Putting Some Emotion into Requirements Engineering

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Abstract

Sometimes, people just like to use a system for the sake of using it. Perhaps it is fun, enjoyable, or intriguing. Emotions like these have often been neglected while formalising requirements. The study described in this paper begins to explore these emotional elements and how they can be formally addressed in the requirements and design processes as a quality attribute. The study also suggests some possible gauges of emotional experience and design elements that may contribute to this.

Keywords:

requirements; affective; affect; software; design; emotion

1. Introduction

Imagine that you are developing an educational program to teach geography. This program must be able to identify countries, their capitals and their flags, provide key characteristics of each of these countries, and also have an option to explore a country in more detail (typography, geology of the land, people and culture, languages). This educational program would be quite powerful. Yet if these functional requirements are all that were addressed in the design it would be difficult to get many people interested in using it. It would be boring.

With educational software people must be motivated to use it. If a person is internally motivated then they will both be more receptive to the information and they will learn more (Brown, 1988). One accepted method to encourage learning is to make it fun, engaging, or enjoyable – and this especially holds true in educational software. In fact, one software type that has stemmed from this is edutainment. "Where in the World is Carmen Sandiego?" is one early edutainment program that recognised motivation as the key factor, and was successfully used around the world to assist in teaching geography. Many times, people used this program by choice simply because it was enjoyable!

Educational systems are not the only type of system that attracts this emotional element. Haptic computing attempts to provide a user with an 'overall experience', computer games must be engaging to be successful, interactive toys for children must be fun, some websites are designed solely to provide the user with a 'good experience' (e.g. see Mont-Blanc website at www.montblanc.de), and many mobile devices are sold according to the colour of the display or the different games they have.

These emotional factors described are often termed 'affective factors' or simply 'affect', and this is the terminology that is used throughout this document.

Consider the following actual situation:

> Recently, a Melbourne based web-development company was hired by two municipal governments to redesign their web sites. The two governments required near-identical functionality, and had very similar informational content. However, one client required their site to be very traditional and focus on information delivery; the other client required their design to be "stylish and fun".

The two resulting designs bear little resemblance to one another. The site intended to be fun and stylish is generally considered to be much more engaging to the user, and it encourages the user to explore the site. The information driven site is just that: people use the site, find their information, and leave – they have no desire to see what else there is. Recall, these two sites had essentially the same functional requirements and underwent a similar design process by the same designers, yet the need to convey a different affective response greatly changed the entire product.

Given that requirements give the constraints on how a system should behave, then it is important to see that 'affective requirements' are considered a valid category of requirement. Designing to elicit an affective response is more complicated than simply choosing the right colours – it is inherently part of the overall interaction design.

Accepting that affective factors make valid requirements raises the following questions:

- How does an organisation elicit and document affective requirements?
- How does an organisation design to meet affective requirements?
- How does an organisation validate that the design elicits the required affective response?

To answer these questions, the issue of affect must first be explored and better understood within the context of systems design. This paper presents preliminary results from a study that explored affect and elements of design that lend themselves to creating a positive affective experience. Computer games were targeted because their success basically relies on the pleasure, excitement, engagement, and enjoyment that they bestow on the user, and thus were considered ideal for exploring the concept of affect. The discussion of these results explores how it may be possible to address the questions above, and identifies areas that need further research.

2. Background

Norman (2002) commented in a recent article that colour monitors, when first introduced, offered no productivity benefit. There was nothing that shading could not do on a black and white monitor that a colour monitor could do. In truth, the first colour monitors were actually worse than the black and white monitors, being much lower in resolution. Despite this, the majority of people who were exposed to a colour monitor refused to return to black and white.

Requirements elicitation techniques focus on identifying the utilitarian aspects of software. The functionality and usability of a system, the ability to maintain the program, and the reliability of the program are some issues that are addressed. If this was all that was necessary for successful products, people would have continued to use black and white monitors until colour achieved the same resolution. The need to make something fun, engaging, or enjoyable is usually not considered in requirements elicitation. Software requirements for these and other affective factors are never truly captured in an official manner.

Juran is credited with coining the phrase "fitness for purpose" (for an example of his work, see (Juran & Godfrey, 1998). In his view, the suitability of the product for its intended use is the determinant of its quality. If a system is intended to be a leisure product then the 'fitness for purpose' must also extend to affect.

2.1 The Rebirth of Affect in Design

The idea that system developers and designers should take note of affect is not new. Malone and Lepper (1987) outlined 'four plus three' heuristics to create internally motivating interfaces (discussed in section 3.3). The following year, Carroll and Thomas suggested that researchers consider 'fun' and the possible implications it has on system design (Carroll & Thomas, 1988). However, in subsequent years little work ensued on affect and design, and it was not until recently (approximately the last 5 years) that affect has re-emerged as a potentially desirable design characteristic.

One of the visionaries of this re-emergence was Robert Glass from Sun Microsystems, who said:

> "If you're still talking about ease of use then you're behind. It is all about the joy of use. Ease of use has become a given – it's assumed that your product will work." (Glass, 1997)

Though the entirety of his statement is arguable, the sentiment remains that he recognised joy as fundamental in many new designs.

Draper was outright in his statement that designers must consider 'fun' as a valid software requirement (Draper, 1999). He provided examples where, without fun, the system would not have succeeded. He continued by suggesting possible avenues for people in computing to understand and designing for fun, some of which are only now being brought to fruition.

Additional research into affect is summarised in Table 1.

Affective Factor	Reference	Summary of Work
Beauty	(Karvonen, 2000)	Looks at beauty and how it relates to aesthetic design
Aesthetics	(Lindgaard, 2001)	Has found that people may like a web site for its aesthetic appeal, despite poor usability
Enjoyment	(Hassenzahl, Beu, & Burmester, 2001)	Has classified the attributes of enjoyable interfaces and related them to hedonic design principles
Fun	(Kersten-Tsikalkina & Bekker, 2001)	Has looked at the relationship between fun and usability for children's toys

Table 1: Summary of research into affective factors

A significant amount of knowledge has been gained from this recent research. Theories regarding why people want positive affective experiences have been put forward, and designs that elicit these experiences have been dissected in an attempt to understand what it is that creates the experience.

However, much of the research has remained at the theoretical level, and so far has not been tested. One of the goals of the study described herein was to test three theories related to affect and computing to see if they actually do apply to affective experiences. This study also forms the basis of a research program targeting affect, how to elicit affective requirements, how to design for affect, and how to measure the experience.

3. Exploring Affect

If we wish a product to be engaging, what are the tangible attributes we can specify for it to have? This section highlights some of the postulated factors observed in research and practice.

Three theories have each been said to contribute to computer game enjoyment. To explore these theories, the participants in this study rated each aspect of the theories to see if and how each of them applies. The theories used were usability, flow, and heuristics for designing internally motivating interfaces. The three theories are described in more detail in the following sections.

3.1 Usability

In ISO 9241-11 (ISO, 1998), usability is characterised as consisting of three elements: effectiveness, efficiency, and satisfaction.

Grice (2000) attempted to apply these three elements to computer game design. His hypothesis was that computer games that were enjoyable will have high levels of efficiency, effectiveness, and satisfaction. Some minor experiments conducted under his supervision seemed to indicate that this hypothesis was true.

One issue relating to his conclusions was that all experimenters appeared to be biased towards finding usability as a contributor towards computer game enjoyment. Reading through the studies, one can find examples where a response of a participant was interpreted as being a factor of usability, where an unbiased observer may contribute it to another quality. For example, in one study an experimenter suggested that an ice hockey game would be more learnable (and enjoyable) for non-hockey players if the user was able to gather more information about the players on their team. What they failed to realise was that non-hockey players may not enjoy the game simply because they do not enjoy the context of hockey.

3.2 Flow

Csikszentmihaly describes flow as 'the holistic sensation that people feel when they act with total involvement' (Csikszentmihaly, 1975). In the state of flow, actions flow without conscious intervention by the actor. The term *flow* was used because people in this state often said that they "were in the flow of [the activity]".

The original studies by Csikszentmihaly that led to the concept of flow surveyed modern dancers, chess players, rock-climbers, classical composers, and basketball players – each of whom described the state of flow similarly despite the activities being vastly different. These studies began to look at why people engaged in activities that offered no reward except for the activity itself. In the first study, he asked participants from these groups to rank reasons for enjoying these activities. The participants consistently answered that the experience and the use of the skills, the activity itself (pattern, action, and the world it provides), and further development of skills were the top three reasons for engaging in an activity. In summary – people engaged in these activities because they enjoyed the internal rewards that the activity offered, and did not see external rewards as a vital aspect to participate in an activity.

With further research into flow Csikszentmihaly defined the characteristics of flow-inducing activities, the result being the following characteristics (Csikszentmihaly, 1990). The user:

1. must feel capable of completing the task;
2. must have the ability to concentrate on task;
3. clearly recognises the goals of the task;

4. receives immediate feedback about task performance;
5. is removed from the awareness of worries and frustrations of the external world;
6. has a sense of control over their actions;
7. loses the awareness of themselves, yet has a stronger self-image after the activity; and
8. has the sense of time altered: hours can seem like minutes.

These elements, combined in a single activity, are said to cause a sense of deep enjoyment so rewarding that people are willing to expend a great deal of energy simply to feel it.

According to Csikszentmihaly (Csikszentmihaly, 1975), 'games' are obvious flow activities, though his early consideration of games in 1975 probably did not include computer games. In Draper's discussion of computer games (Draper, 1999) he suggests that the concept of flow may be able to explain the appeal of computer games, as well as other types of software that are intended to bestow a user experience.

3.3 Heuristics for internally motivating interfaces

Malone (1983), in agreement with Csikszentmihaly, believes that fun and enjoyment only arise from activities that are intrinsically motivated. Though Malone does not negate the possibility of an activity being performed to achieve external rewards, he does believe that if the activity is to bestow a positive affective experience then the overriding reason for participating must be internally motivated. Computer games are thought to be played because of intrinsic motivation, with no expectation of a reward other than the activity itself (Draper, 1999).

Malone and Lepper (1987) developed seven heuristics for the design of intrinsically motivated interfaces for instructional environments. They believe that if these characteristics are included in the design of a system that people will be intrinsically motivated to learn and actually enjoy learning – provided that the motivational elements do not deter from the software's instructional capabilities. Of these seven heuristics, four of them were considered major factors, with the remaining heuristics considered minor. The major factors related to intrinsic motivation, and the minor factors related to external motivation.

The 4 major heuristics are:

1. Challenge – The interface should have multi-layers of challenge so that the user will feel initial success, and continue to see improvements (sense of accomplishment)
2. Curiosity – The interface should lead users to believe that their knowledge structures (or skills) are incomplete or inconsistent, and make the user want to strive to solidify these
3. Control – The interface should make the user feel that the outcomes are determined by the users own actions
4. Fantasy – The interface should evoke mental images of physical or social situations not actually present, and should be designed to the emotional needs of the user and so that the user can identify with the characters within the interface

The minor factors include:

1. Competition – The interface should provide the user with some method of comparing their skills with other users' or to benchmarks set within the system

2. Cooperation – The interface should allow the user the opportunity to work with others (system or other users) to promote interactive learning in a social environment
3. Recognition – The interface should allow the user to recognize the purpose of the interface elements presented to them

The addition of the minor factors suggests that Malone and Lepper recognize the influence that external rewards can have upon an individual's affective experience. They were labeled as minor factors because they still believe that internal motivators are much stronger, and these will influence affective experiences the most.

4. The Study

A questionnaire was developed to study the relative importance of the factors in section 3. Participants were requested to select a computer game of their choice and to rate the relevance of these factors to their enjoyment. The survey instrument collected general demographic data as well. Details of the participants, the survey instrument, and procedure are described in more detail below.

4.1 Participants

Participants were recruited from several e-mail list-serves. These list-serves were either related to the field of HCI or computer gaming. According to the information about the number of subscribers to each list-serve, approximately 5000 received the posting. It is impossible to discern if all e-mail addresses were valid, and it is also impossible to discern how widely the posting was distributed beyond this initial group. It is known that approximately one third of participants indicated that they received the link from friends, suggesting that the e-mail posting was quite widely distributed.

To ensure that the participants recruited from the internet list-serves were actually a 'real-population' (i.e. the form was not filled out randomly by participants) the survey was also administered to a defined population consisting of 25 post-graduate students at an Australian University. Comparing the internet population to the defined population, no significant differences were found with respect to their reasons to play various types of computer games confirming that the internet population was 'real', and subsequently the two populations were combined for the remainder of the analysis.

303 people participated in the survey. Detailed demographics are presented below.

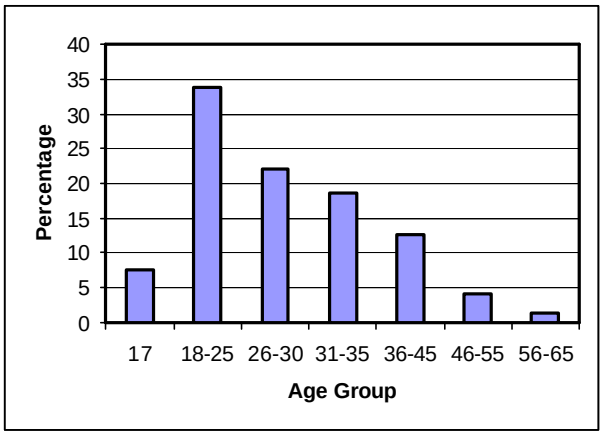

Figure 1: Age group of participants

The age breakdown of respondents does not conform to a survey conducted by the Interactive Digital Software Association (IDSA, 2001) where they found that 42% of people who play computer games are above the age of 35. This study indicated approximately 37% of participants were above the age of 30, and only 18% of participants above the age of 35. It is expected that the computer game list-serves that were targeted were comprised primarily of a younger audience, and that this audience was also expected to be more interested in completing the survey.

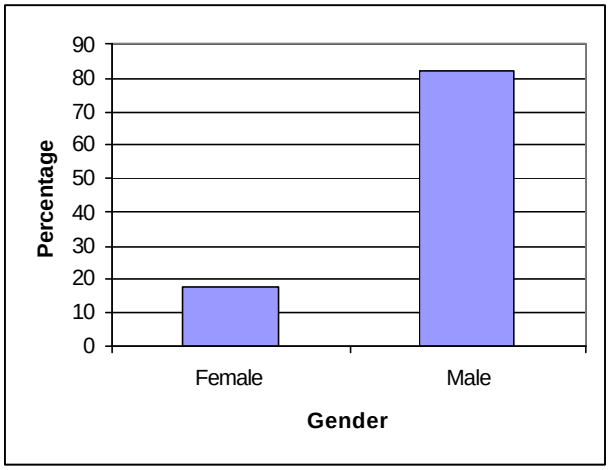

Figure 2: Gender of Participants

The IDSA (2001) found that 43% of computer game players are female, so the results in this survey are much lower than could be expected. Again, this disparity is likely the result of the list-serves that were targeted as the computer game list-serves are likely to be dominated by males.

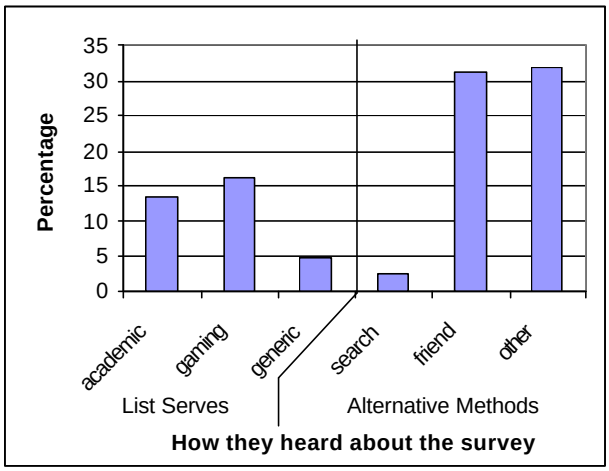

Figure 3: How participants heard about the survey

Figure 3 represents how the participants found out about the survey. The purpose of this demographic was to indicate the amount of devotion each participant has towards computer games, with people from computer gaming list-serves likely to be more 'devoted'. Many people heard about this survey through friends and many people selected 'other'. One possible reason for the high number of participants selecting 'other' was that a link to the survey was found on a widely read website, and this possibility was not catered for in the responses that the users were able to choose from.

4.2 Materials Used

The survey contained three main sections: *Demographics; Reasons for playing computer games;* and a *Comments* section. Participants were given the option to nominate and rate up to three different computer games. The results of the survey were automatically submitted to a MySQL database, and security precautions against MySQL hacking were programmed into the survey.

Section A: Demographics. The aim of this section was to obtain demographic information from the participants. Respondents were asked to report their age, gender, occupation, computer game playing habits (number of games played regularly, and genre preference), and where they heard about the survey.

Section B: Reasons for playing computer games. This section requested participants to rate 19 reasons for playing a computer game that they nominated and that they enjoy. This section first asked the participant to identify the game they enjoy, subjectively rate the enjoyment, approximate the time that they spend playing this computer game, and then rate the reasons for enjoying that game. Participants responded on a five point scale from highly agree to highly disagree, with the additional option of selecting 'Not Applicable' if the participant felt that the reason posed did not apply to the game they were rating.

Section 4: Comments. An open ended question was also provided at the end of the questionnaire to elicit any further comments that the participant had regarding why they enjoy the computer game, but was not covered in the survey.

4.3 Procedure

Prior to distribution of the e-mail posting, all targeted list-serve moderators were contacted to ensure that the distribution of the post is permitted. Following approval, the e-mail post containing a brief description of the study and a link to the survey website was distributed.

People who arrived at the website were provided with details of their role should they decide to participate, and were assured that no extra data except for what they enter would be collected. This was done to alleviate fears of providing information over the internet.

Upon accepting these arrangements, participants were requested to provide some generic background information. Following this, participants could elect to rate up to 3 computer games of their choice on 19 different reasons for enjoying a computer game on a 5 point scale ranging from 'Definitely Disagree' to 'Definitely Agree'. No data was submitted until participants entered all information on the form for that game. This was to ensure that only completed data sets were submitted.

5. Results

As discussed in section 4.1, there was disparity between this survey and the survey conducted by the IDSA (2001). The IDSA survey was more comprehensive, targeting thousands of households in the United States of America, and has been considered representative of computer game players world-wide.

To ensure that the demographics of the participants in this study did not influence the results, comparisons were made within each of the demographics of age, gender, and how people found out about the survey.

Regarding age, there were no differences in the reasons people play a specific computer game genre. It was found that as participants were in higher age groups their choice of games

tended to switch towards individual and mentally active games rather than games relying upon reaction time and coordination of controls.

In a comparison between genders it was found that male and female computer game players play individual genres of games for the same reasons. However females tended to play more simulation and 'individual' style games.

How people found out about the survey also did not have any significant effect on the reasons for enjoying computer games. This indicates that people from a wide range of devotion to computer games will still enjoy games for the same reasons. It must also be noted that the number of people who found out about the survey from 'other' or 'friends' will moderate this result, as their devotion to computer games is unknown.

5.1 Predictors for Affect

Standard multiple linear regression was used to determine which of the 19 reasons most greatly predicted the enjoyment of computer games. The independent variable was enjoyment rating, and the dependant variables were the 19 individual factors. Results of the regression are shown in Table 2. Highlighted variables are significant at the $p<.05$ level.

	Unstandardized Beta	Standardized Beta	Sig.	Meaning
(Constant)	.452		.000	
Ability to Concentrate	.005	.013	.808	
Computer Competition	-.010	-.031	.542	
Clear Goals	-.023	-.072	.203	
Learnability	.047	.166	.002	Less learnable predicts increased enjoyment
Feedback	-.071	-.171	.001	More feedback predicts increased enjoyment
Distraction Element	-.021	-.059	.246	
Control over actions	-.029	-.085	.113	
Efficiency	-.009	-.029	.614	
Computer Recognition	.030	.104	.108	
Self Image	-.070	-.217	.000	Increased self image after use predicts increased enjoyment
Self Competition	.014	.049	.461	
Loss of Time	.029	.101	.043	Less 'Loss time' predicts increased enjoyment
Effectiveness	-.014	-.042	.396	
Curiosity	-.048	-.146	.004	More curiosity predicts increased enjoyment
Attribution	.003	.010	.850	
Fantasy	-.019	-.049	.342	
Challenge	-.031	-.059	.228	
Cooperation	-.034	-.117	.047	More cooperation predicts increased enjoyment
Peer Recognition	.000	.000	.999	

Table 2: Results of standard linear regression

The R square value for this regression was .225. The variables which most greatly predicted computer game enjoyment were a reduced learnability of the game, high feedback, increased perception of self, not 'losing time', increased amount of curiosity, and increased cooperation.

5.2 Further analysis and interpretation

As mentioned in the introduction, this study is a preliminary presentation of results, and a complete data analysis is still underway. However, some unexpected results from the linear

regression were targeted for further exploration to assist in the interpretation. The results being referred to are the learnability and 'losing time' reasons. To further analyse these results linear regression was again performed, however this time each genre of computer game was considered individually.

Learnability

Further exploration into learnability showed that for games where real-time strategy and skill are involved (such as first person action games, real-time role-playing games) learnability is considered a detriment for the game. To perform well at this style of game takes a high level of coordination between strategy and control manipulation – essentially reaction time. Players of this style of game probably pride themselves on achieving this coordination of control and strategy, and this is partially where enjoyment stems from.

For all other genres of computer games (individual games such as Tetris and solitaire, turn-based style games, and simulation games) learnability was a benefit to the game. For these latter genres, the games tend to require minimal manipulation of the controls (it may require frequent minor changes or infrequent major changes) which is vastly different from the genres relying upon reaction time. Players of this genre would prefer a learnable game because success or continuation of the game relies primarily on cognitive strategies developed. One specific genre, simulation games, has no success criterion attached to it and learnability would be an asset because the player could get involved in the game immediately without the need to learn many commands.

Loss of Time

For all computer game genres less 'loss of time' predicts computer game enjoyment. The specific statement that the participants responded to was "I enjoy this computer game because it makes time seem to go faster - hours can pass by in minutes".

Games that do cause 'loss of time' are the ones that truly engage the user, and are most often the computer games that are enjoyed the most. A person who does get caught up in computer games enough to have their sense of time altered probably recognises this as a bad thing, so therefore it does not increase their enjoyment. Thus the result must be re-interpreted as "When I lost time in a computer game it is a game that I really enjoy. However I recognise losing time as 'bad' and therefore losing time itself does not increase my enjoyment, it is a side-effect of my enjoyment".

5.3 Survey Comments

The survey comments have not been analysed in any formal manner at this time. However, reading through the comments one trend was the indication that the survey did not account for the aesthetic appeal of some computer games. Some sample comments are as follows:

- It is graphically very appealing.
- I enjoy the game because of the graphics, physics, level and map design.
- Looks great!
- Love the cheesy voice overs and acting.
- I enjoy the game because of its highly cinematic effects, its cleverly designed space and the innovative take on horror film conventions.

It should be noted that flow and the heuristics for designing intrinsically motivating interfaces were each developed prior to high quality graphics becoming standard, and therefore did not thoroughly address the issue of aesthetic appeal. The concept of usability is intended for production contexts, in which aesthetics is seen as a bonus but not a need.

Therefore, in addition to the predictors of enjoyment already identified, the comments data suggests that aesthetic appeal can also increase the positive affective response of a user. This would be inline with research conducted by both Lindgaard (2001) and Karvonen (2000).

Many other comments also related to the ability to play against others online. Malone and Lepper's heuristics address competition, and the survey expanded this to include both competition against the system or computer, and competition against other real-life players. It would seem that participants who play computer games online clearly wanted this reason to be emphasized in this survey.

6. Discussion

The main questions that must be answered before it is possible to incorporate affect into current requirements engineering practices relate to:

- How does an organisation elicit and document affective requirements?
- How does an organisation design to meet affective requirements?
- How does an organisation validate that the design elicits the required affective response?

While the study did not provide any insight into elicitation and documentation of these requirements, some ideas are presented in section 6.1. However, the results of the study did suggest some design characteristics (6.2) and possible validating metrics for affective requirements (6.3).

6.1 Elicitation

Methods to elicit affective requirements need to be developed further. Robertson (Robertson, 2001) compares and contrasts 15 different requirements elicitation or 'trawling' techniques, but her comparison offered no discussion of how to extract requirements related to affect. She focused primarily on what a system must do and how to do it – not what experience the system must impart on the user.

The method used by the web-design company mentioned in section 1 was a toned-down version of the repertory grid technique. In this method, several different concepts are contrasted and the client must 'select' which they would prefer. This technique requires that many (often 10+) design styles are compared and contrasted. Each design style may be compared with more than one item. This technique can capture the overall user-experience that is desired by selecting appropriate terms to contrast. Figure 4 shows an example:

Fun	|----|----|----|----|----|	Information Driven
Information Driven	|----|----|----|----|----|	Graphically Driven

Figure 4: Example of pseudo-repertory grid technique for affective requirement gathering

Other requirements elicitation techniques, such as the ones discussed in Robertson *et al.* (1999) may also lend themselves to the discovery and documentation of affective requirements.

6.2 Design

The study seemed to suggest that designable elements to elicit positive affective responses from a user include:

- Decrease the learnability of the system if it is to depend upon high level motor skills, therefore creating 'pride' in the user when they achieve a high level of performance.
- Increase the learnability of the system if use of the system depends highly upon cognitive skills, allowing the user more time to focus on the problems presented rather than trying to learn how to use the system.
- Keep the user curious as to what will happen next.
- Increase the amount of cooperation required between users, increasing social interaction where each person is striving to achieve a common goal.
- Increase the aesthetic appeal of the interface by including high quality graphics, sounds, and images appropriate to the design.

These design elements are possibly extreme for many systems, and must be used when appropriate – requirements engineering involves bartering and trade-offs between different requirements. If the system is to depend heavily on affective responses of users, it may be most appropriate to include most of the design elements described above in section 6.2. For other systems, these design elements may detract from the overall productivity of the user, and must be chosen accordingly.

6.3 Validation

To validate the success of the design in eliciting this positive affective response it would seem appropriate to measure:

- The self-image of the user following the use of the system (does the user have an improved self-image following system use);
- Whether the user 'loses time' while using the system.

Even though these are proposed bases for validation, how is it possible to actually measure them objectively? Both of these could be measured subjectively by asking the users how they rate these two variables, but that is not ideal. One alternative is to measure a predictor of these that is objective. For instance, it is postulated that physiological measures (such as heart rate or blink rate) may predict whether a user is in the state of flow. Knowing if the user is in the state of flow would be useful to determine as each of these validation characteristics are components of flow.

6.4 Making Affect a Requirement

Reviewing requirements engineering practices, the only quality requirement that directly deals with the user is usability. Bentley *et al.* (2002) recognised this and proposed to extend the concept usability to include affect, and re-label it as user-experience. Their conceptual model, shown in Figure 5, has been extended by the results from the study described to show that the 'affective factors' component could notionally be subdivided into distinct categories.

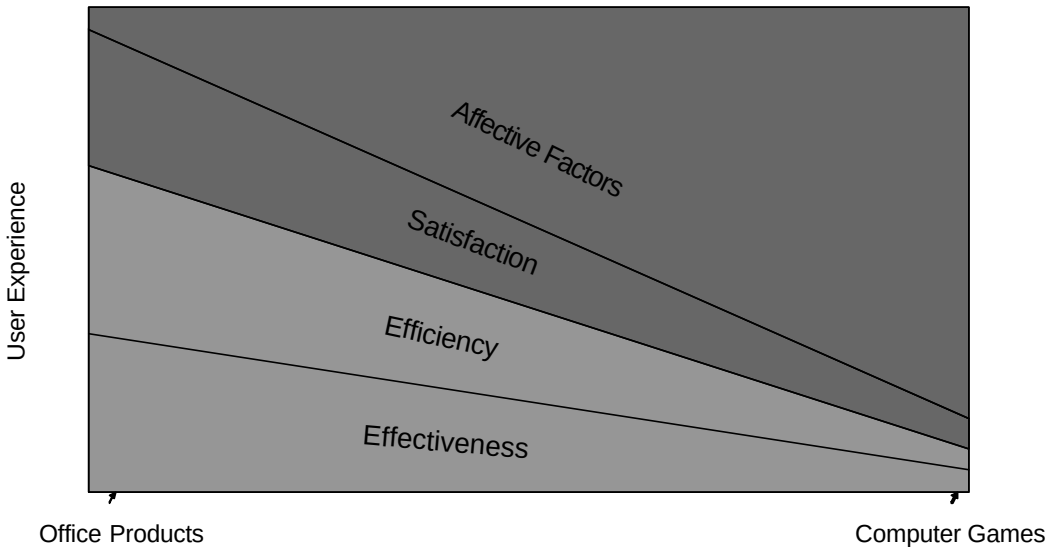

Figure 5: The model of user experience, with notional divisions for affective factors

Very few systems, if any, would be truly represented at a single point along the continuum between office products and computer games as shown in Figure 5. Attempting to make a more realistic model of user experience, Bentley *et al.* adapted an equation from McCall *et al.* (1977) showing that user experience is actually the weighted sum of effectiveness, efficiency, satisfaction, and each identified affective factor.

$UE = \sum w_i \times m_i$ (where m_i is the metric for the i^{th} factor, and w_i is a weighting for that factor)

The affective factors to consider into this equation were not determined in this study. Rather, this study explored designable elements for positive affective experiences and some possible ways to measure these. Table 1 provides a short list of affective factors that could be used in this equation. The limitation of this list lies in the lack of knowledge of how to actually design and measure these. The results discussed in this study begins to shed light on this issue.

7. Conclusions and Future Work

Clients wanting to impart an affective experience to a user are becoming more common. Systems are no longer being designed solely as functional or productivity devices. Most commonly, they seem to be a combination of entertainment and function (i.e. mobile phones, edutainment).

The study described and the ensuing ideas within this paper suggest how affect could be looked at as a requirement. Certainly it will not be a key requirement for all systems, but this is true of most categories of requirements. Bartering and making trade-offs between different requirements is common for any person involved in design. If the success (either sales or use) of the system depends greatly upon the affective factors, then the design must be done with that in mind. Other quality goals may be sacrificed, and *vice versa*. Formalising these affective experiences in terms of requirements will ensure that these issues are addressed at the beginning of the design process. It is not always possible to add affective qualities later.

There is undoubtedly more work to be done to understand this area of affective requirements. The issue of how to elicit affective requirements must be explored further. Also, the results of

this study must be confirmed by seeing if the elements of design described can actually enhance the affective experience, and to see if it is possible to validate a design that has affective goals. Finally, the issue of how to incorporate and include affective requirements as part of established requirements engineering techniques must also be looked at.

8. References

Bentley, T., Johnston, L., & von Baggo, K. (2002): *Designing for Software Quality*. HF 2002.

Brown, A. L. (1988): Motivation to Learn and Understand: On Taking Charge of One's Own Learning. *Cognition and Instruction*, 5, 311-321.

Carroll, J. M., & Thomas, J. C. (1988): Fun. *SigCHI Bulletin*, 19(3), 21-24.

Csikszentmihaly, M. (1975): Beyond Boredom and Anxiety. Jossey-Bass Publishers.

Csikszentmihaly, M. (1990): Flow: The Psychology of Optimal Experience. Harper Perennial.

Draper, S. W. (1999): Analysing fun as a candidate software requirement. *Personal Technology*, 3(1), 1-6.

Glass, R. (1997) The Looking Glass [Web Page]. URL: http://www.sun.com.au/news/onsun/1997-10/page6.html [Last Accessed on 2002, August 26].

Grice, R. (2000): *I'd Rather Play Computer Games Than Do Real Work. Wouldn't You?* Make it easy Conference 2000: IBM.

Hassenzahl, M., Beu, A., & Burmester, M. (2001): Engineering Joy. *IEEE Software*, 18(1), 70-76.

Interactive Digital Software Association. (2001). State of the Industry Report, 2000-2001.http://www.idsa.com/releases/SOTI2001.pdf: IDSA.

ISO. (1998). ISO 9241: Ergonomics requirements for office work with visual display terminals. Section 11: Guidance on Usability Specification and Measures.ISO.

Juran, J. M., & Godfrey, A. B. (1998): Juran's Quality Handbook. (5 ed.)McGraw-Hill Education.

Karvonen, K. (2000): *The Beauty of Simplicity*. ACM Conference on Universal Usability (pp. 85-90).

Kersten-Tsikalkina, M., & Bekker, M. (2001): *Evaluating Usability and Fun of Children's Products*. The International Conference on Affective Human Factors Design .

Lindgaard, G. (2001): *Aesthetics and Usability* . Presentation for Ergonomics Society Australia and CHISIG.

Malone, T. W. (1983): *Heuristics for designing enjoyable user interfaces: lessons from computer games*. CHI 1982 Special Issue of SIGCHI Bulletin: ACM. Pages 63-68.

Malone, T. W., & Lepper, M. R. (1987). Making learning fun: A taxonomy of intrinsic motivations for learning. Conative and affective process analysis (Vol. 3). London: Lawrence Erlbaum.

McCall, J. A., Richards, P. K., & Walters, G. F. (1977): Factors in Software Quality, Volumes 1, 2, and 3. Springield, Virginia, USA: National Technical Information Service.

Norman, D. A. (July 2002). Emotion & Design: Attractive Things Work Better. ACM Interactions. (pp. 36-42).

Robertson, S. (2001): Requirements trawling: techniques for discovering requirements. *International Journal of Human-Computer Studies*, 55, 405-421.

Robertson, S., & Robertson, J. (1999): Mastering the Requirements Process. Addison Wesley.