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An Entertainment-System Framework for Improving Motivation for Repetitive, Dull and Monotonous Activities

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1. Introduction

Much significant research has been done to improve the efficiency of activities, based in large part on continuing improvements in computer power and refinements to computer interfaces. However, such improvements will inevitably reach a limit and even today, in our ordinary daily activities, we are hardly aware of things such as higher CPU frequency. Consequently, we do not expect to see further improvements in efficiency, simply due to improved computer power or refined compute interfaces. If we have little motivation to perform the activities. Although some kinds of activities are automated and others are creative enough to maintain motivation, many dull activities are not yet or cannot be automated.

If we can improve our motivation for some activities, the efficiency and/or productivity with which we perform them can improve. According to the Hawthorne effect, human activity is influenced by psychological effects (Sonnenfeld, 1983). Therefore, a desirable stimulus can improve motivation. To put this effect into practice, I have attempted to introduce entertainment into daily activities for which we normally have a low motivation. Entertainment provides us with fun and escape from dullness; therefore, it is effective for improving motivation.

Entertainment is commonly applied to education, and many studies in computer-supported learning support its value. This area is known as “Edutainment” (Pan et al., 2008). However, its application to daily activities is recently being studied in computer science. Applying games to computer administration tasks, as suggested by Chao, points out that the game interface has large power of expression and can be made intuitive for children and non-technical users (Chao, 2001). However, the author did not discuss the effect of entertainment on improving user motivation.

In this chapter, I present a framework of entertainment systems, called EELF (Entertainment-for-Everyday-Life Framework), and propose a method for introducing entertainment directly into repetitive, dull and monotonous activities. I discuss the following:

- The nature of target activities that are repetitive, dull and monotonous
- The structure of EELF
- How EELF stimulates motivation for such activities

I introduce the following four EELF-based systems; Weekend Battle, ExS, MIPS, and VASC.

2. Entertainment for Daily Activities

Many repetitive activities are dull and monotonous but must be done, such as inputting an enormous number of answers to inquiries, jogging every day for health, and performing Hanon piano exercises.

Such activities are generally:

- Monotonous
- Not creative
- Not fun

To stimulate motivation for such activities, I address these three characteristics by introducing entertainment into the activities. The entertainment should satisfy the following three conditions:

1. It should reflect and represent our efforts (corresponding to A).
2. It should provide something new and attractive (corresponding to B).
3. It should be fun (corresponding to C).

Fig. 1. Overview of EELF

Fig. 2. Sample character representation

Fig. 3. Sample change patterns for a character

3. EELF

EELF (Entertainment-for-Everyday-Life Framework) is an entertainment-system framework for improving and maintaining motivation for daily activities. It has three components: character (avatar) creation, effort estimation, and competitive game. Figure 1 shows an overview of EELF.

3.1 Character Creation

An EELF-based entertainment system, in response to condition 1, has a character-creation component. Each system user creates his/her own character, or avatar, which grows up

from infancy to adulthood in response to user efforts. The method of estimating effort is described in section 3.2.

Figure 2 shows an example of a character. The character is represented by both graphical images and numerical parameters. Graphical images are needed for attractive and intuitive representation, and numerical parameters are needed for explicit and clear indication of achievement. Many additional parameters add to the variety of the character: however, which parameters apply is mainly determined by the types of user activities.

When a user performs an activity at a certain level, the character changes shape step by step along one of several possible of character growth, but the patterns are unpredictable so as to maintain interest and therefore address condition 2. Figure 3 shows an example of a variety of possible growth pattern.

3.2 Effort Estimation

In EELF, entertainment should not be used to assess activities or reflect the final results of an activity. For example, say a user puts a lot of effort for a certain difficult task, but fails. The user's motivation tends to decrease, and an EELF-based entertainment system should address this situation and not merely reflect the user's final results. Thus, the system must pay attention to not just results but also to effort. We use the word "subjective workload" throughout this chapter to describe the degree of effort.

In general, an activity for which subjective workload must be estimated can be decomposed into a number of components. For example, daily work with an office PC can be decomposed into keystrokes, mouse movements, and so on. Subjective workload is based on the number of components and/or the time spent in performing the components. For example, an office worker might write a certain document without mistakes, and another worker, writing the same document, may make many mistakes, perform many more operations, and spend time repairing the mistakes. The latter worker feels that he/she worked harder than the former worker. Thus, although the products are same, the subjective workload of the latter worker is higher than that of the former worker.

We assume that the subjective workload of a certain activity can be estimated by the formula

$$W = \sum a_i x_i \quad (1)$$

In this formula, W is the subjective workload and x_i is the number of components of the activity. The weight a_i is determined by each activity. How to determine the weight a_i of each implementation of EELF-based entertainment system is described in Sections 4.2, 5.2, and 6.2.

3.3 Competition

Play, an important component of entertainment, has four characteristics (Caillois, 2001):

1. Agon: competition
2. Alea: chance, happening
3. Mimicry: simulation, role playing
4. Ilinx: shock, drastic change (such as vertigo)

Character creation has the characteristic of mimicry. It also has the characteristic of alea because users cannot predict the shape of their characters.

Competition can be a particularly important characteristic of entertainment, and address condition 3 of the previous discussion. An EELF-based entertainment system might involve, for example, a battle game with the user's own character. When a character grows up without being taken down, its owner wins the game, and the harder the user performs, the more likely his/her characters wins. The game also makes the user's achievements clear, so introducing a competition game addresses condition 1. Figure 4 shows an example of a competition-game component.

Fig. 4. Weekend Battle: competition-game component

3.4 Distraction Avoidance

There are many other styles of entertainment, such as movies, pictures, animations, and music. However, there are serious problems with introducing some kinds of entertainment into activities because they can distract users from the activity at hand by their heavy visual and/or audible effects. Therefore, EELF-based entertainment systems seek to improve efficiency and productivity, so that they do not interfere with the user activities.

To avoid distraction, extraneous user operations must be prohibited, and heavy visual and audible effects must not be used. However, it is preferable that a user's character should be displayed at all times because it represents his/her achievement of the subjective workload, as mentioned in Section 3.1. To avoid distraction, the character should be displayed so as not to obstruct his/her activities, such as near a certain corner of the display as with some Microsoft Office help agents.

Avoiding distractions a competition-game component is difficult. One solution is that the game is executed automatically, and users can only formulate the strategy of the game. The

competition game of Weekend Battle, described in section 4, uses the solution. Figure 5 shows the strategy-setting window. A user can set up his/her desired strategy during free time such as lunch time or coffee break.

Fig. 5. Weekend Battle: strategy-setting window

3.5. Implementation

We now examine four implementations of EELF-based entertainment systems:

- Weekend Battle: an entertainment system for daily work in an office environment such as preparing documents, presentations, and spreadsheets
- ExS (Exercise Game System): a mobile entertainment system for daily exercise such as jogging and walking
- MIPS (Musical Instruments Practice Supporter): an entertainment system for daily practice of musical instruments
- VASC (Virtual Aquarium for Subjective Competition): an entertainment system for daily work in an office environment, with the same target as for Weekend Battle.

The character-creation and competition-game components of Weekend Battle, ExS, and MIPS are similar, but the effort-estimation component is different. The effort-estimation component of VASC is the same as that of Weekend Battle, but the other two components are different.

The next four sections describe the implementation of the three components and results of experimental evaluations of these systems.

4. Weekend Battle

4.1 Overview

Weekend Battle is an entertainment system for improving user motivation in a computer-aided office work environment. It covers three categories of works:

1. Document preparation by word processor

2. Code preparation by IDEs (integrated development environments)
3. Slide preparation by slide-show applications

It is assumed that users work on individual PC. However, the system can be applied to works that does not involve a PC as long as the workload can be estimated and users have their own displays to show their avatars, perhaps on PDAs.

4.2 Effort Estimation

4.2.1 Components of Effort

The components of PC office work fall into two categories: the amount of computer operations and the work time.

Computer operations are categorized as follows:

1. Number of keystrokes
 - (a) Number of alphanumeric keys
 - (b) Number of keyboard shortcut (Ctrl-X, Ctrl-C, Ctrl-V, and Ctrl-Z)
 - (c) Number of keyboard correction keys (DEL and Backspace)
2. Number of mouse clicks (single or double clicks; left, center, or right buttons)
3. Distance of mouse movements
4. Amount and distance of dragging-and-dropping (left, center, or right drags and drops).

The distance of mouse movement is not the exact length of the trace of a mouse cursor but rather the distance between the points of current and previous clicking. The distance of dragging and dropping is measured similarly, as the distance between the point to start dragging and the point of dropping. Thus, we avoid adding meaningless mouse movements to the subjective workload estimation.

Work time is categorized into writing time, reading time, and thinking time. When a user strikes keys to produce text, the duration is writing time. When he/she reads something on the display, perhaps using the mouse to drag a scroll bar, the duration is reading time. When the user is doing nothing on the PC, the duration is thinking time.

However, it is hard to distinguish between thinking time and reading time because neither involves activity, so both are counted as reading time. Similarly, the time spent using mouse for drawing pictures is counted as reading time, not writing time. Time spent doing nothing is counted as time not working.

We define thresholds T_k and T_r . It is assumed that a user performs a certain operation at time t_1 following the previous operation at time t_0 . To what category the time $t_1 - t_0$ belongs to is determined as follows:

1. **if** $(t_1 - t_0 \leq T_k$ and the operation is a keystroke) **then** writing time;
2. **else if** $(t_1 - t_0 \leq T_r)$ **then** reading time;
3. **else** he/she is not working.

4.2.2 Subjective Workload Estimation Formula

To determine a_i of Formula 1, a user's 10-min subjective workload for three types of work is gathered. Ten users perform three tasks of each type. An easy task could be finished in a few minutes, a normal task in 5 or 6 min, and a hard task not even in 10 min.

Users perform each of the 9 tasks (3 types $\times$ 3 difficulties) for 10 min. After each task, they evaluated the subjective workload of the task on a scale of 0 to 100, 100 implies that they

worked hard through the 10 min as judged by themselves. If they finished the task before 10 min, they could do anything they liked, but could not include that activity in their judgement. I also collected all of their operations during the task.

The weight a_i is estimated by the multiple linear regression analysis method. We calibrated the significance level so as to leave at least three parameters in Formula 1. Then we created three formulas for each type of work as follows (the unit of time is the second):

- Word processing:

$$W_w = (\text{writing time}) \times 0.178 + (\text{reading time with keyboard}) \times 0.164 + (\text{reading time with mouse}) \times 0.211 + (\text{left click}) \times (-1.26) \quad (2)$$

- Creating a presentation

$$W_p = (\text{reading time with mouse}) \times 0.146 + (\text{Ctrl-C}) \times 2.22 + (\text{right click}) \times 0.959 \quad (3)$$

- GUI program coding

$$W_c = (\text{reading time with mouse}) \times 0.0633 + (\text{left drag and drop}) \times 0.623 + (\text{keystrokes}) \times 0.102 \quad (4)$$

4.3 Character Creation

The character-creation component shows the user's character and ability scores on the right-bottom corner the PC display (see Figure 2).

A character has five ability scores for the competition game. Four of them — hit points (HPs), attack points, defence points, and agility points — increase with increasing subjective workload. Each ability score is calculated by its own estimation formula. For example, attack points increase faster than defence points when the users' work application is word-processing software. Speed is generally not a factor, and is not shown by default.

The character-creation component shows a progress bar indicating how much subjective workload is needed to change shape. Subsequent shape changes require increasing amounts of user effort.

The character has a mood (Figure 6). It is happy when the user works hard during a short period and sad when the user does not work. The mood is related to the probability of getting an item. For instance, when a character remains happy for three successive periods, the character can get an item.

The character-creation component provides different functions by time of day, that is, during work and break times. Table 1 shows these functions.

To follow-up the discussion in Section 3.4, the character-creation component does not require any user operation during work time. Excluding the presentation of a character, which is always shown on weekdays, users can view only a summary of the last weekend's game.

At break time, users can manage their characters' settings (Figure 7). They can equip their characters with items for the next competition game, and choose a ratio of actions for the game, including attack, defence and move (Figure 5). In addition, they can set up strategies for selecting the target to fight. Examples include "the character that bites me at the previous turn" and "the character that has the lowest HP." They can select three different strategies, or the same strategy twice or three times.

Fig. 6. Weekend Battle: possible character moods

Work time	Break time	Function
*	*	Showing an avatar
*	*	Showing a summary of the last battle
	*	Showing the details of the last battle
	*	Showing the details of items that an avatar possesses
	*	Setting strategies for the next weekend battle

(*: provided)

Table 1. Weekend Battle: functions of the character-creation component

Fig. 7. Weekend Battle: item representation

Fig. 8. Weekend Battle: battle representation, with full animation

4.4 Competition Game

A competition game system gathers all users characters and has them fight against each other over the weekend, in other words in a “battle royal.” The game is performed automatically according to the strategy that each user has set for his/her character during the previous weekdays. Characters perform their actions in a battlefield. Actions are ordered by ability points, and consist of a movement and one of following for one turn: attack another character, defend self, or use an owned item.

One game has 20 turns. Characters are ranked according to when they go down. If they go down sooner, their ranking is lower. If all characters except one go down, the last one still up is the winner and the game is over. If two or more characters are still up at the end of the last turn, they are ranked according to the ratio of remaining HPs.

Results are logged and it sent to the character-creation component for user viewing during the succeeding weekdays. The component shows the details of the last battle with full animation (Figure 8).

4.5 Evaluation

4.5.1 Methods

I conducted a five-week trial with two user groups (groups A and B), each with eight users, to compare user motivation with and without the entertainment system, with and without the weekend battle, and with different lengths of system use. The evaluation weeks were as follows:

- Week 1:** Control experiment of group A (without the system).
- Week 2:** The system is introduced to group A, and control experiment of group B.
- Week 3:** The system is introduced to group B. A continues to use the system.
- Week 4:** Both groups continue to use the system.
- Week 5:** Both groups stop using the system as control experiments.

I compared A at week 1 (abbreviated to A-1, and so forth) and B-2 to A-2 and B-3 to evaluate the effect of the weekday system only because users had not yet played the weekend battle

game. I compared A-2 and B-3 to A-3 and B-4 to evaluate the effect of the weekend battle game. A-3 and B-4 differ from A-5 and B-5 in the existence of the entertainment system. This situation is slightly different from the first control experiment as to whether users have experience with the system. In addition, group A is compared to group B for differences in beginning to use the system.

At the end of each week, after watching the weekend battle game of the week, users filled out a questionnaire (Table 2) to determine their level of motivation. Answers ranged from -3 (strongly disagree) to +3 (strongly agree). Q3 is asked on weeks when the system is used and Q4 is asked on only the last week.

No.	Question
Q1	You feel motivated to work
Q2	Your work is fun.
Q3	Weekend Battle is fun.
Q4	You want to use Weekend Battle in future.

Table 2. Weekend Battle motivation questionnaire

4.5.2 Results

Table 3 shows the questionnaire results. The standard deviation is in parentheses. Q1 and Q2 results for weeks with Weekend Battle (Week 2/3 and Week 3/4) are significantly higher than for weeks without Weekend Battle (Week 1/2 and Week 5/5). Thus, Weekend Battle clearly improves user motivation, and makes users feel that their work is more fun than without Weekend Battle.

All the answers to Q3 are positive, so Weekend Battle is clearly perceived as begin fun. The average answer to Q4 is also positive, so Weekend Battle is acceptable in the work environment. Moreover, all users have used it continuously since the end of the experiment.

No.	Group	Week 1/2	Week2/3	Week3/4	Week5/5
Q1	A	-0.60(0.84)	1.50(0.71)	1.20(0.63)	-0.90(1.10)
	B	-0.89(0.93)	0.67(1.12)	0.89(0.93)	-0.89(0.78)
	all	-0.74(0.87)	1.11(0.99)	1.05(0.78)	-0.89(0.94)
Q2	A	-0.10(0.74)	0.40(1.58)	0.50(1.27)	-0.90(1.20)
	B	-0.78(1.09)	0.11(1.05)	0.56(1.24)	-0.89(0.78)
	all	-0.42(0.96)	0.26(1.33)	0.53(1.22)	-0.89(0.99)
Q3	A		1.80(0.92)	2.00(0.67)	
	B		2.11(0.60)	1.78(0.44)	
	all		1.95(0.78)	1.89(0.44)	
Q4	A				1.80(0.92)
	B				1.67(0.50)
	all				1.74(0.73)

(Week x/y: Group A's Week x and group B's Week y)

Table 3. Weekend Battle evaluation results

Fig. 9. ExS: equipment and character representation

5. ExS

5.1 Overview

Exercise Game System (ExS) is an entertainment system that supports users' daily exercise for health. Daily exercise can benefit from such a system because achievement is ambiguous and jogging or walking the same route everyday can be boring.

In addition, users may be tempted to give up daily exercise because of lack of time. ExS cannot rely on special devices that restrict the place to exercise. For example, the dance game Dance Dance Revolution is used now in some schools in West Virginia for reducing student obesity (Toppo, 2006). However, it can be used only in places such as schools, where the required special hardware is available. Mueller et al. proposed a football-based entertainment system that aims to enhance social bonding; however, it also is limited to places where it can be used (Mueller et al., 2003).

The implementation of ExS is shown in Figure 9. It consists of a PDA with GPS (HP iPaq rx5900) that measures jogging or walking speed, and a wireless Bluetooth-communicating heartbeat sensor (NONIN 4100). They are light enough to wear and carry in everyday life. ExS measures user heartbeat rate and velocity of movement at all times, and displays the user's own character on a PDA. Thus, ExS can estimate user effort for exercise anytime, and create the user's character to reflecting exercise effort.

Fig. 10. ExS: relationship between heartbeat rate and fatigue level

5.2 Effort Estimation

When a user exercises, his/her heartbeat rate increased compared to when he/she, for example, sits for office work, stands in a train, or sleeps. Masuko et al. use heartbeat rate similarly for physical entertainment, and change the difficulty of a game according to changes of in a user's heartbeat rate (Masuko et al., 2006). ExS determines that a user is exercising when his/her heartbeat is 20 beats per minute (bpm) faster than usual, as measured before using ExS.

When determining that a user is exercising, ExS must also estimate the user effort during exercise. Figure 10 shows the relationship between user effort and heartbeat rate during jogging. The X-axis is the increase in heartbeat rate from the ordinary condition. Two users jog for 30 min, and reported their level of fatigue every minute. I assume that the level of fatigue directly reflects effort. From the shape of the graph, I estimate effort by the formula

$$E = ah^2, \quad (5)$$

where E is the estimated effort during one minute, a is a constant factor that depends on the user, and h is heartbeat rate.

Even for the same heartbeat rate, different types of exercise might incur different feelings of effort. Thus, the constant factor a varies with the type of exercise. ExS measures the velocity of user movement and classifies the exercise into one of three categories:

- <5km/h: exercise in place
- 5-7km/h: walking
- >7km/h: jogging

ExS has three effort estimation equations, respectively.

5.3 Evaluation

I conducted a trial to evaluate the improvement in user motivation by ExS. The competition system is almost the same as that of Weekend Battle; therefore, evaluation focuses on character creation during exercise. Five users are performed one of three kinds of exercise

each day: 20-min walking, 10-min jogging, and 5-min rope jumping. After three days, they filled out a questionnaire.

Table 4 shows the questionnaire results. Values shown are the averages of all users, where 5 is strongly agree, 3 is moderate, and 1 is strongly disagree. Results indicate that the character-creation component of ExS stimulates daily exercise.

Average score	Question
3.8	ExS stimulates the motivation of daily exercise
4.2	Creating my own character on ExS is fun

Table 4. ExS evaluation results

6. MIPS

6.1 Overview

Musical Instrument Practice Supporter (MIPS) is designed for music students. Music is commonly thought to be fun itself; therefore an EELF-based system may not be required. However, many music students quit their studies, usually because they cannot keep to a regular daily practice schedule. Repeated practice can be dull and monotonous, and often involves repeating a simple and not-very-interesting phrase many times (for example, Hanon piano exercises). It is, therefore, appropriate for an EELF-based support system. Although MIPS targets students of the electronic piano, it can be used with other musical devices as long as device operations can be measured.

6.2 Effort Estimation

Many factors are considered to affect the effort of piano practice. I conducted a trial to determine the factors and their intensities. I recruited five users who have a little experience playing the electronic piano to practice 10 scores of classic composition. Each practice period was 30 min. I determined the following components of piano practice:

- Number of touches, counting one chord as one touch
- Ratio of the number of accidental notes (played by black keys) to the number of all notes
- Amount of chords, which is the ratio of the number of notes (counting all notes forming the chord) to the number of touches
- Standard deviation of the pitch calculated by MIDI note number
- Difficulty of the score (easy, moderate, or difficult).

After each period, users indicated the level of effort they felt relative to the first period, which is rated as 100. Effort is estimated by the following linear summation

$$E = \sum_k a_k p_k,$$
(6)

where E is the estimated effort, k is the factor for piano practice mentioned above, p_k is the value of the factor k , and a_k is the constant weight. We determine a_k by the multiple linear regression analysis ($\alpha < .05$). The resulting effort estimation formula is as follows:

$$E = .377 \times p_{\text{stddev}} + 23.2 \times p_{\text{chord}} + 93.6 \times p_{\text{accidental}}.$$
(7)

6.3 Character Creation

In contrast to Weekend Battle and ExS, MIPS aims to support learning musical instruments. In learning instruments, the following are essential:

1. The user should practice every day
2. The user should practice for as many hours as possible

To address these points, the method by which characters grow up is modified in MIPS. A parameter of succession of practice is added. To address point 1, in daily character creation, a character sometimes gets an item that temporally improves its power during competition. If a user practices daily for a week, his/her character can get new, unusually strong items. If the user practices daily for two weeks, his/her character can get even more and stronger items. If the user takes a day off, his/her character loses the ability to get these enhanced items. Similarly, to address point 2, if a user practices for an hour, his/her character can get new, unusually strong items. If the user practices for an additional hour, his/her character can get even more and stronger items. At the end of the day, his/her character loses the ability to get these enhanced items.

By these two modifications, a user who practices every day for long hours can create a stronger character than others who practice less.

6.4 Evaluation

A four-week trial was held to evaluate MIPS. Four beginner piano students with some experience on the instrument were asked to practice a certain piece of classical music for four weeks. Two of them used MIPS and two did not. Each weekend, they answered the question “Does MIPS motivate you to practice (+2: strongly agree; -2: strongly disagree)?” Practice logs for all for users were gathered.

Table 5 shows the average motivation scores. MIPS improves user motivation slightly, and thus, can be effective in maintaining and improving motivation. Table 6 shows the average daily practice time. There is no significant difference between users who uses MIPS and those that did not. The influence of MIPS on amount of practice is unclear, however, for the following reason: users were asked simply to practice a classical piece; They were not asked to perform pepetitive exercises such as the Hanon exercises. MIPS can be effective for such repeated, dull practice.

# Week	With MIPS	Without MIPS
1	1.0	-1.0
2	0.5	0.0
3	1.0	0.5
4	1.0	1.0

Table 5. MIPS evaluation results

With MIPS (std. dev.)	Without MIPS (std. dev.)
19.64 (10.25)	32.04 (42.91)

Table 6. MIPS average daily practice times (in minutes)

Fig. 11. Weekend Battle: results of follow-up questionnaire

7. VASC

7.1 Problem with Weekend Battle over Long-Term Use

Weekend Battle is effective for improving user motivation, as discussed in Section 4.5.2. However, there is one problem; its competition-game component depends on objective measurement of the character’s ability. Once a certain character’s ability score is much higher than another’s, the latter cannot generally beat the former, because it is difficult to narrow the gap in scores.

Figure 11 shows the result of a follow-up questionnaire about the effectiveness of Weekend Battle over six-months of use. Its effectiveness after two weeks of use is high, but after six-months it decreases. Thus, the problem becomes paramount by at least six-months of use.

To solve the problem, I created Virtual Aquarium with Subjective Competition (VASC). The character for each user is a fish, and users compare the appearance of their fish by subjective measurement.

7.2 Adding a Subjective Elements to the Competition

The results described previously for the Weekend Battle are for objective measures of competition. Objective competition has two characteristics that can cause problems:

- 1. There is only one winner
- 2. The winner depends only on explicit measures as numerical parameters

Fig. 12. VASC: character representation (personal window)

In case of Weekend Battle, the only winner is the winner of the competition game. The result of the competition game depends greatly on the characters' ability scores, which increase with increasing subjective workload. Once one character's score is much higher than the other characters' scores, it is difficult for others to win. Closing the gap in scores is difficult because the owners of both the winning character and the other characters continue to work hard and develop their characters.

To solve this problem, I introduced subjective measures for competition, such as prettiness and coolness, to the competition game. As users perform their work, the appearance of their character changes favorably according to their own subjective preferences. Subjective preferences differ among users, and a high score for a particular parameter is not necessarily altogether good.

For example, one user might value height, but another might value a balance between height and width. In this case, the latter user would win the competition even if the former user works much harder.

7.3 Changing the Nature of Character Creation

In VASC, users have their own fish in an aquarium, which can change its appearance as per the user choice. To do so, they use bait, which they earn by working. Figure 12 shows the VASC personal window, which shows the fish owned by a user.

To get the bait, the user must perform a certain amount of effort. This subjective workload is estimated by the same technique as for Weekend Battle. The progress bar at the bottom of the window (Figure 12) indicates the amount of subjective workload required to get the new bait.

Before getting the bait, the user decides on the kind of bait that he/she wants to get. However, he/she does not always get the desired kind. When the progress bar is full, he/she gets a capsule that contains the bait. The probability that the capsule holds the desired bait reflects how hard the user has worked. If he/she works hard enough to fill the progress bar quickly, the probability is high. Thus, the harder the user works, the more likely he/she is to get his/her favorite bait. The user can feed the bait to his/her fish at any time.

Fig. 13. VASC: feeding window

For subjective competition, fish parameters are as follows:

- Skin pattern (texture)
- Color (hue, brightness, and saturation)
- Length/width of body
- Length of breast fins
- Length of tail fin
- Swimming speed

A user can choose the types of bait to increase or decrease each parameter, but cannot specify the precise result. For example, although 400 different kinds of bait change skin pattern, he/she can only choose “skin pattern” and the patterns that he/she gets are determined randomly. Figure 13 shows the interface for feeding.

7.4 Changing the Nature of the Competition

The amount of bait and the number of capsules are clear objective measures; therefore, I limited objectivity as follows:

1. The probability of getting the desired bait is mentioned in Section 7.3. A user does not always get the bait that he/she wants, and normally does not feed undesired bait. Thus, users who get the same number of capsules feed different amounts of bait to their fish. Therefore, users cannot guess how many capsules other users have only from changes in the appearance of their fish.
2. Users can feed their fish whenever they wish, so the time of use is different for each other. Suppose there are two users who want to make their fish grow larger. At a particular instant, one’s fish is larger than another’s. However, the user with the larger fish need not necessarily win because the other user might gather and keep his/her favorite bait for later use, while the former might use entire bait right away.

All fish are shown in a shared display of a virtual fishbowl placed in a common space so that all users can compare their fish during break time.

7.5 Long-Term Evaluation

I conducted an empirical trial for about eight months to ensure that VASC stimulates and maintains user motivation during long-term use.

No.	Question
Q1	VASC is fun
Q2	VASC stimulates my motivation for work
Q3	I compare my fish to other ones (Yes/No)
Q4	I want to use VASC in future

Table 7. VASC questionnaire (Q1-Q4)

No.	Reason	No.	Reason
F1	Comparing fish is fun	M1	I want to grow my fish as I like
F2	Creating my fish as I like is fun	M2	I want to feel my achievement through my fish
F3	Gathering capsules is fun.	M3	I want to get a capsule
F4	Gathering many kinds of bait is fun	M4	I want to get high probability to get my favorite bait

(a) reasons for fun

(b) reasons for stimulating motivation

Table 8. VASC questionnaire reasons (Q1 and Q2)

Fig. 14. VASC questionnaire results (Q1, Q2, and Q4)

Fig. 15. VASC questionnaire results (Q3)

7.5.1 Methods

I recruited 16 participants (11 males and 5 females) from our laboratory, aged 22-26. All were undergraduate or graduate school students majoring in information science. The period of evaluation was 35 weeks (11 Jun 2007-17 Feb 2008). VASC was installed on their laboratory PCs, and they used them in their daily work. The shared display was placed in a public space in the main room of the laboratory where they take breaks and have lunch.

The users filled out the questionnaire in Table 7 at the end of each week except the first. Evaluation weeks are numbered 0th-34th. For Q1, Q2, and Q4, answers range from -3 (strongly disagree) to +3 (strongly agree). For Q1 and Q2, reasons are selected from Table 8 and multiple reasons are allowed.

7.5.2 Results

Figure 14 shows the results for Q1, Q2, and Q4 by week. Figure 15 shows the ratio of users who answered “Yes” to Q3. Figure 16 shows the reason for fun, and Figure 17 shows the reason for stimulating motivation.

The results for Q1 and Q2 indicate that VASC continued to be fun and stimulated motivation throughout the experimental period. However, users became gradually less apt to compare fish (Figure 15; F1 in Figure 16). It appears that the effect of competition on stimulation and/or fun exists only during early use of VASC.

F2 and F3 ratios remain high. The number of bait capsules and the changes in the appearance of the fish reflect user work achievement. Therefore, showing achievement is one of the most important factors in keeping work fun during long-term use of VASC. In contrast, the F4 ratio increases early (0th-3rd), until about 50% of users say that gathering many kinds of bait is fun, and then decreases gradually until, at the end, it falls to 0% (24th week). Koster points out that such a trend indicates that finding something new is fun, but the fun disappears when users find nothing new (Koster, 2004).

M2 (I want to feel my achievement through my fish) is the most frequently cited reasons (Figure 17). Thus, for the purpose of stimulating motivation, achievement feedback is the most important factor. M3 (I want to get a capsule) is also frequently cited for the same reason. However, Weekend Battle has similar feedback. The difference between Weekend Battle and VASC can be explained by how frequently M1 (I want to grow my fish as I like) is cited. In VASC, the user can control how his/her fish grows, while in Weekend Battle the character can change only in strength. In other words, VASC users can win in many different ways, but Weekend Battle users can win in only one way. As mentioned above, most users lose motivation for creating when the characters of others are much stronger, and VASC can avoid this problem. The F2 ratio supports this view. Users did not lose the fun of creating their fish, so their motivation remained high.

Fig. 16. VASC questionnaire results (F1-F4)

Fig. 17. VASC questionnaire results (M1-M4)

8. Conclusion

EELF is an entertainment-system framework that aims to improve motivation for repetitive, dull and monotonous activities. It consists of three components: effort estimation, character creation, and competition game. For the effort-estimation component, subjective workload of repetitive, dull and monotonous activities is estimated. The user of an EELF-based system has his/her own character, which grows in response to the estimated subjective workload, in the character-creation component. For the competition-game component, the characters of all users are gathered and compared with one another, and a winner is chosen. The fun of character creation and competition can stimulate user motivation for the target activities. In this chapter, four EELF-based entertainment systems are introduced. Weekend Battle and VASC are systems for improving motivation for daily work with PCs in an office environment. ExS is a system for daily physical exercises. MIPS is a system for repeated practice on a musical instrument. All such activities are so monotonous that motivation to perform them tends to be low. Evaluation results suggest that they can improve and maintain user motivation for these activities. In addition, VASC can do so over long-term use. In future, I will attempt to understand the mechanism of boredom, which we often see in situations where nothing is new. Boredom decreases motivation and fun; therefore I believe that it is crucial to know about and solve the problem of boredom. I am interested in the fact

that most creators of massively multiplayer online role-playing games revise their systems periodically, although not drastically. I think that a suitable revision frequency for eliminating boredom can be extracted.

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In this book the reader will find a collection of 31 papers presenting different facets of Human Computer Interaction, the result of research projects and experiments as well as new approaches to design user interfaces. The book is organized according to the following main topics in a sequential order: new interaction paradigms, multimodality, usability studies on several interaction mechanisms, human factors, universal design and development methodologies and tools.

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