Two Roads Converge:
Exercises in Discretion in a Virtual Environment

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Paul S. Matthews

Major Professor: Brian Cleveley, M.Arch.
Committee Members: Xiao Hu, Ph.D.;
Rajal G. Cohen, Ph.D.; Rula Awwad-Rafferty, Ph.D.
Department Administrator: John Anderson, M.S.

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Authorization to Submit Thesis

This thesis of Paul S. Matthews, submitted for the degree of Master of Science with a Major in Architecture and Integrated Design and titled “Two Roads Converge: Exercises in Discretion in a Virtual Environment,” has been reviewed in final form. Permission, as indicated by the signatures and dates below, is now granted to submit final copies to the College of Graduate Studies for approval.

Major Professor: __________________________ Date: ___________________

Brian Cleveley, M.Arch.

Committee Members: __________________________ Date:____________________

Xiao Hu, Ph.D.

__________________________ Date: ___________________

Rajal G. Cohen, Ph.D.

__________________________ Date: ___________________

Rula Awwad-Rafferty, Ph.D.

Department Administrator:

__________________________ Date: ___________________

John Anderson, M.S.

Abstract

A client's involvement in the aesthetic component of architectural design has been traditionally limited to responding to a set of options presented by the designer. This has been the prevailing practice at both the micro-level (client-architect) and the macro level (stakeholder-architect). In principle, the elicitation of client, or community, preferences with respect to elements and principles of design before a design process began would allow resulting designs to be more pertinent to the client's aesthetic preferences. However, for a preference model to be useful, any results derived from it must be valid, reliable, and easily integrated into established architectural design processes.

This project attempts to derive a useful quantification of aesthetic preference relating to one selected principle of design (proportion) from a virtualized choice model, presented to presumptive architectural clients, in order to lay the groundwork for future regression analysis and inclusion into a comprehensive aesthetic choice model.

Acknowledgements

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In particular, I would like to thank Senior Instructor Brian Cleveley, whose unflagging optimism, and passion for the possibilities inherent in the field of virtual technology has spurred this non-traditional student to carry on through difficult times.

Dedication

This thesis is dedicated to my wife, Shelly Matthews, an artist and educator who never suffers fools, even as she delights in the sometimes necessary foolishness of the creative process.

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Chapter 1 Introduction

Summary

Aesthetic philosopher Roger Scruton has called architecture, “an exercise in discretion,” advancing an argument that, at its core, architecture is fundamentally about taste.[1]

Certainly, since the earliest days of the world’s “second oldest profession”[2] architects have engaged in the never-ending quest to reconcile their client’s most heartfelt and varied desires with the somewhat more limited modes of architectural expression.

As a practitioner of some thirty-five years standing, I have been made to relearn this lesson countless times: To the degree that an architect can understand so as to embrace -- or when absolutely necessary, inform -- a client’s aesthetic sensibility (their taste). To that degree, the project will be successful.

This could be due to a peculiarity of a truly social form of art -- the long and tortuous path between an aesthetic vision and realization of a building project. Needs analysis, feasibility studies, financing, land-use actions, permitting, construction – every step along the way offers an opportunity for (welcome or unwelcome) modifications to the design. Without a solid commitment to the client’s vision on the part of the architect, and a corresponding understanding of the means by which the architect intends to achieve it in the mind of the client, the most common methods meant to “head-off” compromise (more precise visualizations in ‘formalist’ approaches and more rigorous data collection and analysis in the ‘evidence-based’ ones) can be counter-productive. They mask mutual misunderstandings about the aesthetic task at hand.

That is, in evidence-based approaches to design, architects might emphasize persuasion over education. They can close too quickly on minor points, squelching client hesitancies over the direction of the design with the dead weight of data. Likewise, in formalist settings, architectural visualizations can bedazzle cowed and aesthetically-insecure laymen with highly-stylized representations of resplendent architectural futures if they only have enough sense to keep their mouths shut and not make any sudden moves for the door. Put less flamboyantly, the architect’s current methods of soliciting client input can lock sub-optimization inefficiencies* into the design processes.


Frontop Digital Technology Co.,Ltd

Figure 1.1 Frontop Visualization

Well-intentioned attempts to communicate a design vision can end up kicking a truly collaborative process down the road just-as-far as the first convenient fork, where the client will take a welcome opportunity to step off a path that was never truly theirs to begin with.

The Two Roads project is intended to lay the foundation for a virtual space, where the architect and client can come together -- before the design process proper begins -- to engage in a series “exercises in discretion,” to borrow Scruton’s apt turn-of-phrase. The virtualized space might help the architect to comprehend, without correcting, the client’s sensibility; and assist the client in gaining a more precise understanding of the elements and principles of design -- the architect’s toolkit.

Two Roads is played so the product of a design process will more pertinent to its original intent.

* Sub-optimization inefficiencies occur when a part of a system is highly optimized, but the larger system is left worse off as a result. [3]

The first phase of the Two Roads study explores the design principle of proportionality. As will be discussed in Chapter 7 – Implications, it is a proof-of-concept vehicle. It is meant to be integrated into a larger applied research project to determine the applicability of the game-playing choice-model approach to larger, virtual worlds, where architects can discover client preferences for all the established elements of design: point, line, plane/shape, form, space, color, texture, and light; as well as the principles: scale/proportion, figure/ground, unity/balance, contrast/variety, repetition, pattern/rhythm, superimposition, hierarchy, context, and systems.

Background

I spent most of my years as an architectural practitioner continually re-learning what I heard the architect Charles Moore say in passing while I was a student: "My most successful projects were the ones my clients thought they designed."

My own, "most successful" projects, were ones that began with long, rambling conversations about absolutely everything under the sun but the task-at-hand. These colloquies had the effect of setting me straight about things. They gave me insight into my client's attitudes about nature, politics, their neighbors, small children, employees, God, love, money, and how the patina on the copper finials of the bedposts gleamed in the glow of their nightlight when were a child.

The Two Roads study arises out of a series of conversations that began in April 2014, with Brian Cleveley, Senior Instructor of Virtual Design Technology in the Department of Art & Architecture at the University of Idaho. Brian shared his sense of our profession's collective failure to take full advantage of virtualizations by relying too heavily on them as sales and promotional tools, along the lines of more traditional visualizations.

This project is intended to push the envelope of the theoretical potential (rather than current technical) possibilities of virtual design. Two Roads type virtualizations might succeed in educating the aesthetic discretion of a client (a bit) while the client instructs their architect (a bit more) in the values meant to inform the final design.

Thesis

If, per Scruton, architecture is a series of exercises in discretion, the architectural design process hinges upon the degree to which the architect *understands* a client's aesthetic preferences – their taste. A virtualized game-world can theoretically allow an architect to quantify the dimensions of a client's aesthetic judgments, and possibly predict how they might play out with respect to the principles and elements of design in various "domains and modalities."[4] This could result in less time wasted in re-design, and fewer potentially costly change-orders required during construction.[5]

To test this thesis two research questions are asked relative to a selected element of design in a virtual simulation:

Research Question 1: Can a subject's aesthetic preference be defined -- as it relates to compositional proportion*?

Research Question 2: Will the subject's (self-described) degree of satisfaction with the compositional proportion inversely associate with the amount of time it took the subject to establish the proportion?

* A more precise definition of compositional proportion is offered in Chapter 3- Principles and Elements of Design; however, in brief it is the ratio of part to whole with respect to lines of construction of a composition.[6]

Chapter 2 Literature Search and Context

The Difficulty and Importance in "Accounting for Taste"

"De gustibus non disputandum est"—*that is, there is no disputing against Hobby-Horses; and for my part, I seldom do."*

– Laurence Sterne, The Life and Opinions of Tristam Shandy, Gentleman (1759)

Since the time of the Romans it has been axiomatic that there is no accounting for taste. *De gustibus non disputandum est* – period, full stop. We encounter the principle for the first time as Kindergarteners, when we learn that strict adherence to it can keep us out of messy altercations over divisive questions, like whether "we" should play on the swing-sets, or the monkey-bars at recess. Much later we use it to stay out of real, deathly serious, grown-up conundrums, like whether the Yankees are the greatest or most perfidious baseball team to ever stain, or grace, the planet.

Laurence Sterne had a field day with the over-use and abuse of the *non disputandum* principle in his classic comic-novel Tristam Shandy. The author/protagonist escaped all the fuss and bother of actually discriminating in matters of taste by embracing a promiscuous conturbation of nonsensical propositions and bizarre enthusiasms that are, at best, entirely out of proportion. [7]

—This is vile work.—For which reason, from the beginning of this, you see, I have constructed the main work and the adventitious parts of it with such intersections, and have so complicated and involved the digressive and progressive movements, one wheel within another, that the whole machine, in general, has been kept a-going;—and, what's more, it shall be kept a-going these forty years, if it pleases the fountain of health to bless me so long with life and good spirits.[8]

As we regard the deference paid to the "no accounting" truism in the built environment of the contemporary "post-modern" world, we might wonder if we are not all aesthetic step-children of Mr. Tristam Shandy, Esq.; collectively spinning, like his counter-revolving wheels, both one way and the other between "digressive and progressive" aesthetic tastes without a clear purpose in mind.

With notable exceptions, aesthetic philosophers skirt issues of taste, and treat the topic as a sub-division of epistemology, or ethics. They prefer to focus on questions, like: "What are we talking about when we speak of an object of art – and consequently, what might be the most definitive instance of one?" Or, "How can we determine the relative value of a particular artistic expression, measured against prescriptions from a larger, more encompassing, moral philosophy."

"Taste" in its workaday sense is regarded as: critical judgment, discernment, or appreciation as applied to aesthetic qualities[9] -- is beneath their toplofty interests. We leave it to gangs of self-appointed critics and streetwise, art-school polemicists to scratch it out for us in opposing weblogs. These toughs excel at "disputing against hobby-horses," endlessly contending over who has the finest sensibility; or lauding/excoriating the most heroic/cowardly artist currently speaking truth, or pandering, to "Power." [10]

From the viewpoint of this practicing architect, all the clamor is of no help in finding a cultural norm that can act as a carrier wave in matters of aesthetic preference. It takes a great deal of time and effort to hammer out a common understanding with the client solid enough to serve a joint design endeavor.*

* I had a client once, who wanted to build a house for his wife. She had just been diagnosed with lung cancer. She always wanted to live in a log house. He was, had been, he said "too greedy and selfish" to give it to her. I eventually figured out that I was hired to design his redemption, not a house. Once I understood what we were doing I could abandon certain nonsensical aesthetic objection and begin the task at hand. The structure was completed shortly before she died.

Figure 2.1 Dunn Residence

For architect-practitioners, the few scientific, or quasi-scientific, studies on taste run aground over the horizon. In natural sciences, such as neuroscience and psychiatry, studies seem skewed toward the mechanics of perception, with a great number involving fMRI brain scans (which are at least questionable in application to the topic.[11])

If 'most cited' statistics mean anything, business and economic studies trend toward mass sampling techniques as they apply to predicting herd behavior. [12]

Yet, if we set aside the weighty, no doubt worthy but contentious, philosophical questions of taste: What is it? Where do our brains process it? When did we use it (historically) to best effect? Why do we care, so deeply, whether or not someone else prefers theirs to ours? Or the practical question of how do we tease big data into coughing up the secret to the perfect storm of taste we call a fashion trend, so we can all get ahead of it and get rich? We can, instead, concentrate on one small, uncontroversial yet possibly useful question. From the perspective of the small project, private sector, architect-practitioner (71% of all professional architects in the United States in 2012)[13] it is really the only question that has to be answered: **How will my clients' taste manifest itself with respect to the elements and principles of design that I use to craft buildings?**

An early certain answer to that question could forestall costly re-design, ensure designs are completed as intended, and lay the groundwork for a satisfied return clientele –which historically constitutes 59% of project billings.[14]

The problem remains, however, that the answer to the question requires a kind of accounting for taste, something that can't be done - *non disputandum*, as you recall.

So, if we can't account for (explain) taste, can we at least count (tally) it?

The Two Roads study assigns a numerical value for the type and intensity of aesthetic preference as it relates to an individual principle or element of design.

The State of Research in Scientific Aesthetics

This entails (temporarily) treating matters of preference in taste as purely hedonic* responses – for tactical purposes. In this endeavor the relatively new field of scientific aesthetics may offer a hint of progress in that limited objective.

The following survey of the field relies heavily on an encyclopedic gloss on the state of the discipline since 1962, authored by Stephen E. Palmer, Karen B. Schloss, and Jonathan Sammartino and published in the 2013 *Annual Review of Psychology*. A bullet point summation of which might feature their statement (*italics added*):

"It is widely acknowledged that people differ enormously in their aesthetic preferences for all kinds of different *modalities and domains* (e.g., McManus 1980, McManus et al. 1981).[15] This fact, more than any other, underlies the well-known adages, "Beauty is in the mind of the beholder" and "There is no accounting for taste."[16]

All the same, a key passage of that same paper serves as a summary of progress (circa 2013) in the scientific approach to aesthetic preference within particular domains.

*Hedonic responses are those "relating to or characterized by pleasure." [17] They can be conceived as those preferences simply described by the colloquialism "I like," rather than those justified by more complex strategies.

In spatial composition: *McManus & Weatherby (1997)* [18] *found that average positional preferences were close to the golden section value in horizontal placement, but individuals differences (IDs) were so large that few, if any, participants showed preference functions that looked much like the group averages.*

In color preferences: *Ling & Hurlbert (2009)* [19] *used their extended, four-parameter cone contrast model … to fit individuals' preference data. It accounted well for IDs (average multiple-r = 0.71), indicating that observers differ in the polarity and importance of these four dimensions for single colors.*

From an ecological perspective, Palmer et al. (2012) found thatWAVE measurements for individual observers were more highly correlated with their own color preferences (average r = +0.55) than with those of other observers (average r = +0.40).[20]

In preferences for two-color combinations, Schloss & Palmer (2011) [21] *found that even though average preference ratings correlated very strongly with average harmony ratings (+0.79; see above), the same correlations for individuals ranged widely from about zero to +0.75. Furthermore, these IDs varied with the amount of formal color training participants had completed, following an inverted-U function, with a maximum for intermediate amounts of training and lower correlations for both untrained and highly trained individuals…*

In spatial images: *Eysenck (1940)* [22] *studied people's aesthetic rankings of sets of spatial images of 18 different types (including portraits, landscapes, and photographs of medieval clocks) as well as to colors, odors, and polygons. After correlating the rankings and performing a factor analysis, he identified a single "general objective factor of aesthetic appreciation" (which he called "t" for "good taste") that varied with the extent to which an individual's rankings agreed with the average rankings of the entire group. It turned out to be relatively constant for individuals across domains.*

For harmony across domains: *Palmer & Griscom (2012)*[23] *proposed that "preference for harmony" may be the primary aesthetic ID that underlies Eysenck's t-factor. Following Schloss & Palmer's (2011)*[24] *findings of IDs in preference for color pairs, they studied the* *extent to which people's judgments of aesthetic preference among stimuli in different domains (color pairs, configural shapes, spatial compositions, and music) correlated with their own judgments for the same stimuli in their degree of harmony, where harmony is a dimension characterized by simplicity, regularity, and parts that fit well together, regardless of preference. They found that the correlations between average preference and average harmony ratings over all individuals were quite high in all domains (ranging from +0.97 for music to +0.47 for configural shape) but that the same correlations for individuals were extremely variable: Some people like harmonious stimuli and others dislike them, with IDs in preference for harmony in music ranging from −0.73 to +0.97).*

Most importantly, the correlations between a difference-score measure of preference for harmony were systematically above chance for all pairs of different domains, ranging from +0.60 for color pairs and music to +0.32 for spatial composition and music. Preference for harmony can explain Eysenck's t-factor because the preference judgments of individuals who prefer harmonious stimuli will necessarily be more highly correlated with average preferences to the degree that people generally prefer harmonious stimuli in that domain, as it was for all four of Palmer and Griscom's domains. [25]

To summarize, the research suggests that people have aesthetic preferences and that those preferences correlate to historical concepts of harmony across the range of artistic domains and modalities. However, generally-speaking individual differences vary so widely as to leave the idealized harmonies in the arena of a "mythical average." The mythical average is the belief that we can use statistical averages to understand individuals.[26]

After addressing the general state of documented variations to overlying general preferences based upon group attributes such as: age, gender, culture, relative experience with the aesthetic discipline, and context (i.e. relating to the particular objects assessed); *Palmer, et al* go on to summarize six prevalent general theories for the phenomenon of these widely varying individual aesthetic preferences. The summations are labeled here for easy reference:

1) **Mere Exposure** People tend to like objects and images more as the frequency of seeing them increases.[27]

2) **Arousal Dynamics** A complex and influential theory of aesthetic response based on a psychobiological conception that pleasure is a matter of the viewer's degree of arousal while viewing an image.[28] [29]
3) **Prototype Theory** Rosch's transformative research on prototype effects in categorization suggested a different avenue to explaining visual preferences than that which was developed primarily by Martindale and Whitfield. [30] Simply put, people may prefer prototypical examples of categories to non-prototypical ones.
4) **Fluency Theory** Perhaps the single most general explanation of aesthetic preference, Fluency Theory posits that people prefer visual displays to the extent that they are processed more easily (or fluently). [31]
5) **Representational Fit** Sammartino & Palmer have suggested that people prefer images to the extent that their spatial composition optimally conveys an intended or inferred meaning of the image, thus including a semantic variable that is missing from fluency theory. [32]
6) **Multicomponent Theories** Note: the following sub-paragraph headings in "a," "b," and "c" are designated by the author for convenience and are not *Palmer's,et. al.'s*
    a. I-SKE: "Shimamura , for example, has presented a general approach to understanding people's aesthetic responses to art... the framework is summarized by its acronym, I-SKE, which stands for the intention (I) behind the artwork in relation to the viewer's sensory (S), knowledge-based (K), and emotional (E) responses." [33]
    b. The Five Process Method: "Leder and colleagues [34] formulated a detailed information-processing model that attempts to analyze and synthesize many diverse aspects of people's appreciation of art, and especially of modern art. It consists of a series of five processes, each of which is influenced by many factors. The five processes are proposed to occur in the following order: (a) perception, which responds to stimulus factors, such as complexity, symmetry, color, contrast, and organization; (b) implicit classification, which involves integrating this perceptual information into related information stored in memory concerning familiarity, prototypes, and conventions; (c) explicit classification of the artwork in terms of its style and content; (d) cognitive

“mastering” of its style and content by interpreting them within one’s knowledge about related art and with respect to the viewer’s self; and finally (e) evaluation of satisfaction in terms of both the work’s cognitive aspects (e.g., understanding of meaning and ambiguity) and the cumulative influence of all the stages of processing on the viewer’s affective state.”

c. Appraisal Theory: “Silvia’s theory of aesthetic response is based primarily on analyzing the diverse emotional responses a viewer might have to art objects.[35] [363738]He divides emotions into several kinds—positive emotions (happiness, enjoyment, pleasure), knowledge emotions (surprise, interest, confusion), hostile emotions (anger, disgust, contempt), and self-conscious emotions (pride, shame, guilt, embarrassment)—and argues that all are relevant to understanding aesthetic responses to art.” [39]

The Significance and Difficulties in Establishing Virtual Immersion

I got me a dog and my dog pleased me. I fed my dog under yonder tree.

- Fiddle-I-Fee Traditional additive nonsense song.

As was summarized in the preceding sub-chapter, the state of the research in scientific aesthetics suggests that the prevailing practice in architectural design – that of having a client react, positively or negatively, to preliminary finished, aesthetic harmonic (e.g. a “building design”) -- should not be expected to generate an acceptable understanding of the client’s underlying aesthetic preference because -- over and beyond documented variations relating to age, gender, culture, relative familiarity with the architectural discipline -- the specific context in which the project is presented; individual differences based upon multi-components vary through an as-yet not clearly understood process. [40]

A possible response to this challenge might be to break the principles and elements of design into virtualized base components (the established elements of design), derive quantifiable preferences relating to them out of context, and then re-contextualize them in light of a (signature) model of aggregated preferences.

In this sense the process is a bit like the additive nonsense* folk songs that offered increasingly detailed and precise constructions reflecting set of personal choices, improvised within a fixed structure. The final forms of those song expressed a particular sensibility as it pushed the boundaries of an encompassing domain (in the case of the nonsense songs, the domain of common sense in linguistic construction.)

As with most seemingly obvious solutions, upon further consideration, multiple questions arise: Most immediately: Can “de-contextualized” base preferences even be “re-contextualized.” Is there an event horizon, so to speak, beyond which everything we know about a person’s aesthetic preferences change?

Virtualization holds out a hope of answering that question. Why virtualization? Why not just place a subject in a physical location and measure *actual* responses to *physical* objects?

With respect to compositional proportional preference, for instance, a subject could be ushered into a room and asked to remove an apple from a bowl, and place it on a table in the “most pleasing” arrangement. The objects location could establish a ratio with respect to the frame of the table. The location of the objects could then be recorded, a quantification assigned, and a validity test conducted against another quantified compositional proportion embedded in a different context –say a photograph of a building.

*Those songs were not nonsensical in the sense of being gibberish, but relied up upon a tension between elements of sense and nonsense.[41]

In distinction to this “real world” approach, there are five primary advantages and one additional secondary advantage to the virtual choice model approach:

1) **Confounding** As was noted in the discussion of multi-component theories of aesthetic preference, multiple studies suggest that aesthetic preference cannot be reduced to preference for individual elements within an object of art. The whole is more than the sum of the parts. Small, seemingly innocuous qualities of the object, unrelated to a particular component being studied, might have profound effect upon a subject’s preference.
   The virtual choice model allows extraneous aesthetic content (potential confounding material) to be suppressed.
2) **Modularity/Scalability** The virtual choice model allows new, pristine modules addressing *particular and specific* elements, or principles, of design to be added to established modules. In this way statistical tests for interaction can be performed at each stage and multiple regression analysis can establish the relative importance of any given element to a subject’s preference.
3) **Precision.** The virtual choice model allows for precise measurement. For instance, in Two Roads study, the desired proportion can described to the thousandth of a unit.
4) **Corroboration.** The virtual choice model approach allows the exact same test to be conducted in different physical locations, in all its particulars. This allows for wider collection of data, and lends itself to better test-retest measures of reliability.
5) **Real Time Data.** The virtual choice model allows for the collection of real-time data. The elapsed time between any two virtual movements within the overall process can be quickly determined.
6) **Utility** Finally, there is an important component of a virtual model that transcends academic concerns and touches on the nuts and bolts of architectural practice. Architects lay down lines of construction in a virtual manner – pen on paper, computer model, 3D print. While the domain may vary, the mode of perception is already established. It is virtual. (Additionally, in a highly practical sense, a virtual choice model closely resembles a computer game and can serve as a fun, ice-breaker

to begin a discussion with a client’s about the elements of design and their preferences.)

Despite these advantages, the virtualized model approach also presents some challenges:

1) **Confounding** As has been pointed out, virtual spaces are not physical, three-dimensional spaces. They manipulate certain monocular and (in more recent technologies) binocular cues in order to simulate certain aspects of three dimensional space. Yes, sounds can seem to echo off a virtual wall, and a light source can appear to bounce off of it and create a back-shadow. Motion parallax is evident. But this truncated reality might present a confounding problem of its own. The particular process of decoding dissonant neural stimuli generated by a constrained virtual space might favor certain aesthetic responses over others?

2) **Methodology** Virtual space is accessed and manipulated through the use of various input device. In the strictest sense, the participants interact with the input devices, not the virtualized “objects” being measured. For one instance, the monitor introduces its aspect ratio -- a proportion -- around the virtual objects in play. A mouse is used to select and move objects within virtual space. For another, the ease of use with, say, the mouse might alter the length of time an object is virtually “held.”

With respect to confounding, there is no complete answer to the objection. However, the point remains that numerous potential third variables may eliminated; while one potentiall variable remains. And, since architects almost exclusively rely upon virtualized (or rare small scale physical) models of their work through design, it can be argued the objection – as persuasive as it may be -- is already abaft prevailing practice.

With respect to the methodology, the challenges generally touch on the questions of immersive vs. augmented reality:

Briefly put, augmented virtual reality is an enhanced version of reality created by the use of a device to overlay digital information over an image of an actual thing being viewed through by means of the device.[42] By distinction, immersive virtual reality is a complete artificial environment experienced through sensory stimuli (sights and sounds) generated by a device, through which the subject interacts with and “in” the environment.[43]

Augmented reality is not considered ideal for the Two Roads study, for the reasons very highlighted above: greater opportunities for confounding, lack of modularity/scalability, and all the noted difficulties in replicating any studies.

Immersive technology is favored, with the caveat that more “state of the art” immersive technologies might lead back to the third variable problems mentioned above. (The study could end up measuring technical competency with the input device rather than any favored proportions.) For this reasons, a lower level of immersion is favored over a higher level of immersion. Moving abstracted dots into a favored position on a monitor screen is theoretically less problematic than parking virtualized automobiles in a virtual parking lot.

Consequently, the Two Roads virtualization attempts to achieve something relating to the lowest level of immersion commonly experienced by gamers, or architects designing in *Revit* or *Autocad*, since those types of technology might offer greater utility (be more easily integrated) into the established practices and subculture of the profession.

Chapter 3 Principles and Elements of Design

Aesthetic Terminology as it Relates to Principles and Elements of Design in the Humanities and Prevailing Architectural Practice

There are three objectives for any conclusions drawn from the Two Roads study: reliability, validity, and utility. As traditional components of scientific research, reliability and validity are fairly straightforward and are addressed, as is normally the case, in the Results and Conclusions chapter of the study (Chapter 6).

As was briefly noted in the preceding chapter, utility relies upon developing terminology that will allow any conclusions to be communicated in a manner that can be readily adapted to the mathematical systems and linguistic terms of art currently and commonly employed by architects.

Present architectural practice is formulated on two tracks: an aesthetic track – for purposes of this study "of, relating to, or dealing with the beautiful" [44] and an architectonic track -- for purposes of this study "the scientific study of architecture."[45] Architectonic terminology tends to use the units of measurement favored by scientists and technicians in general: decibels, sones, footcandles, lumens and the like. By contrast, aesthetic terminology is derived from historical art theory and philosophy: symmetry, commodity, delight, the sublime, and so forth.

In particular, (Western) architectural practitioners describe the aesthetic components of their work in terms relating to established principles and elements of art design: scale/proportion, figure/ground, unity/balance, contrast/variety, repetition, pattern/rhythm, superimposition, hierarchy, context, and systems. These terms have become semi-standardized since 1856, when John Ruskin began applying some of them, if not in a wholly original manner, in a comprehensive and systematic way that lent itself to easy incorporation into art education .[46]

As was noted in the previous chapter, the emerging field of scientific aesthetics (and more specifically neuro-aesthetics) might, in time, bridge the gap between these disparate tracks but at the moment that field is focused on sensation and perception. Data is characterized as it might be for established human factors or neuro-scientific research.

The gulf that divides the two architectural sub-realms is not limited to the different areas of focus. It extends to the language used within them. Architectonists commonly speak in absolute terms (e.g. *net-zero*); while formalist architects tend toward part-to-whole comparisons relative ratios and ordinal scales (e.g. *triparte*).

So before embarking on an investigation of the selected element of art design – proportion – from an architectural perspective, it would be best to step back and explain what those formalist architects are talking about when they talk about proportion, and the meaning of the some of the words they use to describe it.

In its least restrictive sense, proportion is the relation of one part to another -- or to the whole, with respect to magnitude, quantity, or degree. In the same way, a ratio is the relationship in quantity, amount, or size between two or more things.[47] This obviously encompasses notions of figure-ground and relative scale.

Compositional proportion refers to implied primary part to whole. With respect to compositional proportion, (Western) architects have, since the Classical era, aspired to "symmetry," famously if somewhat tautologically defined by Vitruvius as "… harmonious proportion."[48] Ratio is the mathematical notation architects use, in part, to express compositional proportion. "In part" because while ratio is precise, it is not precisely descriptive of proportion.

An analogy might be made to music marks, such as *allegro* and the like, as compared to beats per minute. A composer could recognize a *scherzo* irrespective its time signature, possibly based the location of the movement within the piece.

Similarly, architectural ratios are understood with respect to certain historical periods of art which contextualize them. To give one example, a (small 'm') mannered proportion is a proportion slightly and idiosyncratically deviating from an associated, implied historical norm. It does not rely on an absolute mathematical relationship, but rather deviates within an acceptable range that is a sliding scale established by its context. The referenced style of architecture establishes, by implication, a norm that is then a criterion for determining a mannered state. The ratio itself can vary.

For modern Western architects, the significance of proportion within an overall design is a product of history -- as will be described in some detail in the next chapter. A base carrier wave of accepted harmonious proportion was established during the Classical era and given a religious significance by the late classical/early Christian theologian Boethius:

"Boethius explained all of this in terms of the theory of proportion. The soul and the body, he said, are subject to the same laws that govern music, and these same proportions are to be found in the cosmos itself. Microcosm and macrocosm are tied by the same knot, simultaneously mathematical and aesthetic. Man conforms to the measure of the world, and takes pleasure in every manifestation of this conformity: 'we love similarity, but hate and resent dissimilarity'."[49]

In the late Middle Ages this significance to proportion, and the use of underlying stylistic keys in decoding it, were fully integrated into Christian thought in the aesthetic theories of Thomas Aquinas. In *Summa Theologie* (c. 1269) Aquinas argues that beauty has three standards: proportion, clarity, and integrity. Proportion had a place of prominence relating to the position of the Christ within the Trinity. For Aquinas, the Son has *integrity* insofar as he "has in Himself truly and perfectly the nature of the Father," and *proportion* "inasmuch as He is the express Image of the Father."[50]

Therefore: "Proportion is twofold. In one sense it means a certain relation of one quantity to another, according as double, treble and equal are species of proportion. In another sense every relation of one thing to another is called proportion. And in this sense there can be a proportion of the creature to God, inasmuch as it is related to Him as the effect of its cause, and as potentiality to its act; and in this way the created intellect can be proportioned to know God."[51]

In his analysis of the significance of scholastic thought to modern conceptions of beauty, Umberto Eco maintained -- following Aquinas – that proportion has been historically reduced to relationships of quantity and relationships of quality. Relationships of quantity are mathematical, while those of quality more 'habitual.' Eco explained this as a relation of "mutual reference or analogy, or some kind of agreement between them which subjects both to a common criterion or rule."[52] Aquinas felt this second relationship could be one of matter to form, cause to effect, and Creator to created.[53]

This second interpretation of proportion -- fidelity to rule -- was further inculcated into Western architectural practice by Leon Battista Alberti. In his masterful treatise *De re aedificatoria* (On Architecture 1485) Albert argued that beauty depended on "a harmony and concord of all the parts, achieved in such a manner that nothing could be added, taken away, or altered except for the worse."[54] He called the quality *concinnitas.*

Without abandoning the notion of proportion as fidelity to cause, Alberti reimagined the template for cause: he argued that harmony required mirroring nature's physical laws in the number (*numerus*), the placement (*collocatio*), and the proportions (*finitio*) of the parts. He believed those proportions fell along the lines of Pythagoras system of musical harmony.[55] Correspondingly, Alberti introduced a modified theory of the orders based on that system.

As the western world moved on from the Renaissance to the Romantic era, the stylistic norms to which proportions should subject themselves began to multiply. Underlying proportional harmonies became increasingly eclectic. By the late Nineteenth Century, architects were engaged in a subtle forms of "code switching" (the switching from the linguistic system of one language or dialect to that of another)[56] They remained faithful to established proportional rules even after the system of thought that generated those rules had lost popular meaning. They achieved the effect they desired by blending rules. In this way, for a few decades before the Modern movement (c. 1865-1895) the situation facing architects resembled the situation as it stands today.

It might be helpful at this point to glance at the work of one proto-modernist architect who was particularly adept at proportional code-switching. It is suggestive of a de-contextualized/re-contextualized process in application.

Following decades of neglect, during which many of his most important buildings were demolished, there was a revival of interest in the work of Frank Furness in the mid-20th century that coincided with the rise of anti-modernism. “Of the highest quality, is the intensely personal work of Frank Furness (1839-1912) in Philadelphia. His building for the Pennsylvania Academy of the Fine Arts in Broad Street was erected in 1872-76 in preparation for the Centennial Exposition. The exterior has a largeness of scale and a vigor in the detailing that would be notable anywhere,..."[57]

Figure 3.1 Philadephia Academy of the Arts https://creativecommons.org/licenses/by-sa/4.0

Hitchcock’s “vigor in the detailing” might be considered a bit of an understatement when describing Furness’ distinctive method of code-switching. He was fond of plugging isolated super-sized gothic, or other, stylistic ornament into classically-proportioned superstructures. The technique might be best diagrammed on the Paul Peck Alumni Center Drexel University – Furness’ former Centennial Bank Building.

Figure 3.2 (Paul Peck Alumni Center Drexel University) https://creativecommons.org/licenses/by-sa/3.0/

Furness studied under Richard Morris Hunt, whose favored method of instruction involved near-constant sketching of classical designs. He was reported to have instructed his students: “No matter if you never practice classical architecture, you will acquire a certain idea, or instinct, of proportion that will never leave you.”58

The instinct is evident in Furnness’ work. If the viewer looks past the somewhat distracting individually over-scaled elements, the underlying proportional composition is unmistakably Palladian. It replicates the proportioning in Palladio’s iconic Villa Capra (La Rotonda). almost precisely.

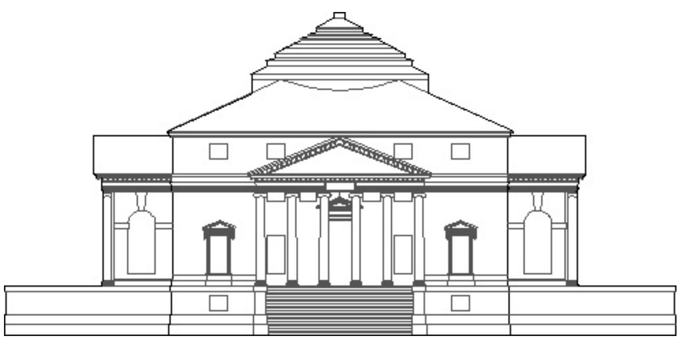


Figure 3.3 Villa Capra (La Rotonda) Andrea Palladio - I Quattro libri dell'Architettura (1570)

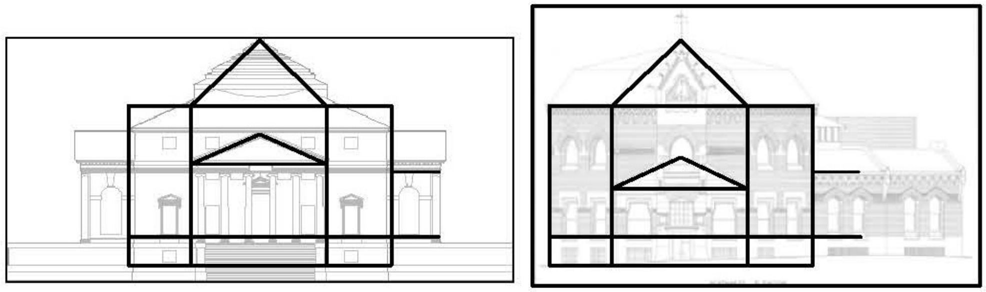


Figure 3.4 La Rotonda vs. Paul Peck Alumni Center

It would be difficult to establish any real degree of utility for proportional preferences derived from the Two Roads study without first relating them to the well-known historical proportional keys. However, once related, the preferences could be easily brought into play in the manner of a Frank Furness composition.

The next sub-chapter illustrates how foundational proportions can be to architectural design, and surveys the established historical norms.

Proportion

To see a world in a grain of sand
And a heaven in a wild flower,
Hold infinity in the palm of your hand,
And eternity in an hour.

– William Blake, Auguries of Innocence (1803)

Or in the shinbone of a supermodel?

If a hypothetical ten-year old girl aspired to the career of high-fashion model, an equally hypothetical modeling talent scout might quickly and reliably sum up her chances of making a living by assessing a few key physical traits, most notably leg-to-stature and femur-to-tibia ratio.

When pressed, the agent might struggle to explain why a 1.4:1 leg length-to-stature ratio is considered desirable by the industry; or a “1:1 F/T” ratio* matters to at all.[59] She might offer up the old truism, that a model must conform to the established proportions because, “They must know that any model from any agency will fit the clothes.”[60] But that would beg the question. A sensible person would want to know why models were being culled to “fit the clothes” rather than the other way around.

One might wonder how common these ideal proportions are in the general population. (“Super models” do seem awfully long-legged.) And that would a good place to start. In point of fact, the preferred leg-length / stature ratio of female models is so rare that the question can’t easily be answered with precision. It exceeds three standard deviations. It is so uncommon that it is quite literally off most charts.[61]

The question is: Why do humans vivisect their bodies to fit clothes?[62] Fortunately, the topic has been much studied. Unfortunately, the answer is a complicated – but it is also interesting and instructive although it requires a Shandyesque digression.

The explanation began on the shores of the Mediterranean Sea twenty-six hundred years ago, where Herodotus recorded that the Assyrian King Assurbanipal (c. 664 B.C.E.) appointed twelve local vice-kings to govern a newly conquered land. One of them, Psammetichos by name, deposed his co-rulers and absorbed their realms into his own with the help of some Greek mercenaries. . . *Certain lonians and Carians, voyaging for plunder, were forced to put in on the coast of Egypt, where they disembarked in their mail of bronze.. . . Psammetichos made friends with the lonians and Carians and promised them great rewards if they would join him.*[63]

* F/T ratio is calculated as: Length of Femur: 'F': Length of Tibia: 'T' where, F+T = 'L' (total length Leg) F / L (100) = FL (Femur to Leg ratio) 100 - 'FL' = TL (Tibia to Leg ratio) FL:TL = F/T ratio

This "first contact" between the Greek and Egyptian peoples led to a long-term trading and cultural relationship. Throughout the part of the latter seventh century BC, the distinctive Egyptian system for the representation of the human figure. (You might recognize it if you ever tried to "walk like an Egyptian.") was imported to the Aegean and applied to the sculpting of Greek Kouros* statues.[64] (Guralnick 1978)

Figure 3.5 Archaic Metropolitan Kouros

The Egyptian proportional canon was based upon a grid derived from a fixed unit of measurement, reportedly based upon the width of the Pharaoh's palm. Under this system, the leg length constitutes 1.12 of the length of remaining body height.

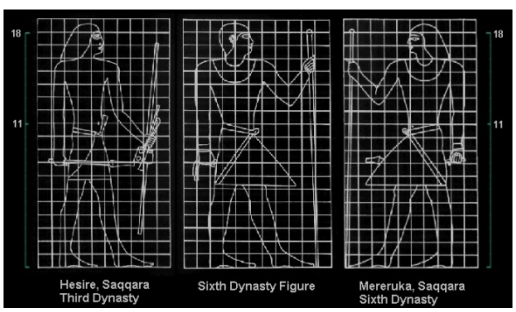


Figure 3.6 Egyptian Canon

* A kouros is modern term assigned to free-standing Greek sculptures that first appeared during the Archaic period

Over the sea, the Greeks tweaked these foreign proportions to suit their own needs and sensibility.

Greek artists favored a system of proportion relative to the individual parts of the figure. They utilized measurements based on the length of the human foot to sketch the human body on the stone before carving, a concept (innovated) in Classical times by Polykletos… The Greek sculptor, not utilizing a rigid system of measurement, began depicting the parts of the human anatomy in proportions related to one another. The height of the head soon became the obvious point of reference, and a standing figure's height was expressed by a number of 'heads.' In reality, the human head's height would fit about seven times into the man's height, and conversely several Kouros exhibit the 1:7 head:body proportions (Kroisos, Aristodikos, Piraeus Bronze Kouros), some 1:8, some 1:6.5 (Sounio Kouros, Kleobis + Biton).65

The head/body ratios continued to evolve throughout the Early Classical period until they settled into a set of fixed proportions which happened render legs 1.4 times remaining body height, which was enshrined in Polykleitos treatise *Kanon*. Although there is some debate, it is generally accepted among art historians that that this classical ideal was the by-product of devotion to a golden ratio* as reported by Vitruvius in the 1rst century BC[66] and famously illustrated by DaVinci.

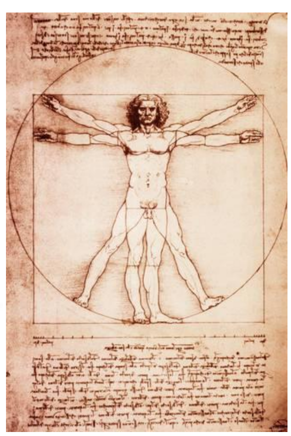



Figure 3.7 Early Classical Pireaus Apollo Kouro Giovanni Dall'Orto.14 November 2009

Figure 3.8 Vitruvian Man as depicted by Da Vinci Leonardo Da Vinci - (1490)

The origin of the preference hardly matters, what is significant is that the classical anatomy is incongruent with actual human bodies, especially with respect to the leg/stature ratios. Although slightly less anomalous among males,[67] (Chandravadiya, et al. 2010) the preferred leg-length/stature proportion was jarringly dissonant when imposed upon females. For several centuries, the problem was literally veiled, as Greeks of the era were reticent about depicting unclothed females, and sculpted even the most powerful female divinities in flowing robes.

It might have been changing tastes that led the Praxiteles to treat his gods and goddesses a little more fairly. He carved the first fully disrobed goddess (Aphrodite of Cnidos) about 350 BC. The great sculptor was compelled to mask the proportional tragic-comedy playing out in the shin region by posing the model stooped over in exaggerated *contrapposto*, creating the famed "Praxitelian curve."

Figure 3.9 Aphrodite of Cnidos

*Two quantities are said to be in golden ratio if their ratio is the same as the ratio of their sum to the larger of the two quantities.

Generations of Greek sculptors mimicked it, or devised other strategies to the same effect, depicting females reclining, supine, sitting, dancing – any which way to conceal the uncooperative leg/shin proportion.

Which brings us back to the notional modern-day fashion model. Over the roughly seven-hundred year period (700 BC- 600 AD) of classical culture, and the later five-hundred year period of neo-classical (1400-1900 AD) representation; humans seem to gradually inculcated the flawed leg proportion into a mental map of the human body.[68] (Bogin 2010)

There are various other possibly sociocultural, feminist, and neuroscientific explanations offered for this preference, touching on; respectively, cognitive behavioral factors,[69] the phenomenology of the body,[70] and the sensory homunculus,[71] respectively. However, the proof of the pudding is in the eating. Figure 3.10 depicts Mattel's famous Barbie doll, juxtaposed against a more recent "healthy body image" (proportionally correct) "Lammily" doll.

Figure 3.10 Barbie v. Lammily Coutresy Lammily https://lammily.com/average-is-beautiful

Which doll looks "right" – proportionally speaking? If a skeptical reader with raised consciousness prefers the more naturalistic Lammily, they are left to explain why Barbie's extruded form did not seem as glaringly incongruent to several generations of Twentieth Century girls, as it did to Praxiteles who labored so artfully to conceal it.

Since we are all intimately acquainted the human body, the subconscious application of an underlying ideal to the human anatomy is easily understood. The Two Roads study is focused on less readily apparent proportional preferences -- ones that fall beneath the notice of most of us, but are just as deeply insinuated into the built environment.

If the reader studies the following paired images of buildings from different historical periods in same manner they viewed the Barbie and Lammily dolls Figures 3.7-3.15. they might notice certain sets of proportions that also feel “right” or “wrong.”

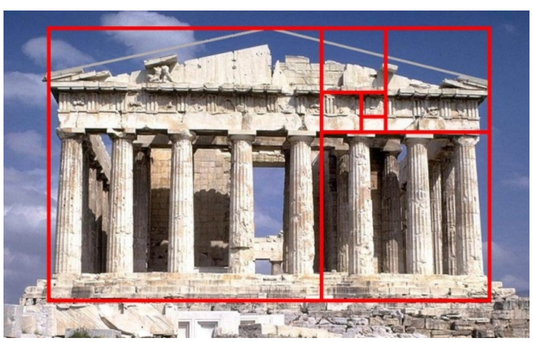
The first image is representative of Upper Paleolithic expression. It displays the distinctively horizontal emphasis and lack of those principles of composition that address boundary. We can speculate that the aesthetic derives from the dictates of gravity as it is manifest in nature: the angle of repose of soil, the horizontal nature of decomposing detritus and the like – combined with peripheral vision’s fuzzy, un-bounded edges. Something like a ratio of 1:.8 seems to be semi-consistent through the few artifacts that have come down to us from that age. (Although David Lewis-Williams has offered persuasive arguments that, at least with respect to the rock art, those examples may have been produced in response to entoptic phenomena.[72])

Figure 3.11 LeMas d'Azil Horse.(c.12,000 BCE) https://creativecommons.org/licenses/by-sa/3.0

By contrast the Neolithic period sees the discovery and adoption of pottery and weaving technologies. Of necessity, textiles incorporate a clearly-defined boundary, and a field characterized by the extruded warp* and truncated weft.* It could be that use of a loom was responsible for the sharp, 1:1 orthogonal underlying the art and crude (mostly megalithic) building remaining from that period.

Figures 3.12 Poulnabrone Dolmen (c.4000 BCE) public domain

Regardless, this Neolithic ratio informs the Bronze, Archaic, and Late Egyptian periods as they evolved toward the Classical 1:1.62 “golden mean” (and its slightly eccentric Mannerist cousin of 1:1.17-1.4) – as we discussed earlier in this chapter.



Figures 3.13 Parthenon - (Ictinos & Callicrates 447 BCE) https://creativecommons.org/licenses/by-sa/3.0
Figures 3.14 Palazzo Te - Mantua.) (Guilo Romana 1534) https://creativecommons.org/licenses/by-sa/3.0

Possibly the greatest visual distinction between contemporaneous architectural epochs can be found in buildings of the Classical and Baroque eras. The Baroque represents a clear break from the Mannerist/Classical/NeoClassical traditions that bracket it. Some have theorized that Baroque proportioning constituted a self-conscious, in-your-face counterstroke against

Platonic, historically-derived ideal proportions by Counter-Reformation propagandists that preferred self-referential, numero-logical, "Aristotelian" rational numbers. This new breed of architects supposedly eschewed "ineffable" ratios, such as those found in the Golden Ratio, and sought more "heavenly," natural intervals: 1:x 2:x, especially favoring prime numbers. [73] (Hershey 2000) Their work ultimately favored that 1:5 ratio, so preeminent in the Baroque.


Figures 3.14 Palazzo Te - Mantua (Guilo Romana 1534) https://creativecommons.org/licenses/by-sa/3.0
Figure 3.15Church of the Gesu–Rome(Giacomo della Porta–façade-1573) https://creativecommons.org/licenses/by-sa/3.0

The Romantic era witnessed further innovation. The *Zeitgeist* found expression in living proportions evocative of a beating heart -- the heroic struggle of a soul yearning to give birth to itself. It gave us that exaggerated, proportional elasticity in the *tempo rubato (ad libitum, apiacere, a capriccio)* of nineteenth century symphonic music.[74] The fanciful historical revival styles of that time, exhibited equally idiosyncratic proportioning that might owe their existence to the cult of the heroic architect – Henry Hunt Richardson, *et al.* Still, if we limit our focus to Nineteenth Century vernacular design, over against the more varied grand design traditions (Academic and Beaux Arts) we find an unwavering vertical emphasis influenced by the fashion for all things Gothic. The range of ratios from 1: 2.7 to 2.9 might capture the favored proportion and still accommodates outliers.

Figure 3.16 Houses of Parliament - London. (Charles Barry 1840) https://creativecommons.org/licenses/by-sa/2.0

If the Romantic was diverse and eclectic, whenever we speak of the Modern we are reminded of Bertrand Russell's admonition apropos mathematicians, that "we never know what we are talking about, nor whether what we are saying is true."[75] The sheer number and variety of sub-styles within Modern architecture frustrates classification. This diversity leads many architectural historians to adopt taxonomies built upon underlying processes or stated manifestos of intent; rather than the morphology of the built work itself.

Since our study addresses proportion *per se*, we will focus on one particular sub-variant of the International Style. It was wildly popular in the United States between 1945 and 1975, and was both highly enamored of nine-square grids and beholden to neoclassicism's fascination with tripartite composition. A 1:3 ratio is almost stereotypical within Mid-Century Modernism.

Figure 3.17Neutra Kaufman House. (Richard Neutra c.1946) https://creativecommons.org/licenses/by-sa/3.0

Which brings us up to today, and the proportional anarchy that frustrates many contemporary practitioners. Post-structuralist, quasi-sculptural "blobitecture"[76] might be the consequence of a society without what William James called an "apperceiving mass;" that is, an automatic, broadly-shared Hidden Mind preference for "this over that" [77] that formerly characterized cultural identity.*

Figure 3.18 KunstHaus - Graz (Peter Cook Colin Fournier 2003)

Marxist critic Walter Benjamin's prescient 1936 essay *The Work of Art in the Age of Mechanical Reproduction* envisioned a future era where works of art would be stripped of any "aura" of authenticity – meaning direct relationship a specific spiritual, or philosophical origin event -- and appraised for their "exhibition" value over its "cult" value.

Although he felt architecture was the most resilient of the arts. It too, would be made to serve the capitalist mode of production and consumption. *Buildings have been man's companions since primeval times. Many art forms have developed and perished. Tragedy begins with the Greeks, is extinguished with them, and after centuries its 'rules' only are revived. The epic poem, which had its origin in the youth of nations, expires in Europe at the end of the Renaisance.*

*In keeping with all our other speculations, we might also look for the origin of Safire's "blobitecture" in the adoption of CADD (computer aided drafting and design) software in the early 1980's. CADD played a role within early post-modernism similar to that played by the drafting machine in late Mid-Century Modernism, which was so strongly attached to the architectural device of the skewed grid.

Panel painting is a creation of the Middle Ages, and nothing guarantees its uninterrupted existence. But the human need for shelter is lasting. Architecture has never been idle. Its history is more ancient than that of any other art, and its claim to being a living force has significance in every attempt to comprehend the relationship of the masses to art.[78]

Accordingly, Benjamin's predicted a future canon of architectural design devoid of meaningful (cultic) proportional queues, making use of materials, such as glass, which could not engage on a tactile level. This architecture would be meant to be viewed casually, and be received in a state of distraction. Through "shock-effect" it would deny its users any opportunity for contemplation. The perfect capitalist architecture would exercise covert control over the masses, reducing them to disengaged atoms of consumption. "The latter, too, occurs much less through rapt attention than by noticing the object in an incidental fashion. This mode of appropriation, developed with reference to architecture, in certain circumstances acquires canonical value."[79]

So it is notable when Marc Kushner, architect and co-founder of the Architizer platform, takes issue, as he recently has, with complaints about the current state of architecture, and proclaims a new canon:

The apex was a recent episode in France where Frank Gehry raised his middle finger to the press and declared that "98% of everything built and designed today is pure shit."

Architecture is on the verge of a golden age, but it feels like a catastrophe to the established critics and tastemakers whose power is being wrested away by the public—the people who actually use architecture. This fundamental shift in architecture is happening thanks to social media. Take a moment to think about how you consume architecture. Five thousand years ago, you had to walk to a city to see a building. As faster modes of transportation developed, the upper-class Grand Tours of the 17th through the 19th centuries became accessible to everyone in the 20th. People could travel faster, explore farther, and experience more of the built environment.

Media has accelerated too, of course. Just 20 years ago, you could only see buildings on a printed page that had passed the discerning eye of a magazine editor. Now, social media means the consumption of architecture is both instantaneous and freed from geography; it has transcended the historic limits of time and space. <u>That means that a selfie taken in Seattle with OMA's sharp Seattle Public Library in the background becomes a part of our collective consciousness, and this happens faster and with more authority than with buildings of the past.</u>

The one style that epitomizes our current moment is Experimentalism, and that is because the echo chamber has been smashed. In my mind, I imagine a Buckminster Fuller geodesic dome with architects floating around in black suits and round black glasses talking to each other. Then along comes the giant wrecking ball of social media banging, banging, banging on that dome until POP. Whooooooosh! in rush new opinions about buildings and places.[80]

As fun and as all this speculation might be, for purposes of the Two Roads study there is no need to explain the epochal ratios. It is enough to demonstrate that there have been differing proportional systems in the past, and that (for the moment) they seem to hold some value. People generally know a "proper" proportion when they see one, and judging by their willingness to undergo things like painful leg-lengthening procedures, that ratio speaks to them in powerful ways.

Although "the people who actually use architecture" to use Marc Kushner's phrase, have supposedly transcended a fixed canon of proportion, my clients still seem to harbor a wistful, if dimly understood, attraction to one or another of the historical schemes. As I mentioned, in my own "long rambling conversations" with them I have found the origin of some of those attractions in events as inconsequential as a visit to a favorite aunt's Mid-Century Modern house, or childhood outings to a derelict one room schoolhouse in the country on a Saturday afternoons.


Figure 3.19 Fuller Residence Figure 3.20 Our Lady of Victory

With respect to Cyril Connolly, it seems that hiding in the core of every human being there is an aesthetic preference for this, that, or the other proportion waiting to get out. The challenge is to identify the preference at an early point in the design process and shortstop the need for extensive design revisions down the road. To this end, Two Roads adopts an evidence-based design (EBD) approach.

The model attempts to distinguish preferences between six (Neolithic,Archaic,Classical, Modern, Mannered and Baroque) of the nine historical classes of proportions: Paleolithic, Neolithic, Archaic, Classical, Mannered, Baroque, Modern, Romantic, and Post-Modern. The use of these terms in this study is not intended to directly correspond to namesake artistic epochs; but rather constitute convenient shorthand for well-known ratios that to a degree express preferences resembling them.

The base ratio for the nine classes could be summarized:

(P-P) Paleolithic 1:.8, (P-N) Neolithic 1:1, (P-A) Archaic 1: 1.12, (P-C) Classical 1: 1.62, (P-M) Mannered 1: 1.17-1.4, (P-B) Baroque 1:5, (P-R) Romantic 1:2.7-2.9 (but widely varied), (P-m) Modern 1:3, (P-pm) Post-Modern (randomized).

For purposes of our study the proportions are pared down to six classes. The Paleolithic is disregarded because -- as was briefly mentioned in the historical survey – there remains a persuasive argument that it was produced in an entirely different mode of perception. The Post-Modern is excluded because, as was also mentioned, in that style of composition proportion does not conform to a set canon and is (in theory) randomized. And finally, the

Romantic represents a different mode of compositional proportional expression that might not be best revealed through selection of one particular ratio, but through selection of widely varying ratios with consistently strong attachment expressed for every selection.

So for purposes of the Two Roads study, the resultant classes are:

<u>(P-N)</u> Neolithic 1:1, <u>(P-A)</u> Archaic 1: 1.12, <u>(P-C)</u> Classical 1: 1.62, <u>(P-m)</u> Modern 1:3 <u>(P-M)</u> Mannered 1: 1.4, <u>(P-B</u>) Baroque 1:5.

A visual representation of them – expressed in a simple façade contextualization in the manner of Frank Furness -- might look something like this (respectively).

Two Roads assigns a numerical value to a client's proportional preference that relates to the historical embodied Proportion (P) the client favors.

SCALE

O God, I could be bounded in a nutshell and count myself a king of infinite space, were it not that I have bad dreams.

-- Shakespeare, Hamlet Act II Scene ii (c. 1599)

“Scale” has a peculiar meaning to architects that has little to do with size. The Oxford Dictionary of Architecture and Landscape Architecture defines it as: the proportions of a building or its parts with reference to a module or unit of measurement.[81] This definition differs little from the one adopted by hobbyist model-builder, or engineer. However, the Oxford goes on to use the word in a sentence, in a dramatically altered sense -- one that gets at the more common, nebulous, but well-established usage within the architectural profession.

Ronald Fraser Reekie, is quoted from his delightful Draughtsmanship (1946)[82] A building might disruptively dominate others to the detriment of its context, and its proportions might be such as to render it ‘out of scale’ and uncomfortable to the eye. He believed a building could be “disruptively dominating” if not scaled to a unit of measure defined by buildings in the immediate vicinity (the “context” in architectural jargon). I suppose this is easy enough to understand, but when it comes to scale modulated by proportion, he suggests the architect should rely on a subjective sense of the building being “uncomfortable to the eye.” The question that immediately comes to mind is: whose eye?

There was a (not particularly funny) joke told in Nazi Germany about Albert Speer, the “first architect of the Third Reich.” [83] In the early 30’s, when Hitler was considering architects for a large commission for the Berlin Olympics he told the first architect-applicant that he wanted to build a structure one thousand meters long. The architect pondered this suggestion before suggesting that in light of established construction modules it made more sense to build it 999 meters. -- He was taken from the room and summarily executed. A second architect was likewise brought in. He also suggested trimming the building by one meter. He got as far as, “What if we make it nine --” before being hustled out the door never to be heard from again. Then Albert Speer strolled in. He listened to Hitler’s suggestions, and considered them for a few, brief, seconds before asking: “What if we make it fifty… thousand meters?” Hitler said. “You, mein Herr, are my architect.”

It probably falls in the category of dorm room moments, the sudden realization that there is not really a ‘big’ or a ‘small’ outside of some preconceived point of mental reference. It holds true for the universe, the planets, Hitler’s stadiums, our bathtubs, every potted plant, and the footprint of a suburban home. It’s all relative, a matter of scale.*

Figure 3.22 Harpers

Recent developments in the small house movement and form-based code innovations that allow relaxed infill neighborhood densities have run up against a strong community preference for established scale within the existing urban fabric. Planners report, “Many residents are motivated by past bad experiences with new development, which failed to fit neighborhood patterns and character. New buildings which are out of scale with existing single-family structures can cause particular alarm.” [84]

*I had a client who kept pushing me to design “bigger,’ bigger.” Frustrated that I wasn’t ‘getting it’ he told me that when “IBM” entered the lobby of his proposed factory-showroom he wanted them to suck in their breath and say, “Oh, my God!” I finally got it, so I was only a little bothered when the building was finished and a colleague told me he thought the design was “fascist.”

Apart from any functional considerations, homeowners have expressed their conception of their place in the world by the scale of those same bathtubs, potted plants, and “footprints” of their homes. The innovative small house concept that a city planner, or re-developer, proposes to fit into an established neighborhood can seem just plain wrong to the residents, “uncomfortable to their eye” though they may not be able to say why.

In the Two Roads choice model, the degrees of the Scale feature are based upon certain underlying, pre-conceived scalars. (A scalar is a quantity -- such as mass or time -- that has a magnitude describable by a real number and no direction.[85]) We group them into seven named classes: Infinitesimal, Small, Intimate, Human, Grand, Monumental, Epic. These terms are not intended to correspond directly to emotional states they engender, but rather -- just as with our classes of Proportions -- constitute convenient shorthand for scales that are commonly found in the built environment. (Figures: 3.24 Infinitesimal, 3.25 Small, 3.26 Intimate, 3.27 Human, 3.28 Grand, 3.29 Monumental, 3.30 Epic.)

The base scalar corresponding for each of our divisions is: Infinitesimal (the space of the human hand, which cannot be inhabited as a practical matter), Small (the space inhabited by one human), Intimate (the space inhabited by no more than a few humans), Human (the space inhabited by small groups, say a few score), Grand (the space inhabited by large groups, say several hundred), Monumental (the space inhabited by very large groups, say many thousands) and Epic (seemingly infinite space, which cannot be constructed as a practical matter).

Two Roads assigns a value to the Scale a client favors and assigns a numerical relative value to that preference.

Chapter 4 Research Design

Method of Analysis

The Two Roads study is basic exploratory research, intended to assess the efficacy of a virtualized choice model approach to gathering and quantifying data (a virtual survey) for preference in proportional relationships.

An overall quasi-experimental approach has been chosen; to generate data that can be incorporated (if results warrant) in a future mixed-design study with a qualitative applied-research, case-study component that will further assess validity.

The first phase of this approach (the data-collection survey) includes an element of quantitative research. Data are collected to establish if a subject's (compositional) proportional preference can be defined and if so; whether a correlation exists that will be useful to further qualitative (case) study; namely, the relationship between the elapsed time a subject takes in establishing a (compositional) proportional, and the intensity of the attachment to the established proportion. The intent in this phase is to determine if, and to what degree, the variables of time and satisfaction are associated with an actual preference. An element of qualitative research is included in the form of an open-ended survey to assist in analyzing the data.

The second phase of the approach (if warranted by data collected in the first) includes qualitative research -- to add additional modules to the compositional proportional preference applying the same virtualized choice model instrument to design elements of scale and figure-ground proportion to study the application of the model on a client in an architectural office by case study method.

The third phase of the approach would be an experimental study, gathering data on a systematic sample of architectural design events, incorporating and not-incorporating the finished model to the task of design.

The research in this "Two Roads" (first) phase study features a computer-generated (virtual) environment, devoid of most proportional cues; in which a subject is asked to place a virtual object (an apple) within a virtual frame (a tabletop) in the "most pleasing manner." The ratio of the distance between the virtual element to the width of the tabletop is measured; as well as the elapsed time taken to place the element.

After completing the task, the subject is asked to rate their subjective level of satisfaction with the finished position of the objects on a (five in a pilot study and ten in a follow-along study) level Likert scale.

Research Question 1: Question 1: Can a subject's aesthetic preference be defined -- as it relates to compositional proportion?

The test / retest method is used to determine whether a preferred ratio, rather than merely random placement is being measured. The Method of analysis is Pearson's correlation coefficient formula (Pearson *r* correlation):

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{[n\Sigma x^2 - (\Sigma x)^2][n\Sigma y^2 - (\Sigma y)^2]}}$$

Research Question 2: Once defined, will the subject's (self-described) degree of satisfaction with the proportional relationship inversely associate with the amount of time it took the subject to establish the proportion?

The Spearman rank correlation formula is used to determine if there is an association between the degree of satisfaction with the proportional relationship and the amount of time taken to arrange the placement:

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2 - 1)}$$

Validity Test In the pilot study sample, a final test is performed to assess construct validity (convergent validity of proportional ratios measured against the noted tendency of the median preferred ratio to approach a golden section.) The preferred proportional ratios generated by the test were studied for face validity, and analyzed for similarity or difference using a one sample t-test:

$$t = \frac{M - \mu}{\sqrt{\frac{\sum X^2 - ((\sum X)^2/N)}{(N-1)(N)}}}$$

In a follow up, the final test is also performed to assess construct validity (convergent validity of preferred proportional ratios with a set of different preferred ratios expressed in illustrations of architectural designs generated by a simple algorithm relating to the named classes of proportion.) The preferred proportional ratios generated by the test will be will be studied to confirm normal distribution and face validity, and then analyzed for similarity or difference using a paired sample t-test:

Chapter 5 Research Method

Follow Along Study

Participants

Subjects are a convenience sample of individuals passing in front of an architectural office in Rathdrum, Idaho in a given month. They are invited to participate by a survey assistant in the manner described below.

Apparatus and Materials

- Galaxy Tab 3 tablet
- Pencil
- Piece of paper of with drawn images of buildings on clipboard (attached).
- Written 3-item questionnaire on clipboard (for demographic information).
- Software: The virtualization is run on a Unity5 gaming engine on a Galaxy Tab3

Invitation script: *We are conducting a computer-based survey as part of a research study intended to increase understanding of integrated architecture and design. You are in a position to give us valuable information. This survey takes less than 10 minutes to complete. We are trying to capture your response to the task of completing a simple operation within a computer virtualization. If you agree to participate, your response will be kept completely confidential. You will be assigned a number code to help ensure that any personal identifiers are not revealed during the analysis and write up of the findings. There is no compensation for participating in this study. However, your participation may make a valuable contribution to our research, and our findings could lead to better understanding of the capabilities of computer virtualizations as they relate to the delivery of architectural services.*

If you are willing to participate I will ask you to hold this tablet computer and follow my instructions. If at any time, for any reason you are uncomfortable, just hand the tablet back to me. After you finish the survey on the tablet I will ask you three questions, two about your experience with the virtualization and one about a picture of several buildings.

After that, I will ask you to fill out a three-question information survey (age, gender, handedness) And then I'll hand the tablet to you again and ask you to take the same virtual survey again for purposes of establishing test reliability.

Would you like to participate? Yes / No

Yes*: Great. Thank you.*

No: *Thank you.*

<u>Instruction Script:</u>

Okay, this is a normal touchpad tablet computer. In this virtualization you will move the red apple beside the bowl of fruit on the table and place it on the table in the most pleasing position. You can move the apple by placing your finger over the fruit and dragging it to the desired position on the table.

When you are satisfied with the position of the fruit on the table, press this Complete button (here), and hand the tablet back to me. When you are ready to begin you can push this Begin button (here).

Thank you. On a scale of one to ten, with ten being completely satisfied with the position of the apple on the table, and one being completely dissatisfied, how would you rate your level of satisfaction with your placement of the apple on the table?

There are six drawings of houses on this sheet of paper. Could you please take this pencil and circle the drawing you find the most pleasing?

Please tell me, were you using any strategies when you placed the apple on the table. (Yes/No) What was it?

<u>Paper / Pencil Survey Text:</u>

Age:
Gender:
Are you right-handed, left-handed, or ambidextrous?

Procedure

The subjects perform a simple task within a virtualization. They place a piece of fruit on a table in the “most pleasing” position.

Only two operations are enabled on the computer: POV navigation throughout space with standard drag; and, select and move (drag and drop) function for an activated piece of virtual fruit with standard drag.

After completing the task, participants were directed to press a Complete button and complete a survey expressing their degree of satisfaction with the placement. After taking a brief written survey (age, gender, handedness), they were asked to take the survey again in exactly the same manner.

All measurements were derived from the Unity software statistical output as recorded on the screen grab at the moment the game is paused. The proportional ratio was described as the distance from the center of the apple to the nearest boundary of the table along the x, or y, axis, divided by the total with of the table in the corresponding x, or y, axis.
In Excel the formula is written:

=IF(B5>0,(B5+1.5)/3,IF(B5<0,(B5-1.5)/-3))

<u>Pilot Study</u>

Participants

Subjects composed a convenience sample of clients procuring architectural services at an architectural office in Rathdrum, Idaho in a given month. They were invited to participate by a survey assistant in the manner described below.

Apparatus and Materials

Invitation script: *We are conducting computer-based survey as part of a research study meant to increase understanding of integrated architecture and design. As an architectural services client you are in a position to give us valuable information. This survey takes less than 5 minutes to complete. We are trying to capture your response to the task of completing a simple operation within a computer virtualization. If you agree to participate, your response will be kept completely confidential. You will be assigned a number code to help ensure that any personal identifiers are not revealed during the analysis and write up of the findings. There is no compensation for participating in this study. However, your participation may make a valuable contribution to our research, and our findings could lead to better understanding of the capabilities of computer virtualizations as they relate to the delivery of architectural designs.*

If you are willing to participate please enter this room, sit down and follow my instructions. If at any time, for any reason you are uncomfortable, please press the escape button on the keyboard and leave the room. You will be asked to take the same test again as you leave the office for purposes of establishing test reliability. Would you like to participate? Yes / No

Yes: *Thank you. Please enter the room, sit at the chair in front of the monitor, and follow my instructions.*

No: *Thank you.*

Instruction Script:

In this virtualization you will move the red apple beside the bowl of fruit on the table and place it on the table in the most pleasing position. You can move the apple by placing your cursor over the fruit; clicking, holding, and dragging it to the desired position on the table. You can set the fruit in place by releasing the button.

When you are satisfied with the position of the fruit on the table, press the pause key (here), turn over the piece of paper on the table, and circle the most correct answer to the question written on the paper. After completing the question, the experiment is over and you may leave the room.

When you are ready to begin, you can begin by pressing the start button (here).

Thank you.

Paper / Pencil Survey:

Please rate your level of satisfaction with the position of the virtual fruit on the table?
Very Satisfied
Satisfied
Neither satisfied nor dissatisfied
Dissatisfied
Very Dissatisfied

Room / Desk / Chair: The survey was conducted in a 7’-11” x 11’-6” x 8’-0” (high ceiling) empty windowless room, entered through a 3’ x 7’ solid core, flush wood door located at the end of one of the longer walls. The monitor was placed in the center of a 4’-0” x 2’-6” desk located next to the door, centered on the shorter wall and facing that wall. Neither the floor, nor the ceiling have any pattern or decorations. All wall and ceiling surfaces are lightly stippled with joint compound, and painted yellow-ochre. The flooring is a seamless vinyl sheet membrane with a uniform marbled texture, colored dark red. The chair is a Harpers 117-75 armless conference room chair.

Figure 5.1 Physical Room

<u>Computer monitor:</u> Samsung T240HD 24” screen (physical dimensions: 24” x 16” x 2”) Resolution: 1920 x 1200 pixels Color: Black

Figure 5.2 Monitor

Input devices: Logitech K350 keyboard / Logitech M705 two-button mouse Color: Black

Figure 5.3 Keyboard & Mouse

<u>Software:</u> The virtualization is run on a Unity4 gaming engine (ver. 4.5.5f1) using game object elements modeled in Autodesk AutoCAD Architecture 2015 (ver. J.51.0.0) and manipulated in 3ds MaxDesign 2015 (ver. 17.0) prior to import.

<u>Software Outputs:</u> Statistical data recorded during the game consists of the x and y co-ordinates set to a zero point in the center of the table, the z-coordinate motion of the apple and cursor were disabled. (Note: Unity software does not follow the convention of labeling the “up” direction as the z coordinate. It is labeled “y” on the screen grabs.) Elapsed time between initializing the virtualization and pausing the virtualization was also recorded.

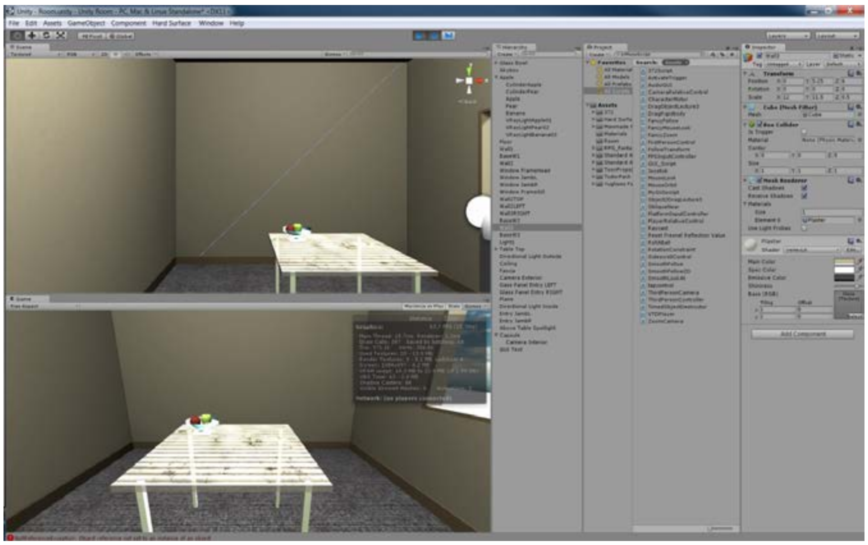


Figure 5.4 Software Outputs

<u>Virtual Space:</u> The virtual space (Unity scene) consists of a paneled, carpeted room (Figure 5.5 Virtual Room Scene) with a square translucent desk with a translucent bowl in the corner. The bowl (Unity game object) contains three pieces of fruit: apple peach banana. Simulated natural lighting is provided by a window, with faintly audible natural sounds that can be heard from the direction of the outdoors. Two other sources of light and the nature of the translucent table material remove any shadowing effect from the table.

The room is a cube. Relative to the size of the fruit, it would be judged to be approximately 10’x10’x10’ by most viewers. The table is a square. It would be judged to be approximately 3’x3’x3’ tall. The window was modeled as a 4’ x 4’ square, however the POV is placed so that only a corner of the window visible, and there is no discernible aspect ratio associated with it. The carpet (Unity material) has no patterning.

Figure 5.5 Virtual Room Scene

The virtualization displays in an area of the monitor, 20” x 13.”

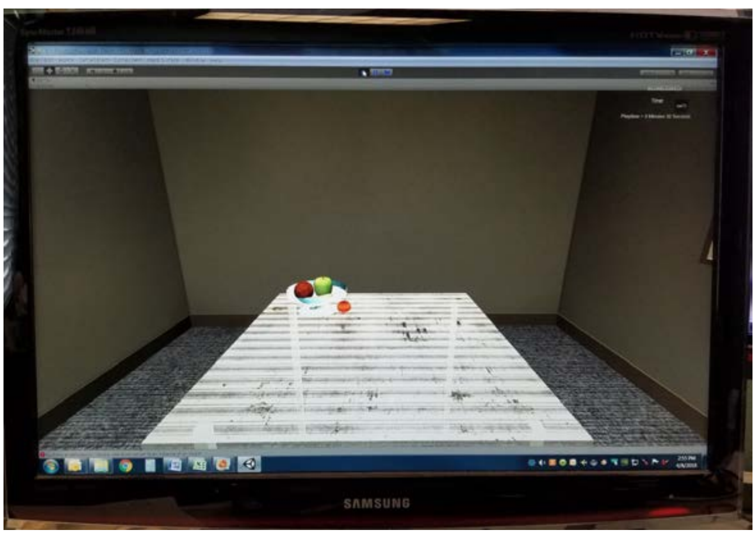


Figure 5.6 Display in Monitor

Procedure

The subjects performed a simple task within a virtualization. They placed a piece of fruit on a table in the “most pleasing” position.

Only two operations were enabled on the computer: POV navigation throughout space with standard 4-directional buttons; and, select and move (drag and drop) function for an activated piece of virtual fruit with click and hold mouse action.

After completing the task, participants were directed to press a print screen button and complete a single-question survey expressing their degree of satisfaction with the placement. As they respondents left the office suite some time later, they were asked to take the survey again in exactly the same manner.

All measurements were derived from the Unity software statistical output as recorded on the screen grab at the moment the game is paused. The participants were not directly observed during the procedure.

The proportional ratio was described as the distance from the center of the apple to the nearest boundary of the table along the x, or y, axis, divided by the total with of the table in the corresponding x, or y, axis.
In Excel the formula is written:

```
=IF(B5>0,(B5+1.5)/3,IF(B5<0,(B5-1.5)/-3))
```

Chapter 6 Data and Conclusions

Pilot Study

Pilot Study Data

Reliability with respect to ratio measurement

The test-retest method generated a Pearson's *r* value of .61 with respect to x-axis ratios. With an *n* of 15 (13 degree of freedom) this generates a *p* of .01.

At a significance level of .05, there **is** significant inter-test reliability with respect to what is being measured in the x-axis. (Something is being measured reliably along in the x-axis.)

The test-retest method generated a Pearson's *r* value of .39 with respect to y-axis ratios. With an *n* of 15 and 13 degree of freedom this generates a *p* of .21.

At a significance level of .05, there **is not** significant inter-test reliability with respect to what is being measured in the y-axis. (Nothing is being measured reliably along the y-axis.)

Correlation with respect to Time / Satisfaction variables

The Spearman rank Order Correlation Coefficient for elapsed time for the **test** is .41. Using the critical value tables for the coefficient, there **is not** a correlation between the respondent's stated degree of satisfaction and the elapsed time it took them to complete the task, with an *rs* of .41, at a level of significance of .05.

The Spearman rank Order Correlation Coefficient for elapsed time for the **re-test** is .52. Using the critical value tables for the coefficient, there **is** a correlation between the respondent's stated degree of satisfaction and the elapsed time it took them to complete the task, with an *rs* of .52, at a level of significance of .05.

Construct validity with respect to proportional measurements

A one sample, two-tailed t-Test, with respect to construct validity (deviation from historical data for proportional preferences) generated a test statistic of 1.7579, which does not fall within the rejection region. The null hypothesis is not rejected.

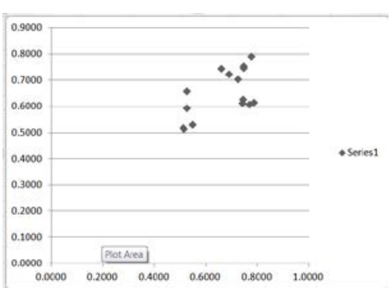
The t-test establishes a *p* of .10.

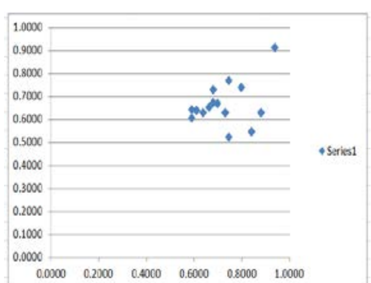
At a significance level of .05, there **is not** significant (construct) validity in the test. At a significance level of .10, there **is** significant (construct) validity in the test.

Pilot Study Conclusions

Reliability with respect to ratio measurement

Something is being measured in the x-axis, but not in the y-axis. If compositional proportional preferences are being measured, since the y-axis virtual space is distorted relative to x-axis space by the point-of-view (POV) placement at the head of the table (through foreshortening) x-axis test values are expected to be more strongly associated with x-axis retest values, while y-axis test values are expected to be less, potentially not, correlated with y-axis retest values. This is precisely the case, which supports the assertion that "something" is being measured.





X-axis test-retest r = .61 Y-axis test-retest r = .38

Figure 6.1 Generally Linear

Correlation with respect to Time / Satisfaction variables

There was concern during the research design portion of the project over the various subject's relative familiarity with input devices, hence the decision to go with a traditional mouse and keyboard rather than VR headset.

The data is straightforward. The range of elapsed time in the test was 52 seconds to 8 seconds. The range of elapsed time in the retest was 28 seconds to 12 seconds. Overall median elapsed time decrease by 32% from the first test to the re-test. "Noise" due to the learning curve can be expected to play out over the two tests.

There was no correlation between the time it took to place the apple into a preferred position and the stated satisfaction with its placement in the *test*. However, there was an inverse correlation in the *re-test*. (Note: *rs* values in this case are shown as positive because stated satisfaction levels were placed in ascending order, while elapsed time is listed in descending order.)

The most logical explanation for the data would be that elapsed time in the test largely measured familiarity with the apparatus, while elapsed time in the retest measured commitment to a preference more directly.

Construct validity with respect to proportional measurements

A test was made to assess the face value of the approach. Generally the shape of the data, so to speak, looked correct. In a test of 15 individuals, ratios corresponding to four separate historical norms were in evidence. (The apples moved all around the table.)

The fundamental question of whether or not proportional preferences can be measured outside of their specific context is debatable,[86] so validity *per se* cannot be measured. But historical data across a number of studies utilizing differing procedures has detected a general, though weak, tendency for the mean preferred ratio to gravitate toward a ratio of .62.[87] The data generally corresponds to that historical observation however at a lower significance level of .10 -- and only for the test and not the (presumably more accurate) re-test values.

Overall Conclusions Pilot Study

The original research questions were -- relative to a selected element of design (proportion) in a virtual simulation:

Research Question 1: Can a subject's aesthetic preference be defined -- as it relates to compositional proportions?

A1: No. The study does not meet the burden of proof required to answer the question. The data is inconclusive. It fails to prove or disprove that a preferred proportional relationship has been found. In total, the data might suggest that a preferred proportion might be found and identifies numerous alterations to avoid in the design of a more effective data collection procedure.

Research Question 2: Will the subject's (self-described) degree of satisfaction with the compositional proportion inversely associate with the amount of time it took the subject to establish the proportion?

A2: Yes. The study concludes that elapsed time in virtual environment can be a viable method for gauging the degree of satisfaction with an aesthetic choice.

In a larger sense, the Two Roads study was devised to establish the potential value in incorporating a second module that integrates other elements of design for the purpose of conducting a case study of the combined product.

The pilot study hinted that the approach might have some value, but further work with data collection apparatus and procedure would have to be completed before a second phase study would be warranted. Correspondingly, a second study was run in light of lessons learned.

Potential Problems and Attempted Solutions in the Follow-Along Study

Aspect Ratios of Instrumentation: It is expected that subjects mentally enter a virtualized room, where great care was taken to suppress proportional cues. However the fact remains that the subjects interacted with the virtualization within a physical room (with a particular aspect ratio) entered by means of a door (with another particular aspect ratio) and observed and interacted with the virtualization with a monitor, mouse, and keyboard – all with ratios of their own.

Certain aesthetic theories link the degree of satisfaction with an aesthetic relationship with ease of neuronal processing based upon familiarity with subject matter.[88] If these theories correctly describe the mechanism behind proportional preferences, any cues – especially those observed immediately before testing – might affect outcomes.

To address this potential issue, the experiment was arranged so that participants walked a mere 4' into the room where the simulation took place to reach the monitor -- with their backs to the rest of the room. Light levels were also manipulated to leave the monitor as the brightest element in the room, partially obscuring the black-colored monitor frame, mouse, and keyboard.

** For the follow-along study, a second version of the virtualization was built that completely eliminated the necessity for a room, mouse, keyboard, and monitor. It was designed to work on a touch-pad tablet and (literally) taken into the street and tried out on a convenience sample.

Handedness in Instrumentation: A mouse was chosen as the input device for all the reasons discussed in Chapter 5. The mouse was positioned to the right of the keyboard when the subjects entered the physical room. This relationship is not unlike the apple sitting to the left of center in the virtualization. A wireless mouse was chosen, in part to allow subjects to reposition the mouse as they desired. But without direct observation it is impossible to know if any of them repositioned the mouse. If not, could there be a bias toward right side positioning of the virtual apple on the table? The data does tend toward positive values in the x-axis.

In theory this right-bias should not matter, since proportion is being measured – part to whole and not right-part to left-part. However, it prompts a question: Is proportion handed? Do we have two distinct populations? By aggregating them we are muddying a data-set? In retrospect, collecting right or left hand dominance information might have been a useful, if for no other reason than to see if two groups diverged meaningfully. Would standard deviations decrease disproportionally if left handed respondents were excluded?

In a similar vein, the data suggests subjects tended to position the apple closer to their virtual point-of-view (in the negative y-axis). Does the act of moving the mouse toward the apple and then clicking on it resonate with the familiar process of reaching out to pick up, and then gather-in an object? It should not matter. But in retrospect, screen saves at the completion of the virtualization were taken, but recordings of the entire interaction would have allowed this possible gathering-in action to be examined. Was the apple moved forward before being moved back? If so, a simple corrective might be to position the point-of-view above a corner of the table. The game is equipped with first-person POV control. In an earlier version of the script, the subject was to be encouraged to navigate the room for a brief period before beginning the process of moving the fruit.

** Both closed and open-ended survey elements were introduced into the follow-along study. The closed elements addressed handedness and allowed left-handed individuals to be excluded from the sample. The open-ended survey question gathered data about any positioning strategies that might affect the elapsed time, or inform implications. Additionally, a limited navigation capability (POV attitude) was introduced into the revised virtual build to allow the subject to address eth table at an oblique angle, and thus mitigate a strong perceived x-axis vs. y-axis distinctions.

<u>Other Technical Issues:</u> The Unity simulation had a frustrating jitter in the mouse follow that could possibly have affected positioning – not the recorded position, or the placement directly, but rather the willingness of the subjects to spend the time to fine-tune location.

Also, the apple disappeared from the simulation briefly each time the mouse button was released. This might have extended elapsed time for those subjects who positioned and then repositioned the apple relative to those who placed it directly into position.

The five-level Likert-type scale survey failed to elicit a measurement of satisfaction with specificity equal to that of the recorded ratios. In retrospect, a seven degree scale might have proven more appropriate. Two respondents gave scores “between” integers degrees. A, Excel forced choice ranking applied to a five degree scale invites imprecision.

Likewise, elapsed time was measured in seconds. Two additional lines of code would have allowed precision to tenths of seconds. The elapsed-time data points tended to cluster, especially in the retests. The additional granularity might prove useful.

** In the follow-along study the slight jitter was removed, as was the disappearing apple glitch. Elapsed time was measured in three manners: total, total after the apple was touched, and total spent on translating apple position. The five-level scale was revised to a ten-level scale. All time was measured in hundredths of seconds.

Selection Bias: The subjects were randomly selected from the population of architectural clients -- of one particular architect. Presumably the clients selected that architect based in part upon familiarity with the architect’s completed work. It is possible that they gravitated toward the office due to preferences for proportional predilections embedded in those projects. If so, there would be a selection bias.

(It should be noted that clients select architects based upon a great many desirable attributes: physical proximity, cost, referrals from friends and associates – in public works projects the provisions of the Brooks Act and Quality Based Selection protocols, which mandate a quantitative approach to selection determined by the number of similar projects completed within a specified time frame. So this bias might be unlikely.)

** In the phase I follow-along study, a convenience sample was taken from individuals passing outside the architect’s office.

Test-Retest Procedure

In some cases test and re-tests were conducted mere minutes apart, in other cases several hours elapsed between them. That data was not recorded due to the somewhat haphazard method of catching clients as they left the office. It should have been. An alternative argument for the data might be that respondents treated the exercise as a memory test, and they were merely engaged in an effort to place the apple where they remembered placing it originally. This would explain both an illusion of reliability and the illusion of an elapsed-time/satisfaction correlation.

** In the follow-along study, the competed virtualizations for both test and re-tests were all time-stamped. The survey was filled out in-between test and re-test to break concentration, and theoretically mitigate the memory text effect mentioned above.

Sample Size: The sample is small. This was occasioned by the difficulty in acquiring a sizable population of qualified subjects and the mistaken assumption that the test might be expanded to multiple modules before testing. The smaller number was deemed to be acceptable in an early proof-of-concept exercise.

Validity Test

While useful with respect to general face validity, conformance to a general tendency for a mean preferred ratio to tend toward .62 was deemed too ephemeral to draw firm conclusions about construct validity.

** In the follow-along study a two sample, two-tailed t-Test is made with respect to correlation between the preferences derived from the virtualization and preferences between sketches illustrating six architectural elements constructed according to a simple algorithm, employing the signature ratio of the named proportional classes.

Two Roads Follow-Along Study

Follow-Along Study Data

Assumptions:

The data is generally normally distributed

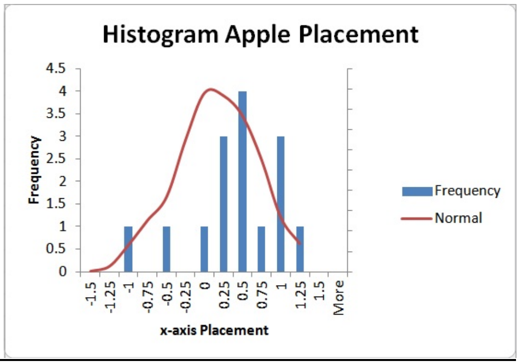


Figure 6.2 Histogram Generally Normal

Reliability with respect to ratio measurement

The test-retest relationship is generally linear

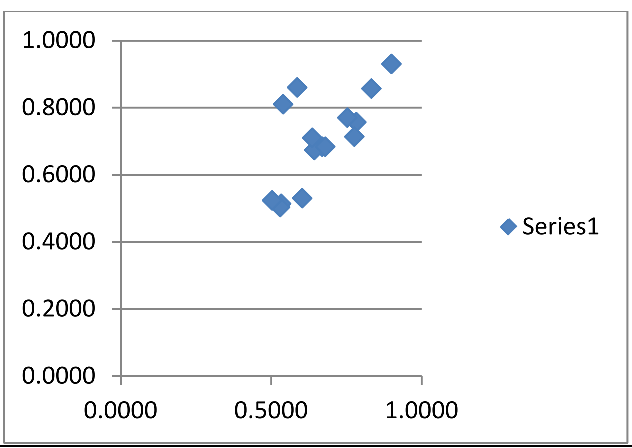


Figure 6.3 Test-Retest Generally Linear

The test-retest method generated a Pearson's *r* value of .69 with respect to x-axis ratios. With an *n* of 15 (13 degree of freedom), this generates a *p* of .01, at a Significance Level of .05

There **is** significant inter-test reliability with respect to what is being measured in the x-axis. (Something is being measured reliably along in the x-axis.) This comports with test in the pilot study (following section).

The test-retest method generated a Pearson's *r* value of .44 with respect to y-axis ratios. With an *n* of 15 and 13 degree of freedom this generates a *p* of .13, at a Significance Level of .05

There **is not** significant inter-test reliability with respect to what is being measured in the y-axis. (Nothing is being measured reliably along the y-axis.)

This also comports with test in the pilot study (following section) and exhibits the slightly higher y-value reliability predicted by allowing the subject to realign POV, and blurring x-y distinctions.

Correlation with respect to Time / Satisfaction variables

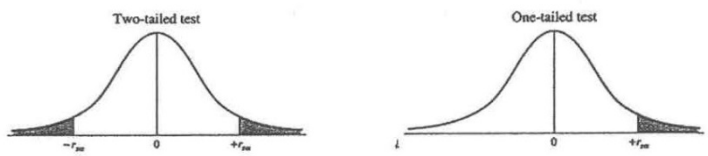
The elapsed time-to-satisfaction relationship is generally (inverse) monotonic

Figure 6.4 Time Satisfaction Generally Inverse Monotonic

The Spearman rank Order Correlation Coefficient for elapsed exercise time-to satisfaction generated an *rs of* .55. Using the critical value tables for the coefficient, there **is** an (inverse) correlation between the respondent's stated degree of satisfaction and the elapsed time it took them to complete the task at a level of significance of .05.

This also comports with the test in the pilot study (following section) and exhibits the slightly higher reliability value that was expected with a more user friendly virtualization. Median exercise time dropped less dramatically from test to retest (16% vs. the pilot study 32%) suggesting a shallower learning curve.

Critical Values of the Spearman Rank Order Correlation Coefficients: The r_s Tables



Level of Significance (Two-tailed test)

N	α = .05	α = .01
5	1.000	–
6	.886	1.000
7	.786	.929
8	.738	.881
9	.700	.833
10	.648	.794
11	.618	.755
12	.587	.727
13	.560	.703

Level of Significance (One-tailed test)

N	α = .05	α = .01
5	.900	1.000
6	.829	.943
7	.714	.893
8	.643	.833
9	.600	.783
10	.564	.745
11	.536	.709
12	.503	.671
13	.484	.648

Figure 6.5 Critical Values Spearman Rank Order

<u>Construct validity with respect to proportional measurements</u>

As was noted, a paired sample t-test is made with respect to the relationship between preferences derived from the virtualization and preferences expressed through sketches illustrating six architectural elements assembled according to a simple algorithm, employing the signature ratio of the named proportional classes as a base tonic.

Generally the shape of the data looks correct. In a test of 15 individuals, ratios corresponding to four separate historical norms were in evidence. (The apples moved all around the table. The subjects selected various facades.) As was noted, the data was generally normally distributed. An expected variance was determined at half the band width between named classes.

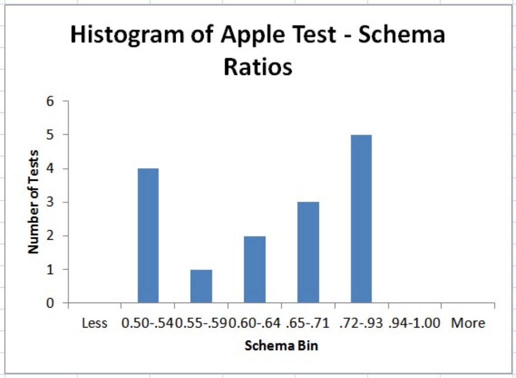


Figure 6.6 Histogram Schema

With 14 degrees of freedom, the test statistic of -1.997 determined a *p* value of .06.

At a significance level of .05 the null hypothesis <u>is not</u> rejected. The research hypothesis is rejected. We cannot say there is a statistically valid relationship between virtualized apple placement and preference for façade studies.

This data also generally corresponds to the pilot test data. At a lower significance level of .10 would be a statistically significant relationship between apple placement and façade study preferences.

Phase I Follow-Along Study Conclusions

The original research questions were -- relative to a selected element of design (proportion) in a virtual simulation:

Research Question 1: Can a subject's aesthetic preference be defined -- as it relates to compositional proportions?

> *A1: The follow-along study still does not meet the burden of proof required to answer the question. The data remain inconclusive. In total, the data might suggest that a preferred proportion can be found and identifies several alterations to make a more effective data collection procedure.**

Research Question 2: Will the subject's (self-described) degree of satisfaction with the compositional proportion inversely associate with the amount of time it took the subject to establish the proportion?

A2: Yes. The follow-along study concludes that elapsed time in virtual environment can be a viable method for gauging the degree of satisfaction with an aesthetic choice.

* The open-ended question revealed that 15% of subjects followed strategies that were essentially non-hedonic in placement of the apple and/or selection of the preferred façade. These individuals chose (for example) a Baroque proportional class because the sketch suggested "snow will slide off the roof," and an apple placement because "I do not want to have to stretch to pick up the apple." While these comments are encouraging in the sense that they support the contention that virtualizations do not exist and function in some special plane outside of reality, they present potential outliers. Ultimately it was decided not to exclude them after the fact and risk a manipulated data set, but they are suggestive of how to refine both test protocol and the façade sketch algorithm for a more useful iteration.

Chapter 7 Implications

Limitations

There are clear imitations to the application of the data derived from the Two Roads study.

First, the study is intended to inform primarily formalist approaches to architecture. Design approaches that view architecture from a purely social, environmental, or other determinist perspective would discount the importance of any particular individual client's aesthetic judgment within the design process, and would not be expected to derive much benefit from the study.

Secondly, the proportional preferences derived are *individual* preferences. There is no support for any extrapolation across groups.

Finally, as was discussed in Chapter 1, the Two Roads virtualization is a proof-of-concept vehicle. It cannot be overstressed, it has limited utility unless and until it is examined in an applied research case study that could assess the validity of the game-playing choice-model approach in a larger virtual world wherein architects discover client preferences with respect to a range of the elements of design: point, line, plane/shape, form, space, color, texture, and light; as well as the other principles: scale/proportion, figure/ground, unity/balance, contrast/variety, repetition, pattern/rhythm, superimposition, hierarchy, context, and systems. This study does not establish that the concept is scalable.

Implications

Notwithstanding these limitations, the study offers some tantalizing possibilities for future research. As was noted in Chapter 2, various explanations have been offered for individual preferences in simple proportions: mere exposure, arousal dynamics, prototype fluency, representational fit and several the multi-component theories. It was also mentioned, in Chapter 3, that there are neuroscientific, phenomenological, and cultural behaviorist explanations for complex proportional preferences – those embedded in cultural products, for instance buildings. Those explanations might be tested by having subjects move from room to room in the virtualizations (scene to scene in Unity terms) with their putative preferences recorded, compared and subjected to multi-factor analysis.

For just one example, a neuroscientific explanation for proportional preference as it relates to buildings might postulate registration between bodies and buildings, and subsequent projection of some form of a sensory homunculus (body schema) onto buildings. In that case a module similar to Module One in the Two Roads study could be followed up with several different modules wherein preferences for building forms, and people, might be recorded and the varying data-sets subjected to multi-factor analysis. Since, in the Western humanistic tradition, architects were admonished for several centuries to design buildings as if they were actual people, cultural differences in that area might be telling.

The advantages to the virtualization approach mentioned in Chapter 1 would apply to these other, cross-disciplinary, applications: avoidance of confounding, modularity, scalability, precision, ease of corroboration, and the advantages of real time data.

With respect to future study, conjoint analysis offers a readily usable, simple mathematical model for weighing each element of design against all the others to determine the importance of each particular element or principle of design relative to the others. (A brief discussion of how conjoint analysis might be applied to the various interacting elements of design follows in the sub-section directly after this introductory sub-section. It addresses Scale over/against Proportion since the two elements are so closely related.)

Since the full validity of the preferences derived from the Two Roads approach is left to the case study, a brief discussion of how a **case study** might apply to a follow-along study is also included.

Finally, on a more visionary note, the Two Roads virtual platform is intended to allow for real-time feedback to test assumptions about the elements of design in a fully integrated virtual architectural world. Our virtualization was primitive by design. Establishing the proper “feel” for a game-world would be essential to further study. With respect to the Unity gaming platform, this might entail embedding a script in the game object to modify the transform aspect ratio of all associated game objects in the scene upon final placement of the apple. As the subject passed through various rooms the colors, textures, light maps, scale/proportioning, contrast/variety, pattern/rhythms, etc, might adapt themselves to the recorded preferences. In essence the rooms would design themselves.

Future Study -- Conjoint Analysis

Woody Allen begins the movie Annie Hall with this little bit of narration:

There's an old joke. Uh, two elderly women are at a Catskills mountain resort, and one of 'em says: "Boy, the food at this place is really terrible." The other one says, "Yeah, I know, and such small portions."[89]

--Woody Allen, Annie Hall (1977)

In considering principles of design, such as scale and proportion, or other elements of design; there is a tendency to discuss each in distinction to the other. As the women in Woody's joke demonstrate, the element of (bad) taste really should alter the sense of (adequate) proportion.

In architectural design, careful proportioning can reduce or inflate scale just as scale can affect proportioning. The interaction of these two individual elements of design seems to pose a problem for the Two Roads study, which attempts to determine client preferences (p) for multiple discrete, but interrelated, principles of design.

Conjoint Analysis offers a solution. It is a technique used in market research to determine how people value different features that make up individual products or services. The objective is to determine which combination of a limited number of attributes is most influential on a respondent's choice. In conjoint analysis, a controlled set of potential products or services is shown to respondents. By studying how they make preferences between these products, the implicit valuation of individual elements making up the product is determined. The implicit valuations (utilities or part-worths) can be used to create models.

(Conjoint analysis techniques are also referred to as multi-attribute compositional modeling, discrete choice modeling, and stated preference research.)

It was developed by Professor Paul Green at the Wharton School, University of Pennsylvania. Other prominent pioneers include: Professor V. "Seenu" Srinivasan, of Stanford University, who developed a linear programming procedure for rank ordered data, as well as a self-explicated approach; Richard Johnson, who developed Adaptive Conjoint Analysis; and Jordan Louviere, at the University of Iowa, who invented and developed Choice-based approaches to conjoint analysis and related techniques such as MaxDiff.[90]

The method was successfully employed in the 1990's to assist with setting priorities respecting the relative importance of features of national health care systems. [(]Jan 2000 et al.) (Ryan et al. 2000) [91] [92] Since most people want to see "their" doctor -- the one they are most familiar with -- however accommodating that desire might occasion a wait. That is to say, how long is "too" long to wait for a visit with your doctor? Or, as in this particular instance, what is the relative importance a client will place on an architectural feature (design principle or element) in terms of their appreciation for another?

While the mathematics becomes a bit more involved as the number of features to be analyzed increases, the fundamental concept is simple. Richard Johnson's Sawtooth Software explains (Curry 1996):

Suppose we want to market a new golf ball. We know that there are three important product features: Average Driving Distance, Average Ball Life, Price. We further know that there is a range of feasible alternatives for each of these features, for instance: 275 yards, 54 holes, $1.25; 250 yards, 36 holes, $1.50; 225 yards, 18 holes, $1.75. Obviously, the market's "ideal" ball would (fly the farthest, last the longest, cost the least)

We'd lose our shirts selling the first ball, and the market wouldn't buy the second. The most viable product is somewhere in between, but where? Traditional research project might consider the rankings for distance and ball life; for instance:
1) 275 yards 1) 54 holes

2) 250 yards 2) 36 holes

3) 225 yards 3) 18 holes

This information does not actually tell us anything that we don't already know about which ball to produce. But consider the same two features conjointly. Consider rankings for the 9 possible products for two buyers (assuming price is the same for all combinations.) Both buyers might agree on the most and least preferred ball, but Buyer 1 might tend to trade-off ball life for distance, whereas Buyer 2 might make the opposite trade-off. The knowledge we gain in going from analysis 1 to analysis 2 is the essence of conjoint analysis.

These three steps: collecting trade-offs, estimating buyer value systems, and making choice predictions-- form the basics of conjoint analysis. (It is easiest) to collect conjoint data by having respondents rank or rate concept statements or by using PC-based interviewing software...[93]

In the Two Roads follow-along study, Buyer 1, and Buyer 2, would be replaced by Client and Architect. Scale and Proportion would be, conjointly, established as respective arms of an x-y axis matrix; and the (previously established) levels of Scale and Proportion assigned as degrees of those features. Estimated values are expressed in the medium of time (for seconds of elapsed time after choice selection in the virtual space) so relative valuation can be assigned for both features, tradeoffs assumed, and total combined utility determined.

Two Roads can establish the combined utility a client places on Scale and Proportion in a Conjoint Analysis matrix by using the relative speed in choosing one proportion over another as a common method of valuation.

CONJOINT ANALYSIS OF SCALE & PROPORTION

RELATIVE VALUE COMBINED UTILITY (ALL VALUES IN SECONDS FOR 200 SECOND GAME)

FEATURE		PROPORTION								
	DEGREE	PALEOLITHIC 1: .84	NEOLITHIC 1:1	ARCHAIC 1: 1.12	CLASSICAL 1:1.62	MANNERIST 1: 1.7	BAROQUE 1:2.66	ROMANTIC 1:2.7-.9	MODERN 1:3	POST MODERN
	INFINITESIMAL									
S	SMALL (SCALAR)									
C	INTIMATE (2 SCALAR)									
A	HUMAN (SMALL GROUP)									
L	GRAND (LARGE GROUP)									
E	MONUMENTAL (VERY LARGE GROUP)									
	EPIC									

Figure 7.1 Conjoint Analysis of Scale and Proportion

Future Study – Case Study Method

But, further, all other things cannot come from Forms in any of the usual senses of 'form'. And to say that they are patterns and the other things share in them is to use empty words and poetical metaphors…anything can either be, or become, like another without being copied from it, so that whether Socrates, or not a man Socrates, like might come to be; and evidently this might be so even if Socrates were eternal. There will be several patterns of the same thing, and therefore several Forms; e.g. 'animal' and 'two-footed' and also 'man himself' will be Forms of man. Again, the Forms are patterns not only sensible things, but of Forms themselves also; i.e. the genus, as genus of various species, will be so; therefore the same thing will be pattern and copy [94] -- Aristotle, Metaphysics Book I Part 9 (c. 330 B.C.E.)

If you ask an architect to describe a case study* they might wax poetic about a house, a very specific one, one of the 36 designed and 19 built in California between 1945 and 1966 as commissioned by Arts & Architecture Magazine to explore solutions to the housing problem facing returning World War veterans.

Those few buildings designed by early modernist luminaries such as: Richard Neutra, Raphael Soriano, Charles and Ray Eames, Pierre Koenig, and Eero Saarinen; entered into American architectural lore and the collective conscious of the profession. Every succeeding generation of architects seems to have felt the pull to creatively re-interpret their work. Neutra and company pulled out all the stops, so much so ‘case houses’ have a place in architectural mythology seventy years on, and an out-sized effect upon practice.

* A case study is in-depth study of a particular situation rather than a sweeping statistical survey. It is a method used to narrow a broad field of interest into one case.

Researchers across a range of disciplines have reservations about the case-study approach though. As early as 1979 Matthew Miles contended that, "research based upon case study (is) unlikely to ever transcend story-telling." [95] (Aristotle might have called it poetical metaphor.)

By way of rebuttal, David L. Barkley, of Clemson University, relied upon the work of R.K. Yin in arguing "case study inquiry copes with the technically distinctive situation(s) in which there are more variables of interest than data points," and "single-case research (is) particularly useful when the case is extreme, unique, or revelatory."[96] Barkley echoed Brent Flyvbjerg's conclusions that single-case design can be useful in testing hypotheses through falsification, since if one observation does not fit the proposition the proposition is not valid.

Flyvbjerg also noted that case studies are popular for exploring innovative programs designed to facilitate entrepreneurship since they provide incentives to other firms to try something different. As he put it, "(The…case study) serves as an example of the potential benefits of change. (As other firms) observe interesting behavioral patterns or correlated phenomena, and these observations may be useful in developing or refining (their own) hypotheses."[97]

Barkley does caution that "the testing of hypotheses or causal relationships will require that the number of case studies (be) expanded from the exploratory case to sufficient numbers to permit generalizations from findings… "ideally, with a well-specified econometric or quasi-experimental model supported by an extensive set of secondary or survey data." However, he concludes, "There are numerous situations…where event characteristics or data limitations reduce the effectiveness… of quasi-experimental design methods in detecting causal relationships." And in these "special cases" case study is more appropriate -- stipulating that: Researchers need to be able to demonstrate that relevant contingencies were considered, and the "special case" is not unusually distinct.[98]

Barkely stands upon the commonsense notion that researchers should select research methods based upon the task at hand and research designs can rely upon some qualitative (case study) as well as quantitative methods. He shares his own experience that case study is especially helpful in situations where the phenomena being studied are too new or limited to be detectable in secondary data sources and the case study, “complements statistical analysis by helping to refine hypotheses, select explanatory variables, and provide insights into how variable ‘x’ affects variable ‘y.’” He summarizes: “In many research situations, the relevant question is not ‘do we use case studies or statistical data analysis?’ but instead, ‘how can we incorporate case studies and statistical analysis into a holistic research design?’” Barkley (2006, p.13)

Mindful of this caveat – that with respect to qualifying special cases, they not be too distinctive -- it seems clear that the case study method would be well-suited to the “exploratory, extreme, unique, or revelatory,” task of integrating data derived from aesthetic choice models into a standard building design process. The general outlines of such a study might entail in-depth interviews with client, architect, and other stakeholders in a building project before, during, and after design process which integrated a Two Roads type choice model virtualization. Careful attention would be paid to the nature and circumstances surrounding any design deviations.

References

[1] Scruton, Roger. *The Aesthetics of Architecture* New Jersey: Princeton University Press, 1979, p. xv.

[2] Buckley, Tom. “Philip Johnson: The Man in the Glass House.” *Esquire* Dec. 1983, p. 282

[3]Kaufmann, Uwe. Chieh, Chew Jian. “Applying Systems Thinking to the Practice of Six-Sigma” iSix Sigma. *http://www.isixsigma.com/tools-templates/cause-effect/applying-systems-thinking-practice-six-sigma*

[4] McManus, I.C. “The aesthetics of simple figures.” Brit. J. Psychol. 1980 71:502–24

[5] Levick-Masters, Shelly. “The Catch-22 of Construction Change Orders” Business Bank of Texas. *https://www.businessbankoftexas.com/business-resource-center/the-catch-22-of-construction-change-orders.htm* March 7, 2011

[6] Tatlow, Ruth. *Bach: Compositional Proportion and Significance* Cambridge: Cambridge University Press, 2015 p.7.

[7] Sterne, Laurence. *The Works of Laurence Sterne* New York: Derby & Jackson, 1859 p.23.

[8] Sterne, Laurence. *The Works of Laurence Sterne* New York: Derby & Jackson, 1859 p.66.

[9] *Merriam Webster’s Collegiate Dictionary, Eleventh Edition* New York: Merriam-Webster, Inc., 2016. Retrieved from *https://www.merriam-webster.com/*.

[10] Jones, Kenneth. (December 6, 2010) “Critic John Simon Hangs His Own Shingle on the Web” Playbill News. *http://www.playbill.com/news/article/critic-john-simon-hangs-his-own-shingle-on-the-web-174185*

[11]Lieff, Jon MD. “The Limits of Current Neuroscience.” Searching for the Mind *http://jonlieffmd.com/blog/the-limits-of-current-neuroscience* August 29, 2013

[12] Al-Nasser, M., R.Z. Yusoff, R. Islam and A. Al-Nasser. “Most cited for the American Journal of Economics and Business Administration 10/06/14” http://thescipub.com/journals/ajeba is.: 2014. Effects of consumers’ trust and attitude toward online shopping. Am. J. Econ. Bus. Admin., 6: 58-71

[13]“The Business of Architecture: 2012 AIA Survey Report on Firm Characteristics, 2012,” The American Institute of Architects, Washington DC

[14] “The Business of Architecture: 2003 AIA Survey Report on Firm Characteristics, 2003,” The American Institute of Architects, Washington DC

[15] McManus, I.C. 1980. “The aesthetics of simple figures.” Brit. J. Psychol. 71:502–24

[16] Palmer, S.E., Schloss, K.B. & Sammartino, J. “Visual Aesthetics and Human Preference” (January 3013) Annual Review of Psychology Vol. 64:77-107

[17] *Merriam Webster's Collegiate Dictionary, Eleventh Edition* New York: Merriam-Webster, Inc., 2016. Retrieved from *https://www.merriam-webster.com/.*

[18] McManus I.C, Weatherby P. 1997. "The Golden Section and the Aesthetics of Form and Composition: a Cognitive Model." Empir. Stud. Arts 15:209–32

[19] Ling Y.L., Hurlbert A.C. 2009. "A New Model for Color Preference: Universality and Individuality, 15th Color Imaging Conf. Final Program Proc., pp. 8–11

[20] Palmer, S.E., Schloss K.B., Hawthorne D. 2012. "Ecological Influences on Individual Differences in Color Preference." Manuscript submitted

[21] Palmer, S.E., Schloss K.B. 2011. "Ecological Valence and Human Color preference." In New Directions in Colour Studies, ed. CP Biggam, CA Hough, CJ Kay, DR Simmons, pp. 361–76. Amsterdam: Benjamins

[22] Eysenck, H.J. 1940. The general factor in aesthetic judgments. Brit. J. Psychol. Gen.-Sect. 31:94–102

[23] Palmer, S.E., Griscom, W. 2012. Accounting for taste: individual differences in preference for harmony. Psychon. Bull.

[24] Palmer S.E., Schloss, K.B. 2011. Ecological valence and human color preference. In New Directions in Colour Studies, ed. CP Biggam, CA Hough, CJ Kay, DR Simmons, pp. 361–76. Amsterdam: Benjamins

[25] Palmer, S.E., Schloss, K.B. & Sammartino, J. Visual Aesthetics and Human Preference (January 3013) Annual Review of Psychology Vol. 64:77-107

[26] Rose, Todd. "The Myth of the Average" Psychology Today *https://www.psychologytoday.com/blog/what-the-wild-things-are/201307/the-myth-the-average* July 19, 2013

[27] Zajonc, R.B. 1968. Attitudinal effects of mere exposure. J. Pers. Soc. Psychol. 9:1–27

[28] Berlyne, D.E. 1957. Uncertainty and conflict: a point of contact between information-theory and behavior theory concepts. Psychol. Rev. 64:329–39

[29] Berlyne, D.E. 1960. Conflict, Arousal, and Curiosity. New York: McGraw–Hill Berlyne, D.E. 1971. Aesthetics and Psychobiology. New York: Appleton-Century-Crofts

[30] Rosch, E. 1975. Cognitive representations of semantic categories. J. Exp. Psychol.: Gen. 192–233

[31] Reber R, Schwarz N, Winkielman P. 2004. Processing fluency and aesthetic pleasure: Is beauty in the perceiver's processing experience? Pers. Soc. Psychol. Rev. 8:364–82

Reber R, Winkielman P, Schwarz N. 1998. Effects of perceptual fluency on affective judgments. Psychol. Sci. 9:45–48

[32] Sammartino J., Palmer S.E. 2012b. Aesthetic issues in spatial composition: representational fit and the role of semantic context. Perception. In press

[33] Shimamura A.P. 2012. Experiencing Art: Explorations in Aesthetics, Mind, and Brain. New York: Oxford Univ. Press. In press

[34] Leder, H., Belkel, B., Oeberst, A., Augustin D. 2004. A model of aesthetic appreciation and aesthetic judgments. Brit. J. Psychol. 95:489–508

[35] Silvia, P.J. 2005a. Cognitive appraisals and interest in visual art: exploring an appraisal theory of aesthetic emotions. Empir. Stud. Arts 23:119–33

[36]Silvia, P.J. 2005b. Emotional responses to art: from collation and arousal to cognition and emotion. Rev. Gen. Psychol. 9:342–57

[37] Silvia, P.J. 2006. Exploring the Psychology of Interest. New York: Oxford Univ. Press

38 Silvia P.J. 2012. Human emotions and aesthetic experience. See Shimamura & Palmer 2012, pp. 250–75

[39] Palmer, S.E., Schloss, K.B. & Sammartino, J. "Visual Aesthetics and Human Preference" (January 3013) Annual Review of Psychology Vol. 64:77-107

[40] Palmer, S.E., Schloss, K.B. & Sammartino, J. "Visual Aesthetics and Human Preference" (January 3013) Annual Review of Psychology Vol. 64:77-107

[41] Susan Stewart *Nonsense: Aspects of Intertextuality in Folklore and Literature* Baltimore: The Johns Hopkins University Press, 1989. pX.

[42] Schueffel, Patrick *The Concise FINTECH COMPENDIUM* School of Management Fribourg (HEG-FR) HES-SO / University of Applied Sciences and Arts Western Switzerland 2017 p.2.

[43] Schueffel, Patrick *The Concise FINTECH COMPENDIUM* School of Management Fribourg (HEG-FR) HES-SO / University of Applied Sciences and Arts Western Switzerland 2017 p.14.

[44] *Merriam Webster's Collegiate Dictionary, Eleventh Edition* New York: Merriam-Webster, Inc., 2016 Retrieved from *https://www.merriam-webster.com/.*

[45] *Merriam Webster's Collegiate Dictionary, Eleventh Edition* New York: Merriam-Webster, Inc., 2016 Retrieved from *https://www.merriam-webster.com/.*

[46] Ruskin, John. *The Elements of Drawing in Three Letters to Beginners*. New York: National Library Association. 2009. p.138-140.

[47] *Merriam Webster's Collegiate Dictionary, Eleventh Edition* New York: Merriam-Webster, Inc., 2016 Retrieved from *https://www.merriam-webster.com/.*

[48] Vitruvius: *The Ten Books on Architecture*. Translated by Morris Hicky Morgan London: Oxford University Press, 1914 p.xx.

[49] Eco, Umberto *Art and Beauty in the Middle Ages*. Translated by Hugh Bredin New Haven: Yale University Press, 1986 p. 27.

[50] Thomas Aquinas. *Summa Theologiae*. Translated by Fathers of the English Dominican Province. Westminster: Christian Classics, 1981. I. 39. 8c.

[51] Thomas Aquinas. *Summa Theologiae*. Translated by Fathers of the English Dominican Province. Westminster: Christian Classics, 1981. I.12.1.

[52] Eco, Umberto. *The Aesthetics of Thomas Aquinas*. Translated by Hugh Bredin. Harvard University Press, 1988. p.82.

[53] Thomas Aquinas. *Summa Contra Gentiles* 5 Volumes. University of Notre Dame Press, 1975. II.16.8; II.80-81.7.

[54] *The Architecture of Leon Battista Albert in 10 Books*, translated by James Leoni, London 1726, J. Rykwert; London, 1955 Book VI Chapter 2

[55] Wittkower, Rudolph. *Architectural Principles in the Age of Humanism Part II* W.W. Norton and Company: New York, 1971. p.33

[56] *Merriam Webster's Collegiate Dictionary, Eleventh Edition* New York: Merriam-Webster, Inc., 2003) Retrieved from *https://www.merriam-webster.com/.*

[57] Hitchcock, Henry-Russell. *Architecture: Nineteenth and Twentieth Centuries* (Baltimore: Penguin Books, 1958, revised 1963), pp. 194-95

[58] Thomas, George E. *Frank Furness: the Complete Works* (New York: Princeton Architectural Press, 1996) p.353

[59] Viren Swami, Dorothy Einon, & Adrian Furnham (2006). The leg-to-body ratio as a human aesthetic criterion (University of Liverpool, Liverpool; University College London, London, United Kingdom), p.320

[60] Bean, Erica, Bidner, Jenni. *Complete Guide For Models* New York: Sterling Publishing, 2004, p.54.

[61] Fredriks, A. M. et al, (2005) *Nationwide age references for sitting height, leg length, and sitting height/height ratio, and their diagnostic value for disproportionate growth disorders* (Archives of Disease in Childhood, April 2005) Figure 2

[62] *Makemetaller.org* is an online community devoted to, "supporting those interested in or considering Leg Lengthening" Page Topic: How You Actually Lengthen Your Legs: Internal and External Methods (Read 10080 times 9/26/2014) *http://www.makemetaller.org/index.php/topic,4938.0.html*

[63] Smith E. M., Naukratis. *A. Chapter in the History of the Hellenization of Egypt* Vienna, 1926, p. 14.

[64] Guralnick, E. *The proportions of Kourai (1978)* American Journal Of Archeology v. 82 461-72

[65] *Ancient Greek.org* is a website containing, "a collection of images, thoughts, and resources about Ancient Greece." *http // www.ancientgreek.orgkouros*

[66] Vitruvius: *The Ten Books on Architecture*. Translated by Morris Hicky Morgan London: Oxford University Press, 1914, p.73.

[67] Chandravadiya Laxmi N., M. Patel, Shailesh Jatin B. Goda, Patel S. V. , (2010) *Estimation of stature from percutaneous tibial length* (International Journal of Biological and Medical Research, 2010), Int J Biol Med Res. 2013; 4(1): 2752-2754

[68] Bogin, Barry & and Maria Inês Varela-Silva, *Leg length, body proportion, and health: a review with a note on beauty* (International Journal of Research and Public Health: Health & Lifespan Research Centre, School of Sport, Exercise & Health Sciences, Loughborough University, Leicestershire, UK, 2010) p.2753 – Table 1

[69] Cash, T.F., & Jacobi, L. (1992). Looks aren't everything (to everybody): The strength of ideals of physical appearance. Journal of Social Behavior and Personality, 7, 621-630.

[70] De Beauvoir, Simone, 1953. *The Second Sex*, London: Jonathan Cape p.307

[71] Penfield, W. & Boldrey, E. (1937). Somatic motor and sensory representation in the cerebral cortex of man as studied by electrical stimulation. *Brain* 60: 389-443.

[72] Lewis-Williams, J. D. The mind in the cave: Consciousness and the origins of art. London: Thames & Hudson. (2002) p.

[73] Hershey, George L. *Architecture and Geometry in the Age of the Baroque* London, University of Chicago Press, 2000 p. multiple

[74] Gehrkens, Karl W. Music Notation and Terminology New York: The A.S. Barnes Company 1921 p.54.

[75] Russell, Bertrand. *Mysticism and Logic: And Other Essays* Bertrand Russell *1910* p. 31.

[76] Safire, William. The New York Times: On Language. *Defenestration.* December 1, 2002

[77] James, William *On Psychology: and to Students on Some of Life's Ideals* New York: Henry Holt And Company1925 Chapter 14 p.1

[78] Benjamin, Walter. "The Work of Art in the Age of Mechanical Reproduction" Illuminations, Edited by Hannah Arendt, 1969, pg 1 – 26.

[79] Benjamin, Walter. "The Work of Art in the Age of Mechanical Reproduction" Illuminations, Edited by Hannah Arendt, 1969, pg 1 – 26.

[80] Kushner, Marc. https://medium.com/architizerArchitect, Mar 10, 2015

[81] Curl, James Steven, *A Dictionary of Architecture and Landscape Architecture* London: Oxford University Press, 2006

[82] Reekie, R. Frazer *Draughtsmanship* London: Arnold 1946 p.12.

[83] *Albert Speer Size Matters* / by Robert Hughes; directed by Teresa Griffiths; producer, Sally Ann Kleiber. An Oxford Film and Television production for BBC in association with RM Associates. Originally released [London]: BBC, c2003, in series: Visions of Space.

[84] Infill Development Strategies for Shaping Livable Neighborhoods (Municipal Research and Services Center, Infill Development Publication, June 1996 – Report #38)p.6

[85] *Merriam Webster's Collegiate Dictionary, Eleventh Edition* New York: Merriam-Webster, Inc., 2016 Retrieved from *https://www.merriam-webster.com/.*

[86] Flip Phillips, J. Farley Norman, and Amanda M. Beers Fechner's Aesthetics Revisited Seeing and Perceiving 23 (2010) 263–271

[87] Fechner, G. (1865). Über die Frage des goldenen Schnittes [On the question of the golden section]. Archiv für die zeichnenden Künste 11, 100–112

[88] Zajonc RB. 1968. Attitudinal effects of mere exposure. J. Pers. Soc. Psychol. 9:1–27

[89] Annie Hall. Screenplay by Woody Allen/Marshall Brickman Dir. Woody Allen. Performers: Woody Allen, Diane Keaton, and Tony Roberts. Rollins-Joffe Productions, 1977. United Artists

[90] Conjoint Analyis. Wikipedia. Last modified: September 21, 2014, from http://en.wikipedia.org/wiki/Conjoint_analysis_(marketing)

[91] Jan S., Mooney G., Ryan M., Bruggemann K., Alexander K.
The use of conjoint analysis to elicit community preferences in public health research: a case study of hospital services in South Australia. Australia N Z J Public Health. 2000 Feb;24(1):64-70

[92] Using Conjoint Analysis to elicit preferences for health care.
Mandy Ryan, Shelley Farrar (British Medical Journal June 2000)
BMJ. 2000 June 3; 320(7248): 1530–1533

[93]Johnson, Richard. “Understanding Conjoint Analysis in 15 Minutes.” Sawtooth Software. http://www.sawtoothsoftware.com (1996)

[94]Aristotle. *Metaphysics*. Translation. W.D. Ross. The Internet Classics Archive. Web Atomic and Massachusetts Institute of Technology. *http://classics.mit.edu/Aristotle/metaphysics.html*. Nov. 5, 2014

[95] Miles, Matthew B. Administrative Science Quarterly, v24 n4 p590-601 Dec 1979

[96] Yin, R.K. Case Study Research Design and Methods. Thousand Oaks, California: Sage Publications. 2003.

[97] Flyvbjerg, Brent. “Five Misunderstandings About Case-Study Research.” Qualitative Inquiry 12(2): 219-245. 2006

[98] Barkley, David L. “The Value of Case Study Research On Rural Entrepreneurship: Useful Method?” University Center for Economic Development Department of Applied Economics and Statistics Clemson University Clemson, South Carolina 2006 p.12

Appendix A.1 IRB Amended Protocol Exemption

University *of* Idaho
Office of Research Assurances
Institutional Review Board
875 Perimeter Drive, MS 3010
Moscow ID 83844-3010
Phone: 208-885-6162
Fax: 208-885-5752
irb@uidaho.edu

To: Brian Cleveley

From: Jennifer Walker
IRB Coordinator, University of Idaho Institutional Review Board

Date: May 14, 2018

Title: Two Roads Converge: Exercises in Discretion in a Virtual Environment
IRB #: 17-219

Submission Type: Protocol Amendment Request Form

Review Type: Exempt

Protocol Approval Date: 10/24/2017

Protocol Expiration Date: None

The Institutional Review Board has reviewed and **approved** the amendment to your above referenced Protocol.

This amendment is approved for the following modifications:

- New participant population, use of a tablet for task, revised questionnaires

Should there be significant changes in the protocol anticipated for this project, you are required to submit another protocol amendment request for review by the committee. Any unanticipated/adverse events or problems resulting from this investigation must be reported immediately to the University's Institutional Review Board.

Appendix A.2 IRB Protocol Exemption

University of Idaho
Office of Research Assurances
Institutional Review Board
875 Perimeter Drive, MS 3010
Moscow ID 83844-3010
Phone: 208-885-6162
Fax: 208-885-5752
irb@uidaho.edu

To: Brian Cleveley

Cc: Paul Matthews

From: Jennifer Walker, IRB Coordinator

Approval Date: October 24, 2017

Title: Two Roads Converge: Exercises in Discretion in a Virtual Environment

Project: 17-219
Certified: Certified as exempt under category 2 at 45 CFR 46.101(b)(2).

On behalf of the Institutional Review Board at the University of Idaho, I am pleased to inform you that the protocol for the research project Two Roads Converge:Exercises in Discretion in a Virtual Environment has been certified as exempt under the category and reference number listed above.

This certification is valid only for the study protocol as it was submitted. Studies certified as Exempt are not subject to continuing review and this certification does not expire. However, if changes are made to the study protocol, you must submit the changes through VERAS for review before implementing the changes. Amendments may include but are not limited to, changes in study population, study personnel, study instruments, consent documents, recruitment materials, sites of research, etc. If you have any additional questions, please contact me through the VERAS messaging system by clicking the 'Reply' button.

As Principal Investigator, you are responsible for ensuring compliance with all applicable FERPA regulations, University of Idaho policies, state and federal regulations. Every effort should be made to ensure that the project is conducted in a manner consistent with the three fundamental principles identified in the Belmont Report: respect for persons; beneficence; and justice. The Principal Investigator is responsible for ensuring that all study personnel have completed the online human subjects training requirement.

You are required to timely notify the IRB if any unanticipated or adverse events occur during the study, if you experience and increased risk to the participants, or if you have participants withdraw or register complaints about the study.

Appendix B.1 Follow Along Study Data

TWO ROADS FOLLOW-UP STUDY

RELIABILITY / DATA

Subject	n	Test Placement x	Test Placement y	Retest Placement x	Retest Placement y	**Test Ratio** Ratio x	**Test Ratio** Ratio y	**Retest Ratio** Ratio x	**Retest Ratio** Ratio y	Void	Test Apple Time	Test Exercise Time	Test Satisfaction	Retest Apple Time	Retest Exercise Time
	1	0.85	-0.50	-0.77	-0.78	0.7833	0.6667	0.7567	0.7600	0	8.92	15.36	7	3.94	5.38
	2	-0.10	-0.27	-0.04	-0.41	0.5333	0.5900	0.5133	0.6367	0	4.68	10.09	8	4.72	12.3
	3	0.09	-1.23	-0.01	-1.05	0.5300	0.9100	0.5033	0.8500	0	3.96	9.45	6	0.63	14.55
	4	0.26	-0.30	1.08	0.81	0.5867	0.6000	0.8600	0.7700	0	5.57	5.57	10	4.22	5.6
	5	0.51	-1.36	0.55	-1.35	0.6700	0.9533	0.6833	0.9500	0	7.61	15.29	10	1.86	8.7
	6	0.43	-0.47	-0.52	0.35	0.6433	0.6567	0.6733	0.6167	0	6.34	12.04	8	11.23	17.23
	7	0.12	-0.03	-0.93	-0.90	0.5400	0.5100	0.8100	0.8000	0	3.17	7.09	5	3.17	7.71
	8	0.01	-0.44	0.07	-0.22	0.5033	0.6467	0.5233	0.5733	0	2.35	3.89	10	3.27	7.53
	9	0.76	1.12	0.81	-0.87	0.7533	0.8733	0.7700	0.7900	0	3.94	5.87	10	4.61	8.88
	10	-0.54	-1.18	-0.55	-0.68	0.6800	0.8933	0.6833	0.7267	0	3.57	19.83	4	4.24	54.83
	11	0.31	-0.37	-0.09	-0.46	0.6033	0.6233	0.5300	0.6533	0	3.84	8.25	10	3.86	11.6
	12	1.20	-1.17	1.29	0.86	0.9000	0.8900	0.9300	0.7867	0	2.25	7.16	9	4.51	6.6
	13	-1.00	-1.26	1.07	0.65	0.8333	0.9200	0.8567	0.7167	0	2.73	7.63	5	3.5	7.46
	14	0.83	-0.23	0.64	0.67	0.7767	0.5767	0.7133	0.7233	0	15.84	25.03	3	2.9	6.69
	15	0.41	0.13	-0.63	-0.88	0.6367	0.5433	0.7100	0.7933	0	5.53	8.5	10	3.9	4.54
Average		0.2760		Average		0.6649				MEDIAN	3.96	8.5	MEDIAN	3.9	7.71
Stdev		0.5598		Stdev		0.1215									
			MEDIAN	0.6433	r(x-x)				r(y-y)						
Pearson Value						**0.69**			0.44						

APPLE TIME

		Satisfaction	Apple Time	Time Rank	Satisfact Rank	d	d^2
	1	7	8.92	14	10	4	16
	2	8	4.68	9	8	1	1
	3	6	3.96	8	11	-3	9
	4	10	5.57	11	1	10	100
	5	10	7.61	13	2	11	121
	6	8	6.34	12	9	3	9
	7	5	3.17	4	12	-8	64
	8	10	2.35	2	3	-1	1
	9	10	3.94	7	4	3	9
	10	4	3.57	5	14	-9	81
	11	10	3.84	6	5	1	1
	12	9	2.25	1	7	-6	36
	13	5	2.73	3	13	-10	100
	14	3	15.84	15	15	0	0
	15	10	5.53	10	6	4	16
					Sum		564
					Numerator		3384
					n		15
					n^3		3375
					Denominator		3360
Spearman Value						rs=	-0.01
						df =	13

EXERCISE TIME

		Satisfaction	Exercise Time	Time Rank	Satisfaction Rank	d	d^2
	1	7	15.36	13	10	3	9
	2	8	10.09	10	8	2	4
	3	6	9.45	9	11	-2	4
	4	10	5.57	2	1	1	1
	5	10	15.29	12	2	10	100
	6	8	12.04	11	9	2	4
	7	5	7.09	4	12	-8	64
	8	10	3.89	1	3	-2	4
	9	10	5.87	3	4	-1	1
	10	4	19.83	14	14	0	0
	11	10	8.25	7	5	2	4
	12	9	7.16	5	7	-2	4
	13	5	7.63	6	13	-7	49
	14	3	25.03	15	15	0	0
	15	10	8.5	8	6	2	4
					Sum		252
					Numerator		1512
					n		15
					n^3		3375
					Denominator		3360
Spearman Value						**rs=**	**0.55**
						df =	13

TWO ROADS FOLLOW UP STUDY

Proportional Schema

SUBJECT				TEST		SUBJECT		Ratio to Schema		
	Ratio x	Predicted Schema	Value	Schema	Value	Satisfaction	e 1 (Predicted Ratio)	Sample 2 (Schema Choice)		
1	0.7833	Mannered	0.81	Classical	0.62	7	0.81	0	0.62	0
2	0.5333	Neolithic	0.52	Neolithic	0.52	8	0.52	0	0.52	0
3	0.5300	Neolithic	0.52	Mannered	0.81	6	0.52	0	0.81	0
4	0.5867	Archaic	0.57	Mannered	0.81	10	0.57	0	0.81	0
5	0.6700	Modern	0.67	Classical	0.62	10	0.67	0	0.62	0
6	0.6433	Modern	0.67	Classical	0.62	8	0.67	0	0.62	0
7	0.5400	Neolithic	0.52	Classical	0.62	5	0.52	0	0.62	0
8	0.5033	Neolithic	0.52	Classical	0.62	10	0.52	0	0.62	0
9	0.7533	Mannered	0.81	Baroque	0.97	10	0.81	0	0.97	0
10	0.6800	Modern	0.67	Classical	0.62	4	0.67	0	0.62	0
11	0.6033	Classical	0.62	Neolithic	0.52	10	0.62	0	0.52	0
12	0.9000	Mannered	0.81	Mannered	0.81	9	0.81	0	0.81	0
13	0.8333	Mannered	0.81	Classical	0.62	5	0.81	0	0.62	0
14	0.7767	Mannered	0.81	Modern	0.67	3	0.81	0	0.67	0
15	0.6367	Classical	0.62	Archaic	0.57	10	0.62	0	0.57	0
						Mean	0.66	Mean	0.67	
							0.12		0.13	

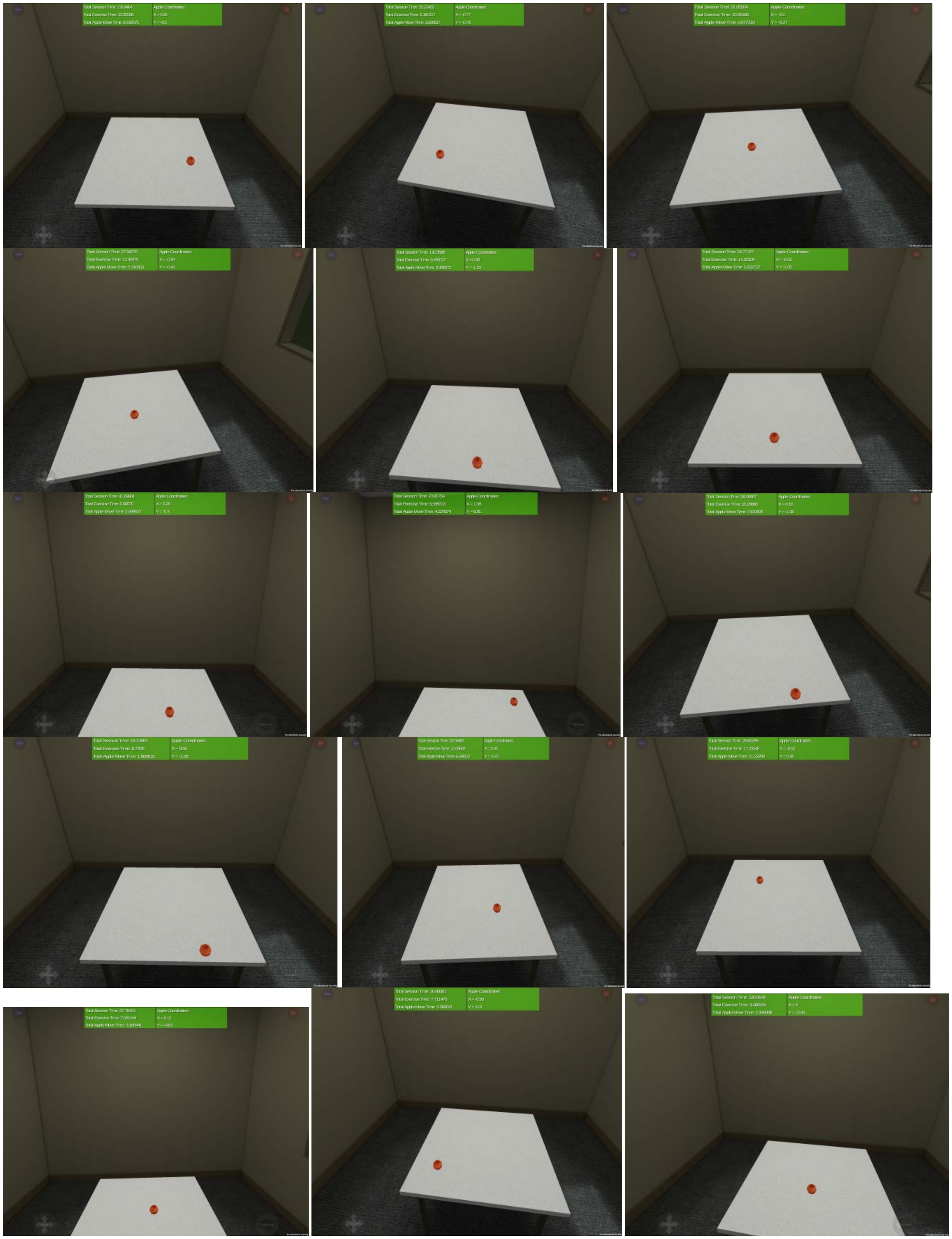
t-Test: Paired Two Sample for Means

Sample 2 (Schemc		Value
Mean	0.668	0.6633
Variance	0.0158	0.0145
Observat	15	15
Pearson	0.2949	
Hypothe	0.08	
df	14	
t Stat	-1.9972	
P(T<=t) c	0.0328	
t Critical	1.7613	
P(T<=t) t	0.0656	
t Critical	2.1448	

t-Test: Paired Two Sample for Means

	Sample 2 (Schema C	Value
Mean	0.668	0.663333333
Variance	0.015802857	0.014452381
Observations	15	15
Pearson Correl	0.294930065	
Hypothesized I	0.08	
df	14	
t Stat	-1.99722004	
P(T<=t) one-ta	0.03280979	
t Critical one-t	1.345030375	
P(T<=t) two-ta	0.065619579	
t Critical two-t	1.761310115	

Appendix B.2 Follow Along Study Screens Saves



Appendix B.3 Pilot Study Data

TWO ROADS STUDY

SUBJECT / DATA

n	Test x	Test y	Retest x	Retest y	Test Ratio x	Test Ratio y	Retest Ratio x	Retest Ratio y	Test Time Begin	Test Time End	Test Elapsed Time	Test Satisfaction	Retest Time Begin	Retest Time End	Retest Elapsed Time	Retest Satisfaction
1	0.7348	-0.5885	-0.7500	-0.5251	0.7449	0.6962	0.7500	0.6750	0	20	20	4	0	15	15	5
2	0.8005	-1.0134	-0.3323	0.1498	0.7668	0.8378	0.6108	0.5499	0	52	52	3.5	0	25	25	2.5
3	0.0327	-0.2643	0.0629	-0.3354	0.5109	0.5881	0.5210	0.6118	0	22	22	4	0	24	24	2
4	0.0366	-1.3119	0.0501	-1.2537	0.5122	0.9373	0.5167	0.9179	0	31	31	4	0	23	23	3
5	0.1453	-0.5352	0.1017	-0.6994	0.5484	0.6784	0.5339	0.7331	0	36	36	4	0	11	11	5
6	-0.7343	0.3246	-0.3900	-0.4343	0.7448	0.6082	0.6300	0.6448	0	55	55	2	0	26	26	4
7	0.7397	-1.1353	-0.7676	-0.4003	0.7466	0.8784	0.7559	0.6334	0	17	17	5	0	18	18	4
8	0.8286	-0.7317	-0.8781	-0.8275	0.7762	0.7439	0.7927	0.7758	0	27	27	5	0	28	28	4
9	-0.7264	0.4021	-0.3443	0.4021	0.7421	0.6340	0.6148	0.6340	0	16	16	3	0	12	12	4.5
10	0.6743	-0.7317	-0.6181	-0.0849	0.7248	0.7439	0.7060	0.5283	0	20	20	4	0	17	17	4
11	0.5611	0.6813	0.6745	0.4021	0.6870	0.7271	0.7248	0.6340	0	25	25	3	0	12	12	5
12	0.0759	-0.2622	-0.4810	0.4413	0.5253	0.5874	0.6603	0.6471	0	8	8	3	0	13	13	4
13	-0.4788	-0.8904	0.7386	-0.7317	0.6596	0.7968	0.7462	0.7439	0	49	49	2	0	22	22	3
14	-0.0770	-0.5352	-0.2863	-0.5352	0.5257	0.6784	0.5954	0.6784	0	25	25	3	0	17	17	3.5
15	0.8511	0.4807	-0.3552	-0.4681	0.7837	0.6602	0.6184	0.6560	0	50	50	3	0	16	16	3
										MEDIAN	25			MEDIAN	17	

	r(x-x)	r(y-y)
Pearson Value	0.62	0.38

n	TEST Satisfaction	TEST Time	TEST Time Rank	TEST Satisfact Rank	TEST d	TEST d^2	RETEST Satisfaction	RETEST Time	RETEST Time Rank	RETEST Satisfaction Rank	RETEST d	RETEST d^2
1	4	20	4	3	1	1	5	15	5	1	4	16
2	3.5	52	14	8	6	36	2.5	25	13	14	-1	1
3	4	22	6	4	2	4	2	24	12	15	-3	9
4	4	31	10	5	5	25	3	23	11	11	0	0
5	4	36	11	6	5	25	5	11	1	2	-1	1
6	2	55	15	14	1	1	4	26	14	5	9	81
7	5	17	3	1	2	4	4	18	9	6	3	9
8	5	27	9	2	7	49	4	28	15	7	8	64
9	3	16	2	9	-7	49	4.5	12	2	4	-2	4
10	4	20	5	7	-2	4	4	17	7	8	-1	1
11	3	25	7	10	-3	9	5	12	3	3	0	0
12	3	8	1	11	-10	100	4	13	4	9	-5	25
13	2	49	12	15	-3	9	3	22	10	12	-2	4
14	3	25	8	12	-4	16	3.5	17	8	10	-2	4
15	3	50	13	13	0	0	3	16	6	13	-7	49
			Sum			332			Sum			268
			Numerator			1992			Numerator			1608
			n			15			n			15
			n^3			3375			n^3			3375
			Denominator			3360			Denominator			3360
Spearman Value					rs=	0.41					rs=	0.52
					df =	13					df =	13

TWO ROADS STUDY

Proportional Schema

SUBJECT	TEST			SUBJECT	RETEST		
	Ratio x	Void	Schema		Ratio x	Void	Schema
1	0.7449	0	Classical	1	0.7500	0	Baroque
2	0.7668	0	Archaic	2	0.6108	0	Classical
3	0.5109	0	Mannered	3	0.5210	0	Mannered
4	0.5122	0	Mannered	4	0.5167	0	Mannered
5	0.5484	0	Baroque	5	0.5339	0	Baroque
6	0.7448	0	Classical	6	0.6300	0	Classical
7	0.7466	0	Classical	7	0.7559	0	Classical
8	0.7762	0	Archaic	8	0.7927	0	Archaic
9	0.7421	0	Classical	9	0.6148	0	Archaic
10	0.7248	0	Classical	10	0.7060	0	Classical
11	0.6870	0	Classical	11	0.7248	0	Classical
12	0.5253	0	Mannered	12	0.6603	0	Classical
13	0.6596	0	Classical	13	0.7462	0	Classical
14	0.5257	0	Mannered	14	0.5954	0	Mannered
15	0.7837	0	Archaic	15	0.6184	0	Classical

Appendix B.4 Pilot Study Screen Saves