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A Person-Artifact-Task (PAT) Model of Flow Antecedents in Computer-Mediated Environments

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Abstract

Flow theory has been applied to computer-mediated environments to study positive user experiences such as increased exploratory behavior, communication, learning, positive affect, and computer use. However, a review of the existing flow studies in computer-mediated environments in Psychology, Consumer Behavior, Communications, Human-Computer Interaction, and Management Information Systems shows ambiguities in the conceptualization of flow constructs and inconsistency in the flow models. It thus raises the question of whether the direct adoption of traditional flow theory is appropriate without a careful re-conceptualization to consider the uniqueness of the computer-mediated environments. This paper focuses on flow antecedents and identifies the importance of separating the task from the artifact within a computer-mediated environment. It proposes a component-based model that consists of person (P), artifact (A), and task (T), as well as the interactions of these components. The model, named the PAT model, is developed by understanding the original flow theory, reviewing existing empirical flow studies within computer-mediated environments, and analyzing the characteristics of computer-mediated environments. A set of propositions is constructed to demonstrate the predictive power of the model.

Keywords: flow theory, flow antecedents, computer-mediated environment (CME), perceived ease of use (PEOU), computer playfulness, Person Artifact Task (PAT) model, affect

1. INTRODUCTION

Csikszentmihalyi eloquently depicts the holistic experience of flow in his books (Csikszentmihalyi, 1975; Csikszentmihalyi, 1988; Csikszentmihalyi, 1990). Flow, the term derived from his respondents' words, is the state that occurs when an individual is partaking in an activity for its own sake; the state is so satisfying that individuals want to repeat the activity continually (Csikszentmihalyi, 1988). Once described, the flow experience is easily recognizable to avid rock climbers, composers, and even Web surfers. Over the last decade, flow theory has been borrowed from psychology to address positive user experiences with personal computers (Ghani, 1991; Ghani & Deshpande, 1994; Ghani, Supnick, & Rooney, 1991; Trevino & Webster, 1992; Webster, Trevino, & Ryan, 1993), and more recently, the WWW (Chen, 2000; Chen, Wigand, & Nilan, 1999; Hoffman & Novak, 1996; Nel, Niekerk, Berthon, & Davies, 1999; Novak, Hoffman, & Yung, 2000). Within a computer-mediated environment (CME), the experience of flow has been shown to lead to increased exploratory behavior (Ghani, 1991; Ghani & Deshpande, 1994; Webster et al., 1993), communication (Trevino & Webster, 1992), learning (Ghani, 1991), positive affect (Chen, 2000; Trevino & Webster, 1992), satisfaction and acceptance of information technology (Ghani, 1991), and computer use (Ghani & Deshpande, 1994; Trevino & Webster, 1992; Webster et al., 1993). Computer-mediated environments that are conducive to flow will yield positive attitudes and outcomes for users, and have broad implications for e-commerce (Hoffman & Novak, 1996) and learning (Guru, 2001).

The practical implications of flow experiences in computer-mediated environments are clear. On the theoretical side, researchers have adopted the traditional flow conceptualization for most of the empirical work of flow in computer-mediated environments. However, we argue that computer-mediated environments (CMEs) present a unique context and add a level of complexity to a person's activity. Flow theory should be carefully re-assessed before directly adopting it. An unclear conceptualization of flow within CMEs will result in haphazard research studies. The inconsistent flow models, different uses of constructs, and ambiguous operationalizations of flow dimensions found in the literature (Finneran & Zhang, 2002) may be a result of an inappropriate underlying conceptualization of flow. With an ambiguous conceptualization, it is difficult to distinguish the aspect of the activity that leads to flow within a computer-mediated environment.

The objective of this paper is to re-conceptualize flow theory for CMEs. Literature has shown that flow does occur in many situations in CMEs. The study of flow antecedents is important in illustrating what might contribute to the optimal experience and thus whether and how to incorporate these factors in Human-Computer Interaction design of CMEs. Thus in this paper, we will not focus on the precise moments of the flow experience itself, but will focus on the flow antecedents, that is, the factors that contribute to flow experience. The result of our re-conceptualization is a component-based model that consists of person (P), artifact (A), and task (T), and the interactions of these components. The model, named the PAT model, is developed by understanding the original flow theory, reviewing existing empirical flow studies, and analyzing the characteristics of CMEs.

Our first contribution is a review of the flow study literature leading to the development of the PAT model. The model functions as a conceptual framework capable of generating propositions on factors influencing flow experience. Similar to the model of organizational communication (Te'eni, 2001), our model is an attempt both to assemble past research and to propose a new understanding of flow antecedents. Flow studies have been conducted in different disciplines, including Psychology (Clarke & Haworth, 1994; Csikszentmihalyi, 1975; Csikszentmihalyi & Csikszentmihalyi, 1988; Haworth & Evans, 1995; McQuillan & Conde, 1996), Consumer Behavior (Griffith, 2001; Novak, 2000; Novak, in press; Nel, 1999), Communications (Chen, 2000, Chen et al., 1999), Human-Computer Interaction (Ghani, 1991; Ghani & Deshpande, 1994; Ghani et al., 1991), and Management Information Systems (Trevino & Webster, 1992; Webster et al., 1993). Our model addresses the shared concerns these studies all have that are fundamental to support human computer interaction, and brings together these perspectives from different sources so as to provide a wider reference for future research. The model also reveals elements of the flow phenomenon that can refine previous findings and help stimulate new work.

The second contribution of our work is the model’s value in informing design. Our model carefully distinguishes the effect of different components and the interactions of these components on the flow experience. The result is a more complex but thorough description of the flow antecedents. Although the model is developed for CMEs, that is, artifact refers to information technology or computers used as vehicles to complete a task, it is general enough to address any environment with an artifact, such as a violinist using an instrument. Depending on the type of artifact, designers could emphasize different components of the flow antecedents for the design to increase the positive user experience with the artifact.

2. THE FLOW THEORY

Flow, the "holistic sensation that people feel when they act with total involvement," (Csikszentmihalyi 1990) was first identified by Csikszentmihalyi when he studied chess players, rock climbers, and dancers (Csikszentmihalyi, 1975). These individuals spent much of their energy on activities that had no financial payback yet provided incredibly high enjoyment and satisfaction. According to Csikszentmihalyi (1988), a person experiencing flow, or achieving an optimal experience, will have clear goals, exercise control, lose their self-consciousness, and experience a distortion of time. An essential contributor toward a person's capacity to experience flow is his/her 'autotelic nature,' or intrinsic motivation. Autotelic, literally meaning self-goal, indicates that a person is focused on the process of the activity more than the end result or extrinsic rewards (Csikszentmihalyi, 1988). The activity the person is involved in must be challenging and require skill, merge action and awareness, provide feedback, and require full concentration on the task at hand (Csikszentmihalyi, 1988). Csikszentmihalyi lists these factors that contribute to flow, however he does not intend them to serve as the exclusive factors of flow, but more as the most commonly exhibited ones.

The original flow activities, like rock climbing or chess playing (Csikszentmihalyi, 1988; Csikszentmihalyi, 1975), can be conceptualized so that the person is immersed in the activity. The activity could be master chess playing, music performing, or the more everyday flow experiences like reading (McQuillan & Conde, 1996). The same activity may not induce flow experience for everybody; and the same person does not experience flow with all possible activities. In these studies, the tools or artifacts that are required to accomplish the activities were not of particular importance or interest. For example, a rock climber may need to use a variety of tools to accomplish climbing. A musician needs to play an instrument in order to make music. These tools or artifacts were not taken into much consideration in studying flow because it is assumed that they are well mastered by the people who experience flow.

In computer-mediated environments, activity needs to be broken down into the task (main goal of the activity) and the artifact (tool for accomplishing the activity). The mastering of artifacts within CMEs cannot be taken for granted due to the complex and dynamic nature of the artifacts (computers). For example, *calculating travel expenses* with *a spreadsheet* is a much different activity than doing it with *pencil and paper*. When a person uses pencil and paper to calculate travel expenses, it is assumed that the person has no problem with using pencil and paper; thus, they are transparent or not noticed. This assumption does not necessarily hold when the person uses a spreadsheet. Depending on the person's experience with the spreadsheet, it can be transparent (a skillful user) thus the person focuses on calculating travel expenses, or cumbersome (a novice user) thus the person struggles with the spreadsheet and it interferes with his/her primary task of calculating travel expenses. In summary, an activity within a computer-mediated environment is a combination of the task (e.g. *calculating travel expenses*) and the artifact used to do the task (e.g. *spreadsheet*). The likelihood of an optimal experience is dependent on the interplay between the person, the task, and the artifact.

For empirical flow studies in computer-mediated environments, researchers have used the following three stages of flow as a framework: flow antecedents, flow experience, and flow consequences (Chen, 2000; Ghani, 1991; Ghani & Deshpande, 1994; Trevino & Webster, 1992), as depicted in Figure 1. These stages have been empirically validated by Chen (2000). Chen used factor analysis to demonstrate this structure of the flow dimensions or stages of flow. He found that the antecedents of flow were: clear goals, immediate feedback, potential control, and the merger of action and awareness. The flow experience itself was composed of: concentration, loss of self-consciousness, time distortion, and telepresence. Finally, the consequences of flow were: positive affect and an autotelic experience. Though some debate exists as to which factors belong in each stage of flow, the structure of Flow Antecedents, Flow Experience, Flow Consequences, (shown in Figure 1) is generally agreed upon.

This paper focuses on the flow antecedents' stage. A better understanding of the antecedents will first, enhance our understanding of what leads to flow and second, inform our design of systems so they can be more conducive to flow. A review of the flow literature indicates discrepancies among various flow models and some unclear conceptualization and operationalization among the constructs (Finneran & Zhang, 2002). Much confusion results from the ambiguity between the artifact and the task. This leads us to develop a new model that re-conceptualizes the flow theory to account for the new environment. Our new model of flow antecedents, the Person Artifact Task model, is shown in Figure 1.

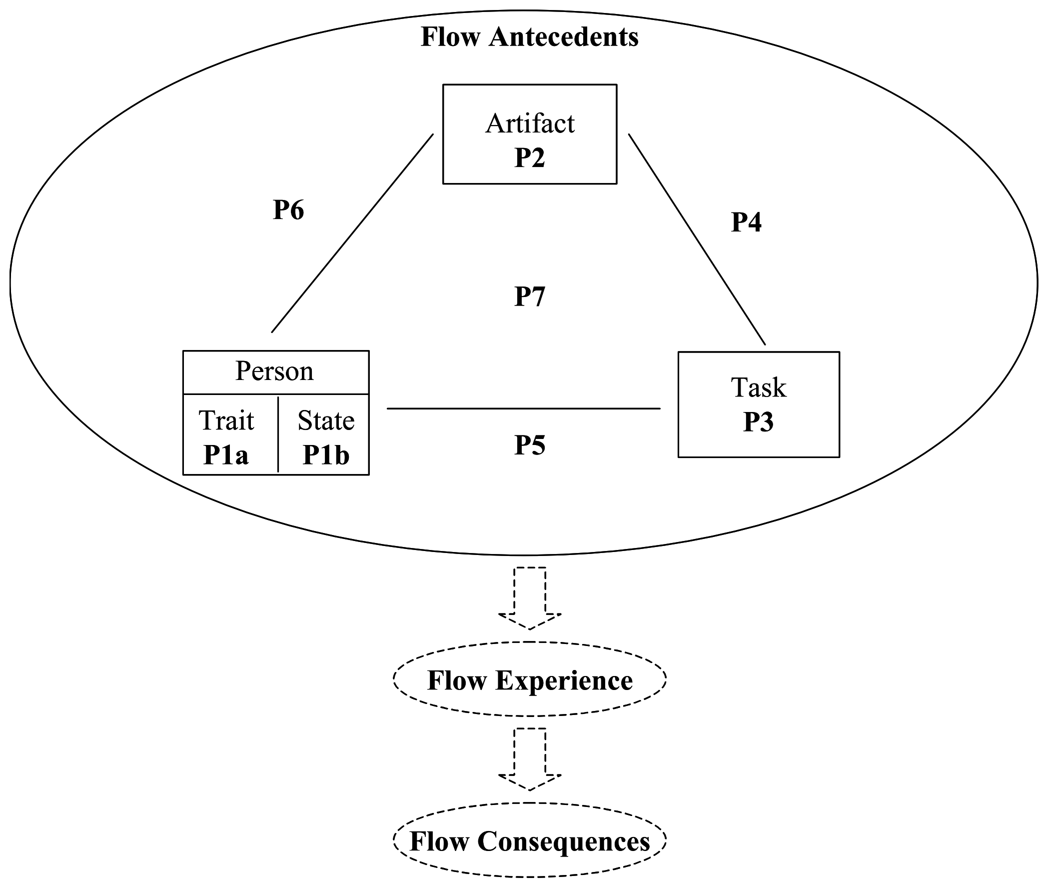

Figure 1. Stages of Flow and The Person-Artifact-Task Model of Flow Antecedents

3. A PROPOSED MODEL OF FLOW ANTECEDENTS

The Person-Artifact-Task (PAT) model (Figure 2) is intended to conceptualize the major components of a person working on a computer related activity that can be influential to the flow experience the person may have. Our model addresses three distinct but interacting components that contribute to the flow experience: person, artifact, and task. In this section, we will briefly introduce each of these three components and the interactions between them. In Section Four, we will go into more detail by incorporating existing flow studies and developing propositions.

3.1. Person

Csikszentmihalyi (Csikszentmihalyi, 1975) spends a good deal of time studying the individual aspects of flow, yet operationalizing concepts like 'autotelic' are difficult. We believe that breaking up the personal characteristics into trait and state (Woszczynski, Roth, & Segars, 2002) will help clarify the relevant constructs for flow studies. The trait attributes are the personality ones that are effectively unchanging. Some people tend to be more likely to experience flow than others. The state attributes are dynamic; they represent the mood of the user and will vary depending on the particular situation. The same person who feels challenged and captivated by searching for information on the Web and experiences flow frequently in such a situation, may have experiences where s/he feels either bored or anxious by a search and will not experience flow.

3.2. Artifact

Though we are primarily concerned with computer-mediated environments (CMEs), our model is broad enough to cover any activity that involves an artifact such as a book, a carabiner, or software application. We chose the broad term, *artifact*, as it was more of a neutral term than *tool* or *toy*. Tools denote "systems used for external sake (Malone, 1981)," while toys denote "systems used for own sake (Malone, 1981)." According to Csikszentmihalyi's (1990) theory, a flow experience would be more typical when a user was interacting with a toy. However, studies have shown that users experience flow while using tools like spreadsheets and word processors

(Ghani, 1991; Webster et al., 1993). We suspect that users experience flow when they may be using these tools, yet having the attitude that they are toys, that the task they are doing is enjoyable unto itself. Artifact can represent either a tool or a toy.

With CMEs, the artifacts are not as simple to operate and usually are not completely within the user's control. Thus an artifact plays a more prominent role in the entire experience because the likelihood of its presence being noticed by the person is much higher and secondly, the characteristics of the artifact itself may influence the likelihood of an optimal experience.

3.3. Task

To date, few flow studies for computer-mediated environments have differentiated between the task and artifact. For example, a survey of user's flow experiences while using the WWW (Chen et al., 1999) found that 17% of them occurred while the user was reading and writing correspondences. Using the PAT model, we argue that the WWW, or more specifically the email application, is the artifact and the task is reading or writing a message. Both the email application and the task of writing a message may be contributing to a person's experience of flow. We need to disambiguate the task from the artifact in order to understand better what aspects of the task enhances flow.

Most of the CME flow studies focus on the artifact and de-emphasize task. Interestingly, the traditional flow studies' primarily emphasized the task of the activity, though they did not differentiate explicitly between task and artifact. We believe that the primary goal of studying flow is to enhance an individual's experience, which is intimately connected with his/her task at hand. Task is an important component; through partaking in tasks, people experience flow.

3.4. The Task-Artifact Interaction

The interaction between the task and the artifact can be conducive to a flow experience if there is a fit. Cognitive fit (Vessey, 1991) has been used in the Information Systems literature to refer to a fit between data representation and the specific task, while Task-Technology Fit (Goodhue &

Thompson, 1995) looks at the matching of the capabilities of the technology to the demands of a task. The Artifact-Task fit in the PAT model is in agreement in principle with both the cognitive fit and the task-technology fit. We would all probably agree that the artifact of Adobe Pagemaker has a higher fit to the task of creating a lengthy newsletter than Microsoft Power Point does.

3.5. The Person-Task Interaction

Many of the factors of flow from Csikszentmihalyi's work relate to the person's interaction with task. The clear goals that Csikszentmihalyi (1988) emphasizes are how clear the person perceives the task to be. The essential challenge/skill balance factor (Csikszentmihalyi, 1988) measures the person's perception of how challenging the task is and how skillful they are in such tasks. The person's sense of control, another important ingredient for flow according to Csikszentmihalyi (1988), is how much control they feel in completing the task. Finally, Csikszentmihalyi's (1988) criterion of immediate feedback implies feedback on task. This concept is the degree of continual feedback the person receives that s/he is successfully completing the task.

3.6. The Person-Artifact Interaction

The concepts that occur in the interaction between person and task appear in a different form in the interaction between the person and the artifact. Perceived Ease of Use (Davis, 1989; Venkatesh & Davis, 1996; Venkatesh & Davis, 2000) is essentially the person's perceived skills in relation to the challenges of the artifact. In most cases, the aim is to keep the artifact transparent, not to have it interfere with the person's focus on the task. Contrarily, in the interaction between person and task, the challenges and skills should be at the appropriate balance so that the person does not experience anxiety or boredom (Csikszentmihalyi, 1990). The interaction between the person and the artifact also involves clear artifact goals, which indicate that the person knows how to perform a specific action using the artifact. The sense of control indicates that the person feels that he/she is in control of the particular artifact.

3.7. The Person, Artifact, and Task Three-Way Interaction

We have been discussing the interaction effects of two of the three components. A three-way interaction between the Person-Artifact-Task can also influence the flow experience. An attribute of the task may demand that the person relate to the artifact in a particular way in order for flow to occur. For example, with complex tasks, it will become more critical that the user perceives the artifact as having a high level of ease of use for flow to occur. In these situations, specific aspects of the three components interact to create an environment conducive for an optimal experience.

4. PROPOSITIONS

One value of the model is to guide the development of propositions that can be further developed into measurable hypotheses. For discussion purposes, we will develop some propositions from the model by expanding on each of the components separately, holding a microscope up to that component while we assume the other components remain stagnant. Given that flow is a situated experience, we are not advocating experiments that will entail holding the other components constant. Rather for the sake of discussion, we merely focus on each component individually. We believe that flow is best studied as a holistic experience considering all of the components discussed below.

4.1. Person

Among the empirical work on flow within computer-mediated environments (CMEs) that we are aware of, only one of these considers the person component in its study. However, individual differences can yield very different flow experiences from the same activity. For example, a non-CME flow study compared models that incorporate individual personality difference with models that do not and found that individual difference accounts for as much as 20% of the variance (Ellis, Voelkl, & Morris, 1994). We have no evidence that these individual differences are less prominent for CMEs.

Csikszentmihalyi (1988) emphasizes that the difference between persons who typically reach optimal experiences is not merely based on their skills, but also in their underlying life attitude, or their ‘autotelic personality,’ traits.

A person’s traits do not vary much in their lifetime without an incredible amount of effort. One of the most fascinating aspects of flow comes from the fact that it is not the mere excitement of the task that yields flow. Readers can experience flow as much as football players. A person’s ‘autotelic nature’, or their appreciation of the process of the task itself, can cause flow to occur in mundane situations. No empirical work that we are aware of considers ‘autotelic nature’ and flow within computer-mediated environments. Hoffman & Novak (1996) attempted to address this omission by incorporating an individual’s optimum stimulation level (OSL) in their conceptual model. They hypothesized that individuals with higher OSLs are more likely to have the ‘autotelic personality’ trait. However, in their following empirical work, they dropped OSL from their study (Novak et al., 2000). We believe that stimulation is less important than intrinsic motivation. Csikszentmihalyi (1990) has shown that some persons can experience flow while partaking in tedious activities, thus, ‘autotelic personality’ is more connected to one’s ability to experience intrinsic enjoyment (Csikszentmihalyi, 1990; Hamilton, Haier, & Buchsbaum, 1984). An intrinsically motivated person participates in an activity for the enjoyment of the process rather than the reward of the end goal.

Exploratory behavior has been measured as an outcome of the flow experience (Ghani, 1991; Ghani & Deshpande, 1994; Novak et al., 2000; Webster et al., 1993). Increased exploratory behavior is an important and valuable consequence of the flow experience. However, an individual’s inherent exploratory behavior trait will influence his/her ability to reach an optimal experience. Particularly relevant to computer-mediated environments is the construct of Innovativeness in the Domain of Information Technology (PITT), which measures an individual’s willingness to try out new technologies (Agarwal & Prasad, 1998).

Similar to exploratory nature is an individual’s playfulness with a computer, or cognitive spontaneity (Webster, 1989). In his flow experiment, Ghani’s (1991) found a significant correlation between flow and his Cognitive Spontaneity scale, adapted from Webster’s. These scales measure an individual's inventiveness and flexibility when s/he is using computing technologies.

Previous work has reviewed and summarized the conceptual and measurement work on the Trait of Absorption (Agarwal & Karahanna, 2000). It is logical to think that an individual, who has been shown to become engrossed within an experience more easily, is more prone to experiencing flow, as concentration is a crucial element to the flow state.

The discussion above leads to the first proposition related to the Person component in the PAT model.

Proposition 1a:
Assuming all of the other components are the same, a person is more likely to experience flow if s/he has traits of an autotelic nature and high exploratory behavior, playfulness and absorption.

Similar to the trait of absorption is the person's state of absorption. Though no measurement scales have yet been established and validated for a state of absorption, researchers have been emphasizing the usefulness of the construct (Agarwal & Karahanna, 2000). The state of absorption takes into account the situational factors around the person and the given activity. One of the key influences on the state of absorption is hypothesized to be the person's trait of absorption (Agarwal & Karahanna, 2000). However, it is not only the trait that yields engagement, but also the particular situation.

In Ghani's (1991) study he essentially measured the state of absorption by measuring the concentration construct. The item on his scale was *found it difficult to concentrate*. A person's state, in how much they are able to concentrate or how absorbed they can become, makes a difference in their ability to reach an optimal state. In flow studies we are interested in this contextualized situation. Thus, the state of absorption is a critical factor in flow. It is important to note that if a person has a high *trait* of absorption, they have a higher chance of reaching a high *state* of absorption than a person who has a lower *trait* of absorption. These two factors are especially connected.

One of the characteristics of a flow experience is that the individual experiences a time distortion (Csikszentmihalyi, 1990). Many people may be familiar with such an experience when they put an engrossing book down, and realize they have been reading long past their usual bedtime. As time distortion is such an important element of the flow state, a person's proneness to time distortion in their current state will have an influence on the probability of achieving flow. For example, if a person has to make an important phone call at precisely eight o'clock, they will try not to become absorbed in something at quarter to eight. If in this situation, a person finds him or herself reading an absorbing magazine article, s/he will probably check the clock regularly to ensure that s/he has not experienced a time distortion. Such a situation would make it difficult for a person to experience flow. If a person's state enables them to experience time distortion, they will be more likely to have an optimal experience.

Another characteristic of flow experiences is the individual's loss of self-consciousness (Csikszentmihalyi, 1988). When a dancer is onstage, they are not thinking about how they look but about the current movement. Likewise, in a computer-mediated environment, such as in a synchronous chat discussion, the person will not be focusing on what others think of them, but on articulating their point effectively. Again, depending on the person's state, losing his/her self-consciousness may be easier or more difficult to achieve. For example, a person may feel self-conscious writing when someone is looking over his or her shoulder. Thus, he or she would be unlikely to reach an optimal state during that state of self-consciousness.

Considering all of these factors regarding a person's state, we come to the second proposition relating to Person in the PAT model.

Proposition 1b:
Assuming all of the other components are the same, a person is more likely to experience flow if his/her current state is conducive to absorption, time distortion, and loss of self-consciousness.

4.2. Artifact

In contrast to presence, telepresence is the, "experience of presence in an environment by means of a communication (Steuer, 1992)." In a computer-mediated environment, telepresence is an essential factor for enabling the person to remain concentrated on the computer-based task. If the person is not attending to the computer-mediated environment, his/her attention will be elsewhere, probably in his/her physical environment. Thus, s/he will not be able to fully focus on the tasks or content of the computer-mediated environment. Only with undivided attention does flow have the possibility of occurring.

When introducing the concept of telepresence, Steuer (1992) identifies vividness as contributing to a medium's degree of telepresence. Vividness represents the breadth, or the number of senses involved and the depth, or the degree of involvement. Hoffman & Novak's (1996) objective media characteristics of content (i.e. text, image, audio, video, experiential, or a combination of any of these) represent vividness. For example, a streaming video with audio of a news event has more vividness than hearing the news on the radio without a visual stimulus. The more vivid an artifact is, the more engaging it may become. Artifacts that are more vivid will be more conducive to flow.

Another important contributor to telepresence is the speed or responsiveness of the medium or artifact (Steuer, 1992). Hoffman & Novak (1996) refer to this factor as machine-interactivity. If the speed of an information system is tremendously slow, the user's attention is likely to be taken away from the computer-mediated environment, and they will again lose his/her concentration on the specific computer-based task. At speeds faster than the user can react, the effect on telepresence may be minimal or nil. However, up to a particular point, the more speed, the more likelihood that flow would occur.

Today's technology usually involves a trade-off between vividness and responsiveness. A Web cast itself may be vivid, however depending on the particular system and network, the responsiveness may be slow and then the user feels disconnected from the event and cannot experience telepresence. Vividness can enhance the feeling of telepresence, however without a reasonable responsiveness, telepresence can never occur.

This leads to the proposition related to the Artifact component in the PAT model.

Proposition 2:
Assuming all of the other components are the same, a person is more likely to experience flow if the artifact has certain characteristics leading to telepresence, such as vividness and responsiveness.

4.3. Task

The task is an essential aspect leading to an optimal experience, yet it has been taken for granted in some of the flow studies in CMEs. For example, Trevino & Webster (1992) study the use of e-mail and voice-mail in relation to flow characteristics. Computer-mediated communication tasks may be assumed by their context, however their survey does not consider what task the employee is undertaking when they use a particular technology. A 'communication task' is too generally defined to have much meaning within the situated experience (Chen et al., 1999) of flow. For an individual, e-mail may tend to yield flow with certain kinds of communication tasks, yet not others.

Many of the empirical studies on flow, like Trevino & Webster's, have not been task specific. Some earlier studies surveyed general behavior patterns. These general surveys have serious validity concerns because flow is a situated experience. Other studies are more valid because the researchers use a specific task to situate the user, however few of these researchers have looked specifically at the characteristics of tasks that influence flow. Studying task is not an easy venture, especially because even identifying task characteristics can be troublesome. More work is needed in building a task taxonomy for use in MIS and HCI research.

A significant challenge with tasks is that they can be at different abstract levels or granularities. For example, the task of asking a friend for a favor via e-mail may include the finer grained task of composing a persuasive e-mail and that task may involve checking the spelling of the message. Whether flow occurs may have to do with at which level of granularity the person is focused and what their attitude and skills are toward that level. If the user is bored by correcting spelling errors then flow will not occur during that task. However, though the person may be bored with the finest grained task of correcting spelling, if his/her mind is focused on the broader task of writing a persuasive e-mail, s/he could experience flow. This would explain why Csikszentmihalyi (1990) finds examples where manual laborers who do the same repetitive task can still experience flow in their jobs. Given the existing task literature, we will outline what we envision as being important characteristics of task within the flow model below.

For the few flow studies that consider tasks in a computer-mediated environment, the task characteristics considered were goal-oriented versus experiential tasks, which were adopted from the marketing literature (Hoffman & Novak, 1996; Hoffman, Novak, & Duhachek, in press). A goal-directed task, such as searching online for a store's location, uses a directed search and has utilitarian benefits, situational involvement, and instrumental orientation. An experiential task, such as general Web surfing or browsing, uses a non-directed search and has hedonic benefits, ritualistic involvement, and enduring involvement. The findings are clear that goal-oriented tasks yield more flow experiences (Hoffman et al., 2002).

The organizational science literature has identified the following task factors: autonomy, variety, and complexity. These are frequently referred to when studying the tasks within a particular job (Fleishman, 1975; Fry & Slocum, 1984; Henry P. Sims, Szilagyi, & Keller, 1976). These characteristics can be applied to the PAT model.

Autonomy is the degree to which the user determines how to accomplish the task. When a person is given a task, they may be told only what the goal or product is or they may be told how to complete the task. When the person is given rigid instructions, it reduces the degree of autonomy the person has with the task.

Variety is the degree to which a task has many ways to be completed. The steps for completing the task may be given by an external source or the task itself may demand them. For example, an organization may have rigid process for getting technical support, requiring that the user call a number and obtaining an incident number. In such a case, we can say there is low variety in completing this task.

Within the task component, autonomy and variety hold similar roles, as they both set limitations on how the task is completed. However, these characteristics relate differently to other components of the PAT model. Autonomy has closer ties to the Person and their understanding of the task. Variety relates to the Artifact and how the Artifact may constrain the method for completing the task.

It is reasonable to believe that the complexity of a task will influence flow as the balance of challenges and skills are so essential in Csikszentmihalyi's work. A complex task could lead to more flow because it engages and challenges. On the other hand, a high complex task could also overwhelm and yield anxiety. Thus, complexity may have a direct positive or negative influence on flow.

This leads to the proposition related to the Task component in the PAT model.

Proposition 3:
Assuming all of the other components are the same, a person is more likely to experience flow if the task is more goal-oriented, autonomous, enables more variety, and at the appropriate level of complexity.

4.4. The Task-Artifact Interaction

In the HCI literature, affordance is the aspect of an object that makes it obvious how the object is meant to be used. An artifact can be designed in such a way that it affords a person's intention of interacting with it. For example, Norman (1988) describes the effect of direct manipulation (Shneiderman, 1987), "When I use a direct manipulation system – whether for text editing, drawing pictures, or creating and playing video games – I do think of myself not as using a computer but at doing the particular task. The computer is, in effect, invisible." When a computer interface has superbly implemented direct manipulation, less mapping between intention and action will be required. The interface feels transparent because it does not tax the user by demanding mapping. It has built-in affordance, thus enabling the user to concentrate on the tasks at hand.

It is commonly understood that some artifacts are more suited for particular tasks. When there is not a good fit between the Task and Artifact components, it will be difficult for an optimal experience to occur. The user's task goal will not be easily convertible into a clear artifact goal, thus confusion and frustration will result. In trying to redeem the situation, the user can alter their task goal to fit the artifact, which will compromise the probability of flow as the task will no longer have a clear goal. Another response, which may in the end yield flow, would be the user abandoning the particular artifact and finding one that will enable them to maintain clear task goals.

This leads to the proposition related to the Task and Artifact interaction in the PAT model.

Proposition 4:
Assuming all of the other components are the same, a person is more likely to experience flow if there is a clear fit between task and the artifact.

4.5. The Person-Task Interaction

The traditional flow studies centered on the interaction between the person and the activity, which essentially was focused on the task. It is identified that having clear goals, balance of challenges and skills, sense of control, and immediate feedback were factors that contributed to flow (Csikszentmihalyi, 1975). These factors have been shown to be important in traditional flow studies and have been included in most of the more recent flow studies within computer-mediated environments. Unfortunately, the CME flow studies have not clearly differentiated these factors between task and artifact. In this sub-section we will discuss each of these factors in relation to the task. In the following sub-section we will discuss them in relation to the artifact.

Having clear goals is an instrumental aspect of Csikszentmihalyi's flow theory (1988). Within a computer-mediated environment, the goals must be clear for both the artifact (discussed below) and the task. For example, a person may have the clear task goal of finding a full text version of a particular journal article on the WWW. If the person is proficient with search engines, the goal with the artifact also will be straightforward. It is essential that research studies clearly disambiguate whether the measurement of clear goals is for the task or for the artifact. Ghani's (1991) instrument contained the item *Felt confused about what to do* without specifying which aspect the user was confused about. If the respondent had clear goals on how to complete the assignment, s/he would not feel confused about the task goals.

Early flow theory addressed the challenge/skill balance by showing that if the balance was off with too high of a challenge, the person would experience anxiety, whereas if the person's skills were too high, the person would experience boredom (Csikszentmihalyi, 1975). This has been further refined to show that if both challenge and skill are low, apathy or relaxation may result (Clarke & Haworth, 1994; Csikszentmihalyi & Csikszentmihalyi, 1988). Thus, flow requires some degree of overall skill and challenge, though of course the level will vary according to the individual. In studying flow, it is important that researchers include the skills and challenges of the task. Ghani's (1991) instrument measured the *challenges of the activity* and *your skills in the activity*, yet did not disambiguate the *activity* by asking about skills with the software package and skills with the task, e.g. resume-writing. When using open-ended questions, Chen et al. (1999) found that the challenges users mentioned were more focused on the task, such as developing a search strategy, than artifact challenges, such as using the hardware or software. Though these open-ended questions provide useful data, future studies will need to specifically ask about challenges with the task and challenges with the artifact to ensure that the respondent is clear on what is being asked.

The sense of control a person feels is important to the flow experience. In a flow study of students faced with their first ever term paper exercise, the quality of the term paper was more dependent on the student's overall emotional state and the amount of control they felt over the exercise than the student's prior grades and writing experience (Larson, 1988). Measuring a person's sense of control has been difficult. In Chen et al.'s (1999) empirical study, 20% of the respondents indicated that they did not know what "sense of control" referred to. We argue that Chen et al.'s question *Have you ever experienced the feeling of 'being in control' during your Web navigation?* could have been more clear. For example, a question stating *Have you ever experienced the feeling of 'being in control' of the task you were doing while using the Web?* perhaps would clarify the researchers intention to the respondent, and certainly lead to information specifically about the Person-Task interaction.

Csikszentmihalyi (1988) has emphasized how important immediate feedback is for flow. With physical activities, such as rock climbing, immediate feedback is a defining part of the experience. With feedback of computer-mediated environments, feedback is typically referred to as interactivity. Hoffman & Novak (1996) distinguish between person-interactivity and machine-interactivity when communicating between persons. They define person-interactivity as, "interactivity between people that occurs through a medium or is unmediated (p. 52-3)." Hoffman & Novak cite Steuer's (1992) definition of machine interactivity, "the extent to which users can participate in modifying the form and content of a mediated environment in real time (p.84)." However, for tasks within computer-mediated environments, the distinction between person and machine is not always as clear-cut. The feedback on a task may be person or machine based. The key point is that the person is obtaining feedback on how well s/he is doing in achieving his/her goal of the task. The feedback could come from a machine (e.g. a spell checker), a person (e.g. colleague's email), or the person's own mind.

This leads to the proposition related to the Person and Task interaction in the PAT model.

Proposition 5

Assuming all of the other components are the same, a person is more likely to experience flow if s/he has clear task goals, a balance between challenge and the skills of the task, a sense of control of doing the task, and adequate feedback on the task.

4.6. The Person-Artifact Interaction

In the prior sub-section, we discussed how clear goals, balance of challenges and skills, sense of control, and immediate feedback related to the interaction between the Person and Task components. Now we will focus on similar considerations on the interaction between the Person and Artifact.

In addition to having a clear task goal, a person must have a clear artifact goal. To continue the example used above, after the person has decided they want to find a full text version of an article, s/he will establish an artifact goal, such as using their favorite search engine and typing in the author and title terms and use some search operators.

Having a sense of control with the artifact is as important as having that sense with the task. Though some aspects of the sense of control may be features of the artifact, such as modifiability (Webster et al., 1993) or range of ways to do something (Steuer, 1992), this construct also is based on the user's attitude toward the artifact. Thus, if the user is intimidated by a computer system, s/he may not feel in control of the artifact.

Csikszentmihalyi (1975) points out that anxiety is associated with a person's perceiving his or her skills of doing a task to be less than needed to meet the given challenges. Adopting this to a computer-mediated environment, computer anxiety (Simonson, Maurer, Montag-Torardi, & Whitaker, 1987) would be associated with a perceived computer skill deficit. In the MIS discipline, perceived ease of use (PEOU) is a person's perception of his or her being able to use a technology (artifact). PEOU is an established and validated construct (Davis, 1989; Venkatesh & Davis, 1996; Venkatesh & Davis, 2000). Empirical work has shown that computer anxiety associates with PEOU (Venkatesh, 2000), and PEOU, as an antecedent, influences flow (Trevino & Webster, 1992).

PEOU represents a strong linkage between Person and Artifact. According to the operationalization of PEOU, it contains the other aspects between Person and Artifact mentioned above. Studies on Technology Acceptance Model (TAM) have measured PEOU with the following four items: clear and understandable interaction with the particular technology, easy to become skillful with the technology, easy to get the technology to do what I want, and interacting with the technology does not require a lot of mental effort (Venkatesh, 2000). When reconsidering the above-mentioned constructs adopted from the flow theory, PEOU is a broad enough construct to include clear artifact goals, sense of control with the artifact, and feedback from the artifact. Clear artifact goals are reflected in PEOU's *clear and understandable interaction* item. A sense of control is reflected in the *easy to get the system to do what I want* item. Finally, a system that gives immediate feedback would indicate that it was *clear and understandable* and *easy to use*. Within the PAT model, PEOU serves as the Person-Artifact interaction.

Proposition 6:
Assuming all of the other components are the same, a person is more likely to experience flow if s/he has high PEOU of the artifact.

4.7. The Person-Artifact-Task Three-Way Interaction

Besides main and two-way interaction effects of the three components on flow experience, there are also three-way interaction effects. This further indicates the complex nature of the flow antecedents. Here we illustrate one of such three-way interactions with the belief that more interaction effects exist.

Among the potential three-way interaction effects, we believe that task complexity has a mediating effect on other variables. One study looking at the general behavior of managers (dealing with complex tasks) versus lower-level workers (dealing with relatively simple tasks) found that when the managers experienced flow it was more due to their feeling of control (Ghani & Deshpande, 1994). When the workers experienced flow it was because they felt more challenged. Thus, we could extrapolate that with more complex tasks, the PEOU on the Person-Task linkage becomes more essential in yielding an optimal experience. In other words, with more complex tasks, it is essential that the artifact becomes transparent so that it requires minimal attention and cognitive resources. Such a transparent artifact will be necessary for flow to occur with complex tasks. With less complex or repetitive tasks, the task itself is not challenging and thus consumes few cognitive resources of the person. The person will most likely experience boredom, however a flow experience could potentially result from a challenging interaction of the Person-Artifact linkage. The person may focus their cognitive resources on getting the artifact to efficiently accomplish with the lower-level tasks. This leads to Proposition 7.

Proposition 7:
Assuming all of the other components are the same, with complex tasks, it is more likely that a person experiences flow when the artifact supporting the tasks has high PEOU, or is transparent. With less complex tasks, it is more likely that if a person experiences flow, s/he will perceive the artifact as having a high challenge.

5. THE INTENDED USE OF PAT

We intend the PAT model to be used to help researchers conceptualize the flow experience within computer-mediated environments as they are approaching empirical work. Specifically, when researchers distinguish between an artifact construct and a task construct, we believe clearer and more valid research will follow. To demonstrate this value of PAT, we will consider a prior research study as it was conceptualized and then re-conceptualize it using PAT.

Ghani (1991) conceptualizes the antecedents of flow as cognitive spontaneity, task challenges and perceived control. To operationalize cognitive spontaneity, Ghani adopts the Adult Cognitive Spontaneity scale developed by others (Lieberman, 1977; Webster, 1989). When considering the task challenge, Ghani hypothesizes that if there is a fit between the challenges and the user's skills, flow will result. However, because fit is assumed to have a curvilinear relationship with flow, he measures fit (the mathematical difference between skills and challenges) as well as fit^2 (the square of fit). Fit^2 is hypothesized to be negatively correlated to flow because if the difference is too great, the user will be either bored or anxious. Fit is measured by a self-report where the user indicates the *challenges of the activity* and *your skills in the activity* using a 9-point scale from low to high. Finally, the construct of control is measured with a 7-point agreedisagree scale containing the following five items: *difficult*, *felt confused about what to do*, *felt calm*, *felt in control*, and *felt frustrated*.

Adopting the PAT model, we will disambiguate the challenges and control constructs of Ghani's original model by using task challenges, artifact challenges, task control, and artifact control. Note that though Ghani uses the phrase "task challenges," his instrument actually measures the challenge and skill of the activity, which includes both the task and the artifact. Control also will be refined into artifact sense of control and task sense of control. No changes will be made to cognitive spontaneity, as this construct clearly represents a person's trait and is measured as such. When measuring the task challenges, the instrument would read *challenges of knowing how to put together a resume*, while the artifact challenges' instrument would read *challenges of using Microsoft WORKS.* Similarly the sense of control constructs would be measured using the control scales but modifying them so that they measure either the sense of control with the artifact or the task. For example, an item for the task sense of control would read *felt confused about how to put together a resume*, while the analogous item for the artifact sense of control would read *felt confused about how to get Microsoft WORKS to do what I wanted.* Note that we have assumed the task for Ghani's experiment was resume creation. He used this task for his pilot test, but it is unclear if he used the same task for the main experiment; he did use Microsoft WORKS as the artifact. Regardless, this illustration is not meant as a critique of this particular study but as a demonstration of the usefulness of the PAT model.

At the conceptual level, PAT enables refining constructs in a researcher's particular model. The PAT model clarifies the original ambiguities between the task and the artifact. Though in our paper we have used constructs that are common in prior flow studies, PAT is certainly not limited to these constructs. PAT sits above any of these particular constructs to serve as a guide to remind researchers that a person's experience with the artifact may be different from that with the task.

6. PAT IN RELATION TO OTHER MODELS

The PAT model's three components -- person, artifact, and task -- and their interactions were derived from studying flow theory and the characteristics of computer-mediated environments, and then, examining the existing empirical work on flow to identify trouble spots. Taking a broader look at our work in lieu of the HCI and MIS literatures, we see a similarity in these three components. HCI takes an approach that at a high-level considers the task, human, and computer. The Task-Technology Fit model (Goodhue, 1995, 1997, 1998; Goodhue & Thompson, 1995), a noteworthy model within MIS, has task, technology, and person as the three components. These recurring components serve as a reminder of the overlap in the HCI and MIS disciplines. Perhaps more importantly, the similarity of these models from different disciplines bolsters each individual model's call for considering the interaction between humans, tasks, and technological artifacts as well as each of these components separately.

When we further examine these models, the generally useful construct of PEOU may be common, however, overall the models are quite distinct at the construct and operational levels. The Task-Technology Fit model, which is intended to measure performance, looks at constructs as performance impact and production timeliness (Goodhue & Thompson, 1995). The PAT model, which is intended to measure optimal experience, considers constructs such as time distortion and feedback on task. The outcome of considering person, task, and technology in both the Task-Technology Fit and HCI models is performance. These models imply a somewhat mechanistic underlying force where if the fit between the computer and the task matches, performance will excel. Flow does not focus on performance per se, but on an optimal experience that occurs at a deeper personal level. The component of person exists not merely to measure their skills, but to consider their current state and attitudes. Flow draws on the affective as well as the cognitive aspects of humans. In this way, Flow and PAT are very different from the other models.

7. IMPLICATIONS AND CONCLUSIONS

Flow theory has been an asset to the Management Information Systems and HCI literature. Within computer-mediated environments (CMEs), the outcomes of flow have the potential to increase the degree of technology use and the enjoyment from using technology. These consequences of flow have wide implications for technology acceptance and adoption, e-business, learning, and training.

The strength and depth of Csikszentmihalyi's work on flow has left with it a hearty legacy. Though it has been questioned in some of the minute details, the high-level conceptualization has gone without challenge for CMEs. In order for MIS/HCI researchers to progress further in understanding the antecedents of flow, we need to re-examine the over-arching framework of the original flow work.

We have proposed a model of flow antecedents in CMEs, reviewed recent flow studies from several distinct fields of research, and demonstrated how to generate propositions from the model. The literature review suggests that no existing flow studies we found consider the activity in traditional flow theory as a combination of two distinct components that have different main and interaction effects on flow experiences, and thus should be treated differently.

The PAT model contributes to the theoretical work by re-conceptualizing the original flow theory for CMEs and providing an understanding of flow antecedents at a conceptual level. The implication for future research is to use the PAT model to develop measurement level models, hypotheses, and instruments that will be able to disambiguate the person, task, and artifact dimensions of flow. By resolving these ambiguities we will be in a better position to say unequivocally that the artifact contributed to the flow experience as opposed to a particular absorbing task. PAT will encourage more valid and rigorous studies of the flow phenomenon. The strength of the PAT model is in helping researchers conceptualize the flow dimensions and their interaction, however it is limited and does not address directly how to study the dynamic flow experience. More work on the methodology of studying flow, often a fleeting experience, within a computer-mediated environment is needed.

This article focuses on conceptual issues in studying flow in CMEs. Review of the existing flow studies also demonstrates methodological challenges (Finneran & Zhang 2002), which is beyond the scope of this paper. Further research is needed to carefully evaluate whether some of these methodological difficulties are caused by conceptual confusions in previous flow studies.

The PAT model can be further refined, especially for identifying other possible attributes for each of the three components and their interactions, and the impact of these attributes on flow experience. For example, PEOU is currently the relationship between Person and Artifact. Studies have shown that system acceptance and use associate with high perceived aesthetic value (Tractinsky, 1997; Tractinsky, Katz, & Ikar, 2000) or joy of use (Hassenzahl, Beu, & Burmester, 2001). This perceived joy of use (PJOU) between Persona and Artifact, direct or together with other elements, may have an impact on flow experience.

At the practical level, flow has been shown to lead to positive consequences, such as increased enjoyment, increased exploratory behavior, increased use of technology, and positive affect. If designers can develop information technologies to enhance the opportunities for flow, users will have a more positive attitude toward that particular technology, and be more willing to adopt a technology that will help productivity. Further, the degree of use of a technology has been shown to increase when a user experiences flow (Trevino & Webster, 1992). As technology adoption and use has been a bottleneck for an organization's efficiency and effectiveness gains from IS implementations, flow has the potential to ease that bottleneck. We have detailed some characteristics of artifacts (e.g., telepresence) and the interactions between artifacts and tasks (e.g. fit), and between person and artifacts (such as PEOU), which we believe will influence flow. With the findings from this and further research, designers will be given clearer guidance as to what aspects they can alter so as to increase the chances of the user having an optimal experience.

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