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Effective Affective User Interface Design in Games

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Abstract
It is proposed that games, which are designed to generate positive affect, are most successful when they facilitate flow (Csikszentmihalyi 1992). Flow is a state of concentration, deep enjoyment, and total absorption in an activity. The study of games, and a resulting understanding of flow in games can inform the design of non-leisure software for positive affect. The paper considers the ways in which computer games contravene Nielsen's guidelines for heuristic evaluation (Nielsen and Molich 1990) and how these contraventions impact on flow. The paper also explores the implications for research that stem from the differences between games played on a personal computer and games played on a dedicated console. This research takes important initial steps towards defining how flow in computer games can inform affective design.

Keywords: games, flow, affect, user-interface design

1. Introduction

The value of affectively designed software increases as computers are continually integrated further into our lives. Designing for function and performance remains important, but increasingly the significance of designing for pleasure is recognised. Designing for positive affect is emerging as an important field of study and researchers interested in affective design face a variety of novel challenges. One important question to explore, at this early stage, is 'what factors lead to positive affect in software users'?

The majority of research on non-leisure software design has been directed towards functionality and performance. Evaluation techniques have focused on measures of performance as a means of assessing usability, for example, keystroke analyses and target acquisition tasks (for reviews see Shneiderman 1992, Newman & Lamming 1995 and Helander et al. 1997). Where the relationship between usability and user affect has been considered, the focus has largely been on negative emotions; a need to prevent the user from experiencing negative affect as opposed to a desire to promote pleasurable interactions.

Video games constitute a genre of software in which the user's affective experience is paramount. If a game does not generate positive emotions in the user it is unlikely to succeed. Although video games are played for a variety of reasons the key motivating factor for the majority of game players is to experience positive affect. The positive affect associated with game playing can take a variety of forms including satisfaction, a sense of achievement, amusement or excitement. The motivation to experience positive affect is one of the main differences between a game and a non-leisure software application. As a means of helping the user of a game achieve this sense of positive affect, games provide the user with a secondary task or goal (e.g. save the princess, annihilate the enemy, win the football game). In contrast to this focus on positive affect in games, most non-leisure software is designed to facilitate the user's achievement of a pre-existing task or goal (e.g. write a document, produce a web page, create a spreadsheet). The user's primary motivation is to achieve this goal and the desire to experience positive affect, if considered at all, is secondary to the achievement of the task at hand. It is proposed that affective design researchers interested in creating non-leisure software applications that promote positive affect have a great deal of subject matter at their disposal – video games.

1.1. Flow

Flow is a euphoric state of concentration and involvement, often claimed to be one of the most enjoyable and valuable experiences one can have (Csikszentmihalyi 1992). Flow is a state in which one is happy, motivated and cognitively efficient. When in a flow state one becomes totally absorbed in an activity and irrelevant thoughts and perceptions do not enter consciousness. An important precursor of flow is a match between one's perceived skills and the challenges associated with an activity such that the challenges are not greater than the one's skills, which would lead to anxiety, and one's skills are not greater than the challenge, which would lead to apathy. An activity that produces flow tends to be so gratifying that one is willing to undertake they activity for its own sake, without concern for what one will get out of the activity (Csikszentmihalyi 1992, Chen et al. 1999).

Research on flow began with Csikszentmihalyi's desire to understand happiness. Initial studies focussed on 'experts' – people who spend a great deal of time on activities they prefer – such as artists, athletes, musicians, chess masters and surgeons. Interviews revealed evidence of the state of flow as it is described above. In order to achieve greater precision in measurement of the quality of subjective experiences the 'experience sampling method' was developed. The experience sampling method requires subjects to wear an electronic pager for one week. When the pager signals the subject (the pager beeps at random times during the week), the subject is required to write down their thoughts and feelings at that moment. At the end of the week a running record of the subject's life, made up of a selection of representative moments, has been created (Csikszentmihalyi 1992). Csikszentmihalyi, in the USA, and colleagues from around the world – Canada, Germany, Italy, Japan and Australia – have investigated the concept of flow by interviewing thousands of individuals with a variety of socio-economic backgrounds. The research shows that irrespective of age, gender or culture, people describe their optimal experiences in the same way, that is, in terms of flow. Specifically, when describing enjoyment (or flow) people tend to mention and least one, and often all, of the following components; a task that can be completed, the ability to concentrate on the task, a task with clear goals, a task that provides immediate feedback, deep but effortless involvement, a sense of control over one's actions, decreased concern for self during the task but a stronger sense of self after the task's completion, and an altered sense of time (Csikszentmihalyi 1992).

1.2. Flow and games

Attention has recently been directed towards understanding the means by which games generate positive affect in the user. Researchers (Pausch 1994, Picard 1997, Jones 1998, Draper 2000) have begun to explore the utility of the theory of flow (Csikszentmihalyi 1992) as a means of understanding the popularity of, and positive affect associated with, games (the concept of flow has also been explored in relation to users' positive experiences when interacting with websites, see Chen et al. 1999). Almost by definition, a game that is able to create a sense of flow in the user will be successful, as the user will have a strong sense of involvement and enjoyment when playing the game[1].

Based on Csikszentmihalyi's (1992) theory of flow, Jones (1998) considered a list of the components of flow and how they are manifested in video games, with the goal of informing the design of learning software. He describes the components and the way they manifest in video games as depicted in table 1.

[insert table 1 about here]

1.3. Flow and affective design

It is proposed that an understanding of the process by which games generate flow could inform the affective design of non-leisure software. As Bergman (2000) points out, the game design and HCI design communities have to date had limited awareness of each other's work. While a great deal of research has been directed towards discovering the features of non-leisure software that lead to maximal functionality and minimal negative user affect, very little research has looked at games. Furthermore, even less research has focused on bridging the gap between these two areas. The present paper represents an attempt to narrow this divide by exploring how games design can inform the affective design of other software applications.

Ultimately, empirical study in the form of user questionnaires and observational studies will provide the most detailed understanding of the association between flow and games. However, as a precursor to

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[1] The current paper focuses on the concept of flow as an explanation for the positive affect games generate in a user. This is not to suggest that flow provides an exhaustive or exclusive explanation for game playing behaviour. For example, one interesting potential extension of the idea of flow in games, which is beyond the scope of this paper, is the concept of virtuosity, present when one performs an act of which they were previously incapable or of which others are incapable (see Kubovy, 1999, for an explanation of virtuosity and the links between virtuosity and flow).

such research this paper provides a theoretical consideration of the interaction between flow and games in the context of traditional non-leisure software design. Specifically, this paper will consider whether, and in what way, computer games commonly contravene the accepted user interface design guidelines. In situations where user interface guidelines are contravened to the detriment of the user's experience of flow (or positive affect) insight will be gained into both, the design flaws which have a negative impact on user affect, and the ways that games can be improved. This insight will contribute to the small but growing body of research applying existing HCI knowledge to games design (Johnson 1998, Bergman 2000). Furthermore, given that games are fundamentally aimed at generating positive affect, there may be situations where user interface guidelines are contravened in a way that benefits the facilitation of flow. An awareness of such contraventions in games may indicate ways that enjoyment or flow can be improved in some non-leisure software applications. For users of non-leisure software the advantage of the facilitation of flow (aside from the associated increased enjoyment) stems from the fact that users experiencing flow enter a state of heightened concentration and absorption in their activity – such states are likely to lead to increased efficiency and productivity. It is not suggested that the principles of flow should replace existing HCI guidelines. It is hypothesised however, that for certain software applications (e.g. learning programs) greater facilitation of enjoyment and flow will be beneficial.

Extensive research has been conducted regarding effective software interface design. Heuristic evaluation, developed by Nielsen and Molich (1990), is a method for structuring the critique of a system using a set of general heuristics. The heuristic evaluation method requires a group of people to act as evaluators and independently critique a system and suggest usability problems. The evaluators use the list of heuristics to generate ideas while critiquing the system. The heuristics are as follows: visibility of system status, match between the system and the real world, user control and freedom, consistency and standards, error prevention, recognition rather than recall, flexibility and efficiency of use, aesthetic and minimalist design, the need to help users recognise, diagnose and recover from errors, and the need to include help and documentation (for further detail on the heuristics see Nielsen and Molich 1990, Nielsen 1994a, Nielsen 1994b). Nielsen and Molich's guidelines for heuristic evaluation were considered appropriate for use in the present study as they provide a broad overview of interface design and because they are task-free which allows them to be applied universally to a variety of games. It should be noted that since only one person evaluated the games, the research done in this study is not intended to be a heuristic evaluation per se.

2. Present Study

The first author (who has extensive experience with computer games) undertook a review of a variety of games with the goal of identifying where and how games tended to contravene the user interface guidelines associated with heuristic evaluation. As mentioned above, it was expected that these contraventions would in some cases interfere with flow but that in other cases the facilitation of flow might result. The review extended to games available on both personal computers (PC) and home consoles, for example, Sony Playstation™ and Sega Dreamcast™, as the majority of games are played on these platforms (Henry & Hause 1999). The analysis did not extend to situations where the heuristic guidelines were followed nor to situations in which they were contravened in a manner did not impact upon flow (or the user's experience of positive affect). By cross-referencing the literature on heuristics and the literature on game design, and drawing extensively on expert knowledge of games and game design, it was possible to identify contraventions of the heuristics that facilitated flow and contraventions that prevented flow. These contraventions of the heuristic guidelines that either facilitate (section 2.1) or interfere with flow (section 2.3) are discussed below. The heuristics were used largely as a guide or starting point (as recommended by Dix et. al. 1998) and as such the problems identified are not necessarily linked solely to any specific heuristic.

2.1. Contraventions of HCI guidelines in game design that facilitate flow

It is perhaps unsurprising to realise that contraventions of HCI guidelines in games (as detailed below, in section 2.3) can interfere with flow. It is interesting however, to note that there exist contraventions of the HCI guidelines that facilitate flow in games. For example, many games provide minimal information to the user during actual gameplay. The vast majority of games are based on a structure whereby the user interacts with the system to set all options and preferences prior to commencing gameplay. During gameplay a minimum amount of information is displayed to the user, and often it is possible to elect to further decrease the amount of information displayed if so desired. Indeed, recently games have been released with the interface virtually absent during gameplay (for example, Lionhead Studios' game Black and White, copyright 2001). The entire screen is taken up with the action occurring and the user must deliberately request all other information. It is hypothesised that this focus on, and lack of distraction from, the major task contributes to the facilitation of flow. Immersion in the game is promoted when all distractions are removed.

Games also often display a context-dependant inconsistency in control systems. For example, the button for jump when on land may also be the button for swim towards the surface when underwater. On console games, where there is limited button availability, inconsistency is sometimes a necessity; however, this also occurs in PC games where a multitude of potential buttons are available. The use of a small core set of buttons leads to inconsistency but it has the advantages of requiring less cognition and promoting a sense of control on the part of the user. The user need only remember, for example, that button A generally means take an action with my hands (e.g. open the door, pick up the item) while button B means move downwards in some way (crouch on land or dive when underwater). With less cognition required for remembering or finding input commands, the user is better able to achieve concentration and engagement, and thereby flow, when completing the task.

HCI guidelines suggest that wherever possible users should be prevented from making errors. The prevention of errors is largely contradictory to the manner in which games promote flow and positive affect. When playing a game, part of the challenge for the user is the fact that mistakes must be avoided and thus, during gameplay, the joy of success is dependant upon the possibility of failure (cf. research exploring the value for users in trying out errors, Rasmussen 1986). As Bergman (2000: 301) points out 'the pleasure of mastery only occurs by overcoming obstacles whose level of frustration has been carefully paced and tuned to not be excessive or annoying yet be sufficient to give a sense of accomplishment'. It should be noted that many games fail to achieve the goal of providing a level of difficultly which is neither discouragingly hard nor so easy as to be boring. However, where the goal of a suitably challenging difficultly level is achieved, the notion that errors are possible is integral.

2.2. Implications for affective design

The above consideration of the relationship between flow and games in the context of existing HCI guidelines raises a number of interesting possibilities for the affective design of non-leisure software. For example, in many non-leisure software applications the default settings involve the display of a fairly large amount of information – the design of games (which provide minimal information during gameplay) raises the question of whether the provision of a great deal of information on screen decreases the likelihood of flow for the user of non-leisure software. Similarly, the mapping of several commands to a particular input may prove beneficial to a subset of non-leisure software applications. In educational programs, for example, a decrease in the cognition required for remembering or finding input commands may facilitate a sensation of flow. Furthermore, any decrease in the cognition required for interacting with the interface can be focussed on content, which will ultimately assist learning. Finally, the relationship between frustration and flow in games raises the question of whether the potential for errors on the part of the user can have any benefit in non-leisure software. This is not to suggest that the user interface guidelines encouraging error prevention are questionable or invalid. Rather it is a matter of realising that in some situations, it may promote positive affect in the user if the right decision is made under challenging conditions. Once again, educational software provides a good example, as, in learning environments, flow and a sense of achievement may be more likely to result where errors and mistakes are possible.

2.3. Contraventions of HCI guidelines in games design that interfere with flow

There are a variety of ways in which games contravene usability heuristics to the detriment of flow. For example, games often fail to satisfy the need for error prevention. One area in which this failure is generally seen is menu design. Many games have menus that are poorly and non-intuitively organized leading to confusion as to where a particular option can be found. Moreover the readability of menus in games is often sacrificed for aesthetics. Game menus generally look very attractive and are well-suited to the theme of the game, however animations and eye-catching colours are often used at the expense of functionality. Anytime the user interacts with the menu system frustration may result. If the user wishes to access the menu during gameplay, this frustration is likely to break the flow experience. (These ideas may seem contradictory to the assertions made regarding errors in section 2.1. However, there the focus is on the possibility of making errors during gameplay, whereas the focus here is on errors made while attempting to navigate the menu).

Another common mistake in games design is the failure to achieve flexibility and efficiency by forcing the user to wait. Most games include movies (or animations) that open the game, link levels and generally provide ambience and context. However, often it is not possible to skip these movies. Even when it is possible to skip the movies the user must wait for the entire movie to load before telling the game not to screen it. Loading time can also be an issue when the user makes an error. The loading of the next scene of a game is generally dependent on the user taking a certain action (e.g. picking up an object, walking through a door). However, if the user takes an action by accident (which leads to the loading of the next scene), there is very rarely a way to cancel or undo the action. The user must wait for the new scene to load, then, if possible, reverse the action and wait for the original scene to reload. Perhaps the most destructive form of forcing the user to wait, in terms of interfering with flow, is forcing the user to reconfirm all options and selections at the conclusions of each game event. For example, in a particular car racing game reviewed for this paper an individual race may last between 2 and 15 minutes. Irrespective of whether the user is successful in the race or not, at the conclusion of the race she is sent to a certain point in the game. To reattempt the same race, with the same settings (a common desire when the objective is failed), requires 18 button presses and over a minute of waiting. These situations, in which the user is forced to wait, are inherently frustrating, and moreover, they erode the user's sense of control of the environment, which further detracts from the flow experience.

The concept of online help is often ignored in games. Most games include an online explanation of the control system, but rarely is a soft version of the manual incorporated. If the user seeks information contained in the documentation they must remove themselves entirely from the game environment and consult the hardcopy of the manual. This forced departure from the game environment interferes with the sense of engagement inherent in flow.

The facilitation of flow in games is also often hindered by a failure to develop and adhere to platform conventions. For example, many games allow the user to restart an event before the natural conclusion of that event. When such an option is unavailable in a game, users may feel cheated and frustrated. Similarly, most multiplayer games allow two users to compete using the same character, thereby allowing an inherent equality to be incorporated in the competition if so desired. Once again, the failure to include this feature in competitive games can lead to negative affect on the part of the user.

2.4. Implications for affective design

The identification of these areas in which games commonly breach user interface guidelines at the expense of flow suggests ways that games can be improved. Moreover, it is proposed that some of these issues (and the need to avoid them) may prove to be relevant to the affective design of non-leisure software applications. Although traditional HCI guidelines identify the aforementioned design errors, that fact that they simultaneously interfere with flow highlights the need to avoid such errors when designing for positive affect.

3. Methodological Issues: Cross-Platform Differences in Games

The findings derived from the aforementioned study require further research before any firm conclusions can be drawn. One important initial step is to experimentally confirm the theoretical findings described above (i.e. the potential value of minimal onscreen information, the advantages of context dependant control systems, the value of errors, the costs of non-intuitive game menus, the disadvantages of forcing the user to wait, the disadvantages associated with the absence of online help and the costs of failing to adhere to platform conventions). Moreover, the link between flow and games is yet to be experimentally validated. Exploration of the hypothesised links between games design (particularly that which contravenes HCI guidelines) and flow will require the study of users interacting with games. As a result of the dearth of research on games and game design a number of methodological issues need to be considered before the links between flow and game design can be explored. One pertinent methodological issue stems from the fact that games are currently available to users on a variety of platforms. As mentioned, the majority of games are played on PC or home console. However, it may be inappropriate to assume that games are equivalent across platforms.

The population of console gamers is substantially larger than that of PC gamers. The ratio of console games sold to PC games sold is approximately 2 to 1 (Bergman 2000). This disparity may be a result of differences across the platforms. Indeed, the relative merits of the two platforms have long been a hotly debated topic in gaming communities (e.g. Bateman and Matthews n.d.). It has often been argued that the content and style of the games available for each platform differ; that consoles are dominated by action games whereas PC games tend to be more cognitively challenging (Bergman 2000).

There are also cross-platform differences in terms of the means of interaction provided to the user. Users of PCs largely rely on the use of a keyboard and mouse, whereas when playing a game on a console, the user communicates with the system using a controller (or joystick). While controllers are available for use with PCs and many of the latest consoles support mouse and keyboard input, the platforms are less commonly used with their respective alternative input devices. Moreover, games for each platform are almost exclusively authored with the more common input devices in mind.

In light of these differences and the fact that the majority of non-leisure applications are used on PCs, it could be argued that this research (exploring how game design and flow can inform the design of non-leisure software) should be limited to the study of games on PCs. However, there are three advantages that result from including console games in this field of study. Firstly, given the potential cross-platform differences in audience and game style, it is possible that console games generate flow to a far greater extent than PC games. Secondly, exploration of the exact nature and impact of the cross-platform differences may prove informative. Finally, on a strictly pragmatic level, as the number of console gamers is approximately twice the number of PC gamers, researchers will have a far larger population to study if research is not limited to the consideration of PC games.

4. Follow-up Study

Given the advantages of including console games in future research it is important to explore the nature of the existing cross-platforms differences. Ultimately, a comprehensive comparative review of games available on each platform, supplemented with extensive user interviews would allow the most informative exploration of cross-platform differences. Given the dearth of research in this area, however, the following initial exploratory study was conducted in order to identify the relevant issues and areas of interest. A comprehensive analysis was conducted that compared two games that are available on both PC and console (thus, a total of four games were studied; two titles across the two platforms). The titles analysed were Tony Hawk Pro Skater 2 (copyright 1999, 2000 Activision; hereafter referred to as THPS2) and Quake 3 Arena (copyright 2000 id Software; hereafter referred to as Q3A). The study involved a comparison of the user-interfaces across platforms and case studies exploring users' affective experiences of each game.

4.1. Cross-platform user-interface comparison

All four user interfaces were fully mapped and compared. That is, each screen displayed in a game was reproduced using paper and pencil and then points where cross-platform differences arose were noted. The goal of the analysis was simply to identify where and how the user interfaces differed across platform. Many of the differences discovered were content related, that is they resulted from the need to offer different options and preferences across the platforms. For example, in THPS2 for the Sega Dreamcast™ there is no need to offer keyboard set-up options as it is not possible to use a keyboard when playing THPS2 on the Sega Dreamcast™. Similarly, in Q3A for the PC there is no need to include a single screen allowing for up to four users to join the game, as in a multiplayer game played across PCs each player would have their own computer. Differences such as these are to be expected and are relevant to research in this area in as much as they highlight the fact that the interfaces will differ as a function of the platform they are provided on.

Beyond these basic content differences there exists the possibility of substantive design differences. Analysis of THPS2 revealed no such differences, however there were several substantive design differences across platform in Q3A. The menu system in Q3A is reasonably complex with a large variety of options and preferences available to the user. Generally, the Sega Dreamcast™ version of Q3A appears to be far less effectively designed. The PC version of Q3A consistently provides the user with more useful information than the console version, and the information is laid out in a far more understandable and intuitive style. For example, in one section of the setup menu, Q3A offers 5 subcategories each containing several options. On the PC these 5 subcategories appear running down the left of the screen. When selected these subcategories remain on screen and the options included within appear on the right of the screen. The same content on the Sega Dreamcast™ is represented very differently. The 5 subcategories never appear on screen simultaneously. The user must recognise that the name of the first subcategory, which appears at the top of the screen, is actually a sub menu that can be manipulated to access the other four subcategories and their associated options. This is done by highlighting the name of the first subcategory and pushing left or right on the controller to scroll through the other available subcategories, the associated options then appear below each subcategory. It is suggested that the design implemented in the console version of the game is a far less intuitive and understandable than the design implemented in the PC version and that the former is likely to lead to frustration on the part of the user.

In the interest of further exploring this difference in the menus a small user evaluation was undertaken with two subjects who were asked to perform a task that involved negotiating the menu in question. When interacting with the Sega Dreamcast™ both users spoke of confusion when trying to find the option they were looking for. Moreover, both users made negative comments about the design of the interface when they realised what was required to access the subcategories. Such confusion and negative affect did not arise when the users interacted with Q3A on the PC.

The aforementioned cross-platform differences were all found within the menu system that is presented to users prior to actual gameplay. In terms of the interface displayed while gameplay occurs, both games were identical across platform. The input devices and associated controls differed, but the nature of the gameplay and the onscreen representation were the same.

4.2. Implications for affective design

These findings suggest that researchers interested in studying affective design in games (whether to improve games or other software applications) need to be aware that the menu systems (separate to the actual gameplay) can differ substantively across platforms. These differences are not limited to what could be expected based on physical differences between the platforms. Rather they extend to variations that can influence the affective impact of the games. It could be concluded that researchers interested only in the actual gameplay component of games may find very little evidence of cross-platform differences. However this ignores the possibility (dealt with in the next section) that although the gameplay looks identical across platforms, the differing input devices may make the games a qualitatively different experience in terms of user affect.

4.3. Cross-platform case studies of user's affective experience

The case studies incorporated semi-structured informal interviews to explore whether users' affective experiences differed across platforms. Potential subjects for the study were recruited informally via word of mouth. Subjects were screened on the basis of their prior experience with computer games. Inexperienced subjects were used as most potential subjects who had played the games before had played exclusively on one platform. It is believed that such subjects would be predisposed to preferring the familiar platform to the unfamiliar one. More broadly, irrespective of familiarity with the games used in the present study, it is suggested that subjects familiar with a particular platform might show a preference for that platform. The four subjects selected to participate in the study fulfilled the requirements that they had not played the particular games being used in the study before and that on average they played games for less than half an hour a week. The subjects were asked to play THPS2 and Q3A on a Sega Dreamcast™ console and on a personal computer (the computer had a Pentium III 733mhz processor, 256mb ram, a 32mb video card and a 16 bit sound card).

The subjects were a 25 year old male (referred to as m25), a 35 year old male (m35), a 23 year old male (m23), and a 33 year old female (f33). All subjects had completed or were in the process of completing tertiary education. Subjects played one title on both platforms and were interviewed regarding that title, they then played the other title on both platforms, and were interviewed regarding the second title and the differences between their experience of the platforms overall. Subjects played each game on each platform for approximately 15 minutes. Although it was expected that the longer subjects played a game the more chance they had of experiencing flow, this time limit was selected to ensure that subjects were not required to make an unreasonable time commitment in order to participate in the study. It should be pointed out that flow is not conceived as being a dichotomous variable, that is, people will experience varying degrees of flow in different activities. Thus, the study aimed to explore the extent to which users reported experiencing flow when playing each game on each platform. The order of the titles played and the platform on which the games were played were counterbalanced across subjects. Subjects were provided with an instruction sheet for each game which consisted of a diagram of the relevant control device with commands mapped to input points. During the semi-structured informal interview subjects were asked to report on their experience of the game on each platform, if they felt they were different, if they enjoyed one more than the other and why, and which they would prefer to play in the future. The key comments and ideas from each subject were recorded by the experimenter. The subjects were given a great deal of freedom in the interviews and encouraged to discuss any aspect of the games that came to mind.

Subjects expressed a strong preference for each game on one platform or the other. All subjects preferred Q3A on the PC and indicated that were they to play Q3A again they would prefer to play it on the PC, however opinions on THPS2 varied. In expressing their preference subjects made affect laden comments, for example, when discussing THPS2 m23 mentioned '… I can see that the game looks a little better on the computer, but playing on the [Sega] Dreamcast is still more fun', and f33 espoused, '…I had a good time playing both …but, [THPS2] was more satisfying on the computer'. The interviews conducted supported the general notion that games are a software application that successfully generates positive affect in users. However, researchers exploring affective design should be aware that the degree of positive affect generated for particular users can vary across platforms.

All subjects made unprompted direct references to the control system in the discussion of each game. This is perhaps unsurprising given that the gameplay itself is identical across platforms and hence, the most obvious difference is the input device. However, it highlights the relevance of the input device to the affective experience of a game and supports the idea that a sense of control is an important prerequisite for the achievement of flow. In discussion of Q3A, all users were positive about the control system on the PC relative to the control system on the Sega Dreamcast™. For example when discussing Q3A, m25 stated '… just easier to co-ordinate your hands on the PC version …', and 35m espoused that '… the movement keys on the computer were easier to get hold of'. There was far less consensus regarding the relative merits of the control systems for THPS2. For example, m23 mentioned '… [THPS2] … felt more natural with the [Sega Dreamcast™] controller … easier to work out what to do … more fun', whereas, m35 felt that ' … really prefer the computer 'cause the movement on the [Sega] Dreamcast is really hard to control … sloshing all over the place … computer was much better'. Thus, it does not appear to be a simple matter of certain games suiting particular control systems. Nor do particular users prefer one control system to the other irrespective of the game.

The comments made by subjects also support the idea of a state of flow occurring during gameplay. Although arguably the subjects may not have had time to experience flow during the case study, the comments made often implied an expectation that flow could or would occur during gameplay. When discussing the relative cross-platform merits of THPS2, m35 stated '… feel like the learning curve on the computer would be less … but the [Sega] Dreamcast is likely to become a more immersive environment…'. Similarly, m25 espoused that '… the [Sega] Dreamcast version was better at drawing me in … I felt more involved…'. The subjects indirectly alluded to the presence of certain components of flow during gameplay, in the absence of any knowledge of the relevance of flow to the study.

4.4. Implications for affective design

These results provide interesting insights for researchers exploring affective design. A variety of comments were made which stated or implied the experience of positive affect while playing the games. These comments support the basic assumption that games are a software application that can generate positive affect and thus, that research on games is likely to be informative for the design of non-leisure software. Moreover, the results of the present study raise the possibility that for different users, certain games are more enjoyable with certain control systems. The use of the mouse and keyboard is standardised across the majority of software applications, however the present study supports the idea that for some users increased positive affect may result from an alternative input device. Subjects also made spontaneous remarks that implied that flow could result from playing the games, highlighting the value of further research on the presence and precursors of flow during gameplay. Knowledge of the precursors of flow would benefit research on the generation of positive affect in non-leisure software applications.

Considering the results of the two studies together (the user-interface comparison and the user evaluation) it becomes clear that important cross-platform differences exist. The pre-gameplay user-interfaces differ and although the user-interfaces displayed during gameplay appear equivalent, users' affective experience of gameplay tends to differ across platform.

5. Discussion and Conclusions

It is important to explore the factors that lead to positive affect in software users. This paper attempts to facilitate further exploration of the precursors of positive affect in software users by considering some of the initial issues. Specifically, the paper shows that games are a software genre that can potentially contribute a great deal to the study of affective design as games contravene the accepted user-interface guidelines in ways that promotes positive affect and flow on the part of the user. Games often provide minimal information to the user, they employ context dependant commands, and they allow the user to make a variety of errors. Knowledge of the contraventions of usability guidelines which effect flow in games can be used to inform the design of non-leisure software applications. It should be noted that the thesis of this paper is that such knowledge is useful for the affective design of certain non-leisure software applications. It is not suggested that the affective design of all forms of non-leisure software will benefit from consideration of the interaction between flow in games and usability guidelines.

The contraventions and associated implications considered in this paper are not intended to be exhaustive. Rather they are considered to be the most important and informative examples which arose from the cross referencing of the literature on heuristics and game design. It is expected that further interactions and examples would result from comparisons of other areas of the HCI literature with game design.

The paper also highlights the fact that researchers interested in the ways games can inform affective design should be aware of the cross-platform differences that exist. Substantive design differences exist such that, a particular title cannot be considered to be identical on different platforms. Moreover, users' affective experiences of particular titles tend to differ across platforms.

5.1. Future research

Research should be directed towards ascertaining which non-leisure software applications or domains would benefit from the application of the findings from the present study. While it seems theoretically likely that educational software would benefit from the application of many of the findings described, this should be empirically confirmed and the potential applications in other domains should be considered. Moreover, further research is needed in order to validate and generalise the findings listed above. To date all research regarding the association of flow and games has been theoretical. Empirical confirmation of the association between flow and games would provide converging evidence for the existing theory and allow for more in-depth exploration of the causes and pre-requisites of the relationship. A deeper understanding of flow in games will contribute greatly to research on affective design. The value of such research is undeniable; after all, what is more important than a good time for the user?

References

BATEMAN and MATTHEWS. No date, *PCs Vs. Consoles.* Retrieved April 10, 2001, from the World Wide Web: http://www.gamecenter.com/Hardware/Roundup/Console/

BERGMAN, E. 2000, *Information Applicances and Beyond.* (San Diego: Academic Press).

CHEN, H., WIGAND, R.T., and NILAND, M.S. 1999, Optimal experience of web activities, *Computers in Human Behavior,* **15, 585-608.**

CSIKSZENTMIHALYI, M. 1992, *Flow: The Psychology of Happiness.* (London: Random House).

DIX, A., FINLAY, J., ABOWD, G., and BEALE, R. 1998, *Human Computer Interaction,* **2nd ed.** (Hertfordshire: Prentice Hall).

DRAPER, S.W. 2000, *Analysing fun as a candidate software requirement* [online journal article]. Retrieved February 15, 2001, from the World Wide Web: http://medusa.psy.gla.ac.uk/~steve/fun.html

HELANDER, M. G., LANDAUER, T.K., and PRABHU, P.V. (eds.) 1997, *Handbook of Human-Computer Interaction.* (Amsterdam: Elsevier Science).

HENRY, K., and HAUSE, K. 1999, *Videogame Consumer Segmentation Survey, 1999*. Retrieved February 19, 2001, from the World Wide Web: http://www.itresearch.com/alfatst4.nsf/unitabsx/W20237?openDocument&q=games

JOHNSON, J. 1998, Simplifying the controls of an interactive movie game, *Proceedings of the Computer Human Interaction Conference,* (New York: CHI).

JONES, M.G. 1998, *Creating engagement in computer-based learning environments*. Retrieved April 12, 2001, from the World Wide Web: http://itech1.coe.uga.edu/itforum/paper30/paper30.html

NEWMAN, W., M. and LAMMING, MICHAEL, G. 1995, *Interactive System Design.* (Essex: Addison Wesley Longman).

NIELSEN, J., and MOLICH, R. 1990, Heuristic Evaluation of User Interfaces, *Proceedings of the Computer Human Interaction Conference,* (Seattle: CHI).

NIELSEN, J. 1994a, Enhancing the explanatory power of usability heuristics, *Proceedings of the ACM Computer Human Interaction Conference,* (Boston: ACM CHI).

NIELSEN, J. 1994b, Heuristic evaluation, in Nielsen, J. and Mack, R.L. (eds.), *Usability Inspection Methods*, (New York, NY: John Wiley & Sons).

O'DONOGHUE, T., and RABIN, M. 2001, Addiction and Present-Biased Preferences. Unpublished manuscript, Retrieved June 6, 2002, from the World Wide Web: http://www.people.cornell.edu/pages/edo1/addicts.PDF .

PAUSCH, R. 1994, What HCI designers can learn from video game designers, *Proceedings of the ACM Computer Human Interaction Conference,* (Boston: ACM CHI).

PICARD, R. W. 1997, *Affective Computing.* (Cambridge: MIT Press).

RASMUSSEN, J. 1986, Information Processing and Human-Machine Interaction, in A. Sage (ed.), *System Science and Engineering*, (vol. 12). (New York: North-Holland).

SHNEIDERMAN, B. 1992, *Designing the User Interface.* **2nd ed.** (Reading, Massachussets: Addison-Wesley).

Table 1. The components of flow and the manner in which they are manifested in video games.

Component of Flow*	Manifestation in Video Games
A task that can be completed	The use of incrementing levels in games that culminate in the completion of the game. Also, most games allow the player to select an appropriate difficulty level
The ability to concentrate on the task	Games often use detailed worlds that draw the user in
The task has clear goals	Goals are consistently present in games although the topic is varied e.g. save the princess, build a civilisation
The task provides immediate feedback	Feedback is consistently included in games although the form is varied e.g. points, the vanquishing of foes
Deep but effortless involvement	Such semi-automatic immersion is commonly reported by game-players and also by those who observe them
Exercising a sense of control over actions taken	Mastery of the control system is an important part of most games
Concern for self disappears during flow but sense of self is stronger after the flow activity	Many games user a metaphor which allows for greatly reduced concern for self during gameplay e.g. shooting games, extreme sport games
Sense of duration of time is altered	Many games run on an altered time system, moreover, many game-players report devoting entire nights or weekends to playing games without being concurrently aware of doing so and/or without consciously deciding to do so

* In addition to these components, in an article considering the value of flow (and fun) as a software requirement, Draper (2000), suggested that Jones' list should include reference to the sense of engagement experienced during flow. A strong sense of engagement is a commonly reported experience of game-players.