Every design problem begins with an effort to achieve fitness between two entities: the form and the problem. The form, or creative product, is the solution to the problem (Alexander, 1966.)

In terms of the artistic elements of design, Hopper finds a connection between landscape architecture and fine art when he says that landscape architecture is the art and science of the designed mediation of the zone between art and nature (Hopper, 2007.) Rogers confirms the creative aspect of the domain by saying that landscape

architects apply creative skills in the planned arrangement of natural and constructed elements on the land (Rogers, 1997.) Creative processes are involved in landscape architecture and, therefore, research regarding the ability to generate creative products is applicable to the domain. Hopper states that, in its brief existence, landscape architecture has had a marked capacity for innovation, reinvention and development (Hopper, 2007.)

1.3 Creativity as a neglected research topic

Creativity is a relatively new research topic in the field of psychology (Sternberg, 1999.) Guilford reported that less that 0.2% of the entries in *Psychological Abstracts* up to 1950 focused on creativity, and although interest in creativity research began to grow somewhat in the 1950's, only a few research institutes concerned with creativity were founded (Guildford, 1950.) Several indicators of the volume of work on creativity show that it remained a relatively marginal topic in psychology, at least until recently (Sternberg and Lubart 1999.)

Sternberg and Lubart give five reasons why the field of psychology has neglected creativity as a research topic, 1) the origins of the study of creativity occurred in a tradition of mysticism and spirituality, which seems indifferent or even possibly counter to the scientific spirit; 2) the impressions conveyed by pragmatic, commercial approaches to creativity lacks a basis in psychological theory or verification through psychological research; 3) early work in creativity that was theoretically and methodologically apart from the mainstream of theoretical and empirical psychology resulted in creativity sometimes being seen as peripheral to the central concerns of the

field of psychology as a whole; 4) problems with the definition of and criteria for creativity seemed to render the phenomenon either elusive or trivial; 5) approaches to creativity have tended to view it as an extraordinary result of ordinary structures or processes, making it seem unnecessary to have any separate study of creativity; 6) unidisciplinary approaches to creativity that have tended to view a part of creativity as a single phenomenon, often resulted in what we believe is a narrow vision of creativity and a perception that creativity is not as encompassing as it truly is (Sternberg and Lubart 1999.)

1.4 Approaches to the study of creativity

Six approaches to the study of creativity, according to Sternberg and Lubart, form the highlight of psychological research on the subject. Although it does not exhaust all the approaches to creativity they believe that it provides a good overview of research in the field of field of psychology (Sternberg and Lubart, 1999). The approaches include the mystical approach, the psychoanalytic approach, the pragmatic approach, the psychometric approach, the cognitive approach, the social-personality approach, and the investment theory approach (Sternberg and Lubart, 1999)

1.4.1 Mystical approach to the study of creativity

"Perhaps the earliest accounts of creativity were based on divine intervention. The creative person was seen as an empty vessel that a divine being would fill with inspiration" (Sternberg and Lubart, 1999.) For Plato, creativity was inspired by the muses (Rothberg and Hausman, 1979.) The mystical approach to the study of creativity

is spiritual and does not lend itself to research by scientific psychologists (Sternberg and Lubart, 1999.)

1.4.2 Pragmatic approach to the study of creativity

The pragmatic approach to the study of creativity finds practical ways to develop creativity and presents tools to deliver creative solutions when needed. These include brainstorming, role playing, lateral thinking, finding analogies and learning to see things from different points of views. These approaches have had commercial success but lack a basis in serious psychological theory (Steinberg and Lubart 1999.) Proponents of this approach include Edward De Bono (1971, 1985, 1992), Gordon (1961) and von Oech (1986)

1.4.3 Psychodynamic approach to the study of creativity

This approach purports that creativity arises from the tension between conscious reality and unconscious drives (Freud 1908.) The primary creative process of the psychodynamic approach is adaptive regression where unmodulated thoughts enter consciousness. Elaboration, the secondary creative process, refers to the reworking and transformation of primary process material through reality-oriented, ego controlled thinking. It can occur during active problem solving, sleep, intoxication from drugs, fantasies, daydreams or psychoses (Kris 1952.) Other theorists (for example, Kubie 1958) have said that the preconscious, which falls between conscious reality and the encrypted unconscious, is the true source of creativity because thoughts are loose and vague but interpretable (Steinberg and Lubart, 1999.)

1.4.4 Psychometric approach to the study of creativity

The psychometric approach to the study of creativity was first developed by Guilford (1950.) It refers to divergent thinking and problem solving abilities tested through paper-and-pencil tasks. Torrance (1974) built on Guilford's work by developing tests for fluency, flexibility, originality and elaboration.

1.4.5 Cognitive approach to the study of creativity

The cognitive approach to creativity seeks to understand the mental representations and processes underlying creative thought. In the generative phase an individual constructs mental representation referred to as pre-inventive structures, which have properties promoting creative discoveries. What follows is an exploratory phase where these properties are used to come up with creative ideas. A number of mental processes may enter into these phases of creative invention, including the processes of retrieval, association, synthesis, transformation, analogical transfer, and categorical reduction (mentally reducing objects or elements to more primitive categorical descriptions) (Sternberg and Lubart, 1999.) Weisberg (1986) proposes that creativity involves essentially ordinary cognitive processes applied to knowledge already stored in memory (Steinberg and Lubart 1999.)

1.4.6 Social-personality approach to the study of creativity

This approach focuses on personality variables, motivational variables, and the socio-cultural environment as sources of creativity. Creative people display certain personality traits such as independence of judgment, self-confidence, attraction to complexity, aesthetic orientation and risk taking (Steinberg and Lubart 1999.) Self-

actualization is also a personality variable and include traits such as boldness, courage, freedom, spontaneity, self-acceptance and other traits that lead a person to realize their full potential (Maslow 1968.) Intrinsic motivation and a support system also contribute towards creativity (Rogers 1954). At the societal level, cultural diversity, war, availability of role models, availability of resources such as financial support, and number of competitors influenced creativity (Steinberg and Lubart 1999.)

1.4.7 Investment theory approach to the study of creativity

The investment theory of creativity is essentially a confluence of the other approaches to creativity. It describes creative people as ones who are willing and able to "buy low and sell high" in the realm of ideas (Sternberg and Lubart, 1999.) "Buying low means pursuing ideas that are unknown or out of favor but that have growth potential. Often, when these ideas are first presented, they encounter resistance. The creative individual persists in the face of this resistance and eventually sells high, moving on to the next new or unpopular idea" (Sternberg and Lubart, 1999:10) Sternberg and Lubart propose an investment theory that requires a confluence of six distinct but interrelated resources: intellectual abilities, knowledge, styles of thinking, personality, motivation, and environment.

1.5 Methods and limitations

The methods used in this research to test creative processes are based on existing tests on creativity. The research instrument consists of test questions borrowed from creativity test by Frank Barron (1988), Paul Torrance (1974), Nielson, Picket and Simonton (2008), and Charyton, Jagacinski, and Merrill (2008.) Design task questions,

together with convergent task questions, divergent task questions, and analogous task questions, enable the research to find correlations between cognition and creative design.

Limitations of the research include the testing instrument, scoring methods, and the test group size. No creative design assessment tool for landscape architects could be found. The design task question is based, therefore, on a creative design test for engineers.

Creative design between engineers and landscape architect are similar, but there are differences also. The tests are scored by the primary researcher only. When creative abilities are assessed, multiple qualified examiners should score the responses in order to limit bias. The test group for this research consisted of 21 participants. This is an acceptable amount of participants for psychological testing; however, a larger test group should produce more reliable results.

1.6 Significance of the research for landscape architects

The significance of this research for landscape architecture is that it enables novel technologies and celebrated landscape installations the opportunity to be viewed by society on similar terms as scientific discoveries, medical break-troughs or famous art works. It also puts importance on the peer group which serves to recognize novelty in the domain through its associations, publications and competitions.

Finally, education of landscape architecture are impacted because if this research suggests that knowledge and experience contribute to the ability to generate creative products, academic units, their curriculums and research products may be in

part responsible for progress in the domain and even directly influence the installations of innovative and novel projects which can be accepted by the society to which they are presented.

1.7 Conclusion

This chapter discussed the premise for the applicability of research on creativity for the field of landscape architecture. It explained why it is appropriate to refer to creativity as 'generating creative products'; distinguishing between products of skill, and products that move a domain forward through innovation and discovery. The implication of this research on the domain of landscape architecture is touched upon. The chapter gave an overview of research on creativity and concluded that four aspects of creativity need to be considered: the creative product, the creative process, the creative environment and the creative person. In the following chapter, the four aspects of creativity are discussed in greater detail. This presents further opportunities to consider the creative aspects of landscape architecture and to illustrate why the acquisition of knowledge and experience of landscape architecture contribute to ones ability to generate creative products.

CHAPTER 2

PRODUCTS, PROCESSES, PERSONS, ENVIRONMENTS

2.1 Introduction

This chapter discusses the four approaches to the study of creativity, namely: the creative product; the creative process; the creative person; and the creative environment. Since this thesis focuses primarily on cognitive processes involved in creativity, more attention is given to the creative process, where cognitive processes can be studied. This chapter does conclude, however, that the creative person and the creative environment influence the creative process greatly.

2.2 The creative product

A creative product is by its nature *propulsion* and it implies leadership because the creator tries to bring others to a particular point in the creative space (Sternberg, 2003.) This leadership ability manifests in three different ways: products that accept current paradigms and attempt to extend them; products that reject current paradigms and attempt to replace them; and products that merges disparate current paradigms (Sternberg, 2003.)

2.2.1 Products that accept current paradigms and attempt to extend them

2.2.1.1 Replication

A replication helps establish the validity of a novel contribution and shows that its principles can be applied not just to a single product (Sternberg, 2003); for example, the speculation of Jensen (1982) that intelligence can be traced by velocity of neural conduction was confirmed by other neural-conduction velocity tests that predicts outcomes in conventional intelligence tests (Vernon and Mori, 1992.)

2.2.1.2 Redefinition

"The contribution is an attempt to redefine where the field is. The current status of the field thus is seen from different points of view. The propulsion leads to circular motion, such that the creative work leads back to where the field is, but viewed in a different way" (Sternberg, 2003:127.) Andy Warhol who turned studies of soda bottles into pieces of valued art helped redefine conceptions about art which started much earlier by Roy Lichtenstein's approach to comic art as a serious art form (Sternberg, 2003.)

2.2.1.3 Forward incrementation

"This contribution is an attempt to move the field forward in the direction it already is going. The propulsion leads to forward motion" (Sternberg, 2003:127.) Original studies on cognitive dissonance (Festinger and Carlsmith, 1959) was clarified and refined by later theories on the same topic which proposed that self-perception reactions are linked to cognitive dissonance (Bem, 1967.)

2.2.1.4 Advance forward incrementation

"The contribution is an attempt to move the field forward in the direction it is already going, but beyond where others are ready for it to go. The propulsion leads to forward motion that is accelerated beyond the expected rate of forward progression" (Sternberg, 2003:127.) An example of work that is ahead of its time, is the ballet *The Rite of Spring* which pressing and irregular rhythms shocked the Parisian audience at its premiere performance, but proved to be an important step in the course of music history (Machlis, 1979.) This application of rhythm, however, was a continuation of rhythmic experimentation begun by Stravinsky's teacher, Nikolai Rimsky-Korsakov (Machlis, 1979.)

2.2.2 Products that reject current paradigms and attempt to replace them

2.2.2.1 Redirection

"The contribution is an attempt to redirect the field from where it is toward a different direction. The propulsion thus leads to motion in a direction that diverges from the way the field is currently moving" (Sternberg, 2003:127.) Beethoven redirected the field of music by using many of the same classical forms that had been employed by Haydn, Mozart and others, but Beethoven showed that a greater level of emotion could be expressed without sacrificing those forms (Sternberg, 2003.)

2.2.2.2 Reconstruction / Redirection

Products that aim to redirect or reconstruct suggests that a field have gone 'off track and should move back to where it once was (a reconstruction of the past) so that it

may move onward from that point, but in a direction different from the one it took before" (Sternberg, 2003.)

2.2.2.3 Reinitiation

"The contribution is an attempt to move the field to a different as yet unreached staring point and then to move from that point. The propulsion is thus from a new starting point in a direction that is different from the one the field previously pursued" (Sternberg, 2003:127.) Marcel Duchamp and other Dadaists' art pieces made provocative statements about the definition of art and set the stage for modern artist to challenge our ideas of what art encompasses (Hartt, 1993.)

2.2.3 Products that merges disparate current paradigms

"The contribution is an attempt to integrate two formerly diverse ways of thinking about phenomena into a single way of thinking about a phenomenon. The propulsion is a combination of two different approaches that are linked together" (Sternberg, 2003:127.) Rob Silvers combines pointillist techniques and photography to creative a new style in art called photo mosaics (Silvers, 1997.)

2.3 The creative process

In terms of mental processes involved in generating creative products, this research deals with four issues: reasoning, problem solving, memory and the origins of ideas. These issues are interrelated but found in different research approaches on creativity including scientific insight, processes involved in forming analogies, information processing, information indexing and retrieval, and processes involved in

problem solving. Creative products may differ, but the processes responsible for varying levels of creativity are the same, and may differ only in degree (Tardif and Sternberg, 1988.)

2.3.1 Reasoning by analogies

Creative persons are particularly adept at generating insights regarding connections between seemingly unrelated issues and forming analogies and explanations (Taylor, 1963.) Creativity occurs whenever the mind can see the relationship between two items in such a way as to generate a third item (Spearman, 1931.) But how do we come by these analogies, these 'third items'; and how are analogies connected to the hypothesis that learning improves the ability to generate creative products? Reasoning by analogy centers on mechanisms of indexing and retrieval of information in memory (Langley and Jones, 1988.) Langley and Jones explain these mechanisms as follows:

> "Reasoning by analogy involves mapping from some existing structure, the *source*, into some new structure, the *target*. One typically begins with an incomplete description of the target [the problem that needs to be solved]. The first step involves retrieving a plausible source from long term memory; this is the *recognition* process. Once a likely source has been identified, one must *evaluate* the analogy to ensure that it is reasonable. Assuming that the mapping is acceptable, one then carries over into short-term memory [working memory], the relevant aspects of the sourced to fill the target description; this is the elaboration stage. Finally, for successful analogies, one may want to store an abstract description in memory to simplify retrieval in future situation; this is the *consolidation* phase (Langley and Jones, 1988:186)

The many references to memory point to the need for research and understanding of memory processes; therefore, memory is discussed as a separate topic. An important aspect of reasoning by analogy is that the retrieval of a suitable analogy may be unconscious, but reasoning or deciding which elements of the matching analogy should be carried over into the to the new schema (which leads to the new idea or the innovative solution to a problem), is a function of conscious mental processes (Langley and Jones, 1988.)

According to Gentners' *structure mapping theory*, the way we choose between useful analogies and poor ones is by noticing the relationships and similarities between two situations (Gentner, 1983); for example, there are similarities between the X12 star system in the Andromeda galaxy and our solar system, but there is a relationship between the solar system and the hydrogen atom (Langley and Jones, 1988.)

Finding analogies can also be described as divergent thinking, which explains the ability to develop information out of what is given by stimulation, or, going off in different directions when faced with a problem (Guilford, 1959.)

2.3.2 Problem solving

It has long been believed by psychologists that research in problem solving will illuminate issues regarding thought processes involved in creative work in art or in science (Wiesberg, 1988.) It is important to note that research in problem solving shows that all attempts to solve problems are firmly based on past experience and the

individuals initiate work on problems based on a match between that problem and their knowledge, through local memory searches (Greeno, 1980.)

Another important point is that components of intelligence underlie problem solving and creativity (Sternberg, 1985.) The intellectual components that Sternberg refers to are called higher-order executive processes or metacomponents and knowledge-acquisition components. Knowledge-acquisition components include selective encoding (fitting out relevant from irrelevant information), selective combination (synthesizing what might originally seem to be isolated pieces of information into a unified whole that may not resemble its parts), and selective comparison (relating newly acquired information to information acquired in the past) (Davidson and Sternberg, 1984.) Metacomponents of the intellect are sometimes called legislative metacomponents because they legislate what one is going to do (Sternberg, 1985.) It includes recognizing the existence of a problem, problem definition, and formulation of strategy and mental representations for problem solution.

2.3.2.1 Recognizing the existence of a problem

Creative individuals are intelligent problem finders and look for problems that are important in their potential consequences, potentially soluble, at least to some meaningful degree, and are large in scope (Getzels and Csikszentmihalyi, 1976.) They know a good problem when they see one and they might be characterized as having "good taste" in problem (Zuckerman, 1983.) The one train that seems to prevail amongst all creative people is what appears to be an almost aesthetic ability to

recognize ‘good’ problems in their field and apply themselves to these problems while ignoring others (Walberg, 1969.) Sternberg shows that the selection of experiments which played a classic role in the history of psychology was far more important than their problem solutions, which were often contradictory (Sternberg, 1988.)

2.3.2.2 Problem definition

Problem definition requires the structuring of the problem in a away that makes the problem both meaningful and soluble (Sternberg, 1988.) Structuring a problem statement in a certain way, one could find what research on the problem should measure and how it differs from what the research actually measures (Sternberg, 1988.)

2.3.2.3 Formulation of a strategy and mental representation for problem solution

Sternberg relates a story of his own weak performance on spatial visualization tests which improved substantially once he realized that most spatial visualization problems could be solved verbally rather that spatially (Sternberg, 1988.)

2.2.3 Memory

In researching processes involved in scientific insight, Langley and Jones states that insight is a memory-based phenomenon (Langley and Jones, 1988.) They further state that insight is a form of reasoning by analogy, requiring indexing knowledge structures in long-term memory in ways that allow retrieval, when this knowledge is needed to construct an analogy. The most important indexing scheme for analogical retrieval centers on behavioral descriptions or envisionments (Langley and Jones, 1988.) The concept of envisionments was developed by Forbes (1984, 1986) in what he

calls *qualitative process theory* and results from visualizing physical systems, its qualitative qualities and its effects.

This theory that resulted from research in qualitative physics, notes that people often reason about physical processes in a qualitative manner (Langley and Jones, 1988.) One creates an envisionment of all possible qualitative states that the system can enter into, along with the order relations between those states (Forbes, 1984.) Each state contains only qualitative information of the qualities of a physical system; for example, water that heats up in a closed container can either heat up to a non-boiling temperature, or some water may turn into steam, or enough water may turn into steam to create enough pressure to cause an explosion (Forbes, 1984.)

The envisionment which is stored in long-term memory as a scheme, or structure, represents the physical system observed, its qualitative qualities, and its effects; and the entire structure is indexed by all the characteristics of the envisionment (Forbes, 1984.) Simon calls schemas which are indexed according to the features of their envisionment "chunks" and explains them as 'found regularities in a domain, formed due to sufficient experience to cause familiarity with its elements and regularities (Simon, 1977.)

Many schemas are stored in long-term memory (Simon, 1977.) According to Quillian (1986), memory becomes a large semantic network consisting of nodes connected by labeled links. He explains that some nodes correspond to general concepts such as 'water' and that they may be activated by interaction with the environment

(Quillian, 1986.) As a new symbol (for example water in a pot on a stove) enters short term memory, activation spreads out from this symbol through the semantic network, causing complimentary nodes (or the indexed features of an envisionment) from long-term memory to enter short-term, or working memory. This process is called spreading activation (Langley and Jones, 1988.)

2.3.4 Origins of thoughts

New forms do not come from nothing, not for us humans at any rate; they come from prior forms, through mutations, whether unsought or invited (Baron, 1988.) In order to understand creativity, we need to understand the mental processes of the intellect that underlie it (Taylor, 1988:132.) Hadamard's (1949) theory of scientific insight discusses the phenomenon of insight and identifies four stages that seem to occur in every documented case of scientific insight: preparation; incubation; illumination; and verification.

2.3.4.1 Preparation

The preparation stage involves intense effort in attempting to solve a given problem and it involves conscious thought through indexing the problem into memory (Hadamard, 1949.) The problem is indexed as an envisionment into long term memory (Taylor, 1988.) As we have seen during our discussion on memory, many schemas (knowledge of many physical situations) are already stored in long term memory. All these schemas are also indexed according to all the different features of their

envisionment (Simon, 1977); therefore, knowledge and experience precedes this phase, or ties in with it (Langley and Jones, 2003.)

Research done in order to solve a problem becomes part of this preparation stage but more intensified attention given to information increase the 'trace strength' of the schema in long term memory, which will increase the possibility for retrieval into short-term or working memory (Langley and Jones, 1988.) The key to inventing creative explanations lies in intelligently indexing information during the preparation stage; meaning the intensity of awareness when researching a problem (Shank, 1988.) This may be because the more components that are indexed, the greater the choice of retrieval possibilities and a bigger scope for analogous connections.

2.3.4.2 Incubation

The incubation stage is occurs during unconscious thought where the unconscious generates combinations of ideas that are specific enough to be fruitful and yet general enough not to miss the solution (Hadamard, 1949.) Gestalt psychologists argue that schemas transform in memory; the process requires the recognition of patterns, and the genesis, spontaneously sought, of one pattern from another (Baron, 1988.)

Envisionments undergo changes as a scene undergoes changes in memory, retaining the transformed gestalt features rather than the more elementary or component features of the original stimulus pattern (Baron, 1988.) According to Hadamard, the duration of the incubation stage can vary widely, because the problem solver must wait

for an appropriate cue to appear; it might be readily available, or it might take weeks or months to present itself (Langley and Jones, 1988:197.)

Developments in cognitive psychology, however, suggests that a search for idea combinations is not carried out by unconscious mechanisms but is a process of information indexing and retrieval, and is therefore memory based (Simon, 1977; Ohlsson, 1984.) Langley and Jones propose that no significant processes occur during the incubation period except the waiting for a cue to retrieve indexed information (Langley and Jones, 1988.)

However, several theorists agree that insight is a form of reasoning by analogy, and that these are pictorial, similar to the picture or 'envisionments' used to store information in memory (Dreistadt, 1969; Winston, 1980; Carbonell, 1986; Gentner, 1983.) What happens after the preparation stage is simply a process of retrieval that occurs because of spreading activation; this is called the illumination stage (Langley and Jones, 1988.)

2.3.4.3 Illumination

Winston's theory of analogy compares all possible mappings between the source (or problem envisionments) and the target (schemas in memory), and then evaluates them according to their degree of match (Winston, 1980.) When new symbols enter short term memory, activation spread out from these symbols through the semantic network causing portions of schemas – or nodes - to enter short tem memory (Anderson 1983)

These nodes, connected by labeled links may be activated by interaction with the environment and the activation spreads out from the source nodes in parallel concentric rings in memory (Quillian, 1968.) An appropriate cue from the environment can activate many different nodes to enter short term or working memory and thus an analogy is found with the existing situation (Langley and Jones, 1988.) An appropriate cue can quite possibly already exist in your mind and does not necessarily need an external experience to bring forth the corresponding analogy that brings about the solution to the problem (Langley and Jones, 1988.) Langley and Jones further postulates that cues can come in a dreams or day dreams where free association is commonplace:

> "There is no inherent reason why the retrieval cues must be external; they might also be internally generated during periods of free association, and this is exactly what dreams provide. But because the chains [connecting schemas in memory] occurring in dreams are semi random, they provide little more direction than chance external cues. Thus, dreams cues may be delayed as long as those based on interaction with the environment" (Langley and Jones, 1988:198.)

The retrieval process is unconscious because the problem solver is not aware of the mental processes involved in information transfer between long term and short term memory (retrieval); however, spreading activation, and choosing between appropriate or valuable analogies are processes of conscious thought (Langley and Jones, 1988.) Langley and Jones also notes that spreading activation may produce 'false insights', because the process responsible for retrieval is not very selective; in many cases it will

propose analogies that will not carry through when examined more closely (Langley and Jones, 1988.) The following quote explains the difference between indexing and retrieval in everyday life, and that of creative insights:

> "…the rarity of such events follows naturally from the notion that activation occurs at different levels. In normal situations, we retrieve relevant schemas and deposit them in short-term memory, but at a relatively low level of activation. In true cases of insight, the retrieved schema has been stored so strongly that when finally retrieved, it receives a major influx of activation. If we assume limited amounts of such activation, then the retrieved schema effectively becomes the center of attention, flushing all other structures almost instantaneously. This rapid reorganization of the contents of short-term memory gives us the "Aha" feeling we associate with true illumination (Langley and Jones, 1988:196.)

In order to understand the process better, the following quote explains by example how this process may play out:

> "Assume that the scientist already has stored knowledge of many physical situations as schemas in long term memory and that he has indexed these situations through features of their envisionment. Now the scientist encounters a new situation and constructs an envisionment from his observation. Presumably, human memory contains thousands of such schemas, many having features in common with the new situation. But if we assume that activation is divided proportionally according the trace strengths, then well stored schemas will be greatly preferred and schemas that have been given significant attention in the past – during the preparation stage – will have very high trace strengths" (Langley and Jones, 1988:195.)

2.3.4.4 Verification

Generative abilities may be unconscious, based on tacit criteria and long term memory, but creators must rely on critical judgment to create works of imagination (Johnson-Laird, 1988.) In the verification stage, only certain characteristics of the source (for example, portions of a search tree in long term memory) are carried over to the target (dumped into short term memory) if an analogous derivation is held for that target (Carbonell, 1986.) Carbonell refers to schemas in long term memory as 'source' and creative products as 'target'. Even after potential schemas have been recognized and evaluated, the mapping must still be elaborated to formulate the analogy (Hall, 1986.)

In Gentner's structure mapping theory, higher-level predicates determine which structures will be elaborated and which will be ignored. This elaboration process in the verification stage is quite selective in order to form an analogy (Langley and Jones, 1988.) In summary, this research argues that novel thoughts and creative ideas are a result in part from unconscious processes (information retrieval from long term memory), but mostly from conscious processes of information indexing and metacognition in elaboration of retrieved memories, or schemes to create analogies.

2.3.4.5 Too much knowledge

It seems that too much knowledge of a domain can deter creativity. Taylor says that accumulation of past knowledge by a person certainly provides no assurance that such a person will be a producer of new knowledge beyond that which is known (Taylor,

1964.) Past knowledge can be learned and retained with such great force that a person might be unlikely to stretch out beyond that knowledge into the unknown or even break away from that knowledge to revise it or to produce future knowledge that has not yet been produced (Taylor, 1988.) Taylor goes on to say that:

> "Knowledge seems to play a role in creativity; in particular, it is impossible to have novel ideas about something if one knows nothing about it. One needs knowledge to extend from in order to see how to apply or extend it creatively. At the same time, too much knowledge can be (although need not be) a dangerous thing. One can become so entrenched in set ways of seeing issues and problems that one is unable to go beyond the existing paradigms and points of view. Thus, often the most creative work in a given area is done by people who are relatively new to a field and who know a fair amount about the field, but not much." (Taylor, 2003: 137)

2.4 The creative person

"Creativity requires working with the world of ideas, and this work is almost always, at least in part, a solitary process. Some gain from interaction with others, and they benefit if they work well with others, but at some point along the way some solitary endeavor is needed" (Sternberg, 1988:142.) There exists a conflict in creative persons between tendencies towards social integration and being socially withdrawn (Tardif and Sternberg, 1988.) For example, creative persons seem to have a need to maintain distance from their peers, avoid interpersonal contact, and resist societal demands but they desire attention, praise, and support (Amabile, 1983.)

Even though they tend towards social isolation, they are courageous, emotionally expressive and sensitive to the needs of others with a drive for accomplishment and recognition (Torrance, 1988; Walberg, 1988.) Three areas of research emerge with regards to the creative person: personality, intelligence and motivation.

2.4.1 Personality

Sternberg has compiled a list of personality attributes which are more conducive to creative performance (Sternberg, 1988:144):

- Tolerance of ambiguity
- Willingness to surmount obstacles (creative person persevere in the face of criticism and failure)
- Willingness to grow
- Intrinsic motivation
- Moderate risk taking
- Desire for recognition
- Willingness to work for recognition

According to tests performed by the same author (Sternberg, 1985) there are six basic elements found in the personalities of creative persons. These elements are:

- Lack of conventionality (one makes up rules as one goes along; has a free spirit; is unorthodox)

- Integration and intellectuality (makes connections and distinctions between ideas and things; has the ability to recognize similarities and differences; is able to put old information and theories together in new ways)
- Aesthetic taste and imagination (has an appreciation of art, music, and the like; can write, draw, compose music; has good taste)
- Decisional skills and flexibility (Follows gut feelings in making decisions after weighing the pros and cons; has the ability to change direction and use another procedure)
- Perspicacity (questions social norms, truisms, assumptions; is willing to take a stand)
- Drive for accomplishment and recognition (is motivated by goals, is energetic; likes to be complimented)

Apart from all other personality characteristics and traits, Amabile believes that a love for what one is doing makes all personality characteristics of the creative person possible, and that talent, personality or cognitive abilities without a 'labor of love' is not enough (Amabile, 1986.)

Roe concluded from extensive interview with 64 eminent scientists that 'driving absorption in their work' characterizes them all (Roe, 1952.) She goes on to say that the drive to create obliges competing drives to assume subsidiary roles, thereby inducing a distinctive motivational profile (Roe, 1952.)

Scientists with a high level of creativity tend to be "schizothymic" (withdrawn and internally preoccupied) and "desurgent" (introspective, restrained, brooding, and solemn) (Cattell, 1963), and avoid interpersonal contact, social affairs, administrative responsibilities, and political activities (Helmreich, Spence, Beane, Lucker, and Matthews, 1980.)

2.4.2 Intelligence

Sternberg's theory of successful intelligence says that people are successfully intelligent to the extent that they have the abilities needed to succeed in life, according to their own definition of success within their socio-cultural context. They succeed by adapting to, shaping, and selecting environments and by recognizing and then compensating for, or correcting their weaknesses (Sternberg, 2003.)

Apart from psychological theories of intelligence, there also exists a biological theory of intelligence that is based on the speed of neurological conduction, or nerve conducting velocity (Vernon and Mori, 1992), but that approach to intelligence and creativity lies outside the scope of this research.

2.4.2.1 Components of intelligence

When components of intelligence are applied to fairly abstract but familiar kinds of tasks, they are used analytically; when they involve novel tasks, they are used creatively; and when they are involved in adapting to, shaping of, and selecting of environments, they are used practically (Sternberg, 2003.)

Intelligence is therefore at the base of mental all operations. The components of intelligence include metacomponents, performance components, and knowledge-acquisition and are described as follows:

> "*Metacomponents*, or executive processes, plan what to do, monitor the plans as they are being carried out, and evaluate them after they are done. Examples of metacomponents are recognizing the existence of a problem, defining the nature of the problem, monitoring the solution of the problem, and evaluating the solution after the problem is solved. *Performance components* execute the instructions of the metacomponents. For example, inference is used to decide how two stimuli are related and application is used to apply what one has inferred. Other examples of performance components are comparison of stimuli, justification of a given response as adequate although not ideal, and actually making the response. *Knowledge-acquisition components* are used to learn how to solve problems or simply to acquire declarative knowledge in the first place. Selective encoding is used to decide what information is relevant in the context of one's learning. Selective comparison is used to bring old information to bear on new problems. And selective combination is used to put together the selectively encoded and compared information into a single and sometimes insightful solution to a problem. Although the same processes are used for all three aspects of intelligence universally, these processes are applied to different kinds of tasks and situations depending on whether a given problem requires analytical thinking, creative thinking, practical thinking, or a combination of these kinds of thinking" (Sternberg, 2003: 44.)

2.4.2.2 Intellectual styles

An intellectual style is the manner, or style, with which one directs one's intelligence (Sternberg, 1988.) It refers to intellectual functioning which is a form of mental self-government and can be characterized in terms of five major aspects:

- Functions of mental self-government (legislative, executive, judicial);
- Forms of mental self-government (monarchic, hierarchic, oligarchic, anarchic);
- Levels of mental self government (global, local);
- Scope of mental self-government (internal, external), and
- Learning style (conservative, progressive)

For a description of each style, see Appendix A. Sternberg argues that an internal scope of self-government as well as a progressive learning style is common personality traits of creative persons (Sternberg, 1988.)

2.4.2.3 Motivation

The creative person can be motivated in different ways. First, there is achievement motivation, where one is motivated by moderate challenges and risks; such creative persons are trying to better themselves and their accomplishments, but choose tasks that is neither too easy nor too hard (McClelland, 1985.) Second, competence can be a motivator to the extent that creative persons try to solve difficult tasks in their domains because of their self-efficacy, or beliefs in their own ability to solve the

problem at hand (Bandura, 1977.) Self-efficacy may result from intrinsic and extrinsic rewards (Sternberg and Lubart, 1996.)

Motivation can increase one's level of expertise because it drives the metacognitive skills, which in turn activate learning and thinking skills, which can provide feedback to the metacognitive skills (Sternberg, 2003.) Sternberg makes a list of motivational characteristics to help recognize creative individuals (Sternberg, 1988.) The list includes the following:

- Willingness to confront hostility and take intellectual risks
- A proclivity to curiosity and inquisitiveness
- Being open to new experiences and growth
- A driving absorption
- Discipline and commitment to own one's work
- High intrinsic motivation
- Being task orientated
- A certain freedom of spirit that rejects limits imposed by others
- A high degree of self organization such that these individuals set their own rules rather that follow those of others.
- A need for competence in meeting optimal challenges

By far the most interesting comment regarding motivation is made by Sternberg (2003) when he says that creativity is a decision. He says that motivation is not inherent in a person and one must decide to be motivated by one thing or another; one must

decide to be willing and able to think in unconventional ways, or one must decide to think in different ways as one is accustomed to and with which one feels comfortable (Sternberg, 2003.)

2.5 The creative environment

2.5.1 Domain

"The only way to establish whether or not something is creative is through comparison, evaluation, and interpretation" (Csikszentmihalyi, 1988:332.) Csikszentmihalyi elaborates on this statement by saying that it is the field or domain that selects which creative products are to be incorporated into the domain. Therefore, any attribution of creativity must be relative, grounded in social agreement and from this it follows that social agreements is one of the constitutive aspects of creativity, without which the phenomenon would not exist (Csikszentmihalyi, 1988.)

Domain specificity is also a major consideration when describing creative persons because existing knowledge is a base to create new ideas, and creative products may result from creative persons finding gaps in the domain knowledge (Sternberg and Tardif, 2003.) Csikszentmihalyi says that "…information that will go into an idea existed long before that creative person arrived on the scene. It had been stored in the symbol system of the culture, in the customary practices, the language, and the specific notation of the "domain". A person who has no access to this information will not be able to make a creative contribution, no matter how skilled the person is other wise" (Csikszentmihalyi, 1988: 330.)

Csikszentmihalyi goes on to say that the more precise the notation system [of the domain] the easier it is to detect change and hence to evaluate whether a person has made an original contribution. The structure of the domain is therefore important (Csikszentmihalyi, 1988.) Dawkins coined the term 'meme' to refer to a 'unit of information' that is transmitted from one generation to the next (Dawkins, 1976.) A meme could be a tool like a stone axe, a formula for smelting copper, the concept of democracy – in short, any structured information that could be remembered and is worth passing through time (Dawkins, 1976.) This extra somatic coding of information is the driving force behind the evolution of a culture and a domain (Csikszentmihalyi, 1988.)

Occasionally, great creative reformations appear to take place outside all constituted fields, but without people in neighboring fields who become attracted to the new idea, the creative process will be aborted; for example, in the case of the Wright Brothers, it was automobile and bicycle mechanics and Freud's first followers were other medical men" (Csikszentmihalyi, 1988.)

2.5.2 Social institution

Without the resources of the larger society in which the creative product is generated, creativity would be very limited; for example, disposable wealth is one of the conditions that make the selection of novelty possible (Csikszentmihalyi, 1978) In addition, it takes disposable attention (people who in addition to being wealthy have to take an interest in the domain) (Csikszentmihalyi, 1978.) However, evidence exists that

performing a task for money significantly decreases subjects' intrinsic motivation for that activity (Pritchard, Campbell, and Campbell, 1977.) Even so, every field is embedded in a specific social system and the resources of the larger society help support the recognition of new ideas" (Csikszentmihalyi, 1988.)

2.5.3 Individual

The creative person has already been discussed at length. However, it is important to note that the society and culture in which a creative person operates, and in which he grew up will influence his/her creative output. Apart from personality types, cognition and intelligence, the developmental history of the creative person also has an influence on creative ability (Sternberg, 1988.) Sternberg lists these influences as follows:

- Being first born
- Having survived the loss of one/both parents in early childhood
- Experiencing unusual situations
- Being reared in a diversified, enriching, and stimulating environment
- Being exposed to a wide range of ideas
- Demographic characteristics of childhood
- Education
- Having a future career image
- Having definite role models, mentors and patrons while in training
- Sustained effort through life (development) and thus enjoy enduring reputation

- Intense preparation in the field

2.5.1 Summary

Generating creative products depends on three main shaping forces: a set of social institutions -or field- that selects from the variations produced by individuals those that are worth preserving; a stable cultural domain that will preserve and transmit the selected new ideal or forms to the following generations; and finally the individual, who brings about some change in the domain, a change that the field will consider to be creative (Csikszentmihalyi, 1988.)

In a field like music, the structure of the domain is extensive and includes sheet music, recordings, live performance, education (one-on-one lessons, primary, secondary, and tertiary education), ethnomusicology, history, theory and the like. With such a precise 'notations system' it is easy to detect change and evaluate if a person has made an original contribution or not.

The field of landscape architecture, by contrast, is fairly new and much debate still surrounds the validity and creativity of its products. It may therefore be less easy to determine true contributions and the responsibility falls largely on the educational system of landscape architecture to better define and standardize the notational system of the field. What can a domain do to encourage creative contributions in that domain? Sternberg provides a list of elements that can influence creativity in a domain (Sternberg, 1988.)

- Availability of general contributions and resources to individuals.

- Education and employment opportunities
- A wealthy society
- Background knowledge of the domain
- Access to cues for insights
- Good teachers
- Roles, norms, and precedents
- Peers to confirm and evaluate creativity in the field
- Stimulation and sustenance of creative processes
- Methods of reservation and selection of new ideas in the domain
- Precision in notational systems – so it is easy to agree amongst experts what is going to be defined as creative.

2.6 Conclusion

This chapter discussed the creative product, the creative process, the creative person, and the creative environment. We learned that the mental processes, the personality type and a nurturing and receptive environment are all necessary for creativity to occur. We also discovered that we need to judge creativity according to a specific domain, and that the domain itself determines whether a contribution is creative or not. Therefore, knowledge of a domain plays a vital role in creativity.

Sternberg (1988) concludes that it is impossible to have novel ideas about something if one knows nothing about it. But it can also inhibit creativity. One can become so entrenched in set ways of seeing issues and problems that one is unable to go

beyond the existing paradigms and points of view (Sternberg, 1988.) Research done by Taylor shows that past knowledge can be learned and retained with such force that a person might be unlikely to stretch out beyond that knowledge to the unknown or even break away from that knowledge to revise it or to produce future knowledge that has not yet been produced (Taylor, 1988.) Sternberg goes so far as to say that the most creative work in a given area is done by people who are relatively new to a field and who know a fair amount about the field, but not too much (Sternberg, 1988.)

It is also important to note that experience and knowledge goes hand-in-hand. Shank's model of dynamic memory explains that experience constantly changes mental structures and that understanding requires an active memory (Shank, 1988.) Knowledge based on ossified experiences and novel experiences unmerged with other events becomes a reference point for interpreting new events (Shank, 1988.) Taylor, however, postulates that accumulation of past knowledge by a person provides no assurance that such a person will be a producer of new knowledge beyond that which is known (Taylor, 1964.)

These conflicting statements about knowledge challenge the hypothesis that learning (academic and tacit knowledge acquisition) contributes to the ability of landscape architects to generate creative products. On the one hand one needs a certain amount of knowledge of a domain as a starting point for creative processes, but too much knowledge may prevent creative flow.

It seems, therefore, valuable to test the creative abilities outside of the domain and compare it with creative abilities that are domain related. Since the mental processes involved in creativity are assumed to be similar for all domains (based on the literature review), it will be possible to test creative ability purely from a cognitive perspective. To test whether learning improves landscape architect's abilities to generate novel products, we need a testing instrument that test the creative use of skills that pertain to the domain using criteria for that domain.

The next chapter will focus on creativity tests in general and then on tests that pertains to the field of landscape architecture specifically. Based on that research, the thesis will propose a test that incorporates skills used by landscape architects, as well as cognitive processes that are generally involved in creativity.

CHAPTER 3

TESTING CREATIVITY

3.1 Introduction

The previous chapter discussed the complexity of creativity by investigating the creative product, the creative process, the creative person and the creative environment. The literature suggests that an interactivity exists between these four elements and they all influence creativity (Taylor, 1988.) In testing creativity or creative processes, it stands to reason that all four elements need to be considered.

In a test developed to identify creative engineers and their occupation potential, called the Purdue test (Lawshe and Harris, 1960), it was found that the test was moderately correlated with other general creativity measures: Creative Personality Scale (CPS); Creativity Temperament Scale (CTS); and Cognitive Risk Tolerance Scale (CRT) (Charyton, Jagacinski, and Merrill, 2008.)

In another study to assess creativity in engineering design the authors developed a theoretical rationale of constructs necessary for the creative design process and for the selection of instruments to assess creativity in engineering design. Apart from tests for creative personality, creative temperament and cognitive risk tolerance, they included their own test called the Creative Engineering Design Assessment (CEDA) (Charyton, Jagacinski, and Merrill, 2008.) The theoretical rationale they used, shown in figure 1, is

based on previous studies that assess creativity as defined by the person, process, product, and environment (Charyton, Jagacinski, and Merrill, 2008.)

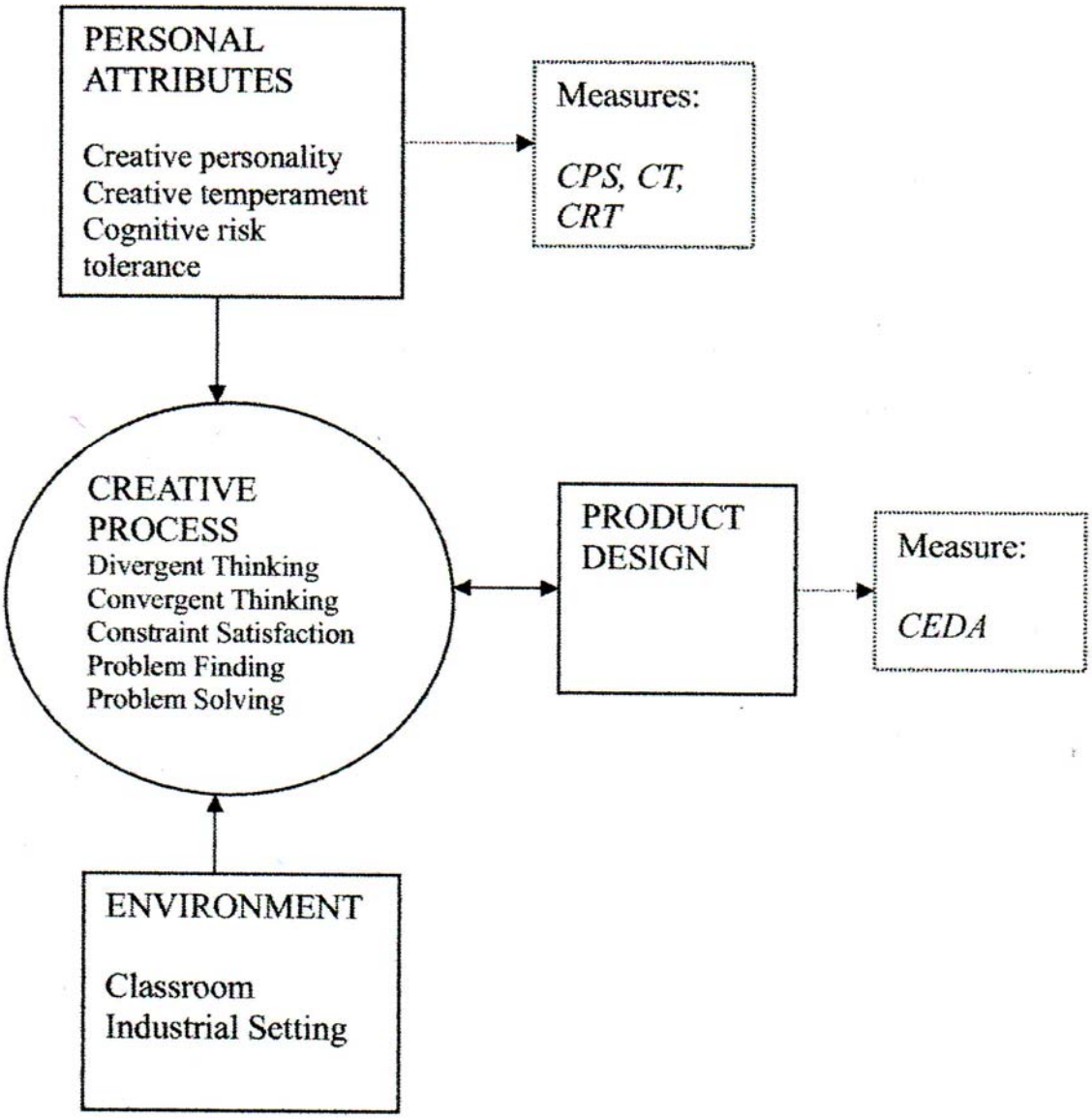


Figure 1. Conceptualization of measures addressing creative mechanisms in engineering design

The test they developed is of particular interest in developing a testing instrument for creativity in landscape architecture because Charyton, Jagacinski, and Merrill define the creative process as "…using divergent thinking, convergent thinking, constraints satisfaction, problem solving and problem finding to create a design" (Charyton, Jagacinski, and Merrill, 2008:149), and this is exactly what the CEDA tests. The processes involved in engineering design seems to be similar to processes involved landscape design; both require divergent thinking, convergent thinking, constrain satisfaction, problem solving and problem finding. CEDA can therefore be adapted effectively to test creative design abilities for landscape architects.

In terms of intelligence testing and its relationship to cognitive processes of intelligence and creativity, this thesis follows the 'threshold theory' that suggests that there is a minimum level of intelligence below which a person cannot be creative, and that intelligence is therefore necessary, but not sufficient, for creative achievement (Runco, 2007.) This thesis accepts that any creative output on a test also implies a minimum intelligence threshold and therefore does not include tests on intelligence into the research.

3.2 Convergent and divergent creativity

This thesis focuses on cognitive style research. Cognitive style research is based on the notion that creativity happens when one explores options while solving problems (Nielsen, Pickett and Simonton, 2008.) An example of this kind of test is the Torrance Incubation Model which emphasizes the importance of looking at a task from a variety

of different angles in order to increase the potential for a creative solution (Torrance, 1979.) A problem can be defined as a situation with a goal and an obstacle (Runco, 2007.) Guilford believes that all problem solving is creative (Guilford, 1967.) Cognitive processes involved in problem solving involve convergent thinking as well as divergent thinking, which may be seen as two ends of a continuum (Runco, 2007.)

Divergent thinking occurs when an individual is faced with a problem that required open ended tasks (Runco, 2007.) Convergent thinking requires retrieval from memory a single correct response, while divergent thinking leads and individual to numerous and varied correct responses (Runco, 2007.) The open ended tasks in divergent thinking tests give and individual the opportunity to produce original answers (Runco, 2007.) Many theories of creative cognition focus on associative processes, or, how ideas are generated and chained together. The reason for this is that original ideas tend to be remote, and are usually only found after the most obvious ideas are depleted (Mednick, 1962.) Creativity tests should therefore require numerous responses. Numerous responses to convergent task questions can by tested by finding remote associations to objects or concepts, or through insight questions (Runco, 2007). Finding multiple uses and for objects, as well as their various attributes, provide numerous responses through divergent thinking tasks (Guilford, 1967.)

Divergent tasks also tests reasoning by analogy, metaphors, remote associations and envisionment transformations in memory. The following section gives examples of creativity tests which uses convergent and divergent tasks.

3.3 Test Examples

3.3.1 Nielson, Pickett and Simonton's test for conceptual and experimental creativity

Nielson, Pickett, and Simonton developed a convergent and divergent thinking test for research on assessing whether conceptual or experimental creativity works best on convergent or divergent tasks (Nielson, Pickett, and Simonton, 2007.) Although their hypothesis is unrelated to assessing creativity in the design professions, their test is appropriate for quantifying convergent and divergent thought processes.

For convergent tasks they used remote association tasks and insight problem tasks (Nielson, Pickett, and Simonton, 2007.) The remote association tasks were taken directly from Bowden and Beeman (2003) and were coded for (a) number of correct answers, and (b) time to complete (Nielson, Pickett, and Simonton, 2007.)

They also included verbal insight problems including the "unseen walker" (Sloan, 1992, p.11), "twins" (Dow and Mayer, 2004), "light" (a lateral thinking problem), and "man" (a lateral thinking problem).

For divergent tasks, they included multiple use tasks (paperclip and rubber band) and attribute tasks (blue and wheels) (Runco, 1999.) These tasks were coded by total number of answers, and (b) likely original answers by eliminating all duplicate answers (Runco, 1999.) Table 1 show the convergent thinking tests and table 2 show the divergent thinking test.

3.3.2 Barron's Symbolic Equivalent test

This test by Frank Barron measures the ability to make original and apt transformations of a given image, received in words and expressed in words (Barron, 1988.) The transformations is a process whereby a standard stimulus images is changed by design into a non-literal or symbolic image that is recognizably another version of the original images (Barron, 1988.) Barron developed this test because he believes that the ability to change things – to transform images in one's mind – is central to the creative process (Barron, 1988.) In the test, respondents are instructed to make up three possible equivalents to the following images: a candle burning low; a ship lost in fog; a floating feather; the increasing loud and steady sound of a drum; sitting alone in a dark room, empty book cases; and trees in the middle of a field (Barron, 1988.) The test is then scored with a one (1) for acceptable or admissible, but not original responses, and two (2) for number of original responses. Original responses were further differentiated as to the degree of originality with a score of three (3), four (4), or five (5) (Barron, 1988.) The total score was simply the sum of the ratings of the individual responses. Table 3 shows examples of the Symbolic Equivalent test.

From these examples we can see that, to be admissible, the response must reproduce the main features of the stimulus images, and the further the responses move away from the stimulus (and the more dimensions the response include), higher the creative score is (Barron, 1988.)

3.3.3 Jagacinski and Merrill's Creative Engineering Design Assessment (CEDA) test

The Creative Engineering Design Assessment (CEDA) test comes closest to providing a model of a creative test for landscape architects. There are similarities between engineering design problems and landscape architecture design problems; for example, engineering products emphasize novelty, resolution, elaboration and synthesis (Cropley and Cropley, 2005.) Also, particular to engineering design, is the need for function and utility in a cost-effective manner (Larson, Thomas, and Leviness, 1999.) Engineers uses "functional creativity" (Cropley and Cropley, 2005), and it includes originality, adaptiveness, problem solving and usefulness (Jagacinski and Merrill, 2008.) Another similarity between landscape architects and engineers is expressed by Jagacinski and Merrill with their finding that engineers may increase creative production through understanding their domain-specific constraints. Different types of constraints such as

tasks, goals, subjects, functions materials and rules may be unique to different domains (Stokes, 2005.)

Understanding the constraints of a domain becomes paramount when one considers the findings of Finke, Ward, and Smith which says that the relative number of creative inventions increases significantly the more constrained a task becomes (Finke, Ward, and Smith, 1996.) In order to test divergent thinking for engineers specifically, Lawshe and Harris (1960) developed the Purdue Creativity test which asked

participants to list as many possible uses for one of two shapes provided (Charyton, Jagacinski, and Merrill, 2008.)

Charyton, Jagacinski, and Merrill, however, developed this concept further in the CEDA test by asking engineers to sketch designs that incorporate one or several three-dimensional objects, to list the users (people), and to perform problem finding (generate alternate uses for their designs) as well as problem solving in response to specific functional goals. These open ended questions were scored similar to Torrance and Frazier's (1984) model of divergent thinking tests; they were scored for fluency, flexibility, and originality (Charyton, Jagacinski, and Merrill, 2008.) The test itself is different from the more traditional divergent thinking tests because it relies on domain specific knowledge and therefore includes divergent as well as convergent thinking (Charyton, Jagacinski, and Merrill, 2008.) Table 4 shows the instructions to the CEDA test, and figure 2 gives a sample question of the test.

This test can be adapted for landscape architects by using objects and shapes more common to the profession of landscape architecture, and by asking participants to create designs that will accomplish goals customary for landscape architects. With these adaptations, the CEDA test can be successfully applied to test design creativity for landscape architects.

Table 1. Wording for Convergent Creativity Tasks (Nielson, Pickett, Simonton, 2007)

Term	Type	Wording
Watch	Remote associations	What word are all three of these words related to? Night, wrist, stop
Boat	Remote associations	What word are all three words related to? Show, life, row
Sore	Remote associations	What word are all three of these words related to? Loser, throat, spot
Ice	Remote associations	What word are all three of these words related to? Cream, skate, water
Cheese	Remote associations	What word are all three of these words related to? Cottage, Swiss, cake
Light Light house operator	Insight problems	There once was a man who never left his home, The only time anyone ever visited him was when his food and supplies were delivered, but they never came inside. Then one stormy winter night when an ice gale was blowing, he had a nervous break down. He went upstairs, turned off all the lights and went to bed. Next morning, he had caused the deaths of several hundred people. How? If you have seen this question before, type x

Table 1 - continued

Man Fire man with a nametag on his uniform	Insight problems	Acting on an anonymous phone call, the police raid a house to arrest a suspected murderer. They don't know what he looks like but they know his name is John and he is inside the house. The police burst in on a carpenter, a taxi driver, a mechanic, and a fireman all playing poker. Without hesitation or communication of any kind, they immediately arrest the fireman. How do they know they got their man? If you have seen this question before, write x.
Walker Man walking in the subway tunnels	Insight problems	On a busy Friday afternoon, a man walked several miles across London from Westminster to Knightsbridge without seeing anybody or being seen by anybody. The day was clear and bright. He had perfect eyesight and he looked where he was going. He did not travel by any method of transport other than by foot. London was full of people but not one person saw him. How? If you have seen this question before, type.

Table 1 - continued

Twins Two pets	Insight problems	Marsha and Marjorie were born on the same day of the same moth of the same year to the same mother and the same father, yet they are not twins. How is this possible? If you have seen this question before, write x.

Table 2. Wording of Divergent Creativity Tasks (Runco, 1999)

Term	Type	Wording
Paper clip	Multiple uses	List as many uses for a paperclip as you can think of.
Rubber band	Multiple uses	List as many uses for a rubber band as you can think of.
Blue	Attribute extraction	List as many things that are blue as you can think of.
Wheels	Attribute extraction	List as many things with wheels as you can think of.

Table 3. Wording for the Symbolic Equivalent Test (Barron, 1988)

1. Stimulus images: A candle burning low	
Admissible responses: Life ebbing away A basin of water emptying down a drain The last drops of coffee going through a filter The last pages of a faded book The last hand in a gambler's last card game	 Score 1 Score 2 Score 3 Score 4 Score 5
2. Stimulus image: Empty book case	
Admissible responses: A hollow log An empty sack An abandoned beehive An arsenal without weapons A haunted house	 Score 1 Score 2 Score 3 Score 4 Score 5
3. Stimulus image: Sitting alone in a dark room	

Table 3 - continued

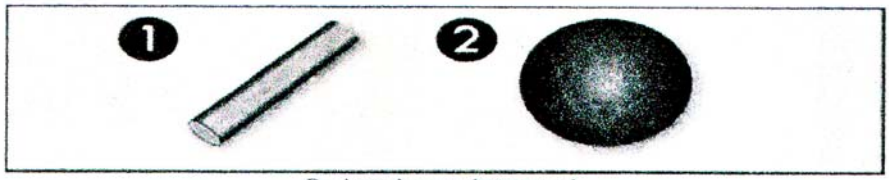
Admissible responses:	
Lying awake at night	Score 1
An unborn child	Score 2
A stone under water	Score 3
A king lying in a coffin	Score 4
Milton (he became blind toward the end of his life)	Score 5

Table 4. Wording for the Creative Engineering Design Assessment Test (Charyton, Jagacinski, and Merrill, 2008)

Instructions
At the top of each page is a set of 2, 3, or 4 figures. Please use one or more of these figures to generate designs that will accomplish the general goal written below them. Generate as many possible designs as you can on each page. They can be solid or hollow and can be manipulated in any manner you wish. You may combine the figures on each page and may draw additional elements as required by your design. However, each figure can only be used once per design. On each page, be sure to : 1. sketch your design 2. Label each design (provide a description) 3. Identify the materials

Table 4 – continued

4. Identify problems that this design may solve 5. Identify the users of each design The total time for this assessment is 25 minutes for 5 pages, or about 5 minutes for each page. You may use your time as you see fit. At least one design should be created per page. Additionally, at least one response should be indicated for each of the five questions of each design. You may use a pen or pencil, whichever you prefer



Designs that produce sound.

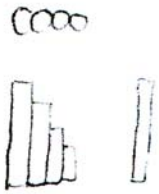
Sketch	1	2	3	4
				
Description	Pan Pipes	Rattle	Bomb	
Materials	Hollow pipes with putty/ stopping material in the bottom	Stick, hollow gourd, pebbles	Hollow metal sphere, TNT, fuse	
Problems solved	Makes sound	Makes sound	Makes big sound	
Users	Satyrs and Fauns	Musicians	Terrorists/ military/ demolition men	

Figure 2. Sample Question from Creative Engineering Design Assessment (Charyton, Jagacinski, and Merrill, 2008.)

3.4 Conclusion

This chapter explored established psychology tests on convergent thinking abilities, divergent thinking abilities, analogous thinking abilities, and creative design abilities. By combining questions of these different tests into a single testing instrument, it becomes possible to gather data concerning the different mental processes involved in generating creative products.

The next chapter discusses the method used for testing the hypothesis of this thesis. It includes the research instruments and the procedures used, as well as the result that were found from the tests. The outcomes is discussed from the standpoint of the validity of the tests and whether these tests can be used as a larger, more elaborate research instrument which can develop empirical data to assess whether a relationship exists between cognitive processes associated with creative genius, and creative design abilities of landscape architects.

CHAPTER 4

METHODS, RESULTS, ANALYSIS

4.1 Introduction

This thesis contributes to the development of a psychological test which can measure creativity for landscape architects. The purpose of the research is to find a relationship between creative design abilities and the cognitive processes of convergent thinking, divergent thinking and analogous thinking. This research tests the hypothesis: if students achieve a high score on a divergent task test, a convergent task test, and an analogous thinking test then they also will get high scores on a creative design assessment test.

Creative design assessment is done through a design-problem question with a series of constraints and requirements. Because this research could find no creativity tests for landscape architects, the design problem question is based on the Creative Engineering Design Assessment (CEDA), discussed in chapter 3. Designing projects in both engineering and landscape architecture are similar to the extent that both fields design for a client, both fields consider specific site requirements, both fields have to design within budget constraints, and both fields design with a solution to a problem in mind.

The differences in the design approach between theses two professions is that engineers focus on functional design only (Nielson, Picket, and Simonton, 2008), and

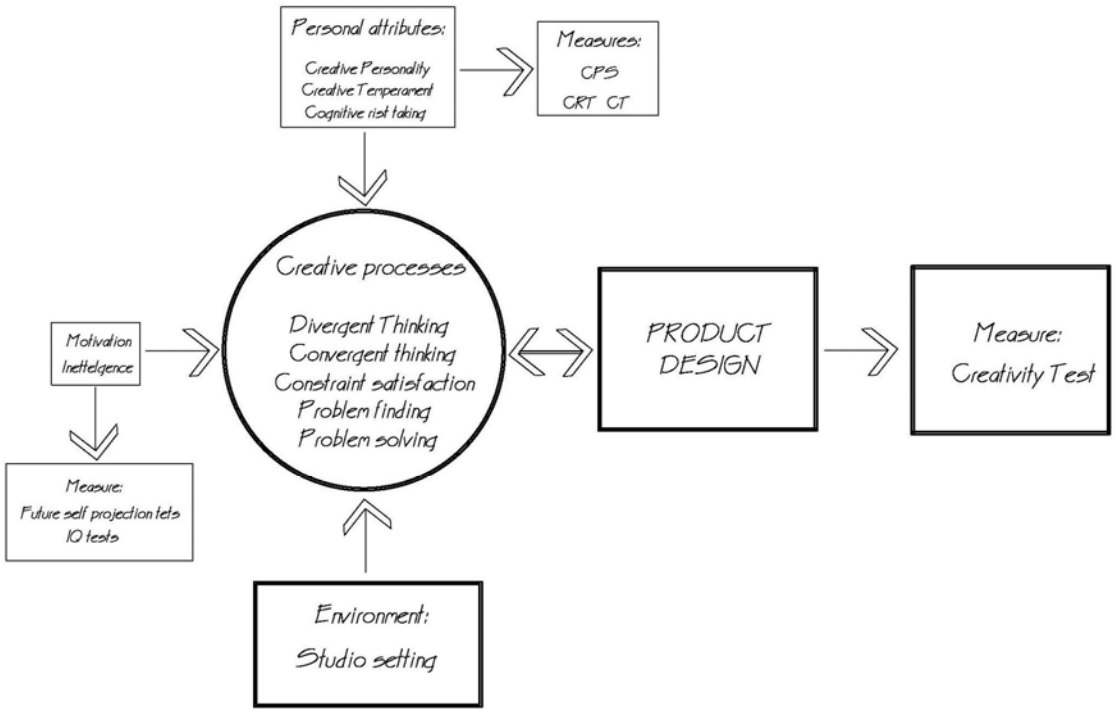


Figure 3. Conceptualizations of measures addressing creative testing in landscape architecture design

landscape architects include an aesthetic dimension (Bourassa, 1991.) Because of the similarities between the two fields, it is argued that it is appropriate to emulate this engineering creativity test for landscape architects. The other questions were chosen because they test the cognitive processes involved in generating creative products discussed in the previous chapters. These questions are from the convergent and divergent task test (assembled from other sources) by Nielsen, Picket, and Simonton (2008), and questions from the symbolic equivalent test by Frank Barron (1988) which

measures analogous thinking abilities. The instructions and scoring methods of these questions are taken from the respective authors of the tests as discussed in chapter 3.

The theoretical rationale for this testing instrument is derived from Charyton, Jagacinski, and Merrill's (2008) model, but does not include tests for intelligence, personality types, thinking styles, cultural differences and gender. The rationale, as shown in bold in figure 3, includes divergent thinking, convergent thinking, constraint satisfaction, problem solving and problem finding.

4.2 Participants

Twenty one (21) students from The University of Texas at Arlington participated in this research. Selection criteria required that participants be enrolled in the Program of Landscape Architecture, be fluent in English, and be over 18 years of age. Participants for this research included students from studio 1, studio 3, and studio 5 in the program in landscape architecture at the University of Texas at Arlington (UTA).

Nine students from studio 5 participated, eight students from studio 3 participated, and four students for studio 1 participated. These were the three studios which were offered during the fall semester of 2008, at the time this thesis was compiled. All the students enrolled in design studios at the time of the test were included.

4.3 Testing Instruments

The creativity test developed for this research consists of four sections. Section A assesses creative design abilities, section B assesses convergent thinking abilities, section C assesses divergent thinking abilities, and section D assesses analogous

thinking abilities. The questions included in this creativity test are taken from the convergent and divergent tasks test used by Nielson, Pickett, and Simonton (2008), the symbolic equivalent test developed by Frank Barron (Barron, 1988), as well as a creative design question adapted from the CEDA test developed by Charyton, Jagacinski, and Merrill (2008.)

4.3.1 Section A: Design problem question

In this test, students are asked to sketch up to six (6) different designs incorporating given forms, for example, a straight line, an arc, a square and a circle. For each design, students have to answer questions and offer a description about their designs.

The introduction to the question includes a list of instructions, and students are able to ask the examiner questions before they start the test. Students are given thirty (30) minutes to complete as many designs as they can, but they are not required to complete more than six (6) designs. The questions in section A was adapted from the Creative Engineering Design Assessment test developed by Nielson, Pickett, and Simonton (2008.)

4.3.2 Section B: Convergent task questions

The convergent task questions require one correct answer per question. Question 1 through 5 assesses remote association. Question 6 through 9 assesses insight. The nine questions used in section B was taken from a creativity test assembled, from other sources, by Nielson, Pickett, and Simonton (Nielson, Pickett, and Simonton 2008.

4.3.3 Section C: Divergent task questions

The divergent task question includes multiple use tasks and attributes extraction tasks. The questions used in section C was taken from a creativity test by Frank Barron (Barron, 1988.)

4.3.4 Section D: Symbolic equivalent questions

The symbolic equivalent questions are divergent-type questions that require the test subject to generate metaphors and analogies from stored images in memory. Although the questions were asked and answered in words, it relied more on images and imaging than the previous divergent task test. Charyton, Jagacinski, and Merrill assembled analogous task questions from a variety of sources (Charyton, Jagacinski, and Merrill, 2008) and three of those questions were used in section D of this creativity test. To see the complete testing instrument, see Appendix B.

4.4 Procedure

Students in the Program of Landscape Architecture at the University of Texas at Arlington were called to a meeting of the student chapter of the American Society of Landscape Architecture (SASLA) during the fall semester of 2008. The students were notified through emails and announcements from the faculty members that they would be asked to participate in a test on creativity for the purposes of research during the meeting. As an incentive, students were provided with pizza and refreshments made available at the beginning of the meeting. During the meeting the students were asked to participate in this research study. Students who agreed to participate took the test in the

same room at the same time. Participants were instructed not to communicate with each other during the test. The test asked participants to note the start and end time of each section of the test.

A large electronic clock was visible to all participants. Participants were asked not to write their names on the tests, but to write which studio they were in. They were also told that the test would not affect their grades or academic progress and that they should view the test as fun and should try to be as creative as possible. Participants were instructed to note the time at the end of each question, and write it down. When participants had completed their tests, they were free to leave the room.

4.5 Scoring

The four sections of the test were scored independently. Averages were calculated through 'least-square regressions' using the Pearson Correlation Coefficient (r). The scoring for section A, B, C, and D were as follows:

Section A: Scoring was based on fluency (number of responses), flexibility (number of response categories defined as variety of responses, or number of category types), and originality (novelty). Fluency was given a score for number of responses: 1 (per design); 1 (per description provided); 1 (per materials description); 1 (per problems solved description); 1 (per users identified). Scoring of the test and weighing of the individual responses was based on the scoring and weighing methods developed by Guilford (1984) to assess creativity of figural creative feedback. The total was the sum of the items, with a maximum score of 5 points per design. Flexibility was given a

scored for number of responses: 1 (per designs); 1 (per description provided); 1 (per materials description); 1 (per problems solved description); 1 (per users identified). The total was the sum of the items, with a maximum score of 5 points per design. Originality was given a qualitative number assigned to the entire design. The following rubric with a quantitative number, paired with a qualitative description was used: 0 - dull; 1 – commonplace; 2 – somewhat interesting; 3 – interesting; 4 – very interesting; 5 – unique and different; 6 – insightful; 7 – exceptional; 8 – valuable to the field; 9 – innovative; 10 – genius. The totals were calculated as follows:

(a) Average raw score per design = ∑ totals {flu (0-5)+flex(0-5)+orig.(0-10)}/ # designs

(b) Section A total average score = average raw score per design/time ratio

Section B: Nine (9) questions were scored for (a) number of correct responses (using 0-1 dummy scoring) and (b) time to complete. The totals were calculated as follows:

(a) Average raw score = remote associations ∑ totals {(0-5) + insight (0-4)}

(b) Section B total average score = average raw score/time ratio

Section C: Four (4) questions multiple task and attribute task questions were coded for (a) number of admissible responses and (b) time to complete. The totals were calculated as follows:

(a) Average raw score = ∑ responses (0-< per response)

(b) Section C total average score = average raw score/time ratio

Section D: Three (3) symbolic equivalent questions were scored for each response as follows: 1 point for an acceptable response (meaning, the response was recognizably a different version of the stimulus image); 2 – 3 points of a creative response; 4 – 5 points for responses with an added dimensions to the response. The totals were calculated as follows:

(a) Average raw score = ∑ responses (0-5 per response)

(b) Section D total average score = average raw score/time ratio

4.6 Results

The responses in the four different sections showed a great variety of test results. Participant's scores ranged from very high scores on some parts of the test, to very low scores on other parts. From all the tests that were scored, only one participant (participant '6' from studio 5) achieved a high score for all the sections of the test.

The most accurate interpretation for creative design abilities was found in the originality score in section A because the question asked participants to sketch a design. The number of designs was factored into the average originality score, since more designs could potentially generate a higher originality score. In general, students from studio 5 achieved higher scores for originality of their designs than participants from studio 3 or studio 1. The lowest creativity score was achieved by participant '17' who only received 3 points for four designs. The highest creativity score was achieved by participant '6' who accumulated 31 points for 6 designs (at least 5 points per design).

In section B, C, and D, the scores were influenced by the time it took to complete the questions. The best score was from participant '17' who took 7 minutes to achieve 8 points out of 9 possible points. This participant, however, achieved the lowest creativity score. The more time participants spent on these sections, the higher their scores were.

From the cognitive task questions, more participants received high scores for the divergent task questions (section C) than from the convergent task questions or the analogous task questions. However, most participants who excelled in section C did so for section B, and section D also.

Table 5. Raw Scores of the Testing Instrument

	TEST SCORES											
Paricipant	designs	fluency	flexibility	originality	Section A	time	Section B	time	Section C	time	Section D	time
Studio 5, 1	3.00	12.00	12.00	20.00	44.00	35.00	4.00	9.00	27.00	10.00	8.00	3.00
2	6.00	30.00	23.00	12.00	65.00	26.00	3.00	2.00	35.00	11.00	9.00	5.00
3	8.00	36.00	28.00	18.00	82.00	50.00	1.00	5.00	1.00	1.00	1.00	1.00
4	4.00	19.00	19.00	10.00	48.00	15.00	3.00	8.00	21.00	3.00	14.00	10.00
5	6.00	30.00	28.00	18.00	76.00	20.00	6.00	10.00	55.00	12.00	37.00	6.00
6	6.00	30.00	30.00	31.00	91.00	30.00	2.00	5.00	20.00	5.00	4.00	5.00
Studio 3, 7	5.00	20.00	20.00	22.00	62.00	30.00	1.00	5.00	36.00	8.00	10.00	7.00
8	6.00	30.00	28.00	12.00	70.00	25.00	1.00	10.00	19.00	5.00	0.00	5.00
9	4.00	16.00	16.00	16.00	48.00	33.00	0.00	7.00	40.00	8.00	36.00	4.00
10	3.00	12.00	12.00	21.00	45.00	30.00	6.00	15.00	34.00	5.00	16.00	5.00
11	4.00	20.00	19.00	25.00	64.00	30.00	4.00	10.00	31.00	5.00	23.00	5.00
12	4.00	20.00	20.00	17.00	57.00	30.00	2.00	13.00	25.00	5.00	13.00	7.00
13	4.00	20.00	20.00	4.00	44.00	15.00	7.00	15.00	15.00	7.00	21.00	13.00
14	4.00	17.00	16.00	24.00	57.00	30.00	1.00	5.00	12.00	5.00	1.00	1.00
15	6.00	18.00	18.00	7.00	43.00	27.00	8.00	11.00	10.00	4.00	3.00	3.00
Studio 1, 16	1.00	5.00	5.00	5.00	15.00	15.00	6.00	5.00	28.00	15.00	26.00	5.00
17	4.00	15.00	15.00	3.00	33.00	30.00	8.00	7.00	40.00	8.00	25.00	5.00
18	3.00	11.00	9.00	16.00	36.00	25.00	5.00	15.00	29.00	5.00	19.00	10.00
19	4.00	15.00	14.00	9.00	38.00	30.00	0.00	10.00	15.00	10.00	3.00	4.00
20	1.00	1.00	1.00	3.00	5.00	15.00	1.00	14.00	11.00	6.00	14.00	1.00
21	2.00	10.00	10.00	8.00	28.00	31.00	0.00	8.00	24.00	4.00	8.00	5.00

Statistical analyses were performed using the Pearson Correlation Coefficient to determine correlations between the scores of the different sections in the test instrument. The total averages scores per design (section A) had a correlation of r = 0.26 to section B average score/time ratio, a correlation of r = 0.18 to section C average

score/time ratio, and a correlation of r = -0.02 to section C average score/time ration. All these relationships were either weak or negative. This means that correlation exists between participant's ability to respond to a design problem, and their cognitive processes of convergent, divergent, and analogous thinking.

Table 6. Calculated Averages for Sections A, B, C and D

		A	B	C	D
		design/time ratio	score/time ratio	score/time ratio	score/time ratio
Studio 5,	1	0.42	0.44	2.70	2.67
	2	0.42	1.50	3.18	1.80
	3	0.21	0.20	1.00	1.00
	4	0.80	0.38	7.00	1.40
	5	0.63	0.60	4.58	6.17
	6	0.51	0.40	4.00	0.80
Studio 3,	7	0.41	0.20	4.50	1.43
	8	0.47	0.30	3.80	0.00
	9	0.36	0.00	5.00	9.00
	10	0.50	0.40	6.80	3.20
	11	0.53	0.40	6.20	4.60
	12	0.48	0.15	5.00	1.86
	13	0.73	0.47	2.14	1.62
	14	0.48	0.20	2.40	1.00
	15	0.27	0.73	2.50	1.00
Studio 1,	16	1.00	1.20	1.87	5.20
	17	0.28	1.14	5.00	5.00
	18	0.48	0.33	5.80	1.90
	19	0.32	0.00	1.50	0.75
	20	0.33	0.07	1.83	14.00
	21	0.45	0.00	6.00	1.60

The average originality score for the design question had an independent correlation of r = -0.25 to section B average raw score/time ration, a correlation of r = -0.26 to section C average raw score/time ration, and a correlation of r = -0.26 to section D average raw score/time ration. All these scores had a negative relationship. When

problem solving abilities did not influence the creativity score, there was no relationship between creative abilities and the cognitive processes tested. The total average scores per design (section A) had a correlation of r = 0.14 to the factored averages of the cognitive tests, and a correlation of r = 0.15 for the factored averages of the convergent and divergent task tests. These correlations were also weak. A strong correlation of r = 0.86 were found between the number of designs completed and the raw scores for section A.

An average, but positive correlation of r = 0.47 was found for the number of designs versus time to complete, and r = 0.45 for the raw score per design versus time to complete. This simply means that the more designs a participant generated, the stronger the possibility was for achieving a high creative design ability score.

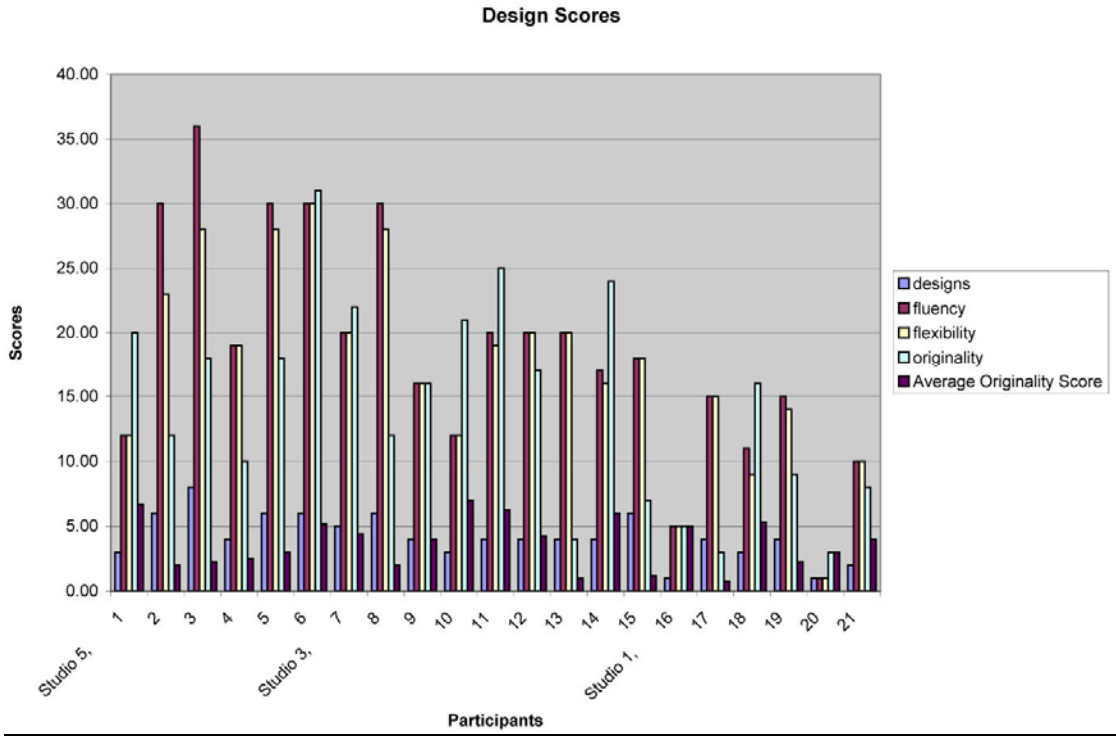
4.7 Discussion

4.7.1 Interpretation of raw scores

The test results imply that students from the advanced studio were better able to generate a variety of design responses, even if those responses were not particularly creative. Students from the intermediate studio had a higher average creative score than the advanced students, but had a lesser output of designs. The beginner students had the lowest creative design abilities, even though some showed promise. There seems to be a close relationship between the fluency and flexibility scores. The originality score seems to be randomly distributed throughout the chart. The written part of the design question may have impacted the originality scores negatively.

The statistical findings portray that only a weak correlation exists between the design question (section A) and the other sections irrespectively. When all the scores for the cognitive questions were factored, there was a weak negative correlation to the design question. This suggests that participant's ability to perform tasks involving the cognitive processes of divergent thinking, convergent thinking, and analogous reasoning, had little or no relationship to their ability to perform design tasks. This relationship is shown in table 8.

Table 7. Design Scores Analysis



4.7.2 Analysis of Results

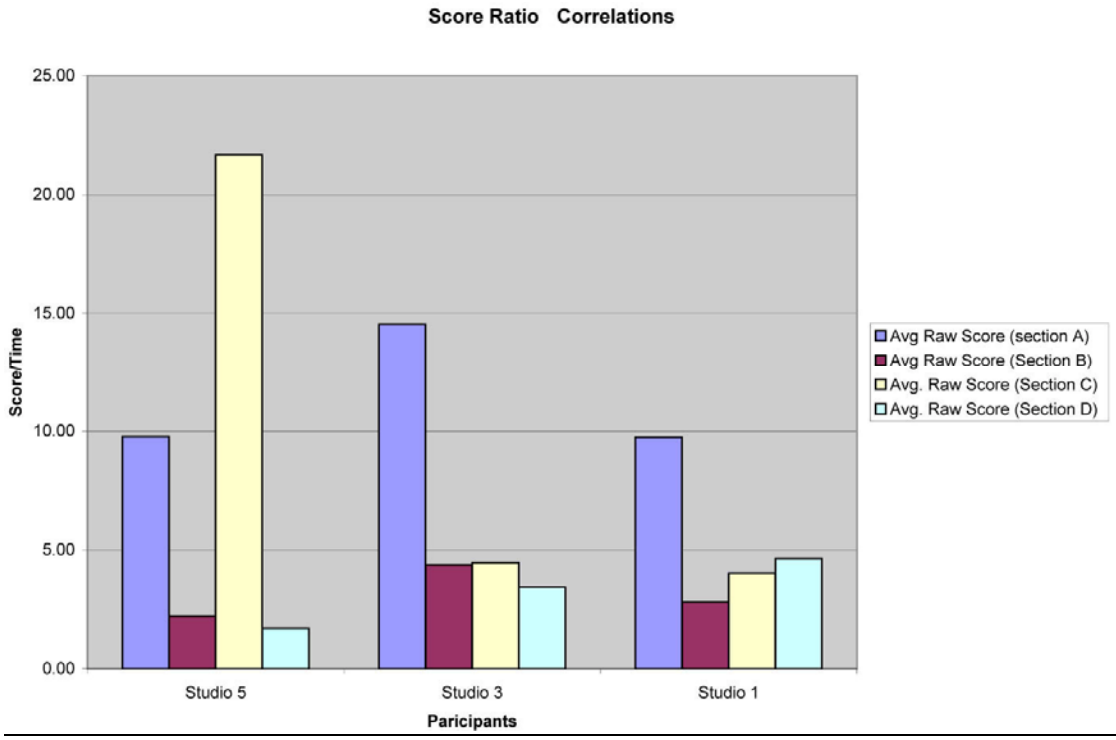
Because of the influence of the written part of section A on the score results on the creativity of the designs, the averages for section A was also interpreted by using the originality scores only. This result showed that students in studio 3 received the highest creativity scores. The results for the other sections shows a high level of divergent thinking ability from studio 5, and relatively low convergent thinking abilities from studio 5, and studio 1. The analogous thinking abilities were highest for participants from studio 1, and lowest for participants from studio 5.

Table 9 shows the results of the scores when 'time' is removed from the equation. This gives a clearer description of the different abilities tested, without it being influences by a ratio, or factors such as thinking styles, personality types, or motivational characteristics. This graph shows that scores for creativity of participants from the respective studios were quite similar, with the beginner students being somewhat less creative.

It is interesting, however, to note how closely related the creativity scores are to the analogous thinking scores. There also seems to be a clear distinction between the divergent thinking abilities of participants from the three studios. The scores which was least related to any of the other scores were the convergent thinking scores. When the scores for the different sections were simply tallied up, without time, or any other ratio taken into account, the results were very similar to the results in table 9. The biggest difference, however, was between the originality score and the average originality score

when ‘time’ was removed from the factoring. This implies that time constraints in the design process have a negative effect on creative abilities of the test participants

Table 8. Score averages against ‘time to complete’

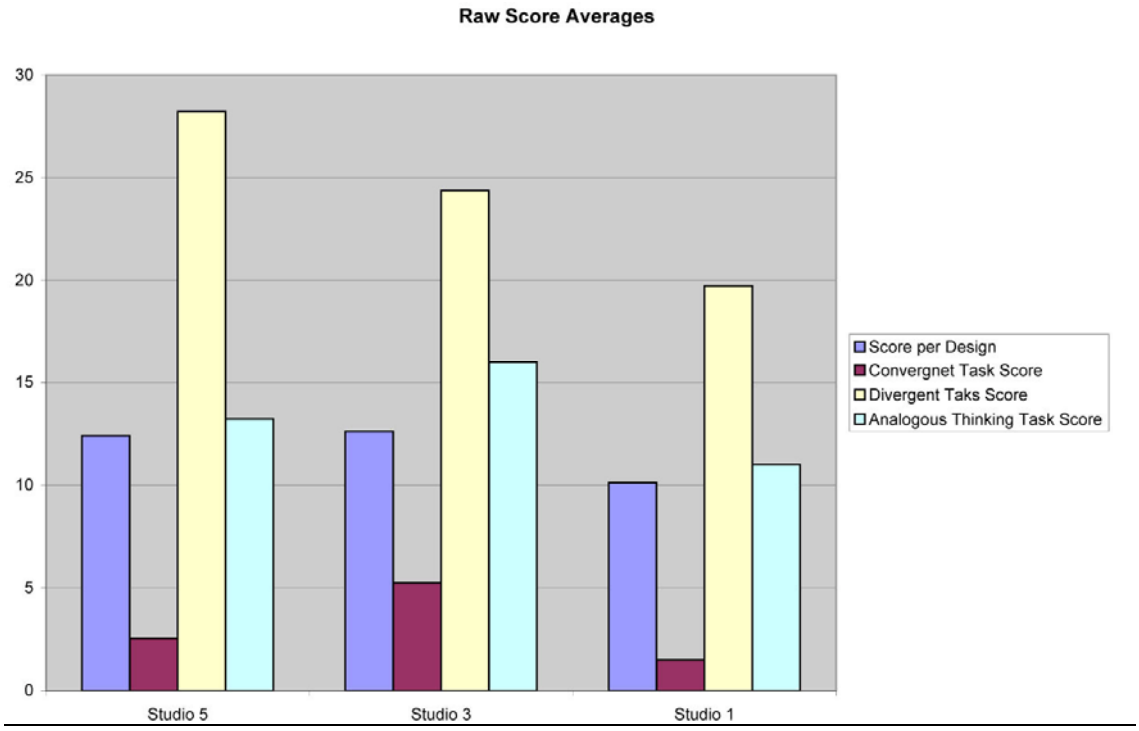


4.7.3 Result Irregularities

The test results in table 7 and in table 9 show a correlation between the creative abilities of participants and the divergent thinking tasks. The sections’ score/time ratios (shown in table 6 and in table 8) show only a very weak correlation between design abilities and the cognitive thinking abilities. This latter result fails to prove the hypothesis that creative design abilities are related to cognitive abilities. However, the

raw test results shows that design abilities and divergent thinking abilities may be related.

Table 9. Scores without 'time' as a factor



There may be a number of reasons for this outcome. First, the scoring of the test's design problem was flawed. Since participants received 50% of each design's score from the descriptions given to the design (the scoring for fluency and flexibility), the score may not represent the originality of the design correctly. In other words, if participants produced a highly original design, but did not supply descriptions to the design, they could only achieve as much as 10 points out of 20 points total. Even an above average design would thus achieve 7 out of 20 or 35%. Second, there was either

too little time to complete the design tasks, or there were too many design tasks. This could have put pressure on the participants and influence their creative abilities negatively.

For this reason, a calculation was also made for a correlation between the average originality score only, and section B, C, and D of the test. The result showed a slightly stronger correlation between originality and divergent tasks, but a very weak correlation between originality and analogous abilities, and a negative correlation between originality and convergent tasks. This would suggest that creative design ability is more strongly related to divergent thinking abilities than convergent thinking and analogous thinking abilities. If this is correct, one may interpret the result as an indication that divergent thinking is involved in creative design.

Third, one has to consider these research results in relationship to motivation, and validity. Since creative ability seems to depend on motivation in some respect, the test results may not reflect accurately the participant's creative abilities, since there was no incentive for them to perform well on the test. The validity of the research findings are also under scrutiny. First, the tests were scored only by the primary researcher, and his opinion with regards to originality could be questioned. Multiple test scorers (with adequate knowledge about creative design) should have participated in the scoring of the tests. Second, the research instrument does not account for personality, gender, cultural differences, or environmental influences. Third, the independent variable used in the correlation coefficient was time. For more accurate results, the independent

variable should have been a control test group. 'Time' as an independent variable, could possibly influence motivation negatively and bring other aspects into play. These aspects could include the relationship between the length of the individual test questions, the number of questions and the influence of drawing and writing abilities on test results. Fourth, the number of participants would need to be increased. Although a minimum of twenty (20) participants are adequate for a psychological test, more participants would produce more valid research results.

It has to be concluded, therefore, that the test results in this research have a low validity and that the research instrument did not test the hypothesis accurately. A research instrument which accounts for personality, gender, culture, environment, and motivation is needed and it should include more participants, and it should be tested against a control group in order for the test instrument to have a higher validity.

4.7.3 Summary

Since the strongest correlation existed between the divergent task scores and the originality scores, we can surmise that divergent thinking ability, at least, contributes to creative solutions in design. This does not minimize the importance of convergent thinking or analogous thinking. This research aimed to find a possible correlation between cognitive processes and creative design capabilities; but the research findings did not provide conclusive results. The amount of time it took to complete the different questions, and the number of responses given in each section, influenced the test outcomes to show conflicting results.

The research findings were inconclusive in proving this hypothesis. However, this may reflect more accurately on the validity of the research instrument than on the hypothesis. Since previous research on creative ability provided different results from this research, it is clear that further testing of the hypothesis is needed. The following chapter discusses the possible implications of such research for the profession of landscape architects and will suggest further research possibilities on this topic.

4.8 Conclusion

This chapter discussed the research method used in this thesis, the testing instrument, and the results from the test. The data was compared and analyses from a statistical perspective as well as form a variety of score combinations. Some findings leaned towards a correlation between design abilities and divergent thinking abilities, but different approaches to the analysis of the data produced different results. Although some interesting results were found, the testing instrument was brought under scrutiny.

In the next chapter, the implications of this research are discussed. The importance of the testing instrument for further research on this topic is emphasized. Future research possibilities are presented, as well as the impact, contribution, and benefits of research on creativity for the field of landscape architecture.

CHAPTER 5

CONCLUSION

5.1 Introduction

Creativity refers to the process by which a person generates something new, that contributes to a certain field and moves that field forwards. This definition of creativity separates skillfully produces products, from creative contributions because the latter produces "effective surprise" in the observer, and a "shock of recognition" that the product or response is novel and appropriate. Recognition of creativity is dependent on social agreement; meaning, members of the domain to which the product is presented decide whether a creative product is to be included into the domain or not.

Landscape architecture can be a creative field. The domain has the capacity for innovation, reinvention and development. Some of the processes studied by psychologists to assess creativity include problem solving and problem finding, analogous thinking, finding metaphors, and transforming mental images. These processes occur within landscape architecture.

Studying creativity is complex and so is its testing. The strong relationships between the creative environment, the creative person, the creative process and the creative product, necessitates comprehensive research and detailed testing instruments. A test that assesses the cognitive processes of creativity, for example, may be

influenced by the motivational characteristics and the personality profiles of the test participants.

Other aspects of creative persons that may impact test outcomes include personality characteristics (can they tolerate ambiguity, do they persevere in the face of criticism and failure, are they social or socially withdrawn), motivation (are they motivated by achievements, self-efficacy, intrinsic or extrinsic awards), and intelligence. Intelligence is of particular importance since it may be at the base of all mental operations, or, creativity may be just one of many types of intelligences. Components of intelligence that may influence creativity testing outcomes are metacomponents (higher-order executive processes that plan, monitor, and evaluate mental operations), performance components (execute instructions of metacomponents), and knowledge-acquisition components (learning new skills and knowledge, selectively coding information into memory, and intellectual style).

The creative environment and the creative product are closely related since creative contributions are mostly domain specific. A set of social institutions, or domain, decides which creative contributions are worth preserving, and a stable cultural domain preserves and transmits the new idea or form to the following generation. Also, resources from the larger society (disposable wealth and attention) help create favorable conditions for creativity to occur. Lastly, the historical, social and cultural milieu may influence individuals' creative abilities.

The creative process is the primary focus of this research. Hadamard's theory of scientific insight provides a plausible description of the process. This theory identifies a preparation phase during which one accumulates information and stores it in memory, an incubation phase which happens in unconscious thought, an illumination stage where selective information from long-term memory provides the creative person with an 'a-ha" experience, and a verification stage where the new inspired idea are subject to critical judgment. This process may be found in creative activities such as problem solving, problem finding, reasoning by analogies, finding metaphors, bisociation and insight. Preparation, incubation, and illumination all involve information indexing and retrieval, and creative processes are therefore memory based. To test creative ability, psychologists like Paul Torrance and Joy Paul Guilford use memory tasks involved in reasoning by analogies, finding metaphors and solving problem. These tasks include convergent thinking tasks, divergent thinking tasks, and analogous thinking tasks (Giulford, 1959; Torrance, 1974.)

5.2 Implications of the research

The purpose of this research was to test if landscape architects use the same cognitive processes of convergent, divergent, and analogous thinking for designing, as scientists use during scientific insight. The following hypothesis was tested: If participants' scores are high for a divergent task test, a convergent task test, and an analogous thinking test, then they will also achieve higher scores than the mean score of a testing group on a creative design assessment test. To test this hypothesis this research

used existing psychological tests for convergent and divergent thinking abilities, and adapted a creative engineering design assessment.

The test results showed no significant correlation between the cognitive tasks and the design tasks. This may be due to shortcomings of the testing instrument, lack of motivation from the test participants to fully employ their creative abilities, biased scoring of the tests, or an array of other extraneous factors. The hypothesis is, therefore, not entirely disproved. However, the research results may imply that landscape architects do not use cognitive processes associated with scientific insight. If that is the case, research identifying the cognitive creative processes involved in the design process of landscape architects would be valuable.

If a creativity assessment tool cannot be found, as was the case with this research, developing one could also be a subject for further research. When the creative abilities of landscape architects can be successfully tested, such an assessment tool can be used as an independent variable in a correlation coefficient for a number of other variables such as different cognitive processes, cultural background, gender, personality, learning style, and the like. A creativity test for landscape architects may also verify progress of students in academic units.

Other implications of this research may be that aptitude tests pointing towards a career in landscape architecture, but which are based only on the usual creativity measurements, may be inadequate. The processes of retrieving information for problem solving, creating analogies, metaphors and bisociation may be different from processes

used by landscape architects to come up with creative contributions and appropriate forms for the domain.

5.3 Future research possibilities

First and foremost, further research on a creative measurement tool for landscape architects is needed to either support or reject the findings of this research. It should lead to the development of an actual creative abilities test specific for the profession. With such a test, the cognitive processes involved in generating creative products in landscape architecture may be tested. This may contribute to an understanding of the design process in our domain, and the steps needed to improve, and teach it. However, cognitive style research cannot stand alone when testing creative abilities. The creative person, creative environment, and creative product must be considered also. As a minimum, a Creative Temperament Scale, a Creative Personality Scale, and a Cognitive Risk Tolerance Scale should be included in future tests.

A starting point for further research may be found with the Creative Engineering Design Assessment test used in this research. Differences in creative operational models between these two professions may lead to uncovering the specific processes used by landscape architects when generating creative products. Similar studies can be done between landscape architecture, architecture, interior design, fashion design, and art.

Scoring methods for creative design ability tests is as important as the test itself. This research shows that inadequate scoring methods may lead to low test validity and incorrect data. If the scoring method includes a rubric, multiple scorers are needed and

they should be qualified and knowledgeable about what they are scoring. Statistical analysis for interpreting data is adequate for future research projects, but tests results could be more specific with a better understanding and utilization of psychometrics.

Finally, it should be interesting to see if a relationship exists between the creative process (preparation, incubation, illumination, and verification) and the design process used by landscape architects, for example, research, analysis, synthesis, concept, and design development. This may support the notion, put forth by this thesis, that knowledge and experience contributes to perceived or recognized creative abilities of landscape architects, which may lead to further research on the subject.

5.4 Conclusion

The field of landscape architecture can benefit from the field of psychology when in comes to research on creativity. The influences and mental processes involved in generating creative products is a large research topic and requires interdisciplinary knowledge of psychology, psychological testing, psychometrics, statistics, landscape architecture history, landscape architectural design processes, aesthetics and the various approaches to the study of creativity. Since literature on this topic is relatively limited and research on creativity for landscape architects is fairly unknown, research on this topic itself can be a creative contribution to the field of landscape architecture. Studying creative processes may even improve one's own creative abilities, but more importantly, it will contribute to the body of knowledge of landscape architecture by supplying the domain with ways to understand its own creative processes, and may

catalyze the increased generation of novel products in landscape architecture that can be regarded as true creative genius.

APPENDIX A

INTELLECTUAL STYLES

Sternber, 1988: 1

Intellectual styles refer to the style or manner in which one directs one's intelligence. It is a functioning which is a form of mental self-government and can be characterized in terms of five major aspects: functions, forms, levels, scope, and learning:

1. **Functions of self-government:**

    a. Legislative

- Like to create their own rules
- Like to do things their own way
- Prefer problems that are not pre-structured
- Like to build structure as well as content
- Like legislative activities like designing projects and writing papers
- Like legislative occupations: architects, scientist, artist, policy maker, creative writer

    b. Executive

- Like to follow rules
- Like to figure out which of existing ways to do things
- Like executive activities: solving math problems, applying rules to problems, give talks on other's ideas
- Executive occupations: lawyer, policeman, engineer, builder (of other's designs), surgeon, soldier

    c. Judicial

- Like to evaluate rules and procedures
- Like to evaluate existing structures
- Prefer problems in which one analyzes and evaluates existing things and ideas

- Like to judge structures and content
- Judicial activities: writing critiques, giving opinions, judging people and their work, evaluating programs
- Judicial occupations: judge, critic, program evaluator, systems analyst, consultant

2. Forms of mental self-government

a. Monarchic

- Motivated by a single goal/need at a time
- Are single minded
- Are driven
- Believe that the end justifies the means
- Believe in going full speed ahead, and damn the obstacles
- Are over-simplifiers
- Is un- self-aware
- Tend towards intolerance
- Are inflexible
- Have little sense of priorities

b. Hierarchic

- Motivated by a hierarchy of goals, not all goals, can be fulfilled equally well, some goals are more important that others
- Tend towards a balanced approach to problems
- Believe the ends do not justify the means

- Can deal with competing goals
- Are complexifiers
- Are self-aware
- Are tolerant
- Are flexible
- Have a good sense of priorities

c. Oligarchic

- Motivated by multiple, often competing goals of equally perceived importance
- Follow multiple, possibly competing approaches to problems
- Are driven by goal conflict and tension
- Believe that the ends do not justify the means
- Believe that competing goals and needs tend to interfere with task completion
- Are complexifiers to the point of frustration
- Are self-aware
- Are tolerant
- Have trouble setting priorities

d. Anarchic

- Motivated by a potpourri of needs and goals that are often difficult to sort out
- Exhibit what seems like a random approach to problems
- Are driven by “muddle”, and sometimes seemingly inexplicable forces
- Believe the ends justify the means

- Are often unclear as to their goals
- Tend to be simplifiers
- Are un- self-aware
- Tend towards intolerance
- Cannot set priorities because they have no basis for them

3. Levels of mental self-government

a. Global

- Prefer big ideas
- Ignore or eschew details
- Conceptualizes and idea-oriented
- Enjoy abstract thinking
- Tendency to get lost on cloud nine
- See the forest but overlook the trees

b. Local

- Prefer details
- Deal well with details
- Are oriented towards pragmatics
- Tend towards concrete thinking
- Are down-to-earth

4. Scope of mental self-government

a. Internal style

- Introverted

- Task orientated
- Aloof
- Socially less sensitive
- Interpersonally less aware
- Alone when they work

b. External

- Extroverted
- People orientated
- Outgoing
- Socially sensitive
- Interpersonally aware
- With others when they work

5. Learning of mental self-government

a. Conservative style

- Like to adhere to existing rules or procedures
- Like to minimize change
- Prefer familiarity in life and work
- Avoid ambiguous situations

b. Progressive style

- Like to go beyond existing rules and procedures
- Like to maximize change

- Prefer unfamiliarity in life and work
- Seek ambiguous situations

APPENDIX B

TESTING INSTRUMENT

Influences and Mental Processes Involved in Generating Creative Products Test

Studio: _____ Time: 1 hour

If you have any question during the test, please raise your hand for assistance. You may withdraw from this research at any point during the test without any penalty or consequence to you.

Have fun!

Section A

Design for landscape architects is a balance between aesthetics and functions. Please generate designs that divide space (in plan-view) to create a variety of meeting places to accommodate people in a courtyard. Please use one or more of the following figures: a straight line; an arc; a square; and a circle, to generate your designs. These figures can be solid or hollow and can be manipulated in any manner you wish. You may combine the figures on each page and may draw additional elements as required by your design. However, each figure may only be used once per design. On each page, be sure to:

1. Sketch your design
2. Label each design and provide a description.
3. Identify the materials
4. Identify problems that this design may solve
5. Identify the users of each design Generate as many possible designs as you can on each page.

There are six (6) pages provided for six (6) designs at the back of this test. You may create more designs if you like using the backs of each page. The total time for this assessment is 30 minutes for 6 designs, or about 5 minutes for each design. You may use your time as you see fit. You should create at least one design. Additionally, at least one response should be indicated for each of the five questions of each design. You may use a pen or pencil, whichever you prefer. Upon completion of this question, please note the current time in the space below.

Current time

_____

Turn page

Section B

The following questions require one correct answer per question. Question 1 through 5 assessed remote association. Question 6 through 9 assessed insight. Please answer the following questions:

1. What word are all three of these words related to? Night, wrist, stop
_____

2. What word are all three words related to? Show, life, row
_____

3. What word are all three of these words related to? Loser, throat, spot
_____

4. What word are all three of these words related to? Cream, skate, water
_____

5. What word are all three of these words related to? Cottage, Swiss, cake
_____

6. There once was a man who never left his home. The only time anyone ever visited him was when his food and supplies were delivered, but they never came inside. Then one stormy winter night when an ice gale was blowing, he had a nervous break down. He went upstairs, turned off all the lights and went to bed. Next morning, he had caused the deaths of several hundred people. How? If you have seen this question before, type x

_____

_____

_____

_____

_____

7. Acting on an anonymous phone call, the police raid a house to arrest a suspected murderer. They don't know what he looks like but they know his name is John and he is inside the house. The police burst in on a carpenter, a taxi driver, a mechanic, and a fireman all playing poker. Without hesitation or communication of any kind, they immediately arrest the fireman. How do they know they got their man? If you have seen this question before, write 'x'.

_____

_____

_____

_____

8. On a busy Friday afternoon, a man walked several miles across London from Westminster to Knightsbridge without seeing anybody or being seen by anybody. The day was clear and bright. He had perfect eyesight and he looked where he was going. He did not travel by any method of transport other than by foot. London was full of people but not one person saw him. How? If you have seen this question before, write 'x'.

_____

_____

_____

_____

9. Marsha and Marjorie were born on the same day of the same moth of the same year to the same mother and the same father, yet they are not twins. How is this possible? If you have seen this question before, write 'x'.

_____

_____

_____

_____

Please note the current time _____

Turn page

Section C
Please answer the following questions in the space provided:

1. List as many uses for a paperclip as you can think of.

_____

_____

_____

2. List as many uses for a rubber band as you can think of.

_____

_____

_____

3. List as many things that are blue as you can think of

_____

_____

_____

4. List as many things with wheels as you can think of.

_____

_____

_____

_____

_____

Please note the current time

_____

Turn page

Section D

Please think of metaphors, or symbolically equivalent images, for certain stimulus images. The task can best be made clear by an example.

EXAMPLE: Suggested stimulus image: Leaves being blown in the wind.
Possible symbolic equivalents:

A civilian population fleeing chaotically in the face of armed aggression.
Handkerchiefs being tossed about inside an electric dryer.
Chips of wood borne downstream by a swiftly eddying current.

Please give as many symbolic equivalents to the following images as you can think of in the time given. You have five (5) minutes for each question and fifteen (15) minutes in total. You may use your time as you please.

Stimulus image:

1. A candle burning low

_____

_____

_____

2. An empty book case

_____

_____

_____

3. Sitting alone in a dark room

_____

_____

_____

Please note the current time _____

REFERENCES

Adams, J.L. (1979). *Conceptual blockbusting.* (2nd ed.). New York: Norton.

Amabile, J.L. (1983). *The social psychology of creativity*. New York: Springer-Verlag.

Amabile, J.L. (1986). The personality of creativity. *Creative Living*. 15(3), 12-16.

Amabile, J.L. (1996). *Creativity in context*. Boulder: Westview.

Alexander, C. (1966). *Notes on the synthesis of form*. Cambridge: Harvard University Press.

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

Barron, F. (1985). Creativity. *Social Sciences Encyclopedia* (pp. 167-169). London: Routledge & Kegan Paul.

Barron, F. (1988). Putting creativity to work. In R.J. Sternberg (Ed.), *The nature of creativity*. New York: Cambridge University Press.

Bem, D.J. (1967). Self-perception: An alternative interpretation of cognitive dissonance. *Psychological Review*, 74, 183-200.

Berleant, A. (1997). *Living in the Landscape: Towards an Aesthetics of Environment*. Kansas: University Press of Kansas.

Bourassa, S.C. (1991). *The Aesthetics of Landscape*. London and New York: Belhaven Press.

Bowden, E.M., and Beeman, M.J. (2003). Normative data for 144 compound remote associate problems. *Behavior Research Methods, Instrument, and Computers*, 35, 634-639.

Bruner, J. (1962). The conditions of creativity. In H. Gruber, G. Terrell and M. Werheimer (Eds.), *Contemporary Approach to Creative Thinking*. New York: Atherton.

Bryan, M. et al (1998). *The Artist Way at Work*. London: Pan Books

Cattell, R.B. (1963). The personality and motivation of the researcher from measurements of contemporaries and from biography. In C.W. Taylor and F. Barron (Eds.), *Scientific creativity* (pp. 119-131). New York: Wiley.

Charyton, C., Jagacinski, R.J., and Merrill, A. (2008). CEDA: A Research Instrument for Creative Engineering Design Assessment. *Psychology of Aesthetics, Creativity, and the Arts,* 2(3), 147-154.

Ching, F.D.K (1996). *Architecture: Form, Space, and Order* (2nd Ed.). New York: John Wiley & Sons.

Corner, J. (Ed.) (1991). *Recovering Landscape: Essays in Contemporary Landscape Architecture*. New York: Princeton Architectural Press.

Cropley, D., and Cropley, A. (2005). Engineering creativity: A systems concept of functional creativity. In J.C. Kaufman and J. Baer (Eds.), *Creativity across domains: Faces of the muse*. Mahwah, NJ: Erlbaum.

Csikszentmihalyi, M. (1978). Attention and the holistic approach to behavior. In K.S. Pope & J.L. Singer (Eds.), *The stream of consciousness* (pp.335-358). New York: Plenum.

Csikszentmihalyi, M., &Massimini, F. (1985). On the psychological selection of bio-cultural information. *New Ideas in Psychology,* 3(2), 115-138.

Csikszentmihalyi, M. (1988). Society, culture, and person: a systems view of creativity. In R.J. Sternberg (Ed.), *The nature of creativity*. New York: Cambridge University Press.

Csikszentmihalyi, M. (1996). *Creativity*. New York: HarperCollins.

Davidson, J.E., & Sternberg, R.J. (1984). The role of insight in intellectual giftedness. *Gifted Child Quarterly*, 28, 58-64.

Dewey, J. (1959). *Art as Experience*. New York: Capricorn Books.

Dewey, J. (1958). *Experience and Nature*. New York: Dover Publications Inc.

Dow, G.T., and Mayer, R.E. (2004). Teaching students to solve insight problems: Evidence for domain specificity in creativity training. *Creativity Research Journal,* 16, 389-402.

Eysenck, H. (2003). Creativity, personality, and the convergen-divergen continuum. In M.A. Runco (Ed.), *Critical creative processes* (pp.95-114). Cresskill, NJ: Hampton Press.

Feist, G.J., & Runco, M.A. (1993). Trends in the creativity literature: An analysis of research in the Journal of Creative Behavior (1967-1989). *Creativity Research Journal,* 6 (3), 271-286.

Feldman, D.H., (1988).Creativity: dreams, insights, and transformation. In R.J. Sternberg (Ed.), *The nature of creativity*. New York: Cambridge University Press.

French, P.A., and Sternberg, R.J. (1989). Expertise and intelligent thinking: When is it worse to know better? In R.J. Sternberg (Ed.), *Advances in the psychology of human intelligence* (pp.195-158). New Jersey: Erlbaum.

Festinger, L., and Carlsmith, J.M. (1959). Cognitive consequences of forced compliance. *Journal of Abnormal and Social Psychology,* 58, 203-210.

Finke, R.A., Ward, T.B., and Smith, S.M. (1996). *Creative cognition: Theory, research and applications*. Cambridge, MA: MIT Press.

Forbus, K.D. (1986). *Interpreting observations of physical systems* (Technical Report No. UIUCDCS-R-86-1248). University of Illinois at Urbana-Champaign, Department of Computer Science.

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

Gentner, D. (1983). A theorietical framework for analogy. *Cognitive Science,* 7, 155-170.

Gombrich, E.G. (1966). The Renaissance theory of art and the rise of landscape. In *Norm and forms: studies in the art of the Renaissance*. London: Phaidon.

Greeno, J.G. (1980). Trends in the theory of knowledge for problem solving. In D.T. Tuma, and R. Reif (Eds.), *Problem solving and education: Issues in teaching and learning*. Hillsdale, NJ: Lawrence Erlbaum.

Gruber, H.E., and Davis, S.N. (1988). Inching our way up Mount Olympus: The evolving-systems approach to creative thinking. In R.J. Sternberg (Ed.), *The nature of creativity* (pp. 243-270). Cambridge: University Press.

Guilford, J.P. (1950). Creativity. *American Psychologist,* 5, 444-454.

Guilford, J.P. (1959). Intellectual resources and their value as seen by creative scientists. In C.W. Taylor (Ed.), *The third (1959) University of Yah research conference on the identification of creative scientific talent* (pp. 128-149). Salt lake City: University of Utah Press.

Guilford, J.P. (1965).Creativity: A quarter century of progress. In I.A. Taylor, and J.W. Getzels (Eds.), *Perspectives in creativity* (pp.37-59). Chicago: Aldine.

Guilford, J.P. (1967). *The nature of human intelligence*. New York: McGraw-Hill.

Hadamard, J. (1949). *The psychology of invention in the mathematical field.* New Jersey: Lawrence University Press.

Hall, R.P. (1986). *Understanding analogical reasoning: Computational approaches* (Technical Report No. 86-11). University of California at Irvine, Department of Information and Computer Science.

Helmreich, R.L., Spence, J.T., Beane, W.E., Lucker, G.W., and Matthews, K.A. (1980). Making it in academic psychology: Demographic and personality correlates of attainment. *Journal of Personality and Social Psychology*, 39, 896-908.

Hopper, L.J. (2007). Landscape Architecture Graphic Standards. New Jersey: John Wiley & Sons, Inc.

Kanizsa G. (1979). *Organization in Vision*. New York: Praeger Publishers, A Division of Holt, Rinehart and Winston, CBS Inc.

Koestler, A. (1964). *The Act of Creation*. New York: The Macmillan Company.

Kohler, W. (1969). *The Task of Gestalt Psychology*. New Jersey: Princeton University Press.

Kris, E. (1952). *Psychoanalytic exploration in art*. New York: International University Press.

Kubie, L.S. (1958). *The neurotic distortion of the creative process*. Lawrence: University of Kansas Press.

Langley, P., and Jones, R. (1988). A computational model of scientific insight. In Sternberg R.J. (Ed.), *The nature of creativity*. New York: Cambridge University Press.

Larson, M.C., Thomas, B., and Leviness, P.O. (1999). Assessing the creativity of engineers. *Design Engineering Division: Successes in Egineering Design Education, Design Engineering,* 102, 1-6.

Lawshe, C.H., and Harris, D.H.(1960). *Manual of instructions to accompany Purdue Creativity Test forms G and H*. Princeton, NJ: Educational Testing Services.

Lin, M.W. (1993). *Drawing and Designing with Confidence*. New York: John Wiley & Sons, Inc.

Martindale, C. (1999). Biological Bases of Creativity. In R.J. Sternberg, *Handbook of Creativity* (pp137-153). Melbourne: Cambridge University Press

Mednick, S.A. (1962). The associative basis for the creative process. *Psychological Bulletin,* 69, 220-232.

Metcalfe, J. (1986). Feeling of knowing in memory and problem solving. *Journal of Experimental Psychology: Learning, Memory and Cognition,* 12, 288-294.

Meyer, L.B. (1987). Toward a Theory of Style. In B. Lang (Ed.*), The Concept of Style*. New York: Cornell University Press.

Nielson, B.D., Pickett, C.L., and Simonton, D.K. (2008). Conceptual Versus Experimental Creativity: Which Works Best on Convergent And Divergent Thinking Tasks? *Psychology of Aesthetics, Creativity, and the Arts,* 2(3), 131-138.

Ohlsson, S. (1984). Restructuring revisited: An information processing theory of restructuring and insight*. Scandinavian Journal of Psychology,* 25, 117-129.

Quillian, M.R. (1968). Semantic memory. In M.L. Minsky (Ed.), *Semantic information processing*. *Cambridge*, MA: MIT Press.

Reber, A.S. (1985). *The Penguin dictionary of psychology*. Harmondsworth, Middlesex: Penguin.

Roe, A. (1952). A psychologist examines 64 eminent scientists. *Scientific American,* 187(5), 21-25.

Rogers, C.R. (1959). Towards a Theory of Creativity. In H.H. Anderson (Ed.), *Creativity and its Cultivation*. New York: Harper & Row.

Rothenberg, A., Hausman, C.R. (Eds.) (1976). *The creativity question*. New York: Duke University Press.

Runco, M.A. (1999). Tactics and strategies for creativity. In M.A. Runco and S. Pritzker (Eds.), *Encycloopedia of creativity* (pp.611-615). San Diego, CA: Academic.

Runco, M.A. (2007). *Creativity, Theories and Themes: Research, Development, and Practice*. Burlington, MA: Elsevier Academic Press.

Schank, R.C., (1988). Creativity as a mechanical process. In Sternberg, R.J. (Ed.), *The nature of creativity*. *New* York: Cambridge University Press.

Simonton, D.K. (1984). *Genius, creativity, and leadership: Historiometric inquiries*. Cambridge, MA: Harvard University Press.

Sloane, P. (1992), *Lateral thinking puzzles*. New York: Sterling.

Spearman, C. (1931). *Creative mind*. New York: Appleton.

Sternberg, R.J. (1985). *Beyond IQ: A trianchic theory of human intelligence*. *New* York: Cambridge University Press.

Sternberg, R.J. (1985). Implicit theories of intelligence, creativity, and wisdom. *Journal of Personality and Social Psychology*, 49, 607-627

Sternberg, R.J. (1988). A three-faceted model of creativity. In R.J. Sternberg (Ed.), *The nature of creativity*. New York: Cambridge University Press.

Sternberg, R.J., and Lubart, T.I. (1991). An investment theory of creativity and its development. *Human Development,* 34, 1-32.

Sternberg, R.J., and Lubart, T.I. (1992). Buy low and sell high: An investment approach to creativity. *Current Directions in Psychological Science, 1* (1), 1-5.

Sternberg, R.J., and Lubart, T.I. (1995). *Defying the crowd: Cultivating creativity in a culture of conformity*. New York: Free Press.

Sternberg, R.J., and Lubart, T.I. (1996). Investing in creativity. *American Psychologist,* 51, 677-688.

Sternberg, R.J. and Lubart, T.I. (1999). The Concept of Creativity: Prospects and Paradigms. In Sternberg R.J. (Ed.), *Handbook of Creativity* (pp3-16). Melbourne: Cambridge University Press.

Sternberg, R.J. (2003). *Wisdom, Intelligence, and Creativity Synthesized.* New York: Cambridge University Press.

Stokes, P.D. (2005). *Creativity from constraints: The psychology of breakthrough*. New York: Springer.

Taylor, C.W., Smith, W.R., and Ghiselin, B. (1963). The creative and other contributions of one sample of research scientists. In C.W. Taylor and F. Barron (Eds.), *Scientific creativity: its recognition and development* (pp. 60-61). New York: Wiley.

Taylor, C.W. (1988). Various approaches to and definitions of creativity. In R.J. Sternberg (Ed.), *The nature of creativity*. New York: Cambridge University Press.

Thurstone, L. L. (1952). Creative talent. In L.L. Thurstone (Ed.), *Applications of psychology* (pp. 18-37). New York: Harper & Row

Torrance, E.P. (1974). *Torrance Text of Creative Thinking*. Lexington: Personnel Press.

Torrance, E.P. (1979), *The search for satori and creativity*. Buffalo, NY: Creative Education Foundation.

Torrance, E.P. (1988). The nature of creativity as manifest in its testing. In R.J. Sternberg (Ed.), *The nature of creativity*. (pp. 43-76). New York: Cambridge University Press.

Torrance, E.P., and Frazier, M.M. (1984). Style of learning and thinking and biographical inventory measures. *Creative Child and Adult Quarterly,* 8, 206-210.

Tardif, T.Z., Sternberg, R.J., (1988). What we know about creativity. In R.J. Sternberg (Ed.), *The nature of creativity*. New York: Cambridge University Press.

Walberg, H.J. (1969). Sources of great men. *Eugenics Quarterly,* 21, 103-109.

Walberg, H.J. (1988). Creativity and talent as learning. In Sternberg (Ed.), *The nature of creativity*. New York: Cambridge University Press.

Weisberg, R.W. (1986). *Creativity, genius, and other myths*. New York: Freeman

Weisberg, R.W. (1988). Problem solving and creativity. In Sternberg R.J. (Ed.), *The nature of creativity*. *New* York: Cambridge University Press.

Winston, P.H. (1980). Learning and reasoning by analogy. *Communications of the ACM,* 23, 689-703.

Zuckerman, H. (1983). The scientific elite: Nobel Laureates' mutual influences. In T.S. Albert (Ed.), *Genius and eminence: The social psychology of creativity and exceptional achievement* (Vol. 5, pp. 241-252). New York: Pergamon Press.

BIOGRAPHICAL INFORMATION

Theunis Devilliers was born and raised in South Africa and immigrated to the United States of America in 2001. He enrolled in the Masters Degree of Landscape Architecture in 2006 after years as a successful teacher of music where he taught violin and orchestra. He lives in Allen, Texas, at present and enjoys being involved with a number of landscape architecture projects in the Dallas/Fort Worth Metroplex.