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AN HEDONOMIC EVALUATION OF PLEASURABLE HUMAN-TECHNOLOGY
EXPERIENCE: THE EFFECT OF EXPOSURE AND AESTHETICS ON THE EXPERIENCE
OF FLOW

by

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A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy
in the Department of Psychology
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# ABSTRACT

A framework was developed called the Extended Hedonomic Hierarchy (EHH) that provides a basis for evaluating pleasurable human-system experience. Results from a number of experiments within this framework that evaluated specific dimensions of the framework are reported. The 'Exposure' component of the EHH framework and hedonics of the system were investigated to see how changes would affect other dimensions, such as the occurrence of flow, the mode of interaction, and the needs of the user. Simulations and video games were used to investigate how repeated exposure affects flow, interaction mode, and the user needs. The Kansei Engineering method was used to measure user needs and investigate the effect of different hedonic properties of the system on user needs and flow. Findings reveal that: (a) pleasurable human-system experience increases linearly with repeated exposure to the technology of interest; (b) an habituation effect of flow mediated by day; (c) motivation to satisfy human need for technology is hierarchically structured and contributes to pleasurable human-system experience; (d) interactivity is hierarchically structured and seamless mode of interaction is a behavioral outcome of pleasurable human-system experience; (e) there are individual differences among users that affect the likelihood of experiencing pleasurable human-system interaction; (f) performance is positively correlated to flow and (g) the method of kansei engineering provides data from which informed decisions about design can be made and empirical research can be conducted. Suggestions for (a) making Hedonomics a reality in industry, the workplace, and in the field of Human Factors, (b) future research directions for Hedonomics, and (c) principles and guidelines for the practice of Hedonomics are discussed.

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# LIST OF ACRONYMS/ABBREVIATIONS

C3Fire                                    Command Control Communicate Fire

EHH                                      Extended Hedonomic Hierarchy

FSS                                        Flow State Survey

HH of N                                  Hedonomic Hierarchy of Needs

HNQ                                     Human Need Questionnaire

KEM                                     Kansei Engineering Method

NEO FFI                               NEO Five Factor Inventory

WSS                                      Web State Scale

# CHAPTER ONE: INTRODUCTION TO THE EXTENDED HEDONOMIC HIERARCHY FRAMEWORK

## Hedonomics

Traditionally Ergonomics has focused on safety issues and increasing productivity through preventing pain, increasing efficiency, decreasing error, reducing workload, and increasing situational awareness among other related endeavors. However, since the last few years there has been an additional focus that has emerged from the field of Ergonomics that is concerned with the promotion of pleasure and well being through design and in the workplace. This new branch of study has been termed *Hedonomics* which is defined as: the branch of science and design dedicated to promoting pleasurable human-system interaction. The term 'system' is used as an umbrella term for any object or group of objects designed to be utilized by a human. The genesis of this endeavor began with Dr. Helander's identification of this new ideology that, at the time, was under the guise of many different names such as: Affective Design, Pleasurable Design, Funology, Feeling Design, and Emotional Engineering (ENGAGE, 2005). In respect of Hume's observation about the values of naming, Dr. Hancock (2005) suggested the term, *Hedonomics*, derived from two Greek roots, *hedon(e)* meaning pleasure; and *nomos* meaning law-or rule. Since then, there has been numerous articles directly concerned with the study of Hedonomics (Jordan, 2000c; Helander, Khalid, & Tham, 2001; Murphy, Stanney, & Hancock, 2003; Norman, 2004; Hancock, Pepe, & Murphy, 2005).

A science of Hedonomics is needed for several reasons. First and foremost, technology is in a constant burgeoning state making it nearly impossible in today's day and age for humans to escape from interacting with machine. We must ensure that human-machine interaction is not

antagonist but synergistic and pleasurable (Hancock, 1997b). Secondly, making experiences pleasurable and enjoyable are crucial for continued interaction and learning (Hassenzahl, 2003; Wensveen & Overbeeke, 2003). This is important because technology has great potential to be used to facilitate experiences in almost all facets of life such as training, teaching, learning, communication, travel, leisure and work (Becker & Dwyer, 1994; Blythe & Hassenzahl, 2003; Andersen, Jacobs, & Polazzi, 2003; Hohl, Wissmann, & Burger, 2003; Braun, 2003; Blankinship & Esara, 2003) . However, positive affect, enjoyment and pleasure are major factors when it comes to learning and to cognitive flexibility (Brickman & Campbel, 1971; Isen, Daubman, & Novwicki, 1987; Murphy et al., 2003) as well as major motivating factors (Csikszentmihalyi, 1990; Kahneman, Diener, & Schwarz, 1999; Ryan & Deci, 2001; Kippendorff, 2004). Incorporating Hedonomics principles into the design of every day things can potentially dissolve the boundaries between work and play as well as transforming the concept of work from rote-drudgery to enjoyable (Hancock et al., 2005).

As a new branch of science and design, Hedonomics has yet to flower into its full form. In order for it to develop into a legitimate and grounded science, frameworks, methods, and approaches need to be developed to facilitate empirical research. Several frameworks related to Hedonomics have recently emerged (Helander et al., 2001; Murphy et al., 2003). In Industry, several approaches and methods for designing for individual needs are already in use. Kansei Engineering, Personas, and User-Centered Design each represent perfect examples.

Organization of the Thesis

This thesis proposes a framework called the Extended Hedonomic Hierarchy and demonstrates how it can be used as a basis for empirical evaluation of pleasurable human-system

experience. Chapter one introduces the framework and its central constructs. The chapter argues that the framework provides a theoretical and empirical grounding for Hedonomic science that can be used in the design and study of pleasurable human-technology experience.

Chapter two reviews the literature that was used to construct the framework. Drawing on the analogy of the human-human relationship, the discussion relates the sociological principles of close proximity, mere exposure, and attractiveness to the domain of human-technology interaction.

Chapter three and chapter four discuss the method of and results from a series of three experiments conducted to examine two dimensions of the proposed framework: (a) the mere exposure effect on the occurrence of flow, and (b) the effect of the hedonic aspects of the system on the occurrence of flow and user needs.

The first experiment focuses on the relationship development between the human and the system or the 'exposure' dimension which is a major component of the theory and maybe the key to designing for pleasurable interaction. Drawing on the analogy of the human-human relationship, this thesis incorporates the known sociological principles of close proximity, mere exposure, and attractiveness to the domain of human-technology interaction. The experiment uses a micro world paradigm to investigate the how mere exposure (frequency of exposure) to the system affects the experience of flow, interaction mode, and the needs of the user.

The second experiment extends experiment one by doubling the exposure to the technology and changing the technology from a micro world to a video game paradigm. The focus is on the occurrence of flow across 16 repeated exposures over a period of four days.

The third experiment utilizes the method of Kansei Engineering to examine how user needs, as defined in Kansei Engineering, are affected by changes in the hedonic properties of the

system; specifically, aesthetic differences and how these differences may affect the occurrence of flow. The experiment uses a video game paradigm to investigate how user needs and the occurrence of flow are affected by differences in aesthetics of the system and if there is a relationship between the satisfaction of the user needs and flow.

Chapter five discusses the results from three experiments that evaluated specific dimensions of the Extended Hedonomic Hierarchy framework. The chapter includes suggestions for making Hedonomics a reality in industry, the workplace, and in the field of Human Factors. Future research direction for Hedonomics, and principles and guidelines for the practice of Hedonomics are also discussed.

Chapter five also argues that in order to make Hedonomics a reality in industry, the workplace, and in Human Factors it must be demonstrated numerically that Hedonomics can financially benefit companies by incorporating its guidelines and principles at the earliest stages of system design and sustaining them throughout system development not only to ensure both pleasurable human-system experience and well-being in the workers but to ensure superior financial returns for the companies.

The Hedonomic Hierarchy of Needs Framework

The hedonomic hierarchy of needs (HH of N), displayed in Figure 1, is a theoretical framework to promote pleasurable interaction based on a design priority hierarchy. Based on Maslow's (1970) model of the optimization of human satisfaction through a hierarchy of needs that specifies that higher level needs can only be fulfilled after lower level needs are satisfied. This framework specifies that the system must first be designed to be safe, functional, and usable

before it can be designed to be pleasurable and uniquely designed for the individual. Note that human need is implicit within this framework. One of the key features of the framework is *Individuation*, and the initial principles suggested for achieving this goal which include: *Hedonomic Affordances*, *Aesthetic Longevity*, and *Seamless Interaction*. Individuation is an individual-centered ethic which emphasizes idiosyncratic rather than nomothetic design. Its goal is to design for each and every individual through the use of customization of tools in order to optimize the pleasure and efficiency of their own personal interaction. One suggested principle for achieving Individuation is through *Hedonomic Affordances* which involves inviting an emotional reaction from the user by the way of the objects' physical attributes [properties] that result in the users' appraisal and perception of something as enjoyable, pleasurable, fun, etc. (Hancock, Pepe, Murphy, 2005). *Aesthetic Longevity* is described as allowing the user to create a balance between typicality and novelty in order to allow for changing cultural norms and personal change over time. The authors suggest that designers should seek to create systems that adapt in order to facilitate a continuous 'state of newness' that consistently elicits pleasurable feeling. *Seamless Interaction* is a principle that enables users to interact optimally with the tool at hand. The tool in itself becomes an unconscious extension of the user eliciting the experience of 'flow' (Cziksentmihalyi, 1997) which is a highly pleasurable experience.

*Idiosyncratic vs. Nomothetic Design*

The HH of N framework specifies that the Hedonomic aspects of the system are 'usability,' 'pleasurable experience' and 'individuation', one way they differ from the Ergonomic aspects (i.e., safety, functionality) is on the emphasis of idiosyncratic rather than

nomotheic. Nomothetic, meaning in a sense, generic or designed for the majority of the population to accomplish a variety of pragmatic tasks with ease. This is practical in that it fulfills a behavioral need to achieve a goal using the system. Whereas, the hedonomic aspect is personal, emphasizing the individual by focusing on what each unique person desires from his/her interaction with the system. Designing for the individual should be purely idiosyncratic and because of the subjective nature of pleasure it can also be a bit fuzzy.

The Extended Hedonomic Hierarchy (EHH) framework (Figure 3) is an addition to the Hedonomic Hierarchy of Needs. Specifically, the EHH focuses on the fourth level of the Hedonomic Hierarchy of Needs called "Pleasurable Experience" and provides an initial framework for to study and design for pleasurable human-system experience.
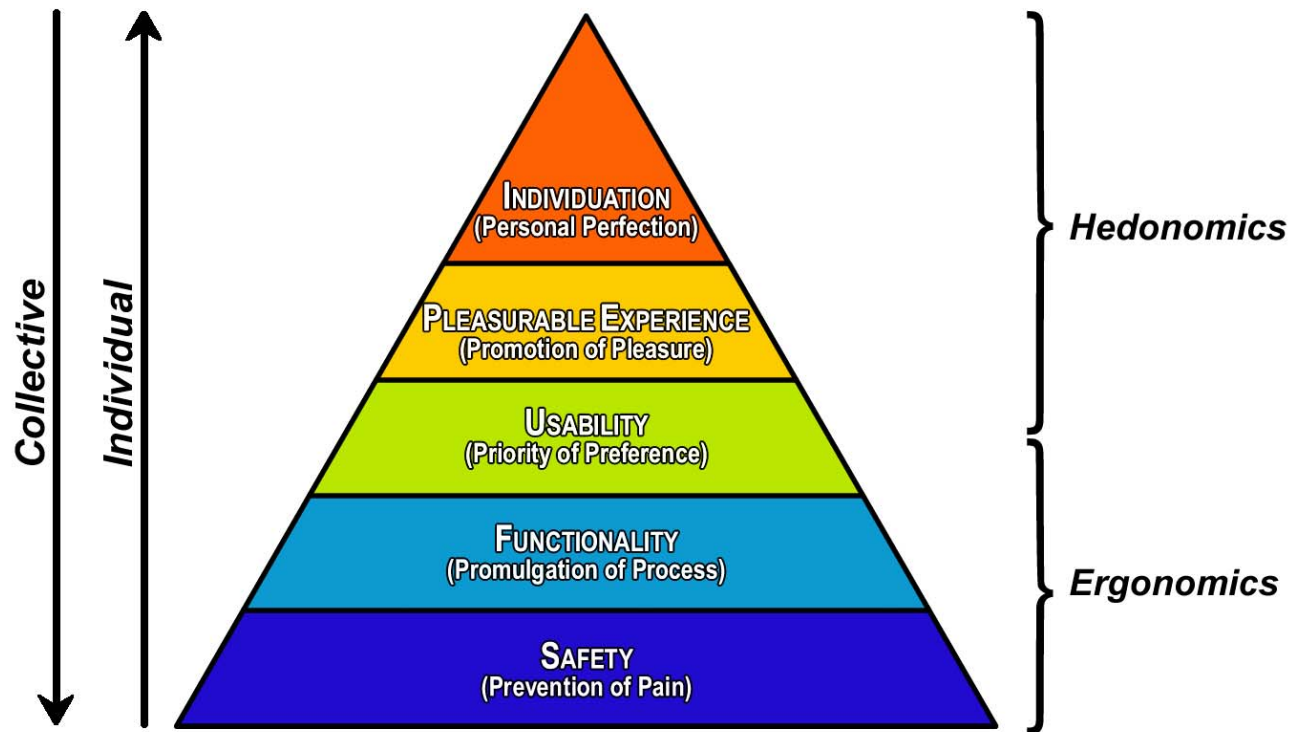
*Figure 1*. The Hedonomic Hierarchy of Needs Framework adopted from Hancock, Pepe, and Murphy (2005).
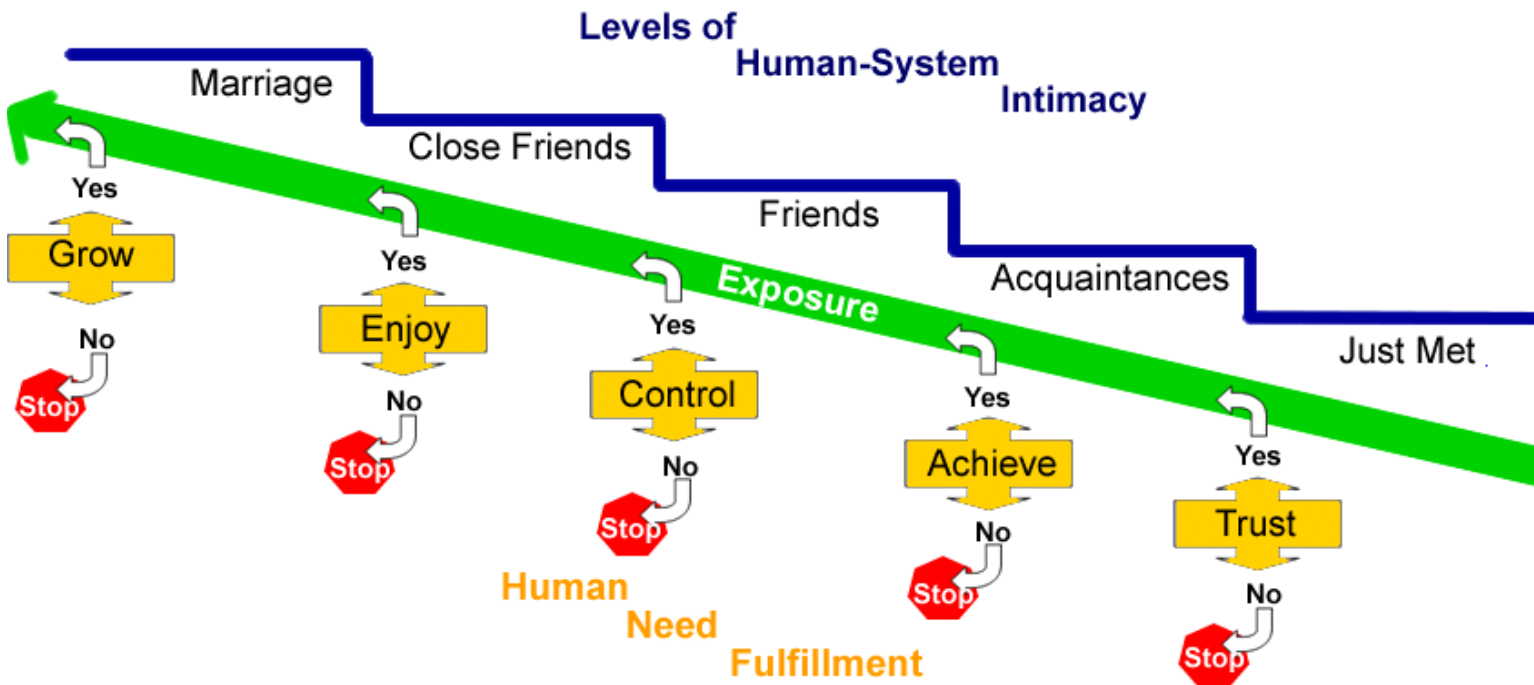
*Figure 2.* The Extended Hedonomic Hierarchy (EHH): A Framework for the Evaluation of Pleasurable Human-System Experience. The EHH is an additional framework within the 'Pleasurable Experience" level of the Hedonomic Hierarchy of Needs adopted from Hancock, Pepe, and Murphy (2005).

The Extended Hedonomic Hierarchy:  A Framework for Pleasurable Human-System Experience

The Extended Hedonomic Hierarchy (EHH), Figure 3, is a framework for evaluating pleasurable human-system experience and is proposed to form a sound basis for the study of Hedonomics in the domain of human-system interaction; its parts are discussed in detail. The framework consists of essentially three main components: (1) Levels of Human-System Intimacy, (2) Exposure, and (3) the Need Fulfillment, each will be discussed in turn.

## Definitions of Constructs and Variables

The EHH framework added: (a) Levels of Human-System Intimacy; an anthropomorphic approach to pleasurable human-technology interaction  in which principles from social psychology regarding love, intimacy, and relationship development are applied to humans and machines; (b) Exposure; acknowledging that frequent exposure to technology breeds fondness and leads to a developing relationship and growing feelings of intimacy from the users toward machines; and (c) Need Fulfillment; an explicit recognition of the human need to be fulfilled for the technology in order for exposure to the technology to continue and the human-machine relationship to continue to develop.

### *Levels of Human-System Intimacy*

There are five theoretical stages in the development of a relationship between the human and the system, much like the development of a relationship between two people; they must first

meet, if they like each other enough it is more likely that they will become more acquainted. From there it could perhaps turn into friendship, potentially very close friendship, possibly lead to marriage, a synergy. The process here is hierarchical; in relationships for example, first you must meet before you can become acquainted. The EHH framework describes the process in terms of the system and human and the other factors essential to the process, including (a) whether or not the developmental needs of the human are being fulfilled (Maslow, 1970; Jordan, 2000d) (b) the systems role in fulfilling the needs of the human (Hancock et al., 2005), (c) the type of interaction occurring between the human and the system (Jordan, 2000d; Wright, McCarthy, & Meekison, 2003), and (d) what the experience is of the human (Csikszentmihalyi, 1990; Kahneman et al., 1999); at each stage of the relationship. (Csikszentmihalyi, 1990). In a sense, this becomes the mental state of the user during the time of interaction (see Hassenzahl. Kekez, & Burmester, 2002). Both interaction mode and type of experience are dependent on the individual differences, challenge of the task, and the skill level of the human.

*Just Met*

Similar to meeting a person for the first time through an introduction of some sort, we are also introduced to new technology, artifacts, systems, etc. With today's burgeoning technology this occurs very often. During the first exposure to a new technology there will be very little interaction and relationship. Exposure with the system can be measured by looking at the start time of when the user began using the system, the frequency of usage, and how frequently the user intends to use the system in the future (Novak, Hoffman, & Yung, 2000). A major factor that may influence the human from continuing to interact with the system is how they feel about

the system. For example, most people need to feel secure and safe from the system imposing any psychological or physical harm to him to want to continue interacting with it. In the EHH framework, this is termed human need to trust.

Most likely the user will test out the system to see if it meets their need for trust. This type of interaction is termed goal mode because the interaction always consists of behavioral goals and actions to fulfill these goals (Hassenzahl, 2003). In goal mode, fulfillment of a particular mission-oriented task is most important thus determining all actions. The human perceives the system, in this instance, as merely 'a means to an end.' According to Hassenzal (2003), users strive to be effective and efficient and are serious and future oriented. Their expectations of the system are met if they accomplish their goal as planned. Hence, arousal is not preferred, if arousal increases (e.g., because of a functionality or usability problem that circumvents goal fulfillment), it is experienced as mounting anxiety (frustration). The interaction is driven by a need to trust. If the system is safe and meets the human's need for trust then, according to the framework, the human-system intimacy will continue to grow through an increase in frequent usage or exposure.

The experience of flow is also possible at this stage of development, although it is unclear how frequent the experience would occur at this level, what is known is that the experience of flow is essential for learning, growing, and enjoyment (Csikszentmihalyi, 1990). Therefore, for the continuation of the human-system development, flow must occur to some extent regardless of the frequency, at all stages of the process.

*Acquaintances*

At this stage, the person is getting to know the system better through an increase in frequency of usage or exposure. In a sense, the system becomes like an acquaintance to the human. If the system is something that is purchased, perhaps this is the stage that it would likely be purchased in. In order for the human to continue to interact with the system she needs to be able to perform the operations that the system is needed to perform. In the EHH framework, this is termed human need to achieve.

The human will interact with the system to see if the system has certain functionality expected or desired by the user. Again, this is goal mode interaction as the human tests to see if the system can perform tasks, that the human expects it and desires it to perform (e.g., "I want to find out if the system works'). In other words, the user must be satisfied with the system's functionality to ensure future interaction. If the system does not enable the user to perform a task that it is needed to perform, then the human will cease to interact with it further because a phone is not a 'phone' unless you can make a call with it. If the system's functionality meets the user's expectations ensuring that the system can help in fulfilling her need to achieve then the human-system intimacy will continue to grow. According to the EHH framework, the experience of flow is most likely still occurring at a lower level.

*Friends*

As the human begins to interact more often with the system, the system may become like an actual friend to the human. The human needs to be able to connect to the system, and the

system needs to be able to perform the operations that it is needed to perform. In the EHH framework, this is termed human need to control.

At this stage the user, according to the EHH framework, interacts with the system with the purpose to understand how it operates. This type of interaction is termed exploration mode because there is no specific task-oriented goal in mind during the interaction, it is just to explore the system (Hassenzahl, 2003). The interaction with the system is the goal in and of itself; the goals are non-specific. Using the system becomes an 'end in itself.' Safety, effectiveness, and efficiency are not a concern of the user, nevertheless, the system must remain safe, effective, and efficient or an exploration mode is less likely to occur. Users may become playful and spontaneous as they become stimulated by their interaction with the system. The stimulation may result in an increase in arousal and excitement. If arousal decreases (because of a lack of stimulation) the experience will become boring. According to the framework, the interaction is driven by a need for control over the system. If the system's usability meets the human's need to have control over the system then the human-system intimacy will probably continue to grow. Perhaps when the need to control is fulfilled by the system, the human will experience an increase in satisfaction, enjoyment and flow. We know that usability is a factor in what makes something enjoyable (Murphy et al., 2003).

*Close Friends*

According to the EHH  framework, the human likeability toward the system will increase as the exposure to the system increases because familiararity, breeds fondness (Bornstein, 1989; Bornstein, 1999) this is called the *mere exposure effect* (Zajonc, 1980). The system can become

like a best friend to the human. The user has a need to enjoy the time that he/she spends interacting with the system. This is termed human need to enjoy. The user most likely will interact with the system with the purpose to play with the system and have fun using it. This type of interaction mode is termed exploration because there is no specific task-oriented goal in mind during the interaction; it is just to play with the system (Hassenzahl, 2003). Often times the act of customization occurs at this stage. The human finds ways to customize the system, personalizing it, making it a part of them. Aesthetic preference is linked to customization and this is where the factor *similar attractiveness* comes into play (Murphy, Staney, & Hancock, 2003; Hancock, Pepe, & Murphy, 2005). Customization and aesthetics are related because the customizing alters the person's perception of how aesthetically pleasing the system is to them. Customization helps shape the human-machine interaction because the system becomes more personalized or familiar, and therefore the more pleasurable it becomes for the person to interact with it. If the system fulfills the user's need to enjoy then the human and the system will continue to interact and become more intimate. When the need to enjoy is fulfilled by the system the human then experiences satisfaction, and enjoyment as well as some experience of flow. Flow probably occurs more frequently at this point.

*Marriage*

At this stage the system becomes an extension of the human. The boundaries between the system and human are lost, leaving a sense of 'oneness,' a marriage if you will. The human needs to expand or transcend, which is the feeling that boundaries of our being pushed forward (Cziksentmihalyi, 1997), this is synonymous to the need to self actualize. This is termed human

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need to grow. This interaction occurs when a task is so engrossing that little if any attention is left to focus on anything else, including the human's own self. Loss of self-consciousness can lead to transcendence. Loss of self is linked to synergy with the environment. Seamless interaction produces a rare sense of unity with what are usually foreign entities (Cziksentmihalyi, 1997). Patrick Jordan (1999) describes the phenomenon as an 'extension of self' to describe the optimal experience of interacting with a tool. Seamless interaction enables the user to interact optimally with the tool at hand. This in turn facilitates the transparency of the tool enabling one to focus effort on task completion not on the tool itself. In this way, the tool becomes an unconscious extension of the user and is integral to their conscious experience of self (Hancock, 1997b; Jordan, 2000b). This promotes the experience of 'flow' or being in the 'zone of optimal function' as the seamless interaction between the user and the system itself enhances intrinsic pleasure. The act of customization should in itself be a seamless interaction enabling the user to easily adapt the tool to himself; but ideally the tool should adapt to the user (Hancock, Pepe, Murphy, 2005).

If the system fulfills the user's need to grow then the human and the system will continue to grow together. In this stage of human-system evolution, it is uncertain whether we will evolve toward synergy or antagonism. Human Factors is defined as the branch of science which seeks to turn human-machine antagonism to human-machine synergy (Hancock, 1997b). Technology can become either a blessing or a curse to the human race. It is no surprise then that Hedonomics is birthed from Human Factors (Helander, 2002; Hancock et al., 2005).

Marriage or synergy between the human and the system is a purely theoretical concept. The EHH framework argues that in order for synergy to occur, designers must design according to the principle of Individuation (Hancock, 1997b; Hancock, 2003), which is an individual-

centered ethic, distinct from human-centered design which only seeks implementation based on functionality and nomothetic or general human capacities. Individuation is directed to explore ways through which each and every single individual can customize their own tools to optimize the pleasure and efficiency of their own personal interaction. In this era of burgeoning technology, it is possible to achieve these goals where systems must be customizable and dynamically adaptable to individuals by responding to their affective needs and their changing requirements (MacDonald, 2003). Customization allows for accomplishment of experience goals on an individual level as users bring their own cognitive appraisals, past experiences, traits, and mood states to the interaction and as these users change their views of the situation and themselves over time. When individuals work in a social context, it is the responsibility of the adaptive, technical system to integrate their respective individual preferences for interaction. In Hedonomics design, operators are viewed as complex entities with a range of multi-level needs. Therefore, tools must be adaptable to fit the individual needs of the operator and to do this we need customization principles.

When the need to grow is fulfilled by the system the human then reaches the optimal experience of engaging in flow. The heart of the EHH framework is in developing intimate human-system relationships and flow is a measurable outcome of a very intimate human-system experience. Flow is necessary to occur at each stage in order to motivate the human to continue to interact with the system so the human-system intimacy can continue to evolve. The experience of flow will occur at all stages of development but possibly less frequently at lower stages. However, occurrence of flow is most frequent in the seamless mode, lesser in the exploratory mode, and least in the goal mode, but necessary to occur at each stage of development.

*Flow*

Flow is the highest, most optimal of experiences during human-system interaction. This psychological state transcends human needs (i.e., need to trust, achieve, control, and enjoy) as this act of engaging in flow is intrinsically rewarding and self-reinforcing. Flow is not merely a passive state, but an active state which involves the active use of skills to overcome challenges. As the system provides the proper balance of clear goals and immediate feedback, concentration and attention are heightened to the point where the concept of self, time, and space disappear. Therefore, flow during human-system interaction is a highly intimate experience. The state is dependent on the level of arousal and the level of skill. If the level of arousal due to the challenge of the task or goal exceeds the skill level of the human than flow will not occur, and vice versa. The arousal level from the challenge of the task must meet the skill level of the human.

*Exposure*

The second component to the EHH framework is exposure or the frequency of exposure to the system. Continued human-system relationship development is contingent upon frequency of exposure. Factors such as close proximity, mere exposure and attractiveness play an important role in determining how relationships between two people develop; as well as how relationships between the human and the system develop. Proximity means geographical nearness and it is a powerful predictor of liking. Sociologists have found that most people marry someone who lives, works, or studies within walking distance (Bossard, 1932; Clarke, 1952; Katz & Hill, 1958; Burr, 1973). This is because they can hardly avoid interacting with each other. This frequent

interaction leads to the feeling of familiarity which breeds fondness (Bornstein, 1989; Bornstein, 1999). This is called the mere exposure effect which is the tendency for novel stimuli to be liked more or rated more positively after the rater has been repeatedly exposed to them (Zajonc, 1980). Attractiveness is a predictor of affection toward another. Hatfield and colleagues found in a study among first-year students at the University of Minnesota, that despite all other factors measured, attractiveness was the only predictor of liking (Hatfield, Aronson, Abrahams, & Rottman, 1966). The more attractive a woman was, the more the men liked her and wanted to see her again, and vice versa. There is a physical attractiveness stereotype which is the presumption that physically attractive people possess other socially desirable traits as well: What is beautiful is good (Dion, 1979).

The system's acceptable functionality, usability, and hedonics create an atmosphere of close proximity, increased exposure, and liking between the human and the system. Functionality ensures proximity in the sense that once the human trusts that the system meets his functional needs and decides to interact with it (e.g. decides to buy the product) this enables an increase in interaction with the system because the system is now in close proximity.  Usability ensures exposure in the sense that the easier it is for the person to accomplish tasks using the system the more he will use the system to complete tasks and this increases mere exposure to the system. Hedonics ensures attractiveness and hence increases affection or liking toward the system (Murphy et al., 2003). Therefore the rate and extent of the relationship development between the human and the machine depends on how functional, usable, and hedonic the system is to the human.

<center>*Need Fulfillment*</center>

The third component of the EHH framework is Need Fulfillment. Continued exposure is contingent upon the system satisfying the human's needs for the system. The human has both behavioral and psychological needs. Behavioral needs are lower level needs, such as the need to trust and need to achieve. Psychological needs are more fragile needs these include: the need to control, the need to enjoy, and the need to grow. Each will be discussed in turn.

*Need to Trust*

Feeling secure and trusting the system is linked to the system's level of safety and functionality. A predictable system will elicit a sense of security and trust. This feeling is related to the dependability of the system and it is developed through the interaction with the system. The user must first become acquainted with the system to the point where he/she able to predict the system's response to each behavior. At this point their expectations of the system are starting to develop. Each time they interact with the system and their expectations are fulfilled; a sense of trust is developed more and more, until the human believes that they understand how the system operates and feels secure with their interaction with the system.

*Need to Achieve*

Functional technology has enabled the human to accomplish tasks easier and faster beyond what could have been imagined 50 years ago. Communication has increased dramatically with the development of email, cell phones and text messaging. Writing and data analyses have become faster and easier just in the last decade with the development of computers and software.

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Developments in the functionality of technology will continue to improve increasing the ease and decreasing the time it takes to accomplish tasks and achieve goals, thus fulfilling the need to achieve.

*Need to Control*

Usability has enabled the human to gain control over the system by shifting the power from the system to the human. Operating machinery and computers were once a daunting task. Not only were the systems designed in such a way that they were difficult to use, but they were constantly changing as well. The system was controlling the free time of the users because of the time it took to initially learn to use the system and the time needed to be invested by the user to remain proficient in this constant developing system. Today with advances due to usability, the system is designed to be intuitive making the interaction between the human and the system easier and more efficient. Instead of our time being invested into figuring out how to use the system, it is being invested into more important, higher level tasks. Consequently, our interaction with the system leaves us with a sense of achievement and control over our accomplishments.

*Need to Enjoy*

Individuals express their self through material objects or possessions (Prentice, 1987; Norman, 2004). This is a self-expression that is purely social in that individuals want to be seen in specific ways by relevant others. To be socially recognized and to be an individual is a basic human motive (Schwartz & Bilsky, 1987). To fulfill this need, a product has to communicate

identity. For example, personal homepages can be used to present the self to others. Borcherding and Schumacher (2002) found that students who believed that others hold unfavorable opinions about them, such as a lack of humor and few social contacts, presented more information about family and friends and humorous links on their homepages. In this case, the possession –a personal homepage – is deliberately shaped to communicate an advantageous identity. In general, people may prefer products that communicate advantageous identities to products that don't.

Products can provoke memories. In this case the product represents past events, relationships or thoughts that are important to the individual (Prentice, 1987; Norman, 2004). For example, souvenirs are symbolic of memories from a pleasant journey. A more technology related example might be the pilot who loves to fly the much older vintage plane, the one in which he first learned to fly, because it triggers memories of the good old days, when planes and flying were new and exciting. To summarize, a product may be perceived as pragmatic because it provides effective and efficient means to manipulate the environment. A product may be perceived as enjoyable because it provides identification, or evokes memories (Norman, 2004).

Need to Grow

Individuals strive for personal development, i.e., increase of knowledge and development of skills. To do so, the system has to be stimulating, providing new opportunities and insights. McGrenere (2000), for example, found in a study on excessive featurism in Microsoft's Word that on average only 27% of the available functionality was used. However, only 25% of the participants wanted to have unused functionality entirely removed. Perhaps these unused

functions are viewed as future opportunities for personal development. They are not needed to fulfill current goals, but still wanted for future perfection of the way current goals are accomplished or for future goals. Thus, functionality that is used and works well will be perceived as Ergonomic, whereas functionality not yet used but interesting will be perceived as Hedonomic. The stimulation provided by novel functionality and interaction style may indirectly help goal fulfillment by increasing attention and motivation.

Transcendence is to rise above earthy limitations of self, time, space, conditions, means, etc. The need to transcend has many names depending on the philosophy (i.e., awakening, nirvana, sainthood, and self-actualization). This is the highest evolutionary level attainable by the individual; all other needs are transcended at this state. Likewise, this is the highest level of evolutionary state for the human race; a sort of evolution of consciousness. Envision a world where basic needs such as food, clothing, shelter, transportation, etc. are transcended through advanced automation (Redfield, 1993). This would be an optimal way of interacting with the environment. The human species will have basic need automatically met and at everyone's disposal, thus freeing up time to pursue more important endeavors.

This thesis demonstrates how the Extended Hedonomic Hierarchy can be used as a framework for evaluating pleasurable human-system experience by conducting several experiments within this framework. These experiments evaluate specific dimensions of the framework, namely the 'Exposure' component of the EHH and 'Pleasurable Experience' level of the HH of N, to investigate how changes in these dimensions may affect the other dimensions of the framework, such as the occurrence of flow, the mode of interaction, and the needs of the user.

# Summary of the Extended Hedonomic Hierarchy Framework

The Extended Hedonomic Hierarchy is a framework that consists of three components including: 'Levels of Human-System Intimacy,' component which applies principles from social psychology regarding love, intimacy, and relationship development to humans and machines. There are five levels of Human-System Intimacy including: Just Met, Acquaintances, Friends, Close Friends, and Marriage (adopted from Katz & Hill, 1958; Sternberg, 1988).

The 'Exposure' component refers to the frequency of exposure the user has with the system over time (adopted from Bossard, 1932; Burr, 1973; Clark, 1952). Continued growth of human-system intimacy is contingent upon the user's continued exposure to the system because of the mere exposure effect (Zajonc, 1980).

The "Need Fulfillment' component represents the user needs toward the system; these needs must be satisfied in order for interaction and exposure to the system to continue. There are five levels of human need for technology including: Need to Trust, Need to Achieve, Need to Control, Need to Enjoy, and Need to Grow (adopted from Adlefer's ERG theory). Each need is expected to correspond to different levels of the HH of N framework. Need to trust corresponds to the 'safety' aspect of the system; need to achieve corresponds to 'functionality'; need to control corresponds to the 'usability'; need to enjoy corresponds to 'pleasurable experience'; and need to grow corresponds to 'individuation.'

Different modes of interaction are expected to occur between the human and system depending on the level of human-system intimacy. There are three types of interaction modes: Goal, Exploratory (adopted from Novak's Model of Web Experience), and Seamless (adopted from Jordan's Four Pleasures). Goal mode is expected to occur most frequently in the earlier

stages of exposure to technology. Exploratory mode is expected to occur most frequently during the middle stages of exposure. Seamless mode is expected to occur most frequently during later stages of exposure. 'Flow' is a type of pleasurable experience that occurs during human-system interaction.

Flow is a measurable outcome of human-system intimacy. Flow is expected to vary monotonically with all other components of the framework. For example, as exposure increases so does flow, and interaction mode changes along this continuum. Whether or not the human needs for the system are being fulfilled is a determining factor for how much exposure the user will have with the system. Literature that supports the framework is discussed in chapter two.

# CHAPTER TWO: LITERATURE REVIEW

For nearly a decade, there has been a reorientation of focus from the negative to the positive in several disciplines. Take the discipline of Psychology, for example, several researchers in this field have argued for a focus on not just the negative aspects of the mind (i.e., mental illness, depression, schizophrenia, neuroticism, brain damage, and diseases but rather on positive aspects of the mind such as well-being, mental health, creativity, optimal experiences (Kahneman, 1999; Seligman & Csiksentmihalyi, 2000) and have termed this new field 'Positive Psychology'.

Similar to the discipline of Psychology and its traditional focus on the negative aspects of the human mind, Ergonomics has traditionally focused on the negative aspects of design and work. For example, for nearly a century now, Ergonomics has wrestled with the problem of pain and focused on its prevention or reduction where this is possible. Although there has been a change in the workplace currency from ergs to bits, we still see the problem of pain persisting, albeit in different and more subtle forms. Being a preventive endeavor, much of the Ergonomists' time is directed to ensuring that certain events do not happen. Hedonomics represents a growing effort that concerns Ergonomists, Psychologists, and Designers not merely in the negative prevention of pain but in the positive promotion of pleasure (cf., The Power of Positive Ergonomics by Hancock, Pepe, & Murphy (2005).

Much recent effort (Jordan, 2000c; Helander et al., 2001; Murphy et al., 2003; Norman, 2004; Hancock et al., 2005) have begun to focus on 'Positive Ergonomics' under the titles of: Affective Design, Emotional Engineering Design, Affective Engineering, Affective Ergonomics, Experience Design, Pleasurable Product Design, Kansei Engineering, Sensorial Engineering

(ENGAGE, 2005). Indeed, there is an ongoing debate within the ENGAGE network (European Project on Engineering Emotional Design) about what the new area will be called. However, it is clear that in order to promote this pursuit properly a name must be agreed upon.  Most recently, this pursuit has been termed Hedonomics (Khalid, 2004; Hancock et al., 2005) and the author believes that this name is most appropriate for this new area. This new face of our science, *Hedonomics*, is our next evolutionary stage in the transformation of work through design.

Hedonomics is important as it has the great potential to transform the quality of work for the good of human kind by promoting the well-being of workers. While we have the pleasure to focus here on Hedonomics which is the conception of pleasurable human-machine interaction, we must never forget that the over-whelming majority perceive work as the curse of Adam as their work remains, rote drudgery in which they tolerate the most soul-destroying of conditions simply to seek out a living wage (Ehrenreich, 2001). It seems very inappropriate that this statement be true in our day and Age. It is much more suited to describe how work was for the pioneers, the first settlers in America or Australia over 200 years ago. Their days consisted of long hard work and very little leisure time, if any. Women were forced into a traditional female role simply because they were not physically strong enough to carry huge timber and such, so it was a waste of man hours to try to do so, and men were forced into a traditional male role for the same reasons. Obviously, work itself has transformed in the last 200 years, yet our feelings toward work have not changed, as it is still perceived as 'rote drudgery'.

Possibly the reason for this discontentment toward our work is that most work environments do not promote positive affect, indeed, with today's technological frustrations resulting in 'computer rage', it seems more likely that they promote negative affect.

Certainly our work environments should not impede the pleasure we gain from our work. This of course, depends on our interaction with our work environments, the feelings our environment elicits, and our thoughts toward our work. Each is dependent upon the other as every artifact or stimulus in the work environment has an emotional component that elicits a feeling that shapes our opinions toward our work (Norman, 2004).

Most of the time, we are unaware of the sources of our feelings and how they influence our conscious thought processes. Evidence supports this idea that automatic evaluation of affective stimuli need not be contingent upon awareness of the stimuli (Kunst-Wilson and (Zajonc, 1980; Seamon, Brody, & Kauff, 1983; Kunst-Wilson & Zajonc, 2005) and most of the time we evaluate stimuli even without the intention to do so (Pratto, 1994). Essentially, we cannot help but to evaluate and be affected by our environment automatically. These research developments in subliminal processing, the mere exposure effect, and affect our relevant to our daily working lives and maybe a key to understanding how to design environments that promote positive affect, and to design for pleasurable human-system interaction. The thesis investigates the mere exposure effect and its potential affect on human-technology interaction.

With today's culture in a relatively peaceful time and its emergent technology we may provide the world with an historical opportunity to 'bless' society by transforming the quality of work. Perhaps this can be achieved by dissolving the division between work and leisure, thus making work enjoyable. Improving this dimension of life will promote wellbeing in the worker. The people that direct this transformation are the mediators between humans and technology (see (Hancock, 1997a) these include all persons involved in the very broad area of Ergonomics and Design. An Hedonomic approach can help to attain the goal of making work enjoyable by making enjoyment a clear and explicit goal of the design requirements.

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Strangely enough the preceding statement needed to be made explicit. It seems even stranger that it needs to be explicitly stated during the design process. But however intuitive and natural it sounds, the concepts of designing for the well-being of the worker, and promoting pleasure and enjoyment through design, as noted earlier, are not even a decade old!

Hedonomics is in its infancy and has yet to be in its full form. Much of the previous work derived from the disciplines of Positive Psychology, Hedonic Psychology, Eudaimonic Psychology, Product Design and Engineering have laid the foundations for Hedonomics. The literature begins by discussing findings from each of these disciplines that will shed light on a number of questions that are crucial for laying the foundation for Hedonomics, these include: What are known about pleasure, pain, happiness, and emotion? Does pleasure lead to well-being? What makes experiences pleasant or unpleasant? How is emotion distinct from pleasure? What are the different types of pleasure? Can characteristics of artifacts elicit different types of emotion? What is flow? Each of these questions are addressed in turn.

Also, several issues must first be recognized and researched for Hedonomics to grow in a healthy direction. Such issues include the: Current approaches to pleasurable design; empirical concerns with current approaches; and current theoretical frameworks for Hedonomics. Each of these issues is addressed in turn. This new EHH framework was first introduced in this present work and is used for conducting experimental research in the area of Hedonomics.

## What is Known about Pleasure, Happiness and Emotion?

Defining pleasure proves to be a difficult task as it is a subjective experience dependent on our past experiences, education, and all other aspects that make up our intimate character. Pleasure and pain are opposing and complimentary notions, one cannot exist without the other.

Pleasure can be the feeling of satisfaction, well being, or enjoyment. This section discusses the various traditions and theories that exist for studying well being, pleasure, happiness, and emotion.

## Does Pleasure Lead to Well-Being?

There are two traditions that exist for studying well-being: the hedonic view and the eudaimonic view. The eudaimonic theories maintain that not all desires, not all outcomes that a person might value, would yield well-being when achieved. Even though they are pleasure producing, some outcomes are not good for people and would not promote wellness. Thus, from this perspective, subjective happiness cannot be equated with well-being. The term eudaimonia is valuable because it refers to well-being as distinct form happiness per se.

In contrast, the hedonic view equates well-being with hedonic pleasure or happiness. Indeed, the predominant view among hedonic psychologists is that well-being consists of subjective happiness and concerns the experience of pleasure versus displeasure broadly construed to include all judgments about the good/bad elements of life. Happiness is thus not reducible to physical hedonism, for it can be derived from attainment of goals or valued outcomes in varied realms (Kahneman et al., 1999).

Perhaps Epicurus (341-270 B.C.) would have agreed with both the hedonic and eudaimonic viewpoints because he is best known for advocating the pursuit of or indulgence in pleasure with a guilt-free attitude as a necessary moral good. He did not advocate over-indulgence, however, saying that the greatest pleasure is merely the absence of pain. All other pleasures are simply variation. Pleasure was defined by Epicurus as: *the absence of pain in the body and of trouble in the soul...* p. 87.

## What Makes Experiences Pleasant or Unpleasant?

Kahneman is now at the forefront of hedonic psychology, the study of what makes life and experiences pleasant or unpleasant; a science of well being. He argues that we have yet to come up with a really good scientific measure of well-being. He conducted experiments with the intent to look at experiences (in the instant) and to separate judgments of the experiences in the instant from retrospective judgments that people can make later. He showed films of ranging in pleasantness and duration, and asked subjects to press a level indicating their feelings at the time, positive or negative. He found a complete insensitivity to duration of film. Affect was independent of length of time. Instead, affect was affected by what happened at two particular singular moments in the experience; the worst moment, or the best, depending on the peak of the experience and the end of the experience. He claims that the average of the peak and the end of the experience is a very good predictor of what the subject will report experiencing overall regardless of the length of the experience.

He draws a distinction between the 'experiencing subject' and the 'remembering subjects.' The experiencing subject is living life in a sequence of moments, there are 20,000 moments of three-sec in a 16 hour day, and each moment is very rich in experience (e.g., the person experiences many things in a moment like a goal, mental content, emotional arousal, mood, physical state, etc.). Most of the time moments are forgotten because we have a selective memory. He describes the experiencing subject as 'hardly having time to exist.'

The remembering subject has permanence, and their point of view is very different from the experiencing subject. Life becomes a story, a narrative with a beginning, peak, and end. The remembering subject is the one that keeps score the one that makes the decisions. Yet,

Kahneman argues that we (the remembering subjects) have a clear inability to accurately forecast the future as far as our tastes, how they will change, and how we may adapt. This is a considerable part of the mistake that we make in life with making choices that eventually do not pay off.

Kahneman describes adaptation as a major puzzle when it comes to happiness. Richard Easterling studied the distribution of wealth and the answers to the question of how happy are you, how satisfied are you with your life? The one statistic that collapses across studies investigating this is that life satisfaction does not follow improvements in standard of living. The hedonic treadmill (Brickman, Coates, & Janoff-Bulman, 1978) suggests that we are not getting anywhere because we are adapting to things as they improve.  It is the idea that you are marching on that treadmill, you keep progressing but you are not getting anywhere. People that report sleeping well and much actually do have a much better mood. Happiness is a trait, some people are just happier than others as a personality variable. Heddy and Waring proposed the 'set point theory' that claims that people return to a set point for happiness. This suggests that we adapt to happiness and that are some pleasures we adapt to and others we do not and there is little know about this.

## How is Emotion Distinct from Pleasure?

There are several basic emotions which distinctly differ from one another such as happiness, sadness, anger, fear, and disgust (Ekman, 1994). According to Kubovy, (1999) Pleasures of the mind differ from these basic emotions for several reasons: (a) Emotions have a distinctive universal facial expression whereas pleasure is not accompanied by any distinctive

facial expression; (b) Basic emotions are almost all present in other primates and this may not be the case with pleasure; (c) Emotions have a distinct physiological response while for pleasure this type of response has not yet been seen; (d) Emotions have a quick onset,  and are short in duration which implies the existence of an automatic appraisal mechanism because they often occur before the person is even aware of them cognitively. Pleasure, however, is generally sought out, is longer in duration, and probably does imply a need for an automatic appraisal mechanism.

## What are the Types of Pleasure?

Tiger (1992) see also (Jordan, 2000d) has developed a framework which models four conceptually distinct types of pleasure. These types of pleasure and examples of corresponding products include: physical pleasure which is derived from the sensory organs (e.g., smell of a new car); social pleasure experienced with the company of others (e.g., an artwork attracting conversation); psychological pleasure experienced after successfully accomplishing a task (e.g., effortless workflow); and ideological pleasure which can be experienced through symbols, artwork, books or learning (e.g., a pendent of a cross). Jordan (2000) argues that an explicit goal of design should be to promote these four types of pleasure.

## Do Design Characteristics Elicit Different Emotions?

Similar to the four types of pleasure, Norman (2004) describes three types of design characteristics called visceral design, behavioral design, and reflective design that of which can

elicit different types of pleasure. Therefore designer should consider the user reaction to all three. *Visceral design* refers to pleasures through the senses such as the visual appearance of an artifact being beautiful. *Behavioral design* refers to pleasure through interaction with an artifact. For example, how can the artifact be manipulated and used? Finally, *Reflective design* refers to pleasure through the mind (e.g., how the user evaluates the design). This is idiosyncratic by nature as taste, fashion, traditions, needs and expectations differ across individuals.

Aesthetics is a concept that is defined subjectively and therefore difficult to manipulate systematically in an experimental setting. There are clear usability guidelines in interface design but no clear aesthetic guidelines. A rule of thumb is that aesthetics should promote pleasure by eliciting positive affect in the human (Hancock, 2002; Norman 2002). According to Norman one way of viewing aesthetics can be through color. Switching from black and white displays to color displays doesn't have an obvious affect on the usability of the display but does have an obvious effect on the aesthetics of the display. Most people prefer color displays. Color may have some emotional affect on the user rendering them to prefer a color to black and white display.

The relationship between aesthetics and perceived usability is congruent with the social phenomenon of inferring personality traits from physical attractiveness. Dion, Berscheid, and Walster (1972) found that people that were viewed as physically attractive were assumed to possess more socially attractive traits than those that were viewed as unattractive. A possible explanation for this phenomenon is the halo effect, which proposes that the most obvious or salient characteristic (in this case, attractiveness) is perceived first and tends to bias perceptions and inferences that come after. Furthermore, social psychology research reveals that initial perceptions persevere even after presentation of contrary evidence (Gilbert, Krull, & Malone,

1990). Based on this halo effect, users may attribute more desirable traits (such as ease of use, ease of learning) to interfaces that are designed to be aesthetically pleasing compared to interfaces that are not aesthetically pleasing. Users may even continue to attribute desirable traits to aesthetically pleasing interfaces even after they are presented with evidence to be contrary.

While color has still to be shown to directly relate to affective state (Sinclair, Moore, Lavis, & Soldat, 2002), it has already been shown to differentially affect information-processing strategy. More specifically, negative and neutral affective colors have been shown to lead to more systematic, discerning processing, while positive affective colors render a more accepting, indiscriminate processing approach. Thus, positive affect may lead to greater cognitive flexibility, where an individual perceives and interprets information from multiple perspectives and in greater detail. Yet, cognitive flexibility has been shown to increase with the mere exposure of a stimulus used to elicit positive affect in a person (Isen, 2000; Isen et al., 1987). Several studies (Estrada et al, 1994; Isen et al, 1987) have found that promoting positive affect improves cognitive flexibility.

This presents a conundrum. Will positive color in a design lead people to process information in less detail and thus potentially gloss over usability weaknesses or will it lead to greater cognitive flexibility and a more discerning assessment of usability? If the former is true, products should liberally incorporate color as it could mask usability weaknesses. If the latter is true, incorporating color could render usability of utmost importance, as users would readily perceive any weaknesses.

Murphy, Stanney and Hancock (2003) investigated this question by determining how affective color cues influence usability judgments. The authors found that aesthetically pleasing designs may only promote pleasure in the user when coupled with good usability criteria.

Interestingly, participants became the most frustrated with poor usability when a color display was used as compared to a non-colored display. This finding contradicted previous findings that reported an increase in perceived usability of aesthetically pleasing designs regardless of their actual usability (Kurosu & Kashimura, 1995; Tractinsky, Katz, & Ikar, 1999). Colors such as yellow and green were shown to enhance performance on cognitive flexibility tasks (i.e., RAT), suggesting that they have the potential to promote positive affect in users.

Therefore, designers should consider incorporating aesthetics such as enhanced color and graphics into designs to help elicit positive emotion in the user. Designers must be aware, however, that incorporation of aesthetics comes with the potential cost of disposing users to be more discerning of usability. It is thus essential that designers fully understand the affective consequences of their designs. With today's advances in technology we now have the flexibility to achieve both usability goals as well as promote pleasure in the user. The findings from this study confirm the importance of both in good human-technology design. The thesis investigates the Hedonomic component of a video game by examining the effect of color and graphic enhancement on the occurrence of flow and the needs of user.

## What Describes the Experience of Flow?

*The Transformation of Time*

A common descriptor of optimal experience is losing track of time. Either time seems to pass by really fast, or time seemed to slow down. Perhaps this phenomenon occurs because the

perception of time, while engaged in flow, has little relation to the passage of time as measured by the absolute convention of the clock. Csikszentmihalyi adds that, "*freedom from the tyranny of time does add to the exhilaration we feel during a state of complete involvement* (p. 67)".

*Loss of Self-Consciousness*

Due to our limited capacity to process information (Kahneman, 1973; Wickens, 1987), when a task is engrossing, there is little if any attention left to focus on anything else, including your own self. Loss of self-consciousness can lead to transcendence, the feeling that boundaries of our being have been pushed forward. Loss of self is linked to synergy with the environment as it produces a rare sense of unity with what are usually foreign entities. Csikszentmihalyi describes a sailor's account of the phenomenon:

*"During the long watches of the night the solitary sailor begins to feel that the boat is an extension of himself, moving toward the same rhythms toward a common goal."*

The term 'extension of self' is a term also used by (Jordan, 2000d) to describe the optimal experience of interacting with a tool. The tool, product, computer, etc. becomes an extension of yourself. A type of seamless interaction occurs between the tool and the human. The sense of boundaries between the tool and human are lost, leaving a sense of 'oneness' with each other, a unity. This type of interaction is highly desirable in the realm of human-machine interaction.

*Loss of Sense of a Self Separate from the Environment*

This is described as a loss of sense of a self that is separate from the world around it. This phenomenon is accompanied with a feeling of union or synergy with the environment, whether it is a mountain, computer, team, or dance.

Flow is an autotelic experience, *auto* meaning self and *telos* meaning goal. The key element of an optimal experience is that it is an end in itself. Even if initially undertaken for other reasons, the activity that consumes us becomes intrinsically rewarding. It is a self contained activity, one that is done not with the expectation of some future benefit, but simply because the doing itself is the reward. The activity has to be paid attention to for its own sake and not for consequences of it.

*Challenging Activity That Requires Skills*

The overwhelming proportion of optimal experiences are reported to occur within sequences of activities that are goal-directed and bounded by rules- activities that require the investment of psychic energy, and that could not be done without the appropriate skills. Activities that provide enjoyment are often designed for this very purpose, e.g., games, sports, artistic and literary forms. But activities from everyday life, (see Csikszentmihalyi, 1997) work activities, reading, and socializing can also lead to optimal experiences.

*The Merging of Action and Awareness*

When a person becomes so involved in what they are doing that the activity becomes spontaneous, almost automatic; they stop being aware of themselves as separate from the task, activity or actions being performed. This occurs when all a person's attention is completely absorbed by the activity. There is no excess psychic energy left over to process any information but what the activity offers. All the attention is concentrated on the relevant stimuli. It is a sense of seemingly effortless movement, where smoothly actions follow actions seamlessly. However in actuality it requires all of your effort and the application of skilled performance.

*Clear Goals and Feedback*

The reason it is possible to achieve such complete involvement in a flow experience is that goals are usually clear, and feedback immediate. Almost any feedback is enjoyable, provided it is logically related to a goal in which one has invested psychic energy. This especially true for the visually-impaired (p. 57) Massimini, Csikszentmihalyi, and Delle Fave (1988) interviewed a group of blind-since-birth woman and found that these blind women stressed more than anyone else the importance of receiving clear feedback as a condition for enjoying whatever they were doing.

*Concentration on the task at hand*

One of the most frequently mentioned dimensions of the flow experience are that, while it lasts, one is able to forget all the unpleasant aspects of life. This feature of flow is an important by-product of the fact that enjoyable activities require a complete focusing of attention on the task at hand-thus leaving no room in the mind for irrelevant information this can also be attributed to our limited capacity to process information (kahneman, wickens).

*Feeling in Control*

Individuals report flow experiences in which a heightened sense of control plays an important part. The flow experience is typically described as involving a sense of control- or, more precisely, as lacking the sense of worry about losing control that is typical in many

situations of normal life. It is the *possibility* rather than the *actuality*, of control because in the world of flow perfection is attainable.

When danger is a factor, the enjoyment comes not from the danger itself, but their ability to minimize it, the positive emotion they enjoy is the feeling of being able to control potentially dangerous forces. (e.g., the whole point of rock climbing is to avoid objective dangers as much as possible through rigorous discipline and by preparation). It's not the sense of being in control that is enjoyable, but the sense of exercising control in difficult situations.

*Flow and Personality Traits*

Do all people have the same potential to engage in flow and if not what distinguishes them from those that do? The answer is the ability to focus attention. It is not clear exactly what personality traits are linked to those that experience flow, except that those people that engage in flow regularly are more likely to experience flow in general and are known for turning negative situations into positive experiences (Jackson, Kimiecik, Ford, & Marsh, 1998). They do this by challenging themselves with the environment they are set in at that moment.

More is known about those that are not able to engage flow. They include people with attention disorders, including schizophrenia, and those with personality traits of excessive self-consciousness, or excessive self-centeredness. A self-conscious person focuses psychic energy on everybody else in the environment worrying what they think of them. A self-centered person focuses all psychic energy on how all information from the environment advances his/her own desires. Csikszentmihalyi believes that these people cannot experience true enjoyment, learn, and forfeit opportunities for personal growth. He points out that schizophrenics suffer from

*anhedonia* which literally means 'lack of pleasure,' and that self-concsious and self-centered people 'condemn themselves permanently from enjoyment' (p. 84). The thesis measures personality traits using the NEO FFI in order to investigate any relationships between traits and occurrence of flow

*Are We Saying Flow is Moral*?

The flow experience, like everything else, is not 'good' in an absolute sense. It is good only in that it has the potential to make life more rich, intense, and meaningful; it is good because it increases the strength and complexity of the self. But whether the consequence of any particular instance of flow is good in a larger sense needs to be investigated. (70).

*Consequences of Flow*

When a person becomes so dependent on the ability to control an enjoyable activity that he cannot pay attention to anything else, then he loses the ultimate control: the freedom to determine the contents of consciousness. This enjoyable activities that produce flow have a potentially negative aspect: while they are capable of improving the quality of existence by creating order in the mind, they can become addictive, at which point the self becomes captive of a certain kind of order. And is then unwilling to cope with the ambiguities of life. Vladimir Nabolov's short story "The Luchin Defense" describes a young chess genius so involved in the game that the rest of his life-his marriage, his friendships, livelihood- is going by the boards.

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Lunchin tries to cope with these problems, but he is unable to see them except in terms of chess situations.

*Flow and Human-Machine Interaction*

Flow theory suggests that the flow state is characterized by four dimensions within human-computer interaction such that flow incorporates the extent to which (a) the user perceives a sense of control over the computer interaction, (b) the user perceives that his or her attention is focused on the interaction, (c) the user's curiosity is aroused during the interaction, and (d) the user finds the interaction intrinsically interesting (Csikszentmihalyi, 1975; Csikszentmihalyi & LeFevre, 1989; Malone, 1980; Trevino & Webster, 1992). Webster, Trevino, and Ryan (1993) conducted a study on flow and software use, their results indicated that flow consists of three (not four) dimensions within computer interaction as the last two dimensions previously mentioned as (c) user's curiosity and (d) intrinsic interest, is best combined into a single dimension that they label as *cognitive enjoyment*. Their data suggest that the two dimensions are highly interdependent in the interaction with computers and they believe that this is because intrinsic interest is accompanied by cognitive arousal and use of the imagination.

Additional findings in HCI and flow that have implications in work settings include the link between exploratory behavior associated with flow and the development of skills and increased learning (Miller, 1973) leading to higher quality and/or quantity of outputs or products from the interactions (Ghani, 1991). Flow has also been found to be positively correlated with

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communication effectiveness and quantity, as well as actual technology usage (Trevino & Webster, 1992; Webster, Trevino & Ryan, 1993).

## Current Methods, Measures, and Approaches to Affective Design

Several methods exist in the fields of psychology, consumer behavior, marketing and advertising that are used for measuring affect, and emotional response to advertisement and consumer experiences of products. For a thorough review of the various measuring methods please refer to Helander and Khalid's chapter, *Affective and Pleasurable Design,* located in the Handbook of Human Factors and Ergonomics (Salvendy, in press). This section focuses on the most popular methods and approaches for designing for affective response from the user that are currently being used today. These include User-Centered Design (UCD), Kansai Engineering, and Personas.

It should be noted that the motive behind using UCD, Personas and Kansai Engineering is not necessarily to elicit pleasurable response or positive affect from the user, but rather to engage them in a particular experience, feeling, or impression from the product so to target a particular group for sales. UCD and Personas are popular approaches used in industry in the United States. Kansai Engineering is a popular method being used in Asia, and beginning to be used in Europe as well.

The goal of the UCD approach is not to design for affect per se but to simply design for the user by making the user an integral part of the design process, so in a sense, the approach designs for user needs. This is usually done through interviews, however, the approach lacks in a clear method. It is mostly used to design for an already existing population that needs a new tool

or system to facilitate efficiency and productivity. For example, new software developed for air traffic controllers to give more information for decision making, or new software developed for folks that work in the customer satisfaction division of a particular company so to focus on the customers and not the software. In these cases, the users are already known, the issues and existing problems with the old software are known as well, and what is left is finding out what users think should be the new ideal software. The approach is beneficial because by making the users a part of the entire design process, it may be possible to alleviate some of the problems that inevitably occur during the transitioning process, in which users usually feel frustration with having to learn a new system. Also, the position is known best by the actual workers in which their opinions are considered during the design process, so the final product should result in higher satisfaction among them.

Personas is similar to UCD except instead of focusing on designing for the real users, the focus is on designing for pretend users in order to target some population that they want to sell the product to. The approach also includes the user as an integral part of the design process expect the user is a made-up character that is meant to represent general characteristics of a specific target group, hence the term 'personas.' For instance, let's say that an Orlando bus transportation company wants to create a website to target young professionals between the ages of 23 to 35 years old. In this case, a design team would make up several personas that would fit the description of some young professionals in the Orlando metropolitan area. For example, one persona would be that of a 27 year-old woman named Jane. She is a graduate of University of Central Florida, works for Disney in the marketing department, has a boyfriend named Peter and drives a 2002 Ford Focus to work. She loves to go Salsa dancing on Thursday nights with friends, works out at the gym twice a week, and goes to the beach with her boyfriend on the

weekends. From this description it is thought that the design team is able to infer what Jane would need from a transportation website in order to use the bus system in Orlando.

Everyone in the design team, including the human factors persons, engineers, computer programmers, and developers are expected to all pretend that they are designing for this person named 'Jane'. In this way, it is thought that biases are left out because when decisions need to be made regarding the design, they are made by considering what Jane would want and not what the individual computer programmer, engineer, etc. would want. Some design teams even go as far as making a cutout poster of Jane with her description and leave it in a place where everyone in the design team will see it so to be reminded of who they are designing for.

Cooper (2005) is a supporter of this approach and claims in his book, 'The Inmates are Running the Asylum,' that by designing specifically for one individual (or persona) you will target at least 20% of the population that will absolutely love the product which results in a profit that justifies the approach. However, not much research, if any, has been reported on what percentage of the population this approach actually does target, if it targets the group intended, and how satisfied the users are with these products created by this approach.

Other concerns are that the approach lacks in a clear method, a theoretical grounding, and is not statistically driven. It has not been used in research and thus does not have much benefit to the study of Hedonomics. The approach may be more methodical if the personas were created from real data collected from surveying the target population and their actual characteristics and needs and not just made up by the design team.

It is a positive step forward in the area of design as it takes the focus off of the designers and engineers and places it onto the users. However, one could argue the design team is still designing for themselves but as themselves walking in Jane's shoes. The major problem with this

approach of course will always remain to be that Jane does not really exist and although this may be used in industry it is harder to justify in science.

Personas and Kansei Engineering are similar in this sense that they are often used to market for a particular target group of potential buyers. However, Kansei Engineering is considered a type of engineering tool while Personas is simply an approach to design. 'Kansei' is a Japanese word that in English is best translated as 'consumer's psychological feeling and image' (Nagamachi, 1997). The method was developed by Nagamachi (Nagamachi, 1994; Nagamachi, 1997; Nagamachi, 2001; Ishihara, 2001). "Kansei" is the impression formed from exterior stimuli through the five senses. These impressions experienced are believed to be stored in the mind hence building the foundation for human behavior.

The method is used for collecting and quantifying the user's emotional needs and establishing prediction models of how the emotional needs are connected to selected product properties in order to develop these needs into products (Nagamachi, 1997).

For example, to use Kansei Engineering to develop a website for the bus transportation company (the example previously used), the first step would be to collect Kansei words. A Kansei word is a word that describes the product domain. The words would be collected from sources such as magazines, manual, experts, experienced users, related Kansei studies, and new ideas of how you want the website to be. It is important to collect as many words as possible to be exhaustive. The number of words collected should range from 50 to 600 depending on the domain (Nagamachi, 1997). The next step is to narrow the words down to a manageable number. This can be done by using experts and affinity diagrams, or using statistical methods such as factor analysis. Many potential sets of descriptors may be used, for our website lets say our Kansei words are narrowed down to: Convenient, Cool, Metropolitan, Easy, Enjoyable, Hip,

Friendly, Hot, Informative, Engaging, and Helpful. The next step is to choose the physical traits of the website that are most important to the users. This can be done by surveying users and asking them what the three most important traits are of a website. Let's say that 80 percent of users reported that navigation layout, appearance, and information were the most important traits of a website. The next step is to connect the kansei words to the product properties. This is done by showing several prototype websites that vary on layout, appearance, and information to the users and having them rate the prototype websites on each of the kansei words using a Likert scale to see how each word is affected by the product properties. The linking of kansei words to product properties can be done by using a statistical method such as regression analysis.

A good example of this linking can be seen from a study conducted on beer can design (Ishihara, 2001). The results revealed that the kansei word 'bitter' is most affected by the color of the can and the shape of the logo. A black color in combination with a non-oval logo elicited a strong bitter kansei whereas a white can with an oval logo elicited a strong opposite of bitter.

A potential concern with Kansei Engineering is with the first stage of the method when kansei words are collected. This is the most important stage of the method because the analysis is based on the kansei words that are chosen. However, it seems that there can be room for error at this stage. How do we know that the kansei words selected are the best descriptors for the product of interest?

This issue was investigated by Helander and Tay (2003). They tested whether the same kansei words could be used to describe different types of kitchen appliances (coffee makers and toaster). A list of 26 descriptors was generated from an original list of 200 descriptors. Each product was then rated for each kansei word by 100 participants. Findings from the factor analyses revealed that the different kitchen appliances generated similar factors, and explained

about 68 % of the variance. The researchers concluded that for kitchen appliances it is possible to use the same set of kansei words.

The thesis utilizes the method of Kansei Engineering to gauge users' needs (kansei words) to investigate how they are affected by changing aspects of the system's hedonomic components, and to observe any relationships that may exist between the user's needs and the occurrence of flow. The domain in which these inquiries are examined is video games. To date, this is the first study that has used the method of Kansei Engineering to examine video game design, and the first study to investigate kansei word descriptors to the occurrence of flow.

## Other Frameworks in Hedonomics

There are two existing frameworks in hedonomics: (a) The Framework for Evaluation of Affective Design (Helander, 2002) and ( b) The Hedonomic Hierarchy of Needs (Hancock et al., 2005). Refer to the introduction for a summary of the Hedonomic Hierarchy of Needs.  This section discusses the key features from The Framework for Evaluation of Affective Design followed by a comparison of the two existing frameworks.

The Framework for Evaluation of Affective Design, as displayed in Figure 4, has two parts: The Designer's Environment and the Affective User Experience. The purpose of the model is to illustrate how a designer may achieve affective design and how the user of the design will perceive and react. The salient features of the model include the *Artifact*, *Society*, and the *Context of Use/Activity* subsystems of the *Designer Environment* and the *Affordances for Affect*, and *Individual Needs* subsystems of the *Affect User Experience*.

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In the *Artifact* subsystem, the design of an object can incorporate several characteristics that can lead to emotional responses which are described in terms of: visceral design, behavioral design, and reflective design. The model emphasizes that the designer should consider and predict if possible the user's responses to all three components adopted from Norman (2004). Another subsystem of the designer's environment is called *Society* which is believed to constrain the design of the artifact through trends, norms, and fashion. This element is important to realize during the design process because of technological advances, culture differences, individual differences, and individuals changing over time. The model emphasizes the user's consideration of the context of use/ activity of the artifact and how activity should be considered in the design process. According to activity theory affective and emotional aspects of objects are capable of changing due to the nature of the activity. Therefore the context of and reason that the artifact used is important for the designer to consider when designing for affect.

In the *Affective User Experience* aspect of the model, *Affordances for Affect* are listed as a subsystem of the affective system. However, nothing is mentioned about the conceptualization of affordances. Another salient feature of the user experience is the *Individual Needs* aspect of the model. The model stresses the importance of individual needs for affective design and designers are encouraged to consider these customer needs during the design process. However Helander and Khalid point out that these needs are difficult to capture and often ignored during the design process. In the framework, the individual needs act as a mediator between the affective system and the cognitive system of the model.

**Designer's Environment**

**Affective User Experience**

**Affective System**

Context of Use, Activity
Goal Formulation

Con-straints

Artifact
Reflective Behavioral Visceral

Society
Trends
Norms
Fashion

Affordances → Needs → Resulting

Individual Needs
Aesthetics, Achievement (Virtuosity), Affiliation, Creativity, Curiosity, Satisfaction, Physical Activity, Power

Evaluation

Perception → Cognition Evaluation → Action

**Cognitive System**

*Figure 3.* Framework for Evaluation of Affective Design adopted from Helander, Khalid, and Tham, (2001).

The concept of Individuation from the Hedonomic Hierarchy of Needs (Hancock et al, 2005) relates to the Individual Needs aspects of the Affective User Designer model. Individuation is a principle that seeks optimization of an artifact for each individual. Therefore the concern for designing for individual needs addressed by Helander and Khalid is integral to this approach of Individuation. Helander and Khalid's addition of context of use via the Activity Theory could be a worthy addition to the concept of Individuation. Individuation should not just address adaptive design to suit the individual needs but should also address the need for artifacts that support multiple roles and adapt to uses and changes to its activities over time.

The Hedonomic affordances encompass several aspects of the Affective User Designer model such as Artifact, Affordances for Affect as well as elements of the Cognitive System of the model. Hedonomics Affordances should not be seen as only encompassing the Affective

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System but also involving the Cognitive System as well. Indeed, reflective, behavioral, and visceral elements can elicit a cognitive as well as an affective response.

# CHAPTER THREE: EXPERIMENTAL METHODOLOGY

## Experiment One

The first study investigates mere exposure on the occurrence of flow in the domain of human-computer interaction. Factors such as close proximity, mere exposure and attractiveness play an important role in determining how intimacy between two people develops; and, in theory, how intimacy between a person and technology develop as well. Proximity is a powerful predictor of liking. Sociologists have found that most people marry someone who lives, works, or studies within walking distance (Bossard, 1932; Clarke, 1952; Katz et al., 1958; Burr, 1973). This is because they can hardly avoid interacting with each other. This frequent interaction leads to the feeling of familiarity which breeds fondness (Bornstein, 1989; Bornstein, 1999).This is called the mere exposure effect which is the tendency for novel stimuli to be liked more or rated more positively after the rater has been repeatedly exposed to them (Zajonc, 1980). The logic of the study is that by increasing the exposure to technology the positive affect (or liking) toward the technology will increase as well. Positive affect has been linked strongly to the occurrence of flow, therefore by increasing the exposure to the technology the result should be an increase of positive affect toward the technology and the occurrence of flow.

The purpose of the first study is to investigate a specific dimension of the framework of human-technology experience called 'exposure' and how it may affect other dimensions of the framework, namely the occurrence of flow, the mode of interaction, and the needs of the user. The main research questions ask: 1) How does exposure to technology affect the nature of flow, as experienced by users engaged in a process control task? 2) What are the major contributors to

the occurrence of flow?  The study is conducted using a micro-world called C3Fire, the following section labeled 'experimental paradigm' gives a thorough description of this simulator.

*Pilot Study for Experiment One*

All three parts of the method were initially tested in pilot study.  Four males drawn from a convenience sample volunteered to participate in exchange for movie tickets.  They engaged in eight cycles consisting of (1) a session with C3Fire immediately followed by (2) questionnaires. Play with C3Fire in the pilot study led to a revision to certain aspects of the experimental scenarios in order to make them progressively more challenging.  After modifying the C3Fire scenarios volunteers were solicited to participate for the first experiment.

## Experimental Participants

Thirty-two volunteers (mean age 24.5, range 20 to 37) participated in the study for monetary compensation. The 32 participants were all over 20 years of age and indicated a willingness to participate in two four-hour sessions.  They were promised 75 dollars in compensation if they completed the full eight hours of experimentation.  The 32 participants reported to the laboratory in four groups of eight.  In the laboratory, the eight were randomly and anonymously assigned to two teams of four.

*Experimental Task*

The experimental task was to give commands to fire fighters to suppress a spreading forest fire. The domain of fire fighting is of subsidiary interest and was chosen because the task itself incorporates the essential 'ingredients' believed to be conducive to the experience of flow. Tasks that require clear goals, rules, attention, skill, and immediate feedback are believed to possess the essential components necessary in an activity that lends itself to the experience of flow (Csikszentmihalyi, 1990). For example, the participants' task to bring a forest fire under control required a sequence of activities that were goal-directed and bounded by rules- a task that required attention, and could not be done without the appropriate skills. The simulations evolved dynamically over time and in response to the participants' actions therefore the feedback was immediate. Additional tasks of the participants included reading and signing the Informed Consent Form, completing the Demographics Questionnaire, the NEO FFI, the Flow State Scale, and the Human Need Questionnaire by answering the items to the best of their ability.

## Apparatus

*Demographic Questionnaire*

The demographic questionnaire is a 16-item self-report questionnaire with both open-ended and forced-choice questions which assesses the participants' (1) personal, academic and

work related background, and (2) experiences of using computers, especially video games. Refer to Appendix A to view the Demographics Questionnaire.

*NEO Five Factor Inventory (NEO-FFI).*

The NEO-FFI is designed to measure the 'Big Five,' five domains of adult personality: extraversion, agreeableness, conscientiousness, emotional stability, and intellect/openness. It will give us valuable insights in the participants' personalities and will facilitate differentiation between individual differences. Refer to Appendix B to view the NEO FFI.

The NEO-FFI is a 60-item personality inventory (Costa & McCrae, 1992). The NEO-FFI has adequate internal consistency, construct, and discriminative validity across diverse samples (Ball, Rounsaville, Tennen, & Kranzler, 2001; Costa & McCrae, 1992).

*Flow State Scale (FSS)*

A 36-item Flow State Scale, developed by Jackson and Marsh (1996), was used to assess degree of flow experienced while engaged in a particular activity. Flow is the subjective experience of connectedness with events and the environment (Csikszentmihalyi, 1990, 1997). The FSS has received initial psychometric support including adequate construct validity (Jackson & Marsh, 1996). Refer to Appendix C to view the FSS.

*Human Need*


The idea that human needs can be satisfied by products (or systems) and that certain aspects of the system fulfill different needs of the human was introduced by Patrick Jordan. The questions from the human need questionnaire (Harbough, 1970) were revised to gauge the level of need the user expects the system to fulfill. Three core needs were focused on, namely *Trust*, *Achieve*, *Control, Enjoy* and *Grow* (Hancock, 2005). Harbaugh (1972) constructed a questionnaire that measures Maslow's need hierarchy (Maslow, 1943). Questions from Harbaugh were adopted and modified for this study to examine human need for technology (Alderfer, 1967; Harbaugh, 1972). Refer to Appendix C to view the Questionnaire.

*Need to trust* or the degree to which the user is concerned with the predictability and safety of the system; several questions were designed to assess this degree. *Need to achieve* when using the system, this is linked to the functionality of the system; how much can the user do with the system, and whether or not they do what they expect to do. *Need to control* when using the system; this is linked to the usability of the system. *Need for enjoyment* when using the system; this need is linked to the 'pleasurable experience' of the system. Questions were asked in order to gauge how much fun the system was to interact with, and how much pleasure the interaction elicited. Finally, *Need to Grow* refers to the desire for personal development, self-fulfillment and self-actualization. These desires are linked to the synergistic aspects of the system, or the transcendence of boundaries between the self and the system, and to Maslow's *need to self-actualize*. Questions were asked in order to gauge the degree to which the user needs to identify with the system, to experience growth, to learn, to improve oneself, and to experience flow. The framework proposes that level of need fulfillment is an indicator of human-technology intimacy.

*Mode of Interaction*

This study investigated whether mode of interaction between the human and the technology is related to mere exposure. The research question asked: Do different types of interaction modes change as exposure to the technology continues over time. The logic behind this definition is that increased exposure will result in increased familiarity, and liking. The research question is based on the assumption that users interact in different modes depending on their degree of intimacy, for example, whether they are engaging in flow, enjoyment, or if they are just simply working at accomplishing a goal whereas the former is more of an intimate type of interaction than the latter. This idea that users interact with different interaction styles have been observed by several theorists (Webster, Trevino, & Ryan, 1993; Novak et al., 2000; Hassenzahl, 2003). The study focused on three modes of interaction which include: *Goal, Exploration*, and *Seamless* mode of interaction. In *goal mode* goal fulfillment is in the fore. The current goal has a certain importance and determines all actions. The system is therefore just a 'means to an end'. In *exploration mode* the exploring is in the fore. The current action or play determines the goal 'on the fly'; the goals are 'volatile' (Webster et al., 1993). Using a certain technology becomes an end in itself (Novak et al., 2000). In *seamless mode* attention is completely consumed by the interaction itself. The user is deeply engrossed, absorbed deeply in the experience of interacting with the game. The user forgets that there is a boundary between them and the game; they feel as if they are the game (Jordan, 2000a).

Items from the Web State Scale (Novak & Hoffman, 1998) will be used to assess the degree of goal, exploratory, and seamless modes of interaction the participants most often engage in while interacting with technology. Specifically, questions will be adopted from the

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playfulness dimension (4 items, chronbach alpha = .782), the exploratory dimension (4 items, Chronbach alpha = .638) of the Web State Scale (Novak et al., 1998) and the focused attention dimension (4 items, Chronbach alpha = .860) (Jackson & Marsh, 1996) of the Flow State Scale. Refer to Appendix C to view the Questionnaire. The study investigates if certain modes of interaction, if any, are indicators of flow.

*Experimental Paradigm*

The C3Fire sessions were conducted over a server-client network of computers in a laboratory. Each of the eight participants sat on a separate client computer in the laboratory. C3Fire (Granlund, 2002) is a fire-fighting microworld in which participants play the roles of fire-fighting unit chiefs and commanders. Their task is to collaborate to fight fires in an experimentally-controlled setting under observation of an experiment manager. The C3Fire interface and instructions on how to interact with C3Fire are discussed in depth in the Instructions to Subjects, refer to Appendix E. An example of the interface is shown in the figure on Appendix D. The interface contains a map, the email facility, and information about fire-fighting equipment. The map is divided into a grid of squares. All members of a team saw the same information on the interface.

The emergency situation is a forest fire. The speed of burning and spreading of the fire are functions of vegetation, terrain, the presence of buildings, and wind direction and speed and are pre-set by the experiment manager. Participants can extinguish the fire by placing fire trucks on top of the squares (of the map grid) that are on fire. The trucks are constrained by limits on

their driving, deployment, and extinguishing speeds, as set by the experimenter. The participants tell the trucks where to go.

The first and second units are water and refueling trucks. Water trucks supply fire trucks with water, and obtain water from water stations. Refueling trucks supply both fire trucks and water trucks with fuel and obtain fuel from fuel stations. The third and fourth units are water and fuel stations. Their limited resources must be allocated across trucks and cannot be moved once established. They can, however, be consumed by the fire.

Every event in the simulation generates time-stamped data. Truck movements, actions of decision makers, and communications between decision makers form a vast amount of data that is generated and stored. The data was used to analyze performance. The performance of the teams was measured by total spread of fire. This was quantified by summating burning cells, burned-out cells, and closed-out cells (or cells that were successfully put out).

## Experimental Hypotheses

The first experiment investigated several research questions including: (a) What is the effect of repeated exposure on flow? (b) Do personality traits contribute to the experience of flow? (c) Does human need for technology contribute to the experience of flow? and (d) Do different modes of interacting with technology contribute to the experience of flow? Hypotheses for each research question are addressed in turn.

Hypothesis (1): Flow was expected to increase linearly with each exposure. Findings from studies in the area of social psychology have examined the effect of repeated exposure and the relationship it has on likeability, fondness, relationship development, and intimacy (Bossard,

1932; Dion, 1979; Zajonc, 1980; Bornstein, 1989). According to the Extended Hedonomic Hierarchy framework, frequent exposure to technology can lead to a developing relationship and growing feelings of intimacy from the users toward machines (Zajonc, 1980). Findings that would reveal a linear increase of flow with each exposure to the technology would support this aspect of the EHH framework.

Hypothesis (2): Personality traits such as 'openness to experience,' 'agreeableness,' and 'extraversion' were expected to contribute to the experience of flow. Personality traits such as openness to experience, extraversion, and agreeableness have been found to be predictors of well-being (Ryan et al., 2001). Flow is believed to promote personal growth by causing an increase in the motivation for one to continue to grow due to the actual experience itself (of engaging in flow) acting as a reinforcer (Csikszentmihalyi, 1990; Kahneman, 1999; Ryan et al., 2001). Therefore it is expected that these three personality traits would be predictors of flow and have a positive relationship to flow. It is expected that no relationship will exist between neuroticism and conscientiousness.

Hypothesis (3): Several human needs for technology including the need to control, the need to enjoy, and the need to grow were expected to contribute to the experience of flow. The EHH framework proposes that level of need fulfillment is an indicator of human-technology intimacy. The need for usability refers to the desire to achieve when using the system and the need to communicate easily with the system in order to accomplish those achievements. Usability has been reported as a factor in what we find enjoyable about interacting with technology (Murphy et al., 2003). The need to enjoy, meaning the need to enjoy interacting with technology; aesthetics and graphics are believed to be a contributor to enjoyment (Blythe, Overbeeke, Monk, & Wright, 2003) also enjoyment or 'autotelic experience' is a dimension of

flow. Need to grow refers to the desire for personal development, self-fulfillment and self-actualization. These desires are linked to the synergistic aspects of the system, or the transcendence of boundaries between the self and the system, and to Maslow's *need to self-actualize*. Because need to self-actualize is link to well-being and positive affect, is expected to be related to flow as well. Therefore, needs to control, enjoy, and grow are expected to be predictors of flow and this finding would support the EHH framework.

Hypothesis (4): Exploratory and Seamless modes of interaction were expected to be predicting variables to the experience of flow. Interaction modes are psychological states of users in which all systems can be experienced in all states. The EHH framework incorporates three types of interaction mode: goal mode, exploration mode, and seamless interaction mode. Different interaction modes occur depending of the individual's experience level with the technology, the context in which it is being used, and the frequency in which the user has been exposed to it. Interaction modes are moderators between the system and the experience. Previous studies have reported exploratory interaction mode as an outcome of flow (Novak and Hoffman, 2000). Seamless mode of interaction is described as a feeling of being completely consumed by the interaction itself. The user is deeply engrossed, absorbed deeply in the experience of interacting with the technology. The user forgets that there is a boundary between them and the game; they feel as if they are the game (Jordan, 2000a). The description is very similar to several dimension of flow such as 'concentration to the task at hand, 'loss of self-consciousness,' and 'action awareness' (Csikszentmihalyi, 1990; Jordan, 2000d). Therefore, both exploratory and seamless modes of interaction are expected to be a major contributing variable to flow and this finding would support the EHH framework.

# Experimental Design

Table 1 shows the systematic manipulation of C3Fire variables across the eight experimental sessions. Each C3Fire scenario lasted until the participants completely suppressed the fire or 20 minutes elapsed, whichever came first.

Participants received scenarios designated A through D on the first day of experimentation. They received scenarios E through H on the second day. Two different maps with differing configurations of forests and houses, etc., form the foundation for the eight scenarios. Four scenarios use map number 1 and four use map number 2. The maps are systematically rotated to make them appear different. The third column of the table indicates the angle of rotation in degrees. 'Initial fire size' indicates the size of the fire, in squares, at the beginning of the scenario. The term 'Relative challenge' refers to an ordinal scale of assumed challenge with following relationships: level 1 < level 2, level 1 < level 3, level 2 < level 4, and level 3 < level 4, where < means 'is less challenging than.' For example, scenarios A and B are assigned the same ordinal level of challenge because the only difference between them is the map. Scenario A (level 1) is assumed to be less challenging than scenario C (level 2) because it has a smaller initial fire size on the same map. Similarly, a smaller fire size is the basis for assuming scenario E (level 3) is less challenging than scenario G (level 4). Four additional variables are manipulated in the scenarios for the second day to increase the challenge and to reduce the likelihood that participants will be able to predict how the emergency will develop. The additional manipulations make it likely that the scenarios in the second day will be more challenging than their counterparts during the first day, e.g., scenario E (level 3) should be more challenging than scenario A (level 1). However, it cannot be known *a priori* the rank order of

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levels 2 and 3. Casual observation and an initial review of the data collected in the first set of experiments suggest a success in making the scenarios more challenging the second day.

## Procedure, Day 1

Table 2 outlines the experimental procedure for the first day of experimentation. The day began with three C3Fire training sessions. Each participant then worked as a member of a team of four to manage the emergencies posed by C3Fire scenarios A through D, Table 1.

*Table 1.*
 Dependent variables and their manipulation in the C3Fire scenarios.

| Scenario Designation | Map Number | Map Rotation Angle | Initial Fire Size | Relative Challenge Level | Additional Manipulation |
|---|---|---|---|---|---|
| **_Day 1 Scenarios_** | | | | | |
| A | M1 | 0 | 2x2 | 1 | |
| B | M2 | 0 | 2x2 | 1 | |
| C | M1 | 90 | 3x3 | 2 | |
| D | M2 | 90 | 3x3 | 2 | |
| **_Day 2 Scenarios_** | | | | | |
| E | M1 | 180 | 2x2 | 3 | faster fire spread rate |
| F | M2 | 180 | 2x2 | 3 | slower vehicle speeds |
| G | M1 | 270 | 3x3 | 4 | slower fire suppression |
| H | M2 | 270 | 3x3 | 4 | smaller fuel tank size |

*Table 2.*
 Outline of the procedure for Day 1.

---

**_Introduction_**
The participants are seated.  Informed consent forms are handed out, explained, and signed.
    Demographic questionnaire and NEO FFI
**_Instructions and training_**
Reading the instructions.
C3Fire training scenarios 1 and 2:  Individual training
The 8 participants are split into 2 teams of 4 randomly and anonymously and work as teams.
C3Fire training scenario 3.
**_Cycle 1_**
    C3Fire scenario A.
    FSS, WSS, HNQ questionnaires
**_Cycle 2_**
    FSS WSS, HNQ questionnaires
**_Cycle 3_**
    C3Fire scenario C.
    FSS, WSS, HNQ questionnaires
**_Cycle 4_**
    C3Fire scenario D.
    FSS , WSS, HNQ questionnaires
**_Thank you and good bye_**
Reminders to return for the second session

---

Participants were asked to sit at their computer stations, to sign the informed consent form, fill in the demographic questionnaire and complete the NEO FFI. The participants could chose computer stations as they wished. Participants were then asked to look at their computers and study the C3Fire interface and to read silently the instruction sheet as the experimenter read the instructions aloud (see Appendix 2 for the Instruction to Subjects form).

Participants then began and completed the three practice sessions using C3Fire.  The training sessions were constructed to help the participants get acquainted with the task and the C3Fire world.  The first two training sessions were played individually.  Each lasts for approximately two minutes. The participants were then randomly and anonymously divided into two teams and played a training session together for approximately five minutes to get a feel for how to work together.

After the practice session, each participant managed the emergencies posed by C3Fire scenarios A through D. After participants finished playing each of the scenarios they then completed the FSS and HNQ.

After completing scenario D, participants were thanked and reminded to return the next day for another session if they wanted to receive their compensation.  The first day of experimentation lasted approximately four hours.


## Procedure, Day 2


Table 3 outlines the experimental procedure for the second day of experimentation.  Each participant worked as a member of a team of four to manage the emergencies posed by C3Fire scenarios E through H, Table 1.  The procedure for the second day was essentially similar to that for the first day.  When the participants arrived, the group of eight was again divided randomly and anonymously into two teams of four.

Participants were given no instructions or training but were told that specific characteristics of the fire or of the vehicles would differ from scenario to scenario.  They were not told that these manipulations, shown in Table 1, were designed to increase the challenge. They were encouraged to listen attentively to the instructions preceding each scenario.

After the short introduction, each participant managed the emergencies posed by C3Fire scenarios A through D. After participants finished playing each of the scenarios they then completed the FSS and HNQ.

When participants were finished playing scenario H, they were paid, thanked for their participation, and encouraged to tell their friends about the opportunity to take part in the experiment.

*Table 3.*
Outline of the procedure for Day 2.

| |
|---|
| ***Introduction*** |
| Short introduction.. |
| ***Cycle 5*** |
| Participants are told that the fire spreads faster in this scenario. |
|     C3Fire scenario E. |
|     FSS, WSS, HNQ questionnaires |
| ***Cycle 6*** |
| Participants are told that the trucks would move more slowly in this scenario. |
|     C3Fire scenario F. |
|     FSS, WSS, HNQ questionnaires |
| ***Cycle 7*** |
| Participants are told that it takes longer to suppress a fire in this scenario. |
|     C3Fire scenario G. |
|     FSS, WSS, HNQ questionnaires |
| ***Cycle 8*** |
| Participants are told that the fire and water trucks have smaller fuel tanks in this scenario. |
|     C3Fire scenario H. |
|     FSS, WSS, HNQ questionnaires |
| ***Thank you and good bye*** |
|     Payment |
|     Open discussion about the game and their experiences of C3Fire and the experiment. |

**Experiment Two**

A second experiment was conducted on the repeated exposure effect on flow in attempt to further investigate the results found in experiment one. The second experiment was almost an exact replica of the first experiment except the technology of interest was not C3Fire but Frogger 3D (1991). The exposure that the participants received to the technology was increased to four days rather than two days. There were a total of 16 exposures over a period of four days, four exposures per day. The time that participants played the game was reduced to 10 minutes, rather

than 15 minutes. The purpose of the study was to investigate if the nature of flow was linear or cyclic across repeated exposure.

## *Participants*

Five graduate students (3 males, 2 females, mean age= 25 yrs) from the University of Central Florida drawn from a convenience sample volunteered to participate. No compensation or credit was given to the volunteers. Participants had experience playing video games, but no experience playing Frogger 3D.

## *Experimental Task*

The task of the participants was to play Frogger 3D for ten minutes then to complete the FSS.

## *Apparatus*

*Flow State Scale (FSS).*

A 36-item Flow State Scale, developed by Jackson and Marsh (1996), was used to assess degree of flow experienced while engaged in a particular activity.  Flow is the subjective experience of connectedness with events and the environment (Csikszentmihalyi, 1990, 1997).

The FSS has received initial psychometric support including adequate construct validity (Jackson & Marsh, 1996). Refer to Appendix C to view the questionnaire.

*Experimental Paradigm*

A Playstation 2 console was used in the experiment to play the video games using a Dell dimension desktop computer. The video game consisted of *Frogger 3D* (1991). The ESRB Rating for Frogger is: *Everyone* (6 years old and up). It is a non violent game that features a frog who must hop across a busy street and a raging river to safety on the other side.

*Hypotheses*

The second experiment again investigated the research questions: What is the effect of repeated exposure on flow? Specifically, will the same trend occur for flow and exposure as seen in results from the first experiment? Again it was hypothesized that flow was still expected to increase linearly with each exposure. This finding would be supported by previous literature that examined the effect of repeated exposure on likeability, fondness, relationship development, and intimacy (Bossard, 1932; Dion, 1979; Zajonc, 1980; Bornstein, 1989). Also this finding would support this aspect of the EHH framework.

## Procedure

Participants were asked to play Frogger 3D for 10 minutes. They were told to have fun. After each 10-minute cycle participants were asked to fill out the FSS. Each day participants completed four cycles of playing Frogger 3D and competed the FSS after each cycle. This continued for four days consecutively. Performance was measured by taking the highest score achieved each 10 min cycle. If participants beat a level they were able to start up again on the next level if they preferred to do so.

## Experiment Three

The goal of the third study was to investigate a dimension of the framework of pleasurable human-technology experience called the 'pleasurable experience' level of the HH of N, refer to Figure 1, and how it may affect other dimensions of the framework, namely the occurrence of flow, the mode of interaction, and the needs of the user. Specifically, the hedonomics of the *System* were manipulated in this study in order to observe differences, if any, in flow, interaction mode and user needs. The main research questions ask: 1) how does aesthetics of the game affect the occurrence of flow, as experienced by users engaged in a video game? 2) How are Kansei words and the occurrence of flow related? 3) How do improved aesthetics affect the needs of the users as defined by the Kansei Engineering Method? The study was conducted using two versions of the same video game called Frogger, the following section labeled 'experimental paradigm' gives a thorough description of this game.

The logic behind the study is that by taking two versions of a video game that are identical in all other aspects expect for their hedonic aspects such as aesthetics, graphics, and perspective then it is possible to observe differences, if any, in the occurrence of flow and needs of users. In this way it is possible to observe the effects on the users caused by the changes in the hedonic aspects of the system as well as any relationships between flow the users needs.

## *Participants*

Fifty eight males and females (between the ages of 19 to 37) participated in the study for experimental credit. Participants were solicited using *ExperimenTrak* at the University of Central Florida. In order to participate, participates had to have normal color vision.

## *Apparatus*

### *Demographic Questionnaire*

The demographic questionnaire asked several questions to assess the participants' (1) personal information such as age and gender, and (2) experiences of using computers, especially video games, word processing and chat programs.

*NEO Five Factor Inventory (NEO-FFI).*

The NEO-FFI is designed to measure the 'Big Five', five domains of adult personality: extraversion, agreeableness, conscientiousness, emotional stability, and intellect/openness. It will give us valuable insights in the participants' personalities and will facilitate differentiation between individual differences.

The NEO-FFI is a 60-item personality inventory (Costa & McCrae, 1992). The NEO-FFI has adequate internal consistency, construct, and discriminative validity across diverse samples (Ball, Rounsaville, Tennen, Kranzler, 2001; Costa & McCrae, 1992). Refer to Appendix B to view the questionnaire.

*Flow State Scale (FSS).*

A 36-item Flow State Scale, developed by Jackson and Marsh (1996), was used to assess degree of flow experienced while engaged in a particular activity. Flow is the subjective experience of connectedness with events and the environment (Csikszentmihalyi, 1990, 1997). The FSS has received initial psychometric support including adequate construct validity (Jackson & Marsh, 1996). Refer to Appendix C to view the questionnaire.

*Human Need*

The questions from the human need questionnaire (Harbough, 1970) were revised to gauge the level of need the user expects the system to fulfill. Five core needs were focused on,

namely *Trust*, *Achieve, Control, Enjoy,* and *Grow* (Hancock, 2005*)*. Questions were adopted and modified for this study to examine human need for technology (Alderfer, 1967; Harbaugh, 1972). Refer to Appendix C to view the questionnaire.

*Mode of Interaction*

The study focuses on three modes of interaction which include: *Goal, Exploration*, and *Seamless* mode of interaction.  Items from the Web State Scale (Novak et al., 1998) will be used to assess the degree of goal, exploratory, and seamless modes of interaction the participants most often engage in when interacting with technology. Specifically, questions will be adopted from the playfulness dimension (4 items, chronbach alpha = .782), the exploratory dimension (4 items, Chronbach alpha = .638) of the Web State Scale (Novak et al., 1998)  and the focused attention dimension (4 items, Chronbach alpha = .860)  (Jackson et al., 1996) of the Flow State Scale. Refer to Appendix C to view the questionnaire.

*Kansei Word Ratings*

The Kansei Word Ratings consisted of twelve descriptors for video games: Innovative, engaging, challenging, control, story, social interaction, strategic, immersive, balance, depth, intuitive, and rejuvenate. Each word is rated separately on a 7-point Likert scale, please refer to Figure 5.

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To what degree does the following word describe the game that you have just played?

## Engaging

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

Very
Low

Very
High
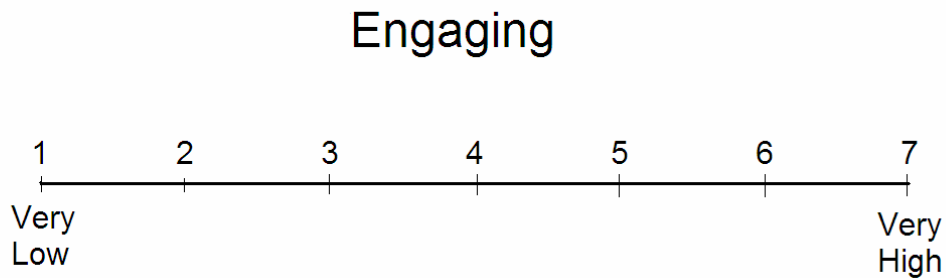
*Figure 4.* Example of Kansei rating for "Engaging," each of the twelve Kansei words were rated in this fashion.

*Experimental Paradigm*

A Playstation 2 console was used in the experiment to play the video games using a Dell dimension desktop computer. The video games consisted of *Frogger (1981 original)*, and *Frogger 3D* (1991). The ESRB Rating for Frogger is: *Everyone* (6 years old and up). It is a non violent game that features a frog who must hop across a busy street and a raging river to safety on the other side. The two versions are identical in game play. The differences between the games are the aesthetics only, specifically in three main areas of aesthetics including: color, detail, dimension, and perspective. Frogger (1981 original) version has only four colors, two dimensional graphics with less detail and a perspective of the entire-world. Frogger (1991)

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version has 20 different colors, three dimensional graphics with more detail with a partial-world perspective.

*Hypotheses*

The third experiment investigated several research questions including: (a) Does aesthetics influence the experience of flow? (b) Are user needs (Kansei word ratings) affected by aesthetics? (c) How is flow related to the user needs (Kansei word ratings)? (d) Do personality traits, human need for technology, and modes of interacting contribute to the experience of flow? Specifically, will the same variables found to contribute to flow in experiment one contribute to flow in experiment three as well? Hypotheses for each research question are addressed in turn.

Hypothesis (1): Aesthetics was expected to influence the occurrence of flow. Specifically it was hypothesized that flow scores would be higher in the high aesthetic condition compared to the low aesthetic condition. There is no research that has reported a relationship between aesthetics and flow. Aesthetics has still to be shown to directly relate to affective state (Sinclair, Moore, Lavis, & Soldat, 2002). However, aesthetics, specifically color has already been shown to differentially affect information-processing strategy. More specifically, negative and neutral affective colors have been shown to lead to more systematic, discerning processing, while positive affective colors render a more accepting, indiscriminate processing approach. Thus, positive affect may lead to greater cognitive flexibility, where an individual perceives and interprets information from multiple perspectives and in greater detail. Yet, cognitive flexibility has been shown to increase with the mere exposure of a stimulus used to elicit positive affect in a person (Isen, 2000; Isen et al., 1987). Several studies (Estrada et al, 1994; Isen et al, 1987) have

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found that promoting positive affect improves cognitive flexibility. Therefore, since positive affect is a component of flow it is hypothesized that greater flow would be experienced in the high aesthetics condition. This finding would support the EHH framework.

Hypothesis (2): User needs as defined by the Kansei words were expected to be rated higher, and more positively in the high aesthetic condition compared to the low aesthetic condition. To date, no study has been published that investigated aesthetics using the method of Kansei Engineering, therefore no previous literature exists to support the hypotheses. However, studies utilizing the Kansei Engineering method to examine other products usually expect higher ratings of Kansei words for the 'new' version of the product (Schutte, Eklund, Axelsson, & Nagamachi, 2004; Schutte, Schutte, & Eklund, 2005).

Hypothesis (3): User needs (Kansei word ratings) were expected to be positively correlated to flow. No study has been published that investigated the relationship of flow to Kansei words or to user needs. Therefore no previous literature exists to support the hypotheses. However, since engaging in flow is reported as one of the pleasurable experiences it is only logical to hypothesize that this construct would be correlated to user needs. The finding would support the EHH framework.

Hypothesis (4): As hypothesized in the first experiment, personality traits such as 'openness to experience,' 'agreeableness,' and 'extraversion;' human needs for technology including the need to control, the need to enjoy, and the need to grow; and  exploratory and seamless modes of interaction were expected to be predicting variables of flow.  These results would be supported by previous literature (Novak et al., 2000; Blythe et al., 2003)  and would support the EHH framework.

# Procedure

The experiment was performed in five main phases, in which the outcome from each phase acted as a basis for the next step in the study.

1. Collection and Reduction of Kansei Words

2. Identification of Hedonomic Properties

3. Pilot Study for Experiment Three

4. Data Collection

5. Connection of the Kansei Words to the Hedonomic Properties of the Video Game

*Collection and Reduction of Kansei Words*

The first step in the method of Kansei Engineering is to choose a domain and the domain of interest here is video games. The second step is to 'span the semantic space.' The third step is to 'span the space of properties.' Finally, the information attained from the preceding steps are then synthesized using statistical method. Each methodological step was conducted in the experiment and is discussed in detail below.
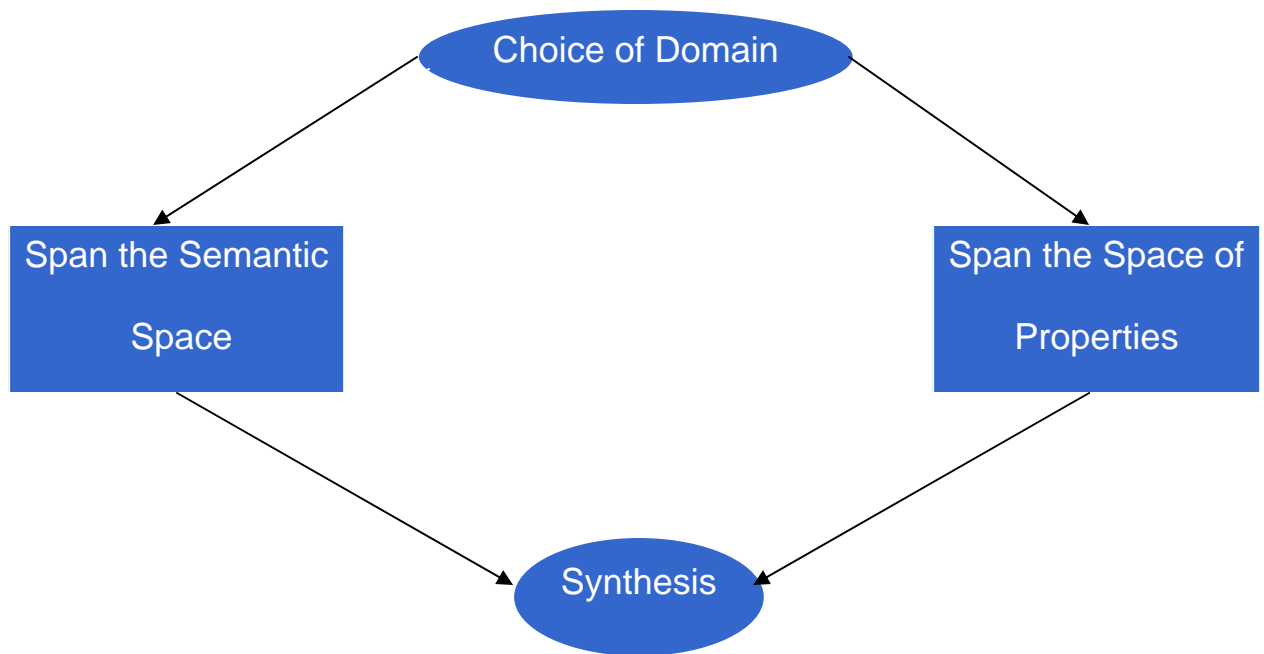
*Figure 5.* Kansei Engineering has four steps which include choosing a domain, spanning the semantic space, spanning the space of properties and synthesizing the information through statistical analyses.

After choosing the domain of interest which was 'video games', the next step consisted of 'spanning the semantic space.' this was done by using three standardized steps according to Schutte (2002):

*Step one: Word Collection.* Video games were described in words or single word adjectives. These words were collected from different sources such as advertisements, web sites, customers in arcade rooms, game chat rooms, customers in game stores, and 'gamers' in order to achieve the most complete semantic description possible. Over 60 kansei words were collected; refer to Appendix F for the complete list.

*Figure 6.* During the 'word collection' phase of the 'span the semantic space' step in the Kansei Engineering Method, over 60 single word adjectives were collected from literature, arcade rooms internet, users, experts, and advertisement.

*Step Two: Reduction of the Number of Words.* Since some words were similar, had identical meaning or were considered to be less important for the ongoing evaluation, the number of words was reduced without losing crucial information. The method used in this study was an affinity diagram grouping the semantic descriptions according to their affinity (Bergman and Klefsjo, 1994), carried out by four experts gamers that were graduate students in Human Factors, Simulation and Training, and Cognitive Science at University of Central Florida, please refer to Table 4.

*Figure 7.* During the 'reduction of the number of words' phase of the 'span the semantic space' step in the Kansei Engineering Method,  the number of words was reduced by grouping the semantic descriptions according to their affinity by four experts gamers.

*Step Three: Final Selection of Kansei Words.* The affinity diagram conveyed groups of words belonging together in several aspects. From this, representative words were chosen and were called Kansei words. The final set resulted in a total of 12 Kansei words for video games, please refer to Table 4.

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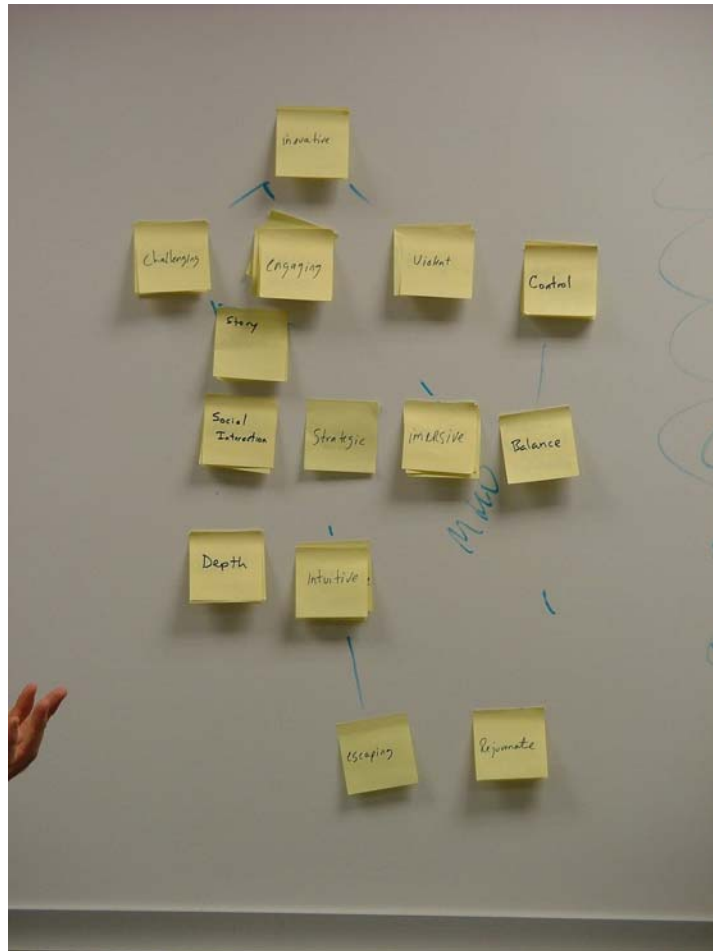
*Figure 8.* During the 'f*inal selection of kansei words*' phase of the 'span the semantic space' step in the Kansei Engineering Method, from the affinity diagram, representative words were chosen and were called Kansei words. The final set resulted in a total of 12 Kansei words for video games.

*Table 4.*
Kansei words used in this study.

| Innovative | Engaging | Challenging | Control |
|---|---|---|---|
| Story | Social interaction | Strategic | Immersive |
| Rejuvenate | Intuitive | Depth | Balance |

The product properties that were chosen for evaluation were properties of the game that are considered hedonic in nature such as aesthetics, graphics, and color. The two video games were specifically selected in order to hold all other aspects of the HH of N levels constant such as *Safety*, *Functionality*, *Usability,* and *Individuation*. Both games were equally safe to use and the main consideration for functionality and usability in this case was the game console and the game play of the games and both of these were held constant. Therefore, only the 'pleasurable experience' level of the HH of N was manipulated in that *Frogger (1981, original)*, illustrated in Figure 5, had fewer color variety, less detailed and two-dimensional graphics with an entire-world perspective of the game. While *Frogger 3D (1991),* illustrated in Figures 10 and 11, had greater color variety, increased detail and three-dimensional graphics with a partial world perspective of the game, refer to Table 5 for a list of the hedonic differences.

For an illustration of what is meant by increased detail please refer to Figures 9 and 10. Both figures display the frog dying by a vehicle. When death occurs in *Frogger (1981 original)* the frog is shown as a splat and a scull and bones, however in *Frogger 3D (1991)* the death effect is much more detailed shown as a sunburst effect with the frog feet displayed at the end. Another example of increased detail, please compare Figures 9 and 11, is that in *Frogger original* where the objective is at the top of the screen, there is no indicator of where not to jump, whereas *Frogger 3D* details where not to jump by adding spikes and sticks. Other examples of increased detail in *Frogger 3D* is the dotted white line on the road, gradient detail on the turtles' scales and logs, the trucks have the word 'Frogger' written on them, the blue river as detail of a current and has gradient to show depth.

In order to better understand the differences in perspective please compare Figures 9, 10, and 11. *Frogger original*, as shown in Figure 9, has a traditional third-person entire-world perspective enabling the player can view the entire world of the game and strategize for future moves. *Frogger 3D*, as shown in Figures 10 and 11 has a third-person partial-world perspective in which only a portion of the game play can be seen at a time, therefore the player cannot strategize as far ahead as with *Frogger original*. The perspective change from entire-world to partial-world is due to the increase in the detail of the graphics. Too much detail cannot be displayed at once without it being a distraction to the player; therefore a partial-world perspective was adopted.

*Table 5.*
Hedonic product properties identified.

| Frogger | Graphics | | | Perspective |
|---|---|---|---|---|
| Old | 5 colors | Low detail | 2D | Entire-World Perspective |
| New | 32 colors | High detail | 3D | Partial-World Perspective |

*Figure 9.* Example of *Frogger original (1981)* version of Frogger in which the frog is experiencing death. Notice the 'splat effect,' limited colors, lack of detail, two-dimensional graphics, and entire-world perspective.

*Figure 10.* Example of *Frogger 3D (1991)* version in which the frog is experiencing death. Notice the more sophisticated 'sunburst effect,' increase in color variety, increase in detail (i.e., dotted lines on road, word 'Frogger written on sides of trucks), three-dimensional graphics and the partial-world perspective.

*Figure 11.* Example of *Frogger 3D (1991)* version in which the frog is fulfilling its objective at the back of the game. Notice the increase in detail (i.e., sticks protruding out of the grass to indicate where in which not to jump) this detail is lacking in the Frogger original version. Again notice the partial-world perspective.

*Pilot Study for Experiment Three*

A pilot study was conducted for experiment three to help determine the duration at which the subjects should play each version of the video game. The purpose was to investigate how long it took before subjects reported experiencing flow. Five participants were recruited for the experiment. Participants were read a brief example describing the experience of flow taken from (Csikszentmihalyi, 1997). Participants were asked to report aloud to the experimenter when they first thought that they were experiencing flow, if at all while playing both versions of the game counterbalanced. Afterward participants also filled out the Flow State Survey and rated the Kansei words. The participants' verbal reports for the onset of flow ranged from 220 seconds to 350 seconds into the Frogger original old version. Similarly, the participants' verbal reports for the onset of flow ranged from 150 seconds to 410 seconds into the Frogger 3D newer version. Therefore, based on these data it was decided that a time limit of 15 min for both games would be sufficient for experiencing flow.

*Data Collection*

The experiment was conducted in a laboratory at the Tech Center located on Research Parkway at the University of Central Florida. Participants were instructed to read and sign the Informed Consent Form. Participants then completed the Demographics Questionnaire and the NEO FFI.

Participants were asked to play either the old version (Frogger, 1981) or the new version of Frogger (Frogger 3D, 1991). The order in which the participants received these games was

counterbalanced. No practice session was required since the learnability time for this game was low (estimated around 1 min). Participants engaged in a 15-min session of playing the video game. For a composite measure of performance, the highest level obtained, the highest score obtained and number of lives left over during the 15-min session was recorded.

Participants then filled out questionnaires including the Flow State Survey followed by the Kansei Word Ratings. Participants then engaged in a second 15-min session with either the old or the new version of Frogger followed by the Flow State Survey and the Kansei Word Ratings. The order in which participants received the questionnaires was always the Flow State Scale first because it is suggested to administer this survey immediately after the task (Jackson & Marsh, 1996) The task of the participants was to play the video game and to answer the survey questions to the best of their ability.

# CHAPTER FOUR: RESULTS

All statistical analyses were performed using SPSS for windows 11.0 (SPSS, 2002). Unless otherwise stated, an alpha level of .05 was used for all analyses.

## Experiment One

Experiment 1 was conducted to investigate whether or not the occurrence of flow (using a 7-point Likert scale) was affected by repeated exposure to the technology of interest (C3Fire). There were a total of eight exposures over a period of two days, four exposures per day.

A repeated measures analysis of variance revealed a significant effect for exposure on the participants' scores for flow, $F(7, 247)=22.97$, $p=.0005$, partial eta squared=0.394. As depicted in Figure 12, the relationship between repeated exposure and flow is linear and has a positive slope for each day.

Pairwise comparisons revealed that participants' scores for flow for Day 1, exposure 1 ($M=2.91$, $SD=.434$) were significantly less than exposures 2 ($M=3.51$, $SD=.422$) and 3 ($M=3.57$, $SD=.452$), $p=.01$. Flow scores for exposure 4 ($M=4.29$, $SD=.796$) were greater than exposures 1, 2 and 3, $p=.01$. But scores from exposures 2 and 3 were not significantly different from each other.

Similarly, flow scores for Day 2, exposure 5 ($M=3.06$, $SD=.445$) were significantly less than flow scores from exposures 6 ($M=3.34$, $SD=.539$) and 7 ($M=3.53$, $SD=.557$), $p=.01$. Flow scores from exposure 8 ($M=4.17$, $SD=.639$) were significantly greater than exposures 5, 6, and 7,

*p*=.01. However, flow scores from exposures 6 and 7 were not significantly different from each other.

Participants scores from the last exposures for Day 1 and Day 2 (exposures 4 and 8) were not significantly different from each other. Likewise, scores from the first exposures for Days 1 and 2 (exposures 1 and 5) were not significantly different from each other. Also, scores from exposure 2 and 3 from Day 1 were not significantly different from exposures 6 and 7 from Day 2. There was no difference between days.

A stepwise multiple regression was performed between flow as the dependent variable and the 17 independent variables listed in Table 6. Seven of these independent variables contributed significantly to the prediction of the occurrence of flow. These included seamless interaction mode (X1), need to enjoy (X2), need to trust (X3), neuroticism (X4), extraversion (X5), openness to experience (X6), and need to control (X7). As shown in Table 7, R for all models was significantly different from zero, $F(7,247)=24.46$, $p<.0005$. Table 8 displays the unstandardized regression coefficients (B) and intercept, the standardized regression coefficients ($\beta$), R, $R^2$, and adjusted $R^2$ for Model 1 through Model 7.

As displayed in Table 7, Model 1 contained only 'seamless interaction mode' and accounted for 20% of the variance, $F(1,253)=65.35$, $p<.0005$. Model 2 added 'need to enjoy' into the regression equation which increased the variance explained ($R^2$) by 8%, $F(2,252)=49.85$, $p<.0005$. Model 3 added 'need to trust' into the regression equation which increased the variance explained by 2%, $F(3,251)=37.06$, $p<.0005$. Model 4 added 'neuroticism' into the regression equation which increased the variance explained by 3%, $F(4,250)=31.96$, $p<.0005$. Model 5 added 'extraversion' into the regression equation which increased the variance explained by 3%,

$F(5,249)=29.52$, $p<.0005$. Model 6 added 'openness to experience' into the regression equation which increased the variance explained by 2%, $F(6,248)=26.55$, $p<.0005$. Model 7 added 'need to control' into the regression equation which increased the variance explained by 2%, $F(7,247)=24.46$, $p<.0005$. All together 39% of the variability in flow was predicted by knowing the scores of seamless interaction, need to enjoy, need to trust, neuroticism, extraversion, openness to experience, and need to control.
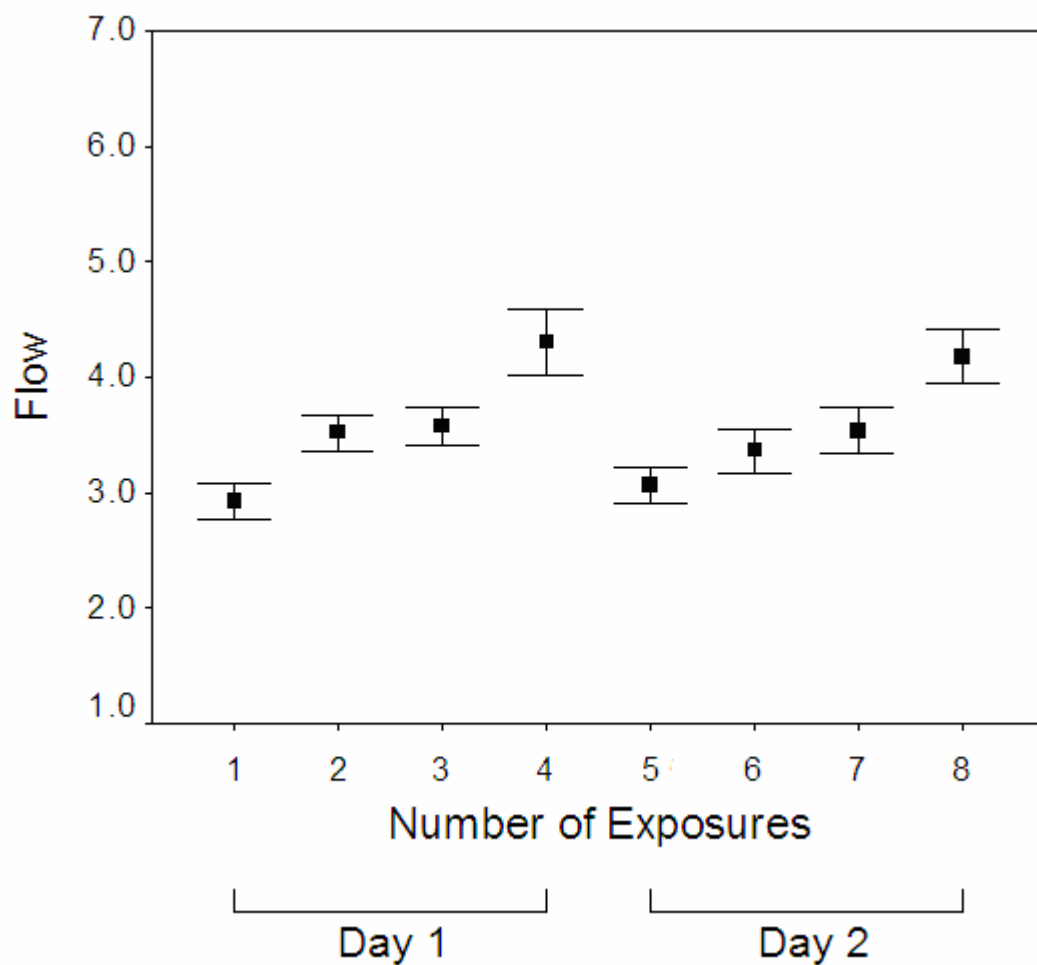


*Figure 12.* Mean flow for each of the eight exposures, four exposures per day for two days. Notice the linear effect of flow across exposures within days.
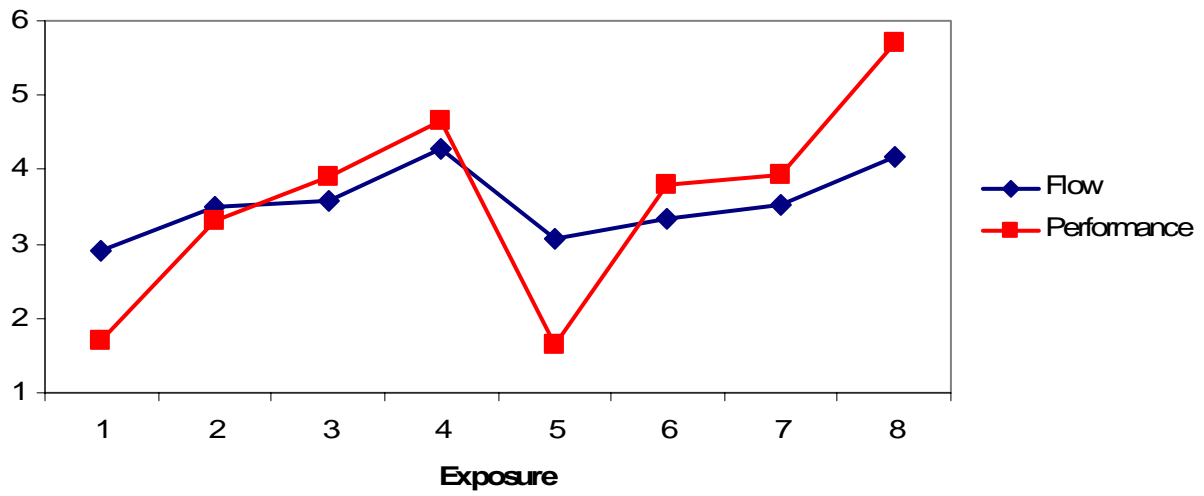
*Figure 13.* Displays mean flow and performance for each of the 8 exposures, four exposures per day for two days. Note how flow varies monotonically with performance.

*Table 6.*
Multiple regression analysis for experiment one using "Flow" as the dependent variable and NEO FFI, mode of interaction, user needs, scenario difficulty, number of exposures, and experience with technology as the independent variables.

| Variable | Source | Scale |
|---|---|---|
| Neuroticism | NEO-FFI | 1 – 5 |
| Openness to experience | NEO-FFI | 1 – 5 |
| Agreeableness | NEO-FFI | 1 – 5 |
| Extroversion | NEO-FFI | 1 – 5 |
| Conscientiousness | NEO-FFI | 1 – 5 |
| Goal Mode | Mode of Interaction Survey | 1 – 7 |
| Seamless Interaction | Mode of Interaction Survey | 1 – 7 |
| Exploration Mode | Mode of Interaction Survey | 1 – 7 |
| Experience with technology | Demographics Survey | Hours per week |
| Performance | C3FIRE output | Total cells put out |
| Need to Trust | Human Need Survey | 1 – 7 |
| Need to Achieve | Human Need Survey | 1 – 7 |
| Need to Control | Human Need Survey | 1 – 7 |
| Need to Enjoy | Human Need Survey | 1 – 7 |
| Need to Grow | Human Need Survey | 1 – 7 |
| Scenario Difficulty | C3Fire Scenario Design | 1-4 |
| Number of Exposures | Exposure to C3Fire | 1-8 |

*Table 7.*
Summary of multiple regression analyses for experiment one using "flow" as the dependent variable.

| Model | Variables | R2 | *F* | *P* | DeltaR2 |
|---|---|---|---|---|---|
| 1 | X1 | 0.202 | 65.350 | 0.005 | 0.000 |
| 2 | X1X2 | 0.278 | 49.849 | 0.005 | 0.076 |
| 3 | X1X2X3 | 0.299 | 37.060 | 0.005 | 0.021 |
| 4 | X1X2X3X4 | 0.328 | 31.958 | 0.005 | 0.029 |
| 5 | X1X2X3X4X5 | 0.360 | 29.520 | 0.005 | 0.032 |
| 6 | X1X2X3X4X5X6 | 0.376 | 26.550 | 0.005 | 0.016 |
| 7 | X1X2X3X4X5X6X7 | 0.393 | 24.460 | 0.005 | 0.017 |

*Table 8.*
Multiple regression analysis for experiment one using "flow" as the dependent variable.

| Model | Variables | Intercept | B | BETA | Adj.R2 | R2 | R |
|---|---|---|---|---|---|---|---|
| 1 | Seamless | 2.767 | 0.225 | 0.453 | 0.202 | 0.205 | 0.453 |
| 2 | Seamless | 2.261 | 0.159 | 0.321 | 0.278 | 0.283 | 0.532 |
| | Need to Enjoy | | 0.201 | 0.309 | | | |
| 3 | Seamless | 2.599 | 0.141 | 0.284 | 0.299 | 0.307 | 0.554 |
| | Need to Enjoy | | 0.217 | 0.334 | | | |
| | Need to Trust | | -0.088 | -0.157 | | | |
| 4 | Seamless | 3.132 | 0.134 | 0.269 | 0.328 | 0.338 | 0.582 |
| | Need to Enjoy | | 0.246 | 0.379 | | | |
| | Need to Trust | | -0.103 | -0.184 | | | |
| | Neuroticism | | -0.016 | -0.183 | | | |
| 5 | Seamless | 2.727 | 0.156 | 0.314 | 0.36 | 0.372 | 0.61 |
| | Need to Enjoy | | 0.248 | 0.382 | | | |
| | Need to Trust | | -0.101 | -0.180 | | | |
| | Neuroticism | | -0.022 | -0.254 | | | |
| | Extraversion | | 0.018 | 0.202 | | | |
| 6 | Seamless | 2.727 | 0.148 | 0.298 | 0.376 | 0.391 | 0.625 |
| | Need to Enjoy | | 0.277 | 0.426 | | | |
| | Need to Trust | | -0.096 | -0.171 | | | |
| | Neuroticism | | -0.021 | -0.245 | | | |
| | Extraversion | | 0.023 | 0.257 | | | |
| | Openness | | -0.012 | -0.157 | | | |
| 7 | Seamless | 2.637 | 0.128 | 0.259 | 0.393 | 0.409 | 0.64 |
| | Need to Enjoy | | 0.253 | 0.389 | | | |
| | Need to Trust | | -0.093 | -0.166 | | | |
| | Neuroticism | | -0.022 | -0.248 | | | |
| | Extraversion | | 0.022 | 0.245 | | | |
| | Openness | | -0.013 | -0.170 | | | |
| | Need to Control | | 0.104 | 0.152 | | | |

Experiment Two


A second experiment was conducted on the repeated exposure effect on flow to replicate and further investigate the linear effect seen in experiment one. A repeated measures analysis of variance was conducted to investigate whether or not the occurrence of flow was affected by repeated exposure to the technology of interest (Frogger 3D). There were a total of 16 exposures over a period of four days, four exposures per day.

The analysis revealed a significant main effect for exposure on the participants' scores for flow, $F(15, 64)=4.48$, $p=.0005$, partial eta squared$=0.512$. The ANOVA table is reproduced as Table 9. As depicted in Figure 14, the relationship between repeated exposure and flow is linear and has a positive slope for Days 1 and 2, and then asymptotes for Days 3 and 4.

The decreasing nature of flow over time is depicted in Figure 16. Notice that flow is linear but decreases with each day. Slopes for the four means of flow from the four exposures were calculated for each day and are depicted in Figure 17. Notice that the decrease of slope over the four days reveals an habituation effect for flow.

Pairwise comparisons revealed that participants' scores for flow for Day 1, exposure 1 ($M=3.795$, $SD=.745$) were significantly less than exposures 2 ($M=4.54$, $SD=.726$) and 3 ($M=5.23$, $SD=.927$) and 4 ($M=5.54$, $SD=.906$) $p=.01$. Flow scores from exposure 4 were greater than exposures 1, and 2, $p=.01$. But scores from exposures 2 and 3, and 3 and 4 are not significantly different from each other.

Similarly, flow scores for Day 2, exposure 5 ($M=4.46$, $SD=.310$) were significantly less than flow scores from exposures 6 ($M=5.33$, $SD=.747$), 7 ($M=5.47$, $SD=.752$) and 8 ($M=5.70$,

$SD=.519$), $p=.01$. However, flow scores from exposures 6, 7, and 8 were not significantly different from each other.

Flow scores from Day 3 for exposures 9 ($M=5.19$, $SD=.369$), 10 ($M=5.71$, $SD=.512$), 11 ($M=5.81$, $SD=.438$) and 12 ($M=5.80$, $SD=.521$) were not significantly different. Likewise, flow scores from Day 4 for exposures 13 ($M=6.00$, $SD=.391$), 14 ($M=6.13$, $SD=.291$), 15 ($M=6.15$, $SD=.291$), and 16 ($M=6.27$, $SD=.266$) were not significantly different.

Participants flow scores from exposure 1 from Day 1 were significantly lower than scores from exposures 9-12 on Day 3 and 13-16 on Day 4. Similarly, scores from exposure 2 from Day 1 were significantly lower than scores from exposures from Days 3 and 4 except from the first exposure of Day 3 (exposure 9) which was not significantly different. Scores from exposure 3 from Day 1 were significantly greater than the first exposure of Day 2 (exposure 5) and significantly less than exposures 13, 14, 15, and 16 from Day 4. No significant difference was found between exposure 3 from Day 1 and exposures 9, 10, 11, and 12 from Day 3. Scores from the last exposure on Day 1 (exposure 4) were not significantly different from any of the exposures from Days 3 and 4. Scores from Days 3 and 4 were not significantly different from each other with the exception of the first exposure from Day 3 (exposure 9) which was significantly lower than any of the exposures from Day 4.

A correlation analysis was performed to investigate the relationship between flow and performance. The results from the analysis revealed that flow and performance had a significant positive relationship, $r = .505$, $p=.01$. It appears that flow varies monotonically with performance, as shown in Figure 15.

*Table 9.*
ANOVA table for experiment two with 'flow' as the dependent variable.

| Source | SS | df | MS | F | p | ES |
|---|---|---|---|---|---|---|
| Between | 2463.37 | 1 | 2463.370 | 6712.92 | .0005 | .991 |
| Exposure | 24.68 | 15 | 1.650 | 4.48 | .0005 | .512 |
| Within | 23.48 | 64 | 0.367 | | | |
| Total | 2511.54 | 80 | | | | |
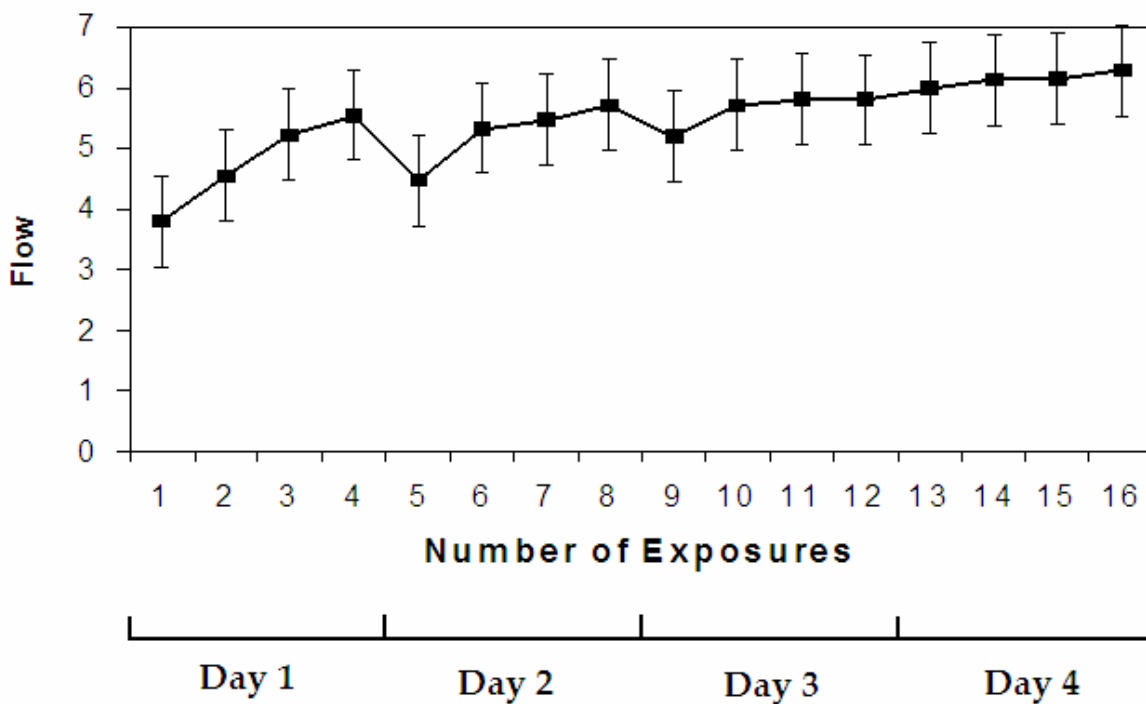


*Figure 14.* Displays mean flow for each of the 16 exposures, four exposures per day for four days.
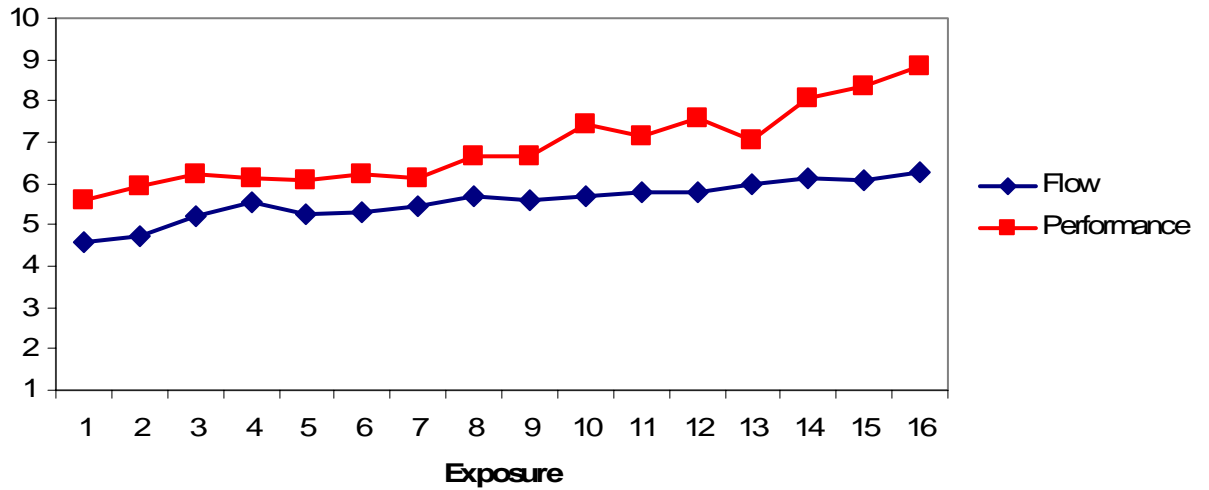
*Figure 15*. Displays mean flow and mean performance for each of the 16 exposures, four exposures per day for four days. Note that flow varies monotonically with performance.
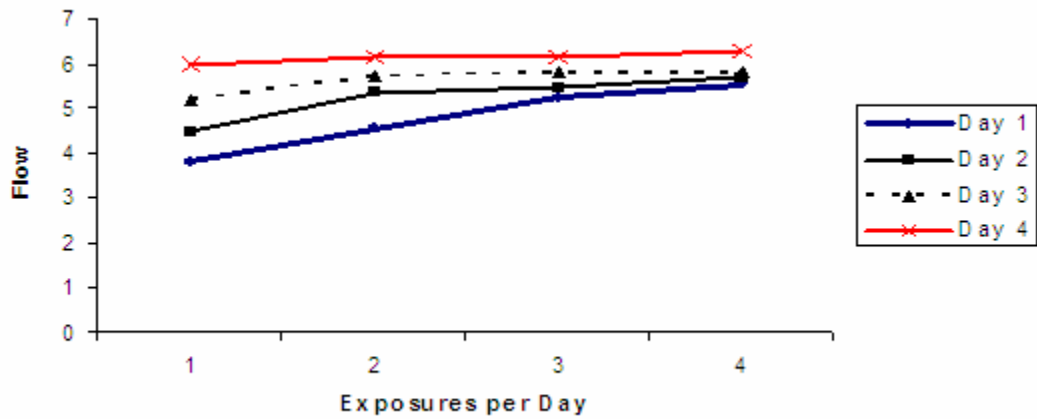


*Figure 16*. Displays mean flow for each of the four exposures per day.
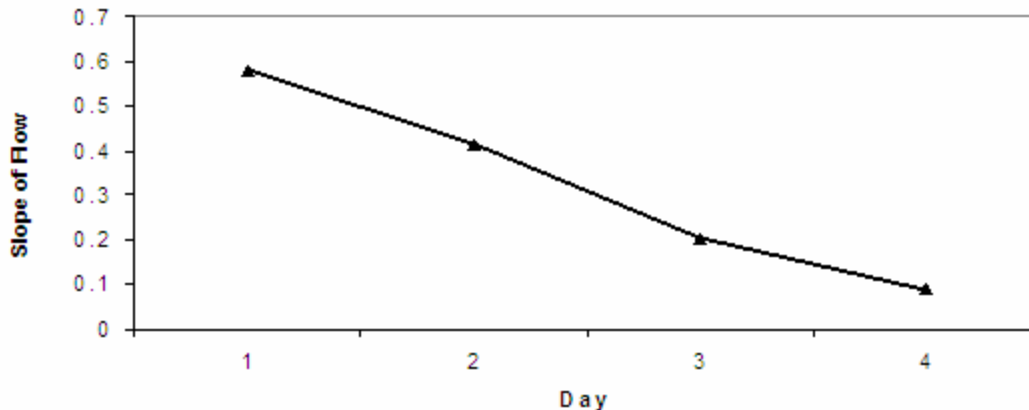
*Figure 17.* Displays the slope of flow for each of the four days.

## Experiment Three

Experiment 3 was conducted to investigate (a) whether or not the occurrence of flow was affected by aesthetics (high vs. low) of the technology of interest (Frogger original and Frogger 3D) and (b) how the Kansei words ratings would be affected by aesthetics. Kansei word ratings for the both the older and newer versions of Frogger are shown in Table 10. Ratings for the words Challenging, Depth, Engaging, and Immersive were rated significantly higher for the newer version than for the older version.

A multivariate analysis of variance revealed a significant effect for aesthetics, Wilks' $\lambda =$ .675, $F(20, 95) = 2.29$, p=.004, partial eta squared $= 0.325$, refer to Table 6. The univariate analysis of variance table is displayed in Table 12. The analysis revealed a significant effect for the dimension of flow called 'skill meets challenge', $F(1,114)=3.96$, $p=.04$, partial eta squared=0.03. Scores for the 'skill meets challenge' dimension of flow were rated significantly

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higher for *Frogger original 1981* (low aesthetic condition) (M=4.84, SD=1.11) compared to the new version of the video game, *Frogger 3D 1991* (high aesthetic condition) (M=4.46, SD=.94).

The univariate analysis of variance also revealed additional main effects for four Kansei words: Challenging, $F(1,114)=20.62$, $p=.0005$, partial eta squared=0.15, Depth, $F(1,114)=9.87$, $p=.002$, partial eta squared=0.08, Engaging, $F(1,114)=4.60$, $p=.03$, partial eta squared=0.04, and Immersive, $F(1,114)=3.99$, $p=.04$, partial eta squared=0.04. Figure 18 illustrates the mean ratings for each Kansei word for the old and the new versions of Frogger. These results suggest that the ratings for the newer version of Frogger, Frogger3D, were higher and consequently more positive for 10 of the 12 Kansei words rated. Non-significantly lower ratings were obtained for the words "Control" and "Strategic." Participants commented that the newer version had a slower response and was more difficult to strategize for future moves due to the fact that they only could see a partial-world perspective of the game.

*Table 10.*
Means and standard deviations for flow and kansei word ratings for experiment three.

| Dependent Variables | Frogger Original | | Frogger 3D | |
|---|---|---|---|---|
| **Flow** | M | SD | M | SD |
| Skill meets challenge | 4.84 | 1.11 | 4.46 | 0.94 |
| Kansei Words | | | | |
| Depth | 3.10 | 1.33 | 4.00 | 1.72 |
| Engaging | 5.03 | 1.36 | 5.55 | 1.23 |
| Immersive | 4.03 | 1.43 | 4.59 | 1.53 |
| Challenging | 4.59 | 1.44 | 5.66 | 1.07 |

*Table 11.*
MANOVA summary table for experiment three.

| Source | Wilks' $\lambda$ | F | df | df error | p | Multivariate $\eta^2$ |
|---|---|---|---|---|---|---|
| Aesthetics | 0.675 | 2.282 | 20 | 95 | .004* | 0.325 |

*Table 12.*
Univariate ANOVA summary table for experiment three.

| DV | SS | df | MS | F | p | Partial $\eta^2$ |
|---|---|---|---|---|---|---|
| Skill meets challenge | 4.172 | 1 | 4.170 | 3.963 | .040* | 0.034 |
| Depth | 23.320 | 1 | 23.320 | 9.865 | .002* | 0.080 |
| Engaging | 7.759 | 1 | 7.759 | 4.600 | .034* | 0.039 |
| Immersive | 8.828 | 1 | 8.828 | 3.993 | .048* | 0.034 |
| Challenging | 33.138 | 1 | 33.138 | 20.625 | .0005* | 0.153 |
| Error | 1016.842 | 114 | | | | |
| Total | 1094.050 | 115 | | | | |
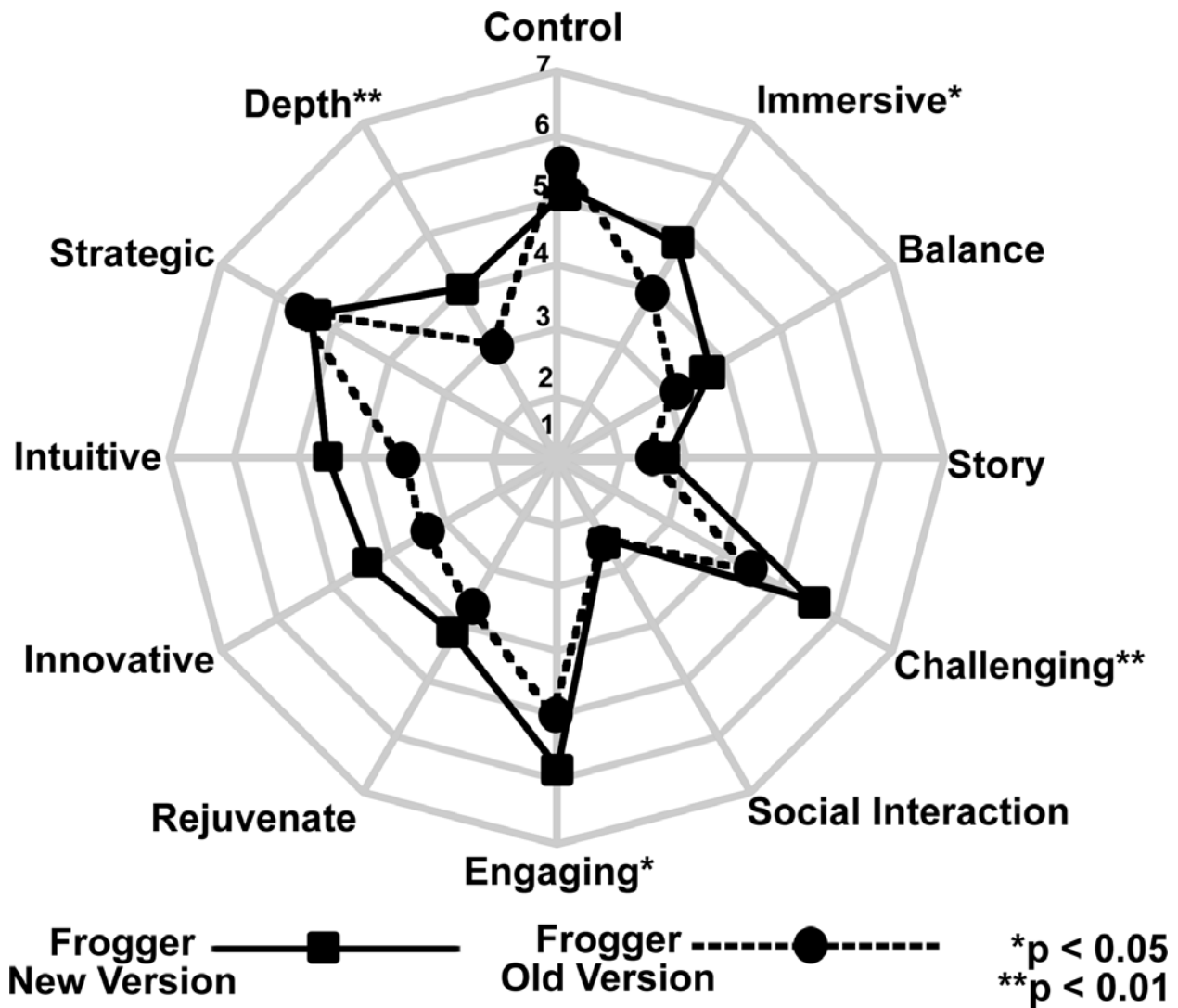
*Figure 18.* Mean Kansei ratings for the new and old versions of Frogger.

A correlation analysis was conducted to further investigate the relationships among all nine dimensions of flow, the Kansei word ratings, performance scores, and experience scores. The correlation table is reproduced as Table 13. The dimension of flow, 'skill meets challenge' had a significant positive relationship with two of the Kansei words, 'control' $r= 0.302$, $p<.01$ and 'intuitive' $r= 0.186$, $p<.05$. The Kansei word 'control' had a positive significant correlation with every dimension of flow except 'clear goals' (refer to Table 13). The Kansei word

'strategic' had a positive significant relationship to 'clear goals,' $r= 0.342$, $p= .01$. These Kansei words were the only words that were rated higher for the old version of Frogger (low aesthetic condition) compared to the new version of Frogger (high aesthetic condition). The Kansei words that were rated significantly higher for the new version of Frogger (Depth, Engaging, Immersive, and Challenging) each had significant positive correlations with at least three of the following five dimensions of flow: Concentration to the task, transformation of time, auto telic experience, clear goals, and action awareness.

*Table 13.*
Correlation analysis between dimensions of flow, kansei word ratings, experience, and performance for experiment three.

| | Concentration | Skill/ Challenge | Action Awareness | Goals | Feedback | Control | Loss of Self-Consciousness | Time | Auto-telic |
|---|---|---|---|---|---|---|---|---|---|
| **Balance** | .054 | -.012 | .288** | .228* | .060 | .117 | .048 | .080 | .065 |
| **Challenging** | .240** | -.035 | -.035 | .051 | -.019 | .075 | .119 | .264** | .257** |
| **Control** | .522** | .302** | .238** | .221* | .268** | .518** | .645** | .237* | .261** |
| **Depth** | .308** | .013 | .314** | .038 | -.045 | .116 | .081 | .368** | .118 |
| **Engaging** | .274** | -.055 | .155 | .187* | -.022 | .064 | .062 | .152 | .273** |
| **Immersive** | .134 | -.111 | .250** | .131 | .086 | .005 | -.013 | .399** | .230* |
| **Innovative** | .247** | .056 | .081 | .089 | .213* | .087 | .079 | .108 | .426** |
| **Intuitive** | .312** | .186* | .172 | .125 | .356** | .072 | .230* | .204* | .517** |
| **Rejuvenate** | .233** | .118 | .243** | -.018 | .199* | -.032 | -.008 | .341** | .551** |
| **Story** | .137 | .037 | .111 | -.233* | .158 | -.069 | .161 | .338** | .306** |
| **Strategic** | .077 | -.024 | .150 | .342** | .038 | .138 | .048 | -.187* | .140 |
| **Experience** | .026 | .066 | .230* | -.080 | .167 | .148 | .135 | -.275** | -.053 |
| **Performance** | .193* | .163 | .215* | .133 | .010 | .261** | .191* | -.239** | -.004 |

Recall that experiment one revealed that 39% of the variability in flow was predicted by knowing the scores of seven variables: seamless interaction, need to enjoy, need to trust, neuroticism, extraversion, openness to experience, and need to control. To test the generality of the results, a stepwise multiple regression was performed using the data from Experiment 3. Once again, flow (using a 7-point Likert scale) was the dependent variable. The 25 independent variables used in the analysis are listed in Table 14. Seven variables contributed significantly to

the prediction of the occurrence of flow:  need to grow (X1), need to control (X2), openness to experience (X3), seamless mode of interaction (X5), neuroticism (X6), conscientiousness (X7), and engaging (X8). The personality trait 'extroversion' (X4) was eliminated from the regression equation in model 8.  Four of these variables (seamless mode of interaction, need to control, openness to experience, and neuroticism) were also found to significantly contribute to flow in experiment one. Table 16 displays the unstandardized regression coefficients (B) and intercept, the standardized regression coefficients ($\beta$), R, $R^2$, and adjusted $R^2$ for Model 1 through Model 9. R for Model 9 was significantly different from zero, $F(7,108)= 56.24$, $p<.0005$.

As displayed in Table 15, Model 1 introduced 'need to grow' which accounted for 57% of the variance, $F(1,114)=154.59$, $p<.0005$. Model 2 added 'need to control' into the regression equation which increased the variance explained ($R^2$) by 6%, $F(2,113)=100.05$, $p<.0005$. Model 3 added 'openness to experience' into the regression equation which increased the variance explained by 4.5%, $F(3,112)=81.74$, $p<.0005$. Model 4 added 'extraversion' into the regression equation which increased the variance explained by 2.5%, $F(4,111)=69.01$, $p<.0005$. Model 5 added 'seamless mode of interaction' into the regression equation which increased the variance explained by 2.3%, $F(5,110)=62.01$, $p<.0005$. Model 6 added 'neuroticism' into the regression equation which increased the variance explained by 3%, $F(6,109)= 60.34$, $p<.0005$. Model 7 added 'conscientiousness' into the regression equation which increased the variance explained by 1%, $F(7,108)= 54.86$, $p<.0005$. Model 8 took out 'extroversion' from the regression equation which decreased the variance explained by only 0.2%, $F(6,109)= 62.88$, $p<.0005$. Model 9 added 'engaging' into the regression equation which increased the variance explained by 0.7%, $F(7,108)= 56.24$, $p<.0005$. All together 77% of the variability in flow was predicted by knowing

the scores for need to grow, need to control, openness to experience, seamless mode of

interaction, neuroticism, conscientiousness, and engaging.

*Table 14.*
Multiple regression analysis for experiment three using "flow" as the dependent variable, and the
NEO FFI, mode of interaction, user needs, and kansei words as the independent variables.

| Variable | Source | Scale |
|---|---|---|
| Neuroticism | NEO-FFI | 1 – 5 |
| Openness to experience | NEO-FFI | 1 – 5 |
| Agreeableness | NEO-FFI | 1 – 5 |
| Extroversion | NEO-FFI | 1 – 5 |
| Conscientiousness | NEO-FFI | 1 – 5 |
| Goal Mode | Mode of Interaction Survey | 1 – 7 |
| Seamless Interaction | Mode of Interaction Survey | 1 – 7 |
| Exploration Mode | Mode of Interaction Survey | 1 – 7 |
| Need to Trust | Human Need Survey | 1 – 7 |
| Need to Achieve | Human Need Survey | 1 – 7 |
| Need to Control | Human Need Survey | 1 – 7 |
| Need to Enjoy | Human Need Survey | 1 – 7 |
| Need to Grow | Human Need Survey | 1 – 7 |
| Balance | Kansei Word | 1-7 |
| Challenging | Kansei Word | 1-7 |
| Control | Kansei Word | 1-7 |
| Depth | Kansei Word | 1-7 |
| Engaging | Kansei Word | 1-7 |
| Intuitive | Kansei Word | 1-7 |
| Innovative | Kansei Word | 1-7 |
| Immersive | Kansei Word | 1-7 |
| Rejuvenate | Kansei Word | 1-7 |
| Social Interaction | Kansei Word | 1-7 |
| Story | Kansei Word | 1-7 |
| Strategic | Kansei Word | 1-7 |

*Table 15.*
Summary of multiple regression analyses for experiment three using "flow" as the dependent variable.

| Model | Variables | R2 | *F* | *p* | DeltaR2 |
|---|---|---|---|---|---|
| 1 | X1 | 0.572 | 154.59 | 0.005 | 0 |
| 2 | X1X2 | 0.633 | 100.05 | 0.005 | 0.061 |
| 3 | X1X2X3 | 0.678 | 81.74 | 0.005 | 0.045 |
| 4 | X1X2X3X4 | 0.703 | 69.07 | 0.005 | 0.025 |
| 5 | X1X2X3X4X5 | 0.726 | 62.01 | 0.005 | 0.023 |
| 6 | X1X2X3X4X5X6 | 0.756 | 60.34 | 0.005 | 0.030 |
| 7 | X1X2X3X4X5X6X7 | 0.766 | 54.86 | 0.005 | 0.010 |
| 8 | X1X2X3X5X6X7 | 0.764 | 62.88 | 0.005 | 0.002 |
| 9 | X1X2X3X5X6X7X8 | 0.771 | 56.24 | 0.005 | 0.007 |

*Table 16.*
Multiple regression analysis for experiment three using "flow" as the dependent variable

| Model | Variables | Intercept | B | BETA | Adj.R2 | R2 | R |
|---|---|---|---|---|---|---|---|
| 1 | Need to Grow | 2.934 | 0.443 | 0.759 | 0.572 | 0.576 | 0.759 |
| 2 | Need to Grow | 2.227 | 0.306 | 0.525 | 0.633 | 0.639 | 0.799 |
| | Need to Control | | 0.243 | 0.344 | | | |
| 3 | Need to Grow | 2.782 | 0.260 | 0.445 | 0.678 | 0.686 | 0.829 |
| | Need to Control | | 0.294 | 0.416 | | | |
| | Openness | | -0.025 | -0.226 | | | |
| 4 | Need to Grow | 2.162 | 0.199 | 0.341 | 0.703 | 0.713 | 0.845 |
| | Need to Control | | 0.312 | 0.442 | | | |
| | Openness | | -0.024 | -0.221 | | | |
| | Extraversion | | 0.023 | 0.187 | | | |
| 5 | Need to Grow | 1.926 | 0.160 | 0.274 | 0.726 | 0.738 | 0.859 |
| | Need to Control | | 0.291 | 0.412 | | | |
| | Openness | | -0.019 | -0.173 | | | |
| | Extraversion | | 0.023 | 0.185 | | | |
| | Seamless | | 0.095 | 0.189 | | | |
| 6 | Need to Grow | 2.864 | 0.106 | 0.181 | 0.756 | 0.769 | 0.877 |
| | Need to Control | | 0.311 | 0.441 | | | |
| | Openness | | -0.021 | -0.190 | | | |
| | Extraversion | | 0.013 | 0.107 | | | |
| | Seamless | | 0.150 | 0.298 | | | |
| | Neuroticism | | -0.027 | -0.221 | | | |
| 7 | Need to Grow | 2.406 | 0.076 | 0.130 | 0.766 | 0.781 | 0.883 |
| | Need to Control | | 0.356 | 0.504 | | | |
| | Openness | | -0.025 | -0.231 | | | |
| | Extraversion | | 0.010 | -0.085 | | | |
| | Seamless | | 0.148 | 0.294 | | | |
| | Neuroticism | | -0.029 | -0.231 | | | |
| | Conscientiousness | | 0.017 | 0.123 | | | |
| 8 | Need to Grow | 2.726 | 0.088 | 0.151 | 0.764 | 0.776 | 0.881 |
| | Need to Control | | 0.357 | 0.505 | | | |
| | Openness | | -0.026 | -0.239 | | | |
| | Seamless | | 0.156 | 0.310 | | | |
| | Neuroticism | | -0.033 | -0.263 | | | |
| | Conscientiousness | | 0.018 | 0.136 | | | |
| 9 | Need to Grow | 3.077 | 0.121 | 0.207 | 0.771 | 0.785 | 0.886 |
| | Need to Control | | 0.338 | 0.479 | | | |
| | Openness | | -0.028 | -0.258 | | | |
| | Seamless | | 0.159 | 0.317 | | | |
| | Neuroticism | | -0.030 | -0.244 | | | |
| | Conscientiousness | | 0.016 | 0.120 | | | |
| | Engaging | | 0.065 | -0.109 | | | |

# CHAPTER FIVE: DISCUSSION AND CONCLUSIONS

The purpose of the thesis was to evaluate pleasurable human-system experience within the Extended Hedonomic Hierarchy framework. The first experiment was designed to investigate the 'Exposure' component of the EHH framework. The effect of repeated exposure to technology on the occurrence of flow was investigated. Experiment two was an extension of the first experiment, in order to further investigate the effect of repeated technology-exposure on flow. Experiment one also examined whether the variables from the EHH framework were predictors of flow. Experiment three was designed to investigate the 'Pleasurable Experience' aspect of the HH of N framework using the Kansei Engineering Method. Important findings from these experiments are discussed in terms of: (a) findings that support the EHH and HH of N frameworks, (b) individual differences and pleasurable human-system experience, and (c) findings from the Kansei engineering method. The discussion then turns to future research directions for Hedonomics, practical guidelines and principles for the application of Hedonomics in industry, and steps that need to be made in order to make Hedonomics a reality in the workplace.

## Evidence that Supports the Extended Hedonomic Hierarchy Framework

### *The Effect of Repeated System-Exposure on Pleasurable Human-System Experience*

The data from experiment one suggest that pleasurable human-system experience increases linearly with repeated exposure to the technology of interest, as hypothesized. Flow

was found to increase linearly with each exposure but appeared to be mediated by day. The linear effect seen of Day 1 did not carry over to Day 2, but instead the values and trend seen on Day 2 was a repeat of that seen on Day 1. Thus the true nature of flow was not clear from these results; it could be either linear or cyclic.

Experiment two was designed in order to ascertain whether the nature of flow is linear or cyclic by extending the number of exposures. Participants were exposed to the game four times a day for four days. The positive linear effect seen from experiment one was replicated and was seen for Day 1 and Day 2 of experiment two. Day 3 showed a similar pattern but by day four flow asymptotes. There is a linear effect of flow mediated by day revealing a cyclic pattern during the early stages of exposure. The cyclic pattern has several peaks with a drop after each peak for both Day 1 and Day 2. The size of the drop in flow after each peak decreased each day for three days; by Day 4 flow remained at a constant level. It is not clear if this is a function of the Flow State Scale reaching a ceiling effect or if this is the true nature of flow across repeated exposure over a four-day time period.

In order to investigate this finding further, slopes from the flow scores were calculated for each of the four days. The data revealed an habituation effect of flow mediated by day. Habituation - the decreasing responsiveness with repeated stimulation - increases linearly with each day. This finding is consistent with the literature on repeated exposure and attention (Bossard, 1932; Burr, 1973; Clarke, 1952). A novel stimulus gets attention when first presented; the more it is presented the weaker the response becomes. To my knowledge, this is an original finding. It makes sense that flow would habituate across repeated exposure since the ability to focus attention is a determining factor of experiencing flow.

Future research should focus on ways of mitigating this effect of habituation of flow. One possibility is *Aesthetic Longevity which* is described Hancock et al., (2005) as a principle that allow the user to create a balance between typicality and novelty in order to allow for changing cultural norms and personal change over time. Perhaps designers should seek to create systems that adapt in order to facilitate a continuous 'state of newness' that consistently elicits pleasurable feeling. This would eliminate the habituation effect of flow by reducing the effect of boredom that comes with familiar stimuli.

Furthermore, the habituation effect can be seen as an indicator to distinguish between good and poor design. For example, for a good design which intrinsically elicits pleasure in the user should continue to show a relative increase in flow, with the habituation effect remaining at a minimum, even after the novelty effect has worn off. However, for a bad design which does not elicit pleasurable interaction would most likely reveal an early and rapid onset of habituation of flow, the data would resemble an inverted 'u' shape for flow.

Future research should replicate experiment 2 and expand the 7-point Likert scale used in the Flow State Scale to an 100-point scale in order to shed light on the ambiguity of whether or not the asymptote of flow was a function of the Flow State Scale reaching a ceiling effect or if it was the true nature of flow across repeated exposure. This is because the distribution of data in Day 4 was negatively skewed. The expansion of the scale helps to eliminate the ceiling effect and keep the distribution normal even with repeated exposures over time.

*Human Need and Pleasurable Human-System Experience*

Motivation to satisfy the human need for technology is hierarchically structured and contributes to pleasurable human-system experience, as depicted in the EHH framework. High motivation to satisfy low-level needs inhibits pleasurable human-system experience. Findings from experiment one revealed that the need to trust, a low-level need, contributed to flow and was negatively correlated to flow. This suggests that low level needs for technology do not correspond to high level experiences with technology, as depicted in the EHH framework.

Additionally, findings revealed that high motivation to satisfy high-level needs facilitated pleasurable human-system experience. High-level needs to control, enjoy, and grow were found to be positive contributors to flow. These results provide support for the hierarchical structure of the HH of N framework and the 'Need Fulfillment' component of the EHH framework. However, the need to achieve was not found to contribute uniquely to the pleasurable human-system experience.

Seamless mode of interaction was found in both experiment one and two to be a predictor of flow. When users are experiencing flow they are most likely interacting with the technology seamlessly. This result suggests that designers should design with the explicit goal to enable a seamless mode of interaction to facilitate pleasurable human-system experience.

*Individual Differences and Pleasurable Human-System Experience*

Data from experiments one and three reveal that there are individual differences among users that affect the likelihood of experiencing pleasurable human-system interaction. Users high

in 'extroversion' are more likely to experience both pleasurable human-system interaction or flow.  Similarly, users high in 'conscientiousness' are more likely to experience pleasurable human-system interaction or flow. Conscientiousness was found to be a contributing variable to the occurrence of flow in experiment 3.  Users high in conscientiousness were more likely to experience flow.  In contrast, users high in 'neuroticism' are less likely to experience pleasurable human-system interaction. Neuroticism was found to be, in both experiments one and three, inversely related to the occurrence of flow.  Users high in neuroticism were less likely to experience flow. Similarly, users high in 'openness to experience' are less likely to experience pleasurable human-system interaction or flow. Openness to experience was found to be, in both experiments one and three, inversely related to the occurrence of flow. Users high in openness to experience were less likely to experience flow.

Not all people have the same potential to engage in flow.  The ability to focus attention is what distinguishes those that do experience flow and those that do not. According the Csikszentmihalyi (1990), it is not clear exactly what personality traits are linked to those that experience flow, except that those people that engage in flow regularly are more likely to experience flow in general and are known for turning negative situations into positive experiences (Jackson et al., 1998). They do this by challenging themselves with the environment they are set in at that moment. People with attention disorders, including schizophrenia, and those who are excessively self-consciousness or self-centered tend to have difficulty focusing attention on the task at hand. A self-conscious person focuses attention on everybody else in the environment worrying what they think of them. A self-centered person focuses attention on how all information from the environment advances his/her own desires. Neuroticism has been found to be related to self-centeredness. Openness to experience interferes with the focusing of

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attention that is necessary to engage in flow. If someone is open to experiencing many different things perhaps that interferes with their ability to narrow their attention span and focus on the task at hand.

These considerations suggest that research in the area of Hedonomics should focus on individual differences and preferences to technology. Studies that investigate individual differences in how users engage in flow, human need for technology, and interactivity with technology can provide crucial information that would be needed in order to design using the principle of 'individuation' or designing for the individual (Hancock et al, 2005). Perhaps in the future design recommendation can be provided by knowing the user's score on the 'big five.' This line of research is also the key to understanding how to design for the 'subjective' component of the experience of pleasure. One way to study this is by examining how preferences in customization options are related to individual differences.

*Kansei Engineering Findings*

The data suggest that the method of Kansei engineering can and should be used in the study of Hedonomics because the method provides data from which informed decisions about design can be made and empirical research can be conducted. This thesis contributed twelve Kansei words describing video games that could be used by researchers and designers to inform and to investigate differences in video game design.

Experiment three investigated the effect of hedonic properties of the system on pleasurable human-system experience. The data revealed that the incorporation of three-dimensional graphics, increased color variety, and partial-world perspective increased user's

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feelings of 'depth,' 'immersion,' 'challenge,' and 'engagement' during video game play. These Kansei words were rated higher for the version of the game with high aesthetic hedonic properties compared to the version with low aesthetics. Additionally, data revealed that the feeling of 'engagement' during game play is a predictor of flow.

Future research in Hedonomics should be directed at improving the method of Kansei engineering. The first stage called, 'collection of Kansei words' has room for improvement. During this stage, designers should collect the Kansei words only from users that fit the user profile, in order to better gage the needs of the users. Also, descriptors could be collected describing only certain aspects of the product properties in order to better connect the user's feelings with product properties.


## How can Hedonomics become a Reality in Human Factors?


For Hedonomics to become the next phase in the evolution of human-technology interaction, it must catch on to and be practiced by designers and usability professionals. For it to be practiced and applied in industry, Hedonomics must first be accepted by the design and usability communities. Hedonomics is *not* a replacement of usability. This point must be made loud and clear. On the contrary, as this thesis demonstrated, usability is a major contributing factor to what makes something pleasant to interact with and to use.

If the demand for pleasurable products increases and sales reflect this demand, then the appeal of Hedonomics will begin to become obvious to designers and usability professionals. According to Tom Kelley in his book called, 'The Art of Innovation," there is a major trend which reflects an increasing demand for 'innovative' design. According to Kelley, the key to

designing innovative products is to know the needs of the users for that product and designing to fulfill those needs. Indeed, Hedonomics is an innovative approach to design.

## Why use Kansei Engineering as a Method to Design for Happiness and Pleasure?

Kansei engineering enables designers to look at how users define their needs in their own lingo. It allows users themselves to tell designers what is important to them about the product. That is what designers should be interested in and measuring. Additionally, this method eliminates any communication barriers between the users and the designers. It allows designers to compare designs and make informed decisions based on quantitative data. It allows designers to link certain feelings to product properties. This allows designers to design for feeling. Since we are poor at predicting how something will make us feel in the future it is important to have data to aid in decisions about design regarding how the design and/or aspects of the design will make us feel when using it in the future.

Kansei Engineering can be beneficial to the study of and application of Hedonomics because it enables this latent knowledge of the designers to be made explicit which otherwise is very difficult to communicate. Designers often have a 'sixth sense' about how products should be designed. They often know the target group and know how impressions and product traits are linked intuitively (Shutte et al. 2004). The data revealed by the method of Kansei Engineering can act as a catalyst for communicating such knowledge and thus providing direction for future research endeavors in the area.

A concern with using Kansei Engineering is in the belief that kansei words represent the needs or feelings of the users. It may be more accurate to claim that it is a method for designing

for the most up-to-date trends, and in this sense, it does design for user needs because trends are about the latest technology which can often satisfy the need to save time, the need for convenience, and the need to be up-to-date with technology. Perhaps the method could be directed more toward satisfying customer needs by specifically surveying users on what their needs are for the product during the 'Collecting Kansei Words' and using these as Kansei words.

## Why should anyone in Industry care about Hedonomics?

There is a growing concern among the large corporations regarding the health of their employees. This is because having unhealthy workers is hitting the big companies where it counts, in the pocket book, by costing them in health care benefits (reported on CBS nightly news, November 3, 2005). Americans are growing more overweight, less healthy, and hence less happy everyday. Large corporations are even trying to profile potential employees based on information that would predict future health problems to aid in the hiring decision-making process. For this reason, industry should care about the welfare and health of their employees and about incorporating Hedonomic principles into the design of tools, machines, workspace, and all other aspects of work.

## How do we make Hedonomics a Reality in the Workplace?

The key for getting Hedonomics accepted is to demonstrate superior financial returns. This would allow Hedonomics to gain wider acceptance. A step before that is to build credibility

within companies that a Hedonomic approach is good although there is no financial evidence to support it. Some industries do indeed make decisions on intuition, when predicting future trends, investing in art such as fashion, music, actors, etc.

In industry, the major criteria for decision making are financial returns. So for example, if a company needs to redesign employee workspace and has a choice to hire either the conservative Ergonomist with no Hedonomic training or interest in designing for enjoyment and employee needs, or the Hedonomist that is interested in designing for these things and both designers will cost the company $100. The productivity from the workers after the redesign of the workspace from designer A is 150, while the productivity from the workers after the redesign of the workspace from designer B is 140. The company will most likely go with designer A.

One could argue that a different criterion should be used in addition to the productivity measure, and that is the happiness and well-being of the workers. Happiness is often left out of the decision-making process by companies because happiness is not as easily quantifiable as money and happiness is not a justifiable criterion in front of investors. However, this reality may change as the cost of health care benefits provided by industry continue to increase so will the concern by companies for the welfare and happiness of their workers.

Kahneman argues that we make this same mistake of not taking into account our own happiness when making decision in our own personal lives. He describes us as two people: the remembering person and the experiencing person. The remembering person has permanence, and their point of view is very different from the experiencing subject. Life becomes a story, a narrative with a beginning, peak, and end. The remembering subject is the one that keeps score the one that makes the decisions. Yet, Kahneman argues that we (the remembering subjects) have a clear inability to accurately forecast the future as far as our tastes, how they will change,

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and how we may adapt. This is a considerable part of the mistake that we make in life with making choices that eventually do not pay off. This is most likely because we ourselves make decisions based off of quantifiable outcomes such as money and not our happiness.

## The Crossroads: Which Way Will We Go?

If we decide as a field (of Human Factors) and as a species (at least technological civilizations of the human species) that we want to be happy interacting with technology, happy working, and just happy in general then Hedonomics is our next step in the evolution of human-technology interaction. If we decide that we want to feel frustrated using everyday things, dislike our work, and, in general, be unhappy then Hedonomics is not our next step in the evolution of human-technology interaction. At this time in history, we are at a crossing point where we as a field must make a decision. Unfortunately, evidence suggests that we are poor at making decisions in our lives that reflect what will make us happy since most people are wrong at predicting exactly how they will feel in the future. It is called 'affective forecasting.' Specifically, we overestimate our emotional reaction in the future. We think things will make us happier than they actually do and sadder than they actually do in life. We are impaired at making decisions about what we want for our happiness. Therefore, it is very possible that Hedonomics may not catch on, if it does not, then I believe we have made the wrong choice while we stood at the crossed roads.  I want to be happy, that is why I choose this topic as my dissertation topic. I believe we can make a significant impact on the future as Human Factors professionals. It is our responsibility to shape where technology is headed in order to bless society and not curse it. At this point in time, we have been given that opportunity and I believe it is a moral obligation. If it

is not us, as Human Factors professionals, who will pursue this righteous endeavor, then who will?   Hedonomics is the way. It is certainly the first step to accomplishing the goal to be happy in our everyday lives.

## The Perversion of Hedonomics

Although, it is possible that Hedonomics could become perverted. There is an ongoing philosophical debate that questions the pursuit of pleasure and well-being. Some say that pleasure and pain is the only thing we know at the present moment. Therefore, what is pleasurable must be good, and what is painful must be bad. If we make decisions on what is pleasurable then it must lead to a good outcome, like being well. This school of discipline is called Hedonics or Hedonism, The father of Hedonism is Epicurus (341-270 B.C.).   On this topic he wrote:

> "I [Epicurus] know not how to conceive the good, apart from the pleasures of taste, the pleasures of sound and the pleasures of beautiful form." p.12. "And as proof that pleasure is the end he adduces the fact that living beings, as soon as they are born, *naturally and unaccountably* to themselves *find satisfaction* in *pleasure* but *reject pain. Instinctively,* then, we *shun pain .... "* [pp. 90-91.]
>
> "*Wherefore we say that pleasure is the beginning* and *the end of the blessed life.* We apprehend *pleasure* as the *first* and *innate good* and *we proceed from it* in all that we do or refrain from doing and to it we come back, inasmuch as *this feeling serves us* as the guide-line *by which we judge of everything good*." pp. 85-86.

However, the philosophy of Hedonism as we know it today is not completely in accordance with Epicurus original teachings. He believed that not all pleasures would lead to good and not all pain would lead to evil. On this topic he wrote:

"And *since* pleasure is our *first* and *innate good for that reason* we do not choose *every pleasure* ....

"*All pleasure therefore, because it is suited to us by nature, is a good, yet not every pleasure is choice worthy*; just as *all pain is an evil* and *yet not all pain is to be avoided under all circumstances. All these matters must rather be decided by weighing one against another* and from the *standpoint* of *advantage* and *disadvantage,* for *what is good proves at certain times to be an evil for us,* and conversely *what is evil* proves to be a good." p. 86.

Therefore, although Epicurus has been called the father of Hedonism he is actually a 'Eudaimonic' and would be more likely to support the Eudaimonic viewpoint. The term Eudaimonia refers to well-being as distinct form happiness per se. The Eudaimonic theories maintain that not all desires, not all outcomes that a person might value, would yield well-being when achieved. Even though they are pleasure producing, some outcomes are not good for people and would not promote wellness. Thus, from this perspective, subjective happiness cannot be equated with well-being.

Hedonomics should incorporate the Eudaimonic philosophical viewpoint to ensure that technology, as it burgeons, will continue to be a blessing to the human race as we continue to interact and evolve with it. In order to do this it is crucial that wellness is promoted in the users through design.

Most people are poor at predicting how outcomes will make us feel in the future. It is important that we learn how to make right decisions that will lead to happiness because happiness is an important factor in well-being. Most of the time we think things will make us happier than they actually do. The important question is why some people's decisions lead to unhappiness and sickness and others leads to happiness and wellness. What are the differences between these two types of people and how is their decision-making process different? The area

of research that focuses on investigating the 'impact bias' or the gap between what we predict and what we ultimately experience can help to shed light on questions related to this topic of well- being and decision making.

## Future Directions for the Study of Hedonomics

Future directions for the study of Hedonomics should focus on the following research questions: How can we promote well-being through technology and design? How can the design of product properties elicit well-being in the users? How do we interact with technology when it is a pleasant experience vs. when it is an unpleasant experience? Are there individual differences in the mode of interaction during a pleasant or unpleasant experience with technology? What are the contributing variables involved in why some people love their work, while others do not? What is the relationship between individual differences (e.g., personality trait) and impact bias? What is the effect of impact bias on human-technology interaction and consumerism? How does repeated exposure to technology affect the occurrence of flow, mode of interaction, and needs of the users when the technology is disliked and/or unpleasant to use? What are the important contributing variables in what makes systems and/or technology disliked and/or unpleasant to interaction with or use? Future research in Hedonomics should also focus on developing better measures of flow, experience, interaction modes, pleasure, happiness, and user needs. Also, methods for designing for pleasure and well-being need to be developed.

# Practical Guidelines and Principles for Hedonomics

- Designers should focus on not just designing for pleasure, per se, but on the well-being of the users.

- Designers should focus on individual differences among users and how it is related to their different preferences toward the technology of interest.

- When using the method of 'Personas' to design, base the persona, not on an imagined person, but on an actual person whom fits the user profile. Interview, observe, and survey this person and use the data to inform in design decisions.

- Designers should use data from Kansei Engineering to inform them on how different product properties elicit certain feelings in the users.

- During the 'collection of Kansei words' stage of the Kansei engineering method, designers should collect the descriptors only from users that fit the user profile, in order to better gage the needs of the users.

- Also during to the 'collection of Kansei words,' designers should specifically survey the profile users by asking them to provide descriptors on what their needs are for the product and using these as kansei words.

- When using the method Kansei Engineering, descriptors could be collected that describe only certain aspects of the product properties in order to better connect the user's feelings with product properties.

- Designers should learn to empathize with the users. Familiarize yourself with the important tasks that the technology is suppose to be designed for. Find a participant whom fits

the user profile and observe their interaction with the technology. Ask what you can do to make their interaction more pleasant. If you were them what would you want done?

• To design for more fragile needs of the user, ask participants whom fit the user profile: What are the things you need from this technology in order for you to (1) enjoy using it? (2) be happy with it? and (3) continue using it?

• Principles of aesthetic longevity and customization should be incorporated into design to mitigate the habituation effect on flow with repeated technology-exposure.

• The principle of *Seamless Interaction* should be used in Hedonomics. It is a principle that enables users to interact optimally with the tool at hand. The tool in itself becomes an unconscious extension of the user eliciting the experience of 'flow' (Cziksentmihalyi, 1997) which is a highly pleasurable experience.

• The principle of *Individuation* should be used in Hedonomics. It is an individual-centered ethic which emphasizes idiosyncratic rather than nomothetic design.

• In order make Hedonomics a reality in industry and the workplace, Hedonomic specialists must demonstrated numerically that by incorporating these guidelines and principles at the earliest stages of system design and sustaining them throughout system development will not only ensure pleasurable human-system experience and well-being for the workers but will ensure superior financial returns for the companies.

# APPENDIX A : DEMOGRAPHICS

Name: _____

Age: _____

Can you separate between red and green

      [ ] Yes

      [ ]No

 Marital status

[ ] Single

[ ] Married

[ ] Divorced

Do you use computers as tools in your work?

[ ] Yes

[ ] No

      If yes, do you use Word or similar word programs

[ ] Yes

[ ] No

How many hours a week do you spend playing computer or consol games?

| 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 |
|---|---|----|----|----|----|----|----|----|
|   |   |    |    |    |    |    |    |    |

Which types of games do you usually play?

_____ first person games ( Delta Force, Spec Ops, Counter-Strike)

_____ Strategie games (Age of Empire, SimCity, Civilization)

_____ other games (Tetris, Fifa, bilspel)

Do you use chat programs such as MSN…

[ ] Yes

[ ] No

Specify which games you use and estimate how many hours a week you use it

_____

| 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 |
|---|---|----|----|----|----|----|----|----|
|   |   |    |    |    |    |    |    |    |

_____

| 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 |
|---|---|----|----|----|----|----|----|----|
|   |   |    |    |    |    |    |    |    |

| 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 |
|---|---|----|----|----|----|----|----|----|
|   |   |    |    |    |    |    |    |    |

**Thank you!**

# APPENDIX B : NEO FFI

This questionnaire contains 60 statements. Read each statement carefully. For each statement, respond by circling the response that best represents your opinion.

Circle the 'SD' if you *strongly disagree* or the statement is definitely false.

Circle the 'D' if you *disagree* or the statement is mostly false.

Circle the 'N' if you are *neutral* on the statement, if you cannot decide, or if the statement is about equally true and false.

Circle the 'A' if you *agree* or the statement is mostly true.

Circle the 'SA' if you *strongly agree* or the statement is definitely true.

For example, if you strongly disagree or believe that a statement is definitely false, you would circle 'SD' for that statement.

Circle only one response for each statement. Respond to all of the statements, making sure that you circle the correct response.

Please do NOT put your name or any identifying information anywhere on this questionnaire.

1.	I am not a worrier.

	SD	D	N	A	SA


2.	I like to have a lot of people around me.

	SD	D	N	A	SA


3.	I don't like to waste my time daydreaming.

	SD	D	N	A	SA


4.	I try to be courteous to everyone I meet.

	SD	D	N	A	SA


5.	I keep my belongings neat and clean.

	SD	D	N	A	SA


6.	I often feel inferior to others.

	SD	D	N	A	SA


7.	I laugh easily.

SD          D          N          A          SA

8.      Once I find the right way to do something, I stick to it.

SD          D          N          A          SA

9.      I often get into arguments with my family and coworkers.

SD          D          N          A          SA

10.     I'm pretty good about pacing myself so as to get things done on time.

SD          D          N          A          SA

11.     When I'm under a great deal of stress, sometimes I feel like I'm going to pieces.

SD          D          N          A          SA

12.     I don't consider myself especially "light-hearted."

SD          D          N          A          SA

13.     I am intrigued by the patterns I find in art and nature.

SD          D          N          A          SA

14.     Some people think I'm selfish and egotistical.

SD          D          N          A          SA

15.   I am not a very methodical person.

SD          D          N          A          SA

16.   I rarely feel alone or blue.

SD          D          N          A          SA

17.   I really enjoy talking to people.

SD          D          N          A          SA

18.   I believe letting students hear controversial speakers can only confuse and mislead them.

SD          D          N          A          SA

19.   I would rather cooperate with others than compete with them.

SD          D          N          A          SA

20.   I try to perform all the tasks assigned to me conscientiously.

SD          D          N          A          SA

21.   I often feel tense and jittery.

SD          D              N              A              SA

22.     I like to be where the action is.

SD          D              N              A              SA

23.     Poetry has little or no effect on me.

SD          D              N              A              SA

24.     I tend to be cynical and skeptical of others' intentions.

SD          D              N              A              SA

25.     I have a clear set of goals and work toward them in an orderly fashion.

SD          D              N              A              SA

26.     Sometimes I feel completely worthless.

SD          D              N              A              SA

27.     I usually prefer to do things alone.

SD          D              N              A              SA

28.     I often try new and foreign foods.

SD          D          N          A          SA

29.     I believe that most people will take advantage of you if you let them.

SD          D          N          A          SA

30.     I waste a lot of time before settling down to work.

SD          D          N          A          SA

31.     I rarely feel fearful or anxious.

SD          D          N          A          SA

32.     I often feel as if I'm bursting with energy.

SD          D          N          A          SA

33.     I seldom notice the moods or feelings that different environments produce.

SD          D          N          A          SA

34.     Most people I know like me.

SD          D          N          A          SA

35.     I work hard to accomplish my goals.

        SD          D           N           A           SA

36.     I often get angry at the way people treat me.

        SD          D           N           A           SA

37.     I am a cheerful, high-spirited person.

        SD          D           N           A           SA

38.     I believe we should look to our religious authorities for decisions on moral issues.

        SD          D           N           A           SA

39.     Some people think of me as cold and calculating.

        SD          D           N           A           SA

40.     When I make a commitment, I can always be counted on to follow through.

        SD          D           N           A           SA

41.     Too often, when things go wrong, I get discouraged and feel like giving up.

        SD          D           N           A           SA

42. I am not a cheerful optimist.

SD          D                N                A                SA

43. Sometimes when I am reading poetry or looking at a work of art, I feel a chill or wave of excitement.

SD          D                N                A                SA

44. I'm hard-headed and tough-minded in my attitudes.

SD          D                N                A                SA

45. Sometimes I'm not as dependable or reliable as I should be.

SD          D                N                A                SA

46. I am seldom sad or depressed.

SD          D                N                A                SA

47. My life is fast-paced.

SD          D                N                A                SA

48. I have little interest in speculating on the nature of the universe or the human condition.

SD        D            N            A            SA

49.    I generally try to be thoughtful and considerate.

SD        D            N            A            SA

50.    I am a productive person who always gets the job done.

SD        D            N            A            SA

51.    I often feel helpless and want someone else to solve my problems.

SD        D            N            A            SA

52.    I am a very active person.

SD        D            N            A            SA

53.    I have a lot of intellectual curiosity.

SD        D            N            A            SA

54.    If I don't like people, I let them know it.

SD        D            N            A            SA

55.    I never seem to be able to get organized.

SD          D          N          A          SA

56.     At times I have been so ashamed I just wanted to hide.

SD          D          N          A          SA

57.     I would rather go my own way than be a leader of others.

SD          D          N          A          SA

58.     I often enjoy playing with theories or abstract ideas.

SD          D          N          A          SA

59.     If necessary, I am willing to manipulate people to get what I want.

SD          D          N          A          SA

60.     I strive for excellence in everything I do.

SD          D          N          A          SA

# APPENDIX C : FLOW STATE SCALE, HUMAN NEED QUESTIONNAIRE, WEB STATE SCALE

**FLOW**

Please answer the following questions in relation to your experience in the event you have just completed. These questions relate to the thoughts and feelings you may have experienced during the event. There are no right or wrong answers. Think about how you felt during the event and answer the questions using the rating scale below. Circle the number that best matches your experience from the options to the right of each question.

Rating Scale:

| Strongly Disagree | Disagree | Somewhat Disagree | Neither Agree nor Disagree | Somewhat Agree | Agree | Strongly Agree |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. My attention was focused entirely on what I was doing. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 2. I was not concerned with what others may have been thinking of me. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 3. Time seemed to alter (either slowed down or speeded up). | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 4. My abilities matched the high challenge of the situation. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 5. Things just seemed to be happening automatically. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 6. I was aware of how well I was performing. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 7. The way time passed seemed to be different from normal. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8. I loved the feeling of that performance and want to capture it again. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 9. I performed automatically. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 10. I knew what I wanted to achieve. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 11. I had a good idea while I was performing about how well I | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

was doing.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 12. I had total concentration. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 13. I had a feeling of total control. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 14. I was not concerned with how I was presenting myself. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 15. It felt like time stopped while I was performing | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 16. The experience left me feeling great. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 17. The challenge and my skills were at an equally high level. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 18. I did things spontaneously and automatically without having to think. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 19. I was completely focused on the task at hand. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 20. I felt in total control of my body. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 21. I found the experience extremely rewarding. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 22. I was not worried about what others may have been thinking of me. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 23. I was challenged, but I believed my skills would allow me to meet the challenge. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 24. I made the correct movements without thinking about trying to do so. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 25. I knew clearly what I wanted to do. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 26. It was really clear to me that I was doing well. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 27. I really enjoyed the experience. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 28. I had a strong sense of what I wanted to do. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 29. It was no effort to keep my mind on what was happening. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 30. I felt like I could control what I was doing. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 31. I was not worried about my performance during the event. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

32. I felt I was competent enough to meet the high demands    1    2    3    4    5    6    7

of the situation.

33. I had a good idea while I was performing about how well    1    2    3    4    5    6    7

was doing.

34. At times, it almost seemed like things were happening in    1    2    3    4    5    6    7

slow motion.

35. My goals were clearly defined.    1    2    3    4    5    6    7

36. My attention was focused entirely on what I was doing.    1    2    3    4    5    6    7

## Human Need Questionnaire (Harbaugh, 1970):

### Questions were adopted from and modified for this study.

1. I feel safe from the game causing any harm to me. (**Need to**    1    2    3    4    5    6    7
**Trust)**

2. I can do the operations that I need to do to achieve my    1    2    3    4    5    6    7

goals. (**Need to Achieve)**

3. Interacting with the game is easy and natural. (**Need to**    1    2    3    4    5    6    7
**Control)**

4. It is enjoyable for me to use the game. (**Need to Enjoy)**    1    2    3    4    5    6    7

5. I need to feel like the game helps me to realize my own    1    2    3    4    5    6    7
potential. (**Need to Grow)**

6. I need to feel that I am safe from it causing me any    1    2    3    4    5    6    7
psychological or physical harm. (**Need to Trust)**

7. I need to know that the game can perform the operations    1    2    3    4    5    6    7

that I need it to perform. (**Need to Achieve)**

8. I need to enjoy using this game. (**Need to Enjoy)**    1    2    3    4    5    6    7

9. I need to be able to use this game easily. (**Need to Control)**    1    2    3    4    5    6    7

10. When playing, I need to feel like I am developing my    1    2    3    4    5    6    7

abilities. **(Need to Grow)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 11. When playing, I need it to facilitate my ability to perform to my fullest potential. **(Need to Grow)** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 12. I need to perform operations and tasks efficiently and effectively. **(Need to Control)** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 13. I need to trust that the game will behave in the manner I expect it to behave. **(Need to Trust)** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 14. I need to like playing the game. **(Need to Enjoy)** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 15. I need the game to function in a manner the enables me to achieve my goals. **(Need to Achieve)** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

### Web State Survey (Novak and Hoffman, 1997)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. When playing, I feel like I forget about my immediate surroundings. **(Seamless Mode)** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 2. When playing, I feel like I am more in the "the game" world then the "real world." **(Seamless Mode)** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 3. When playing, I experimented with new commands. **(Exploratory Mode)** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 4. I did not play much I just wanted to try to work the equipment **(Goal Mode)** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 5. When playing, I usually had a specific goal in mind**. (Goal Mode)** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 6. When playing, I usually explored without a specific goal in mind. **(Exploratory Mode)** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 7. I felt like the controls became an extension of me for a moment during the game. **(Seamless Mode)** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8. I liked to explore the game to find hidden tricks. **(Exploration mode)** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 9. I had one goal, to get to the other side that was my only focus. **(Goal Mode)** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

# APPENDIX D : C3FIRE INTERFACE

**Manager**

File  Edit  Window  Help

Session Control

Session Number = 87

Time
00:00:00

Session Control
Start  Pause  Stop

Roles

| Player A (A) | Free |
| Player B (B) | Free |

Unit Info

| ID | Pos | GoTo | Activity | Water | Fuel |
|----|-----|------|----------|-------|------|
| F1 | O, 15 | | Undefined | 20 | 20 |
| F2 | O, 20 | | Undefined | 20 | 10 |
| F3 | T, 15 | | Undefined | 0 | 20 |
| F4 | J, 15 | | Undefined | 20 | 20 |
| F5 | O, 10 | | Undefined | 20 | 20 |
| F6 | R, 18 | | Undefined | 20 | 5 |
| W7 | B, 14 | | Undefined | 100 | 10 |
| W8 | S, 2 | | Undefined | 100 | 20 |
| W9 | L, 12 | | Undefined | 100 | 0 |
| G10 | W, 6 | | Undefined | 0 | 10 |
| G11 | J, 16 | | Undefined | 0 | 100 |
| G12 | L, 14 | | Undefined | 0 | 50 |

Unit Property

| Property | Value |
|----------|-------|
| ID | G12 |
| Type | Fuel Truck |
| Moving Time | 5 |
| Fuel Tank Size | 100 |
| Fuel Level Count Down Speed | 0.2 |
| Fuel Refill Time | 5.0 |

Pointer Position
x, y = X 10

Unit Palette
Position
Intention

| 1 | 1 | F1 |
| 2 | 2 | F2 |
| 3 | 3 | F3 |
| 4 | 4 | F4 |
| 5 | 5 | F5 |
| 6 | 6 | F6 |
| 7 | 7 | W7 |
| 8 | 8 | W8 |
| 9 | 9 | W9 |
| 10 | 10 | G10 |
| 11 | 11 | G11 |
| 12 | 12 | G12 |

Object Palette

Normal
Swamp
Pine
Birch
House
School
Water
Fuel

Fire Palette

Clear
Fire
ClosedOut
BurnedOut

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# APPENDIX E : INSTRUCTIONS TO SUBJECTS

Please read along as we read these instructions aloud.  If you have questions, please feel free to ask them at any time.

In this study, you will be working with three other participants.  The four of you are a team.

Your team consists of four players with the names A, B, C and D.  You may organize your team in any way you choose.

## Task

Your team will be playing a computer-generated game in which a forest fire is burning.  As shown in Figure 1, on the back of the handout, the simulated fire threatens forests, schools, and houses, and the lives of children in the schools and people in the houses.

Your team communicates by e-mail.  The e-mail system is the only way you can communicate during the games.

The game begins when a fire is spotted somewhere on the map.  Your team's goals are (1) to put the fire out, (2) to save as many schools and houses as possible, (3) to rescue as many people as possible, and (4) to save as much terrain as possible.

## The Interface

Look at your video monitor.  In the center is a map.  The map legend is along the right-hand edge.  There is a clock above the map.  The e-mail tool and the truck status panels occupy the left side of the display.  Every member of your team has access to an identical interface and identical information.  All information is accurate.

## Map

The map is a 40 x 40 matrix.  Each cell in the matrix is uniquely identified by a letter (indicating its column) and a number (indicating its row).  The fire will eventually burn the entire world if

your team does not respond adequately. The spreading speed and the spreading direction of the fire depend on two factors: the type of vegetation, and the activities of the fire trucks you command.

## Vegetation

There are four types of vegetation in the world that burn at different rates:

Normal vegetation.

Pine trees burn three times faster than normal vegetation.

Birch trees burn at half the rate of normal vegetation.

Swamp does not burn at all.

## Trucks

There are three types of trucks: fire trucks, water trucks, and fuel trucks. All trucks will do exactly what your team commands them to do if they have the resources available to do so. They will do only what your team commands them to do. For example, if your team does not tell them to go fight the fire, they will not go fight the fire. Your team is responsible for directing how the trucks save the world.

The map uses numbers in different colors to identify the trucks, their current positions, and where the team has told them to go.

Fire truck - used to fight the fire. A fire truck's current location is shown by the number of the truck in red. Fire trucks use water to fight the fire and use fuel to drive around. Fire trucks can run out of both water and fuel.

A fire truck that arrives and stops on top of a burning cell will automatically start to fight the fire as soon as it arrives if it has any water. A fire truck that is standing on a

non-burning cell that starts to burn will automatically start to fight the fire if it has any water.

Putting two fire trucks on the same burning cell will <u>not</u> put the fire out faster.

**7** Water truck - used to transport water to fire trucks. A water truck's current location is shown by the number of the truck in <u>blue</u>. Water trucks can't fight fires but they can run out of water. Their large water tanks can be refilled only at water tank stations. Water trucks can run out of fuel. They can be refueled by fuel trucks and at fuel tank stations.

**12** Fuel truck - used to transport fuel to other trucks. A fuel truck's current location is shown by the number of the truck in <u>yellow</u>. Fuel trucks can run out of fuel. They can be refueled at fuel tank stations and by other fuel trucks.

**11** You give orders to a truck by moving its red/blue/yellow number to the cell where you want the truck to go. Drag-and-drop the red/blue/yellow number to the location where you want the truck to go. The number of the truck will appear in that cell in <u>white</u>.

A fire, water, or fuel truck will have its number indicated on the map twice when it's given an order to move: The colored (red/blue/yellow) number indicates its current position. The white number indicates where it is going.

If the white number disappears immediately after you have placed it on a cell, the truck has run out of fuel.

The speed of all vehicles is independent of the vegetation or objects on the map.

<div align="center">Objects</div>

The map contains four types of objects.

<div align="center">150</div>

♠ House. Important to protect. May contain people to be saved. Houses burn as fast as normal vegetation.

▦ School. Important to protect. May contain children to be saved. Schools burn as fast as normal vegetation.

🔵 Water tank station. Contains an unlimited amount of water. Water trucks <u>and</u> fire trucks can get water here. Not affected by fire.

A fire truck or water truck that occupies a cell sharing an edge with a cell containing a water refilling station (e.g., <u>in only 4 directions</u>, N, E, S, W) will automatically start to refill itself with water. Refilling will <u>not</u> happen when the truck stands 'on top of' or diagonal to the station!

🟡 Fuel tank station. Contains an unlimited amount of fuel. Fuel trucks, water trucks, <u>and</u> fire trucks can get fuel here. Not affected by fire.

A fire truck, water truck, or fuel truck that occupies a cell sharing an edge with a cell containing a fuel refilling station (e.g., <u>in only 4 directions</u>, N, E, S, W) will automatically start to refill itself with fuel. Refueling will <u>not</u> happen when the truck stands 'on top of' or diagonal to the station!

<div align="center">Fire</div>

Each cell in the map can be in one of four states: normal, burning, no longer burning, or burned-out. The map shows the status of the fire.

🟥 Burning

🟫 No longer burning

⬛ Burned-out

A fire in one cell can spread to all 8 surrounding cells. A normal cell can catch fire from an adjacent burning cell. The likelihood that a normal cell will catch fire increases with the number of adjacent burning cells and the time those cells have been burning. Cells that are no-longer burning or burned-out can't start to burn again.

Any Questions?

INDIVIDUAL PRACTICE SESSION 1

Truck information panels

In the truck information panel you can see the status of all trucks in the world. You can see many types of information:

- o ID: Truck type and number: F means Fire truck. W means water truck. G means fuel (Gas) truck. The number is the number the truck has on the map. So, F1 means Fire truck with number 1, W8 means Water truck with number 8, etc.
- o Pos: Current position of the truck, a coordinate on the map.
- o GoTo: The destination that the truck is driving towards, a coordinate on the map.
- o Activity: The truck's current activity.
- o Water: The current water level of the truck. (Note: fuel trucks, e.g., G10, carry no water.)
- o Fuel: The current fuel level of the truck.

If you click on a line with truck information in the Truck Status panel, you will get detailed information about that truck in the panel directly below. In this Truck Properties panel you can see information about the rate at which the truck works including moving time, tank size, and refill time.

E-mail

With the E-mail tool you can read and send information to one or more of your team members. Sending a note by e-mail is the only way to share information with members of your team. The e-mail system has two parts.  The upper window is the reader where you receive and can read e-mail from your team members.  The lower window is the editor where you write and send e-mail to your team members.

To create an e-mail, type your message in the editor window.  To send your message to a specific team member, click the button with the letter representing his player name.  Figure 2 shows the interface for player A, so clicking buttons B through D will send your e-mail to players B, C, and D, respectively.  You can also send a message to all members of your team by clicking the button labeled All.

When you receive an e-mail from a team member or the emergency alarm center, two things happen.  (1) the number at the top right-hand corner of the viewer window changes.  The number indicates how many e-mails you have received but not read.  (2) The 'Next' button lights up. You don't get any other notification, so keep an eye on the viewer window to see if you have unread e-mails.

The text of the e-mail does not turn up by itself.  Click the 'Next' button once to open and read incoming the e-mail.

It is important that you know that old e-mails can <u>not</u> be viewed again.  They are deleted when you view the next e-mail.  If you have received many e-mails, you have to click through all of them to get to the most recent e-mail.

<center>Summary of truck information</center>

- o   all trucks drive equally fast (5 seconds for one square),
- o   all fire trucks take 10 seconds to extinguish the fire in one square,

<center>153</center>

- water trucks have a larger water tank than fire trucks,
- refilling a water truck with water takes longer than refilling a fire truck with water,
- the fire trucks' water level counts down one unit per second during fire-fighting,
- fuel trucks have a larger fuel tank than fire and water trucks,
- refueling takes the same time for all trucks, and
- every truck consumes 0.2 units of fuel per second when moving.

| Truck ID | Type | Truck Moving Time | Fire Fighting Time | Water Refill Time | Water Tank Size | Water Count down | Fuel Refill Time | Fuel Tank Size | Fuel Count down |
|---|---|---|---|---|---|---|---|---|---|
| 1-6 | Fire truck | 5 | 10 | 5 | 40 | 1 | 5 | 20 | 0.2 |
| 7-9 | Water truck | 5 | | 10 | 100 | | 5 | 20 | 0.2 |
| 10-12 | Fuel truck | 5 | | | | | 5 | 100 | 0.2 |

Any Questions?

# APPENDIX F: WORDS COLLECTED FROM KANSEI ENGINGEERING METHOD

Cool

Exciting

Fun

Entertaining

Thrilling

Chaotic

Old School

Classic

Hilarious

Hot

Awesome

Shooter

First-person

Breathtaking

Gorgeous

Graphic

Game life

Innovative

Original

Novel

Challenging

Demanding

Takes true skill

Difficult

Engaging

Hobby-forming

Absorbing

Involving

Committing

Intriguing

Adicitive

Compelling

Violent

Bloody

Gory

Control

Micro-management

Linearity

Expansive

Story

Adventurous

Social interaction

Commpetitive

Cooperative

Strategic

Immersive

Presence

Emotive

Balance

Exploitability

Depth

Complex

Detailed

Replay Value

Character Growth/Development

Intuitive

Tight Controls

Responsive

Rejuvenate

Revitalize

# APPENDIX G: IRB APPROVAL FORM

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