A STUDY OF HUMAN COMPUTER INTERACTION IN ARCADE GAME DESIGN

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A STUDY INTERACTION

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Thesis submitted in fulfillment of the requirements for the award of the degree of Bachelor of Computer Science (Technology Graphic and Multimedia) with honours

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I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Computer Science (Technology Graphic and Multimedia) with honours.

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I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

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ABSTRACT

This study is to find the perception of users in using game design which the game design has been applied Human Computer Interaction (HCI) rules into it. By using the HCI rules, we can enhance our game design interface, usability and functionality to increase the satisfaction of user in using the application. In order to implement the research, multimedia development life cycle (MDLC) is used to conduct the research study in order to develop a game prototype application based on the HCI framework. A review is done on the Human Computer Interaction (HCI), the Heuristic Usability Rules, HCI in games, comparing types of games and its interface design and usability and relate the human computer interaction with game design. The game design of the prototype game application is improved in terms of usability and interface design based on the specified HCI framework. Data is collected from respondents in the first stage of interview on the sample game testing. In the second stage of survey session, respondents have to test the game prototype with implemented proposed framework and again they have to give comments and also do some questionnaire regarding to the game design. Results are collected and compare with the analyzed result obtained from first interview session. Based on the result obtained, 95% of the respondents prefer the game prototype design with implemented the proposed HCI framework designed. The result is important as it can prove that the nine rules of HCI framework should be applied into the design of game design. The framework is important for game developer to have better understanding to the game design.

ABSTRAK

Kajian ini adalah untuk mencari persepsi pengguna dalam menggunakan reka bentuk permainan yang reka bentuk permainan yang telah digunakan Interaksi Manusia Komputer (HCI) kaedah-kaedah ke dalamnya. Dengan menggunakan HCI, kita boleh meningkatkan antara muka reka bentuk dan meningkatkan kepuasan pengguna dalam menggunakan aplikasi. Bagi melaksanakan kajian ini, kitaran pembangunan multimedia (MDLC) digunakan untuk menjalankan kajian penyelidikan dalam usaha untuk membangunkan satu aplikasi permainan prototaip berdasarkan rangka kerja HCI itu. Kajian dilakukan ke atas Interaksi Manusia Komputer (HCI), iaitu Heuristik Kebolehgunaan Peraturan, HCI dalam permainan, membandingkan jenis permainan dan reka bentuk antara muka dan kebolehgunaan dan mengaitkan interaksi komputer manusia dengan reka bentuk permainan. Reka bentuk permainan aplikasi permainan prototaip bertambah baik dari segi kebolehgunaan dan reka bentuk antara muka berdasarkan rangka kerja HCI yang dinyatakan. Data dikumpulkan daripada responden di peringkat pertama adalah wawancara kepada pengujian permainan sampel. Dalam peringkat kedua sesi temuduga, responden perlu menguji prototaip permainan disiapkan berdasarka rangka kerja yang dicadangkan dan mereka perlu memberi komen dan juga sebahagian soal selidik mengenai reka bentuk permainan. Keputusan dikumpulkan dan dibandingkan dengan keputusan yang diperolehi dari sesi temuduga pertama. Berdasarkan keputusan yang diperolehi, 95% pengguna lebih suka reka bentuk prototaip permainan yang telah direka bentuk mengikut rangka kerja HCI yang dicadangkan. Hasilnya adalah penting kerana ia boleh membuktikan bahawa sembilan peraturan rangka kerja HCI patut diterapkan ke dalam reka bentuk permainan. Rangka kerja ini adalah penting untuk permainan pemaju untuk mempunyai pemahaman yang lebih baik untuk reka bentuk permainan.

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LIST OF ABBREVIATION

HCI	HUMAN COMPUTER INTERACTION
UI	USER INTERFACE
UX	USER EXPERIENCE
GUI	GRAPHIC USER INTERFACE
UMP	UNIVERSITI MALAYSIA PAHANG

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Computer games and Video Games are important products in software industry nowadays. Emerging technology gives a great contribution in improving the software industry. In today's world, people are more attracted to play mobile games. The gaming apps is getting popular and we can see that the sales of Smartphones, Android, iOS devices are rising. According to the NPD Group reports, purchasing of digital games, mobile apps, games subscription and social network games achieved 40 percent of games sales in 2012, it generated \$5.9 billion in revenue (Entertainment Software Association, 2012). Therefore it is improving the economy of game industry every year.

Game designers play an important role in improving the quality of game. Game designers' own experiences in making games and also intuitions are applied into the game design. Human Computer Interaction (HCI) knowledge is needed to be involved in the game design processes to ensure the games design interface is suitable to be used in that particular games in order to increase the usability of the games and make the games design more user-friendly.

HCI is the study on how users interact with computers and to what how the computers can be developed to produce a successful interaction with human. Human computer interaction (HCI) is "a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use with the study of major phenomena surrounding them" (Thomas T. Hewett et al., 1992,p.5).

Computer interface design that we usually can see are the forms, icons, menu bars, home screens, data display and etc. These require knowledge of HCI to form it in a nice manner of sequence. The HCI Rules should be applied in game design, not only to make the user interface of the game become more user-friendly but also to identify the problems in game design at the early stage. The evaluation methods are important in the game development process to ensure that a structured game framework for user interface design can be produced.

1.2 PROBLEM STATEMENT

As the needs high demands of consumers in the game industry rise year by year, technologies have also improved rapidly in order to keep up with new standards. As the development of digital technology is growing up rapidly, the operation of human computer interface is also becoming more complicated. In our daily lives, we always can hear that people are complaining about the bad interaction design. We are considering this problem might cause by the knowledge of HCI which seldom used by game designers because they always used their own thinking to design a game. Game designers are struggling with their own problem which is the processes to decide how to make game better. Due to the limitation of data, and the lack of theoretical foundation in Game Design, most of games have been developed based solely on own experiences and intuitions of the designer. As the result, 80% of games fail on the market every year. (Game Software Industry Report in Alien Brain product catalog. NxN software 2001). Those failed games are usually due to the lacking of good functionality, usability, non-user friendly design and etc. Therefore, this study is conducted to investigate the effect of HCI in game development.

1.3 OBJECTIVE

- 1. To propose HCI framework for game design.
- 2. To enhance interface design of game prototype based on the proposed framework.
- 3. To test the usability of the game design prototype based on the applied design rules of HCI framework to the game design.

1.4 SCOPE

- 1. The research is mainly about gathering all the source information about Human Computer Interaction and to study the HCI principles involved.
- 2. The investigation on different kind of HCI rules that is suitable to be applied into game design and come out with a game prototype with improved design.
- 3. The information and data is gathered from different types of relevant books and trustable websites.
- 4. The respondents were selected from students in University Malaysia Pahang.

1.5 THESIS ORGANIZATION

The thesis contains of seven (7) chapters.

Chapter 1 is discussing about introduction of the research includes the explanation of background of the project, problem statement, objective, and the scope of the thesis. Chapter 2 is about the literature review of the research, this is to explain the review for HCI principles in game design. In chapter 3 is the study methodology of the research. This chapter is mainly about the rules design of framework for the prototype system. Technique of methods will be explained detail in this part. Moreover, this chapter also contains explanation on the hardware and software requirements that need to implement prototype. Chapter 4 is all about the research on design and it is more focused on designing part. In chapter 5 is to explain the implementation part of the prototype. The contents that consists in this chapter is depends on the storyboard designed with design rule of framework. The result and discussion will be covered in chapter 6 where its function is to explain for the results and analysis of data that had been obtained. The last chapter is the conclusion after all the planning research has been done in the whole project.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Human Computer Interaction is the study on how users interact with computers and how the computers can be developed to make a successful interaction with human. The principles of HCI is applied to people who do design technology in the field of entertainment, education, social interaction, psychology, computer science and many others. Therefore HCI prepares people in related fields in addressing human needs with technology and determine useful system functionality and designing usable interfaces by considering different context of people and organization.

Each year, people around the world spend much of the time to play computer games or other digital games. The game industry has become the fastest growing field in entertainment field. HCI rules can be applied in gaming field as its knowledge is really needed in order to design the system with a good interface design with high usability and functionality.

A study will be done on HCI principles and game design so that we can know more deeply about the knowledge of HCI. By using the HCI rules, we can enhance our game design interface and to increase the satisfaction of user in using the application. This chapter will review on the Human Computer Interaction (HCI), the three Heuristic Usability Rules, the HCI in games, comparing types of games and its interface design and usability and relate the human computer interaction with game design.

2.2 OVERVIEW OF HUMAN COMPUTER INTERACTION

Human Computer Interaction (HCI) refers to the interaction between a human and a machine. Usually when designing systems, HCI will be left behind without consideration as mostly game designers would mainly emphasize on the coding and the bugs rather than the interface design of the system. It causes there might be the case where users do not really understand what Human Computer Interaction is but in fact it plays an important role in Computer Science field. Every year, there are increasing number of population that are using computer, so the number of people who facing difficulties in understanding and using the computer also grows gradually.

The term Human Computer Interaction is the same as Interactive System Design and it is designed to make things easier to be used with computer. A computer system is made up of monitor or screen, keyboard, mouse and these all hardware made up a variation of desktop, laptop, smart phone and etc. If we use different types of devices, then the interface will support a different style of interaction. In our daily life, there are lot of technologies that is used such as computer mouse, touchpad, digitizing tablet, the screen of mobile phones, as program of a Windows or Mac that included icons of application and folders, the trash icon, a menu link, a pull down menus in webpage, all these have a common function, which is they are used as communication tools between human and computers.

A User Interface (UI) of Human Computer Interfaces is actually about how human interact with systems. As we know nowadays the people around the world are using applications which involve computer screen and its interactivity between the system and the human. Therefore HCI rules and knowledge is not for expert used only but also average users. Most of the population in the world will use computer application in their daily life, in different market, school, office and workplaces. HCI helps in designing menus and screen in structured way so that it will be easier for the users and make human life better. It will affect the progress of user to use the system, the better the interface design the better the information and messages will be delivered to the users, and the most important thing is that the developers of computer system can deliver a beneficial services to the user in a usable way. There are five basic goals of Human Computer Interactions. HCI concerned with the methodologies and processes for designing interfaces such as designing the best possible interface which is efficient to use. Besides, it is important to know that the methods that used for implementing interfaces. We must have the HCI knowledge and knowing what types of software that able to develop interface of systems. Moreover, we also have to know the techniques for evaluating and comparing interfaces so that we able to find out the part of interface that need to be improved and edit until to a nice one that fulfilled the HCI rules. Developing new interface and interaction technique to ensure HCI can improve the interaction between users and computers. Last but not the least is the developing descriptive and predictive models and theories of interaction.(K P Tripathi, February 2011)

The human computer interaction can be described as a point of communication between the user and the computer. The flow of interaction between human and computer can be explained in the HCI's Loop of Interaction which including a few aspects.



Figure 2.1: HCI's Loop of Interaction

From the Figure 1.1 above, we can see that the loop interaction begins at the task environment and machine environment. **Task environment** is the conditions and goals set upon the user. **Machine Environment** is the environment where the computer is connected to. For instance, a laptop is connected in a college student's hostel room. **Areas of the interface** defined by non-overlapping areas involve processes of the human and computer not pertaining to their interaction. Meanwhile, the overlapping areas only concern themselves with the processes pertaining to their interaction. The **input flow** is the flow of information that begins in the task environment when the user has some task that requires using their computer. The output flow is the information that originates from the machine environment. The final stage is the **feedback** where the loops through the interface that evaluate, moderate and confirm processes as they pass from human through the interface to the computer and back. (Hung Nguyen, 2012, Human Computer Interaction in Game Design, p.11)

2.3 COMPARISON BETWEEN TYPES OF HCI PRINCIPLES

2.3.1 Jakob Nielsen's 10 Usability Heuristic for User Interface Design

There are 10 most general principles for interaction design. They are called 'heuristics' which were developed by Jakob Nielsen together with Rolf Molich in the early 1990 and the latest set was released in 1994 by Jakob Nielsen. Jakob Nielsen's Heuristic are probably the most-used usability heuristic for user interface design.

Visibility of system status is the system has to keep on informing the users what is going on and to give appropriate feedback in a reasonable time.

Match between system and the real world is the system should use language and words that user able to understand, use phrases and concepts that familiar to the user instead of using system-oriented terms.

User control and freedom is to let the users know they are controlling the application. Undo and redo operations enable user to recover their mistake during the time when exploring the application.

Consistency and standards is the consistency increased then the predictability increased. Consistency of a system will affect the progress and the speed of users to control the system in using the application.

Error prevention has to be applied in designing a system with clear information in communicating in the consequences of user's action. For example when deleting some information, ask users a confirmation to delete data as information may be difficult to recreate after deleted. Undo actions can be applied to the system.

Recognition rather than recall is to reduce the heavy memory load by making objects, actions, and options visible. User should not have to remember all the information from one part of the dialogue to another instead they able to get the information or instruction of the system easily whenever appropriate.

Flexibility and efficiency of use. Advanced users usually use systems differently from novice users. As novice users get acquainted with the system and perform certain task frequently and the system should be able to let those frequently performed tasks be

accessible more efficiently. There should be accelerators to help users to perform the frequently performed tasks. Those accelerators include those short-cuts for frequently used tasks (e,g open, save, close, export, etc), keyboard navigation (e.g navigating through an online e-book using the arrows on the keyboard, breadcrumbs let users know where they currently are and let them easily navigate to the next page instead of having to recall from memory where they were previously.

Aesthetic and minimalist design. A minimalist design draws the users to focus on the main subject at hand without being distracted by those irrelevant images or text. Keep the information that will be displayed on the application as simple as possible. Include only relevant information, or else the message will be lost in the "noise". We have to avoid displaying repetitive information. Categorize repetitive information into relevant sections to increase readability. User can jump to the section that they concerned with immediately.

Help users recognize, diagnose, and recover from errors. The error messages have to be expressed in plain language, precisely indicate the problem, and constructively suggest a solution. We have to tell users what happened. The message display should be in simple words and avoid any jargon. Summarize the detail of the error without getting into detail. Inform the users about the error occurred and tell them the solution to solve the error.

Help and documentation. System can be used without documentation, but it may be needed to provide help and documentation. With the document in hand, we can search information easily. It can also help users have of the best experience in using the system as some of the users might curious and would like to know more about why they do a particular task.

2.3.2 Shneiderman's "Eight Golden Rules of Interface Design"

The Golden Rules of Interface Design are the rules written by Ben Shneiderman. Ben Shneiderman is an American computer scientist, and professor for Computer Science at the University of Maryland Human-Computer Interaction Lab at the University of Maryland, College Park. The fundamental research in the field of Human Computer Interaction has been conducted by him. At the same time, he also comes out with new development ideas, methods, and tools such as the direct manipulation of interface and the eight rules of design. These principles is actually helping in create a well designed User Interface improve the usability of the system.

The first rule in Golden rule is *Strive for consistency*. Consistent sequences of actions should be required in similar situations. For example, menus, prompts, help screens, consistent color, layout, capitalization, font and others should be applied throughout the system designed. Consistency performs an important role by aiding users become familiar with the digital landscape so they can perform goal-based actions with confidence.

The second rule is *Enable frequent users to use shortcuts*. As the frequency of use increases, the users want to interact less and able to achieve the same effects. For example, user may utilize abbreviations, function keys, hidden commands, and macro facilities so as the user become expert, they can easily operate and navigate the users interface in a short time with highest accuracy.

Offer informative feedback meaning that for every action there should be system feedback. This feedback should be proportional to the seriousness of the action. For frequent and minor actions, the response can be modest, whereas for infrequent and major actions, the response should be more substantial. For example, when entering a wrong password into the sign in page into hotmail login page, then an appropriate feedback will be pop out to let users know it.

Design dialog to yield closure. Action sequences should be teleological i.e. leading to an ultimate goal or satisfying conclusion. These sequences should be organized in to groups that satisfy the human inclination for task paths with a beginning, middle and end. When the dialogue is complete this should be clearly indicated so that users know they can proceed to their next goal, or whether they must revise, revisit or return to their previous action.

Offer simple error handling. As much as possible to design the system so the user cannot make a serious error. If an error is made, the system should be able to detect the error and offer simple, comprehensible mechanisms for handling the error.

Permit easy reversal of actions. This feature relieves anxiety, since the user knows that errors can be undone; it thus encourages exploration of unfamiliar options.

The units of reversibility may be a single action, a data entry, or a complete group of actions.

Support internal locus of control. This refers to giving users the sense that they are in full control of events occurring in the digital space. Supporting the development of an internal locus of control is achieved by ensuring users are the initiators of actions in the virtual space, as opposed to reducing their involvement to system response.

Reduce short-term memory load. Human attentional resources are limited and we are only capable of maintaining around five items in our short-term memory at one time. Therefore, interfaces should be as simple as possible with information condensed, categorized and as much help offered to memorize and become au fait with system operations when users navigate through the digital space. (Shneiderman, B. and Plaisant, C., Designing the User Interface: Strategies for Effective Human-Computer Interaction: Fifth Edition, Addison-Wesley Publ. Co., Reading, MA (2010), 606 pages. Available from: http://www.pearsonhighered.com/dtui5einfo/)

2.3.3 Don Normans Principles of Design

Don Normans Principles of Design are from Don Normans seminal book, *The Design of Everyday Things*. Most design is intended to be used by people, so the needs and requirements of people ought to be driving much of work throughout the entire process. In this book Norman emphasize on making things that is understandable and usable. This dimension is emphasized because it has been so long neglected. It is the time to bring it to development process. According to Norman, good design will have it all –aesthetic pleasure, art, creativity and at the same time be usable, workable, and enjoyable. (Donald A. Norm, 2002, The Design of Everyday Things, p.10)

In the principle of V*isibility*, the user can tell the state of device and the alternatives for action by just looking at the system interface design. In some of the design, the crucial part of information has been hidden away. The important information is left out due to some distractive design. Therefore, it will minimize the significant cues that should be known by users. The more visible functions are, the more likely users will be able to know what to do next. In contrast, when functions are out of sight,

it makes them more difficult to find and know how to use.(Donald A. Norm, 2002, The Design of Everyday Things, p.116)

Feedback is about sending back information about what action has been done and what has been accomplished, allowing the person to continue with the activity. Various kinds of feedback are available for interaction design-audio, tactile, verbal, and combinations of these. In design, it is important to show the effect of an action. Without feedback, users will always wondering whether anything has happened. For example, when the button is pressed hard enough but there is no response or feedback, users wondering whether the machine has stopped working, maybe it is doing the wrong thing.

Constraint is the design concept of constraining refers to determining ways of restricting the kind of user interaction that can take place at a given moment. There are various forms this can be achieved. For example, a diagramming tool for drawing organizational charts will prevent the boxes and lines from being dragged and dropped and rearrange into configurations that are not semantically legal. Another form is that the dots-per-inch setting on a scanning application is often controlled by a slider that restricts the chosen value to be within a range such as 100 to 400 dpi. This is a good example of a control that can show a constraint visually.

Mapping refers to the relationship between controls and their effects in the world. Nearly all artifacts need some kind of mapping between controls and effects, whether it is a flashlight, car, power plant, or cockpit. An example of a good mapping between control and effect is the up and down arrows used to represent the up and down movement of the cursor, respectively, on a computer keyboard. Another example is using descriptive labels or icons on buttons and menu items by using controls consistently. Control should be in logical ways that match the real-world objects or general conventions. (Kevin Matz, 2012, Donald Norman's design principles for usability, Available from: http://architectingusability.com/2012/06/28/donald-normans-design-principles-for-usability/)

Consistency refers to designing interfaces to have similar operations and use similar elements for achieving similar tasks. Consistency is helping users recognize and apply patterns as one of the major ways that people learn is by discovering patterns. New situations become more manageable when existing pattern knowledge can be applied to the understanding how it works. Things that look similar should do similar things. For example, when we learn that protruding surfaces with labels on them are buttons that can be pressed, we tend to be recognized it as a pressable button. Then next time, we can do the same thing. Inconsistency will confuse the user because the works does not run in a way that the users expect. (Kevin Matz, 2012, Donald Norman's design principles for usability, http://architectingusability.com/2012/06/28/donald-normans-design-principles-for-usability/)

Affordance is a visual attribute of an object or a control that gives the user clues as to how the object or control can be used or operated. For example, in desktop system with pointing devices, it is showing affordance is to change the shape of the mouse pointer when the mouse pointer is moved over a control. There is also a pop-up message appear when mouse pointer is hovered, that can also provide assistance too. When the affordances of a physical object are perceptually obvious it is easy to know how to interact with it. By applying the concept of affordance to graphical user interfaces and using visual cue to make controls look clickable or touchable.

2.4 PRINCIPLES OF USER INTERFACE DESIGN

The use of the visible language can be presented in three fundamental principles.

- Organize: the user is provided with a clear and consistent conceptual structure
- Economize: with the least amount of cues can do the most
- Communicate: match the presentation to the capabilities of the user.

2.4.1 Organize

Screen layout, its consistency and navigability are important concepts of organization.





Figure 2.2: Chaotic Screen

Figure 2.3: Ordered Screen

Consistency

There are four views of consistency: internal consistency, external consistency, realworld consistency, and when not to be consistent. The internal consistency states the same conventions and rules should be applied to all elements of the GUI.



Figure 2.4: Internal Consistency - Dialogue Boxes

External consistency, the second point, says the existing platforms and cultural conventions should be followed across user interfaces.



Figure 2.5: External Consistency for Text Tool Icons

Real-world consistency means conventions should be made consistent with real-world experiences, observations and perceptions of the user.



Figure 2.6: Real-World Consistency

Screen Layout

Three ways to design display spatial layout: use a grid structure, standardize the screen layout, and group elements that are related. A grid structure can help locate menus, dialogue boxes or control panels.

Relationships

Linking related items and disassociating unrelated items can help achieve visual organization.



Figure 2.7: Relationships of non-linking items

In figure 2.7, the shape, location, and value can all create strong visual relationships which may be inappropriate.

		Í	
			B88888
			B66606

Figure 2.8: Relationship of linking items

In figure 2.8, it is showed that a clear, consistent, appropriate, and strong relationships.

Navigability

There are three important navigation techniques which are provide an initial focus for the viewer's attention, direct attention to important, secondary, or peripheral items and assist in navigation throughout the material.



Figure 2.9: Poor Design



Figure 2.10: Example of Improved design; spatial layout and color navigation

It helps in viewer's focus attention to most important title bar areas. Bulleted items guide the viewer through the contents.

2.4.2 Economize

In Economize, there are four major points to be considered: simplicity, clarity, distinctiveness, and emphasis.

Simplicity

Simplicity includes only the elements that are most important for communication. It should also be as unobstrusive as possible.



Figure 2.11: Complicated and Simpler Designs

Clarity

All components should be designed so their meaning is clear.



Figure 2.12: Ambiguous and Clear Icons

Distinctiveness

The important properties of the necessary elements should be distinguishable so that user can see the differences and able to distinguish the different categories or different types of information easily.

Emphasis

The most important elements should be seen easily. Non-critical elements should not be emphasized and clutter should be avoided so that critical information would not be hided.

2.4.3 Communicate

The GUI must keep in balance legibility, readability, typography, symbolism, multiple views, and color or texture in order to communicate successfully.
Test set in	Text set in
Brush Script.	Univers
	, *
Large	Large
Medium	Medium
Small	Small

Figure 2.13: Illegible and Legible Texts

Readability meaning that display must be easy to identify and interpreting, it should also be attractive. Design components to be inviting and attractive. *Readable* design components must be easy to interpret and understand.

Typography includes characteristics of individual elements (typefaces and typestyles) and their groupings (typesetting techniques). A small number of typefaces which must be legible, clear, and distinctive (i.e., distinguish between different classes of information) should be used.





Figure 2.14: Typefaces

Figure 2.15: Typestyles

Figure 2.14 and figure 2.15 are the examples of recommended typefaces and typestyles.

Multiple Views provides multiple perspectives on the display of complex structures and processes. Make use of these multiple views such as multiple forms of representation, multiple levels of abstraction, simultaneous alternative views, links and cross references metadata, metatext, metagraphics.



Figure 2.16: Verbal and Visual Multiple Views

Color

Color is one of the important elements in achieving successful visual communication. It can be a powerful tool for communication if it is used correctly. Colors should be combined so they make visual sense. The advantages of using color is to help communication, emphasize important information, identify subsystems of structures, portray natural objects in a realistic manner, portray time and progress, reduce errors of interpretation, add coding dimensions, increase comprehensibility, increase believability and appeal. When color is used correctly, people will often learn more. Memory for color information seems to be much better than information presented in black-andwhite.

Color Design Principles

The three basic principles can also be applied to color: color organization, color economy, and color communication. Color organization pertains to consistency of organization. Color should be used to group related items. A consistent color code should be applied to screen displays and documentation. Similar colors should infer a similarity among objects. One needs to be complete and consistent when grouping objects by the same color. Once a color coding scheme has been established, the same colors should be used throughout the GUI and all related publications. The second principle of color, color economy, suggests using a maximum of 5+/-2 colors where the meaning must be remembered. The fundamental idea is to use color to augment black-and-white information, i.e. design the display to first work well in black-and-white. Color emphasis suggests using strong contrasts in value and chroma to attract the user's attention to the most important information. Confusion can result if too many figures or

background fields compete for the viewer's attention. The hierarchy of highlighted, neutral, and low-lighted states for all areas of the visual display must be be designed carefully to provide the maximum simplicity and clarity. (Marcus, August 1993, SIGGRAPH 93 tutorial notes: Graphic Design for User Interfaces, <u>http://web.cs.wpi.edu/~matt/courses/cs563/talks/smartin/int_design.html</u>

2.5 GOOD AND BAD USER INTERFACE IN EXISTING GAME DESIGN

2.5.1 Differentiate User Interface (UI) and User Experience (UX)

Game immersion is important in game design. We will immerse ourselves into the game environment when we are playing game. User Interface (UI) and User Experience (UX) are the main factors that contribute in how the users convert their idea into action and to what extent users will immerse themselves into the game environment. Too much information provided, requiring too many inputs and non-useful prompt will confuse the users. Poor UI will even break the game completely.

The terms *UI* and *UX* are sometimes used interchangeably, but they have specific meanings. *UI or User Interface*, refers to the methods (keyboard control, mouse control) and interfaces (inventory screen, map screen) through which a user interacts with the game. *UX or User Experience*, refers to how intuitive and enjoyable those interactions are.

2.5.2 Six Fundamental Questions in the Process of UI Design

Whenever we want to design game interface, we should ask ourselves six questions as following in order to know clearly the criteria and elements that we need to design a game. The world of UI design is a world of endless nitpicking, and it's one of the few areas of game development where it's okay to obsess.

- 1. Does this interface tell me what I need to know right now?
- 2. Is it easy to find the information I'm looking for?
- 3. Can I use this interface without having to read instructions elsewhere?
- 4. Are the things I can do on this screen obvious?

- 5. Do I need to wait for the interface to loading?
- 6. Are there any repetitive tasks that I can shorten or remove entirely?

(DesiQuintans, 22 Jan 2013, *Game UI By Example: A Crash Course in the Good and the Bad,* Available from :http://gamedevelopment.tutsplus.com/tutorials/game-ui-by-example-a-crash-course-in-the-good-and-the-bad--gamedev-3943.)

2.5.3 Example of Games with Poor UIs

It's important for us to understand that when we talk about bad UIs, the judgement is usually based on the ideas and behaviors that bring to the person who plays games with a keyboard and mouse. The user's choice of input is extremely relevant to the user experience, although it's not the whole story. However, someone who is using touch interface is going to find a button interface awkward, but for a well-designed button interface will easy to understand and predict.

Oblivion's UI is a classic example of one platform's UI being incompatible with another. Even though Oblivion was ported from consoles to PC, it still retained its controller-focused UI. This is completely analogous to releasing a game on iOS or Android and making the player move an on-screen cursor around like they're using a laptop's trackpad instead of taking advantage of absolute touch positioning.

The elements that make Oblivion's UI bad is due to it is the combination of wasted space, improper scaling, and inappropriate controls.



Figure 2.17: Interface design of the game Oblivion

These windows aren't adjustable. The actual part of the menu that conveys the relevant information, such as the contents of your inventory, uses only 21.7% of the total screen space at a resolution of 1920x1080.



Figure 2.18: Interface design of the game Oblivion

Using only a fifth of a screen isn't that bad because there is a lot of space remained. The main problem is that the font and icons are double the size they need to be for viewing on a PC monitor, and this limits the number of items that can be displayed.

A linear list view also means that users need to do a lot of scrolling, and the tabbed interface hides everything from users. Checking your status effects involves clicking on the Magic tab, going to the Effects sub-tab, then scrolling through the list. It is actually not that convenience to the users.

Oblivion also has lesser shortcuts. There's no Map button to bring up the map and users have to click on the compass to bring up the Map tab. There's no Quick-Sell key or Sell Stack shortcut.

Far Cry 3's menus are awkward to the users. Sometimes it doesn't respond to clicks so users have to click three times, menus can take some time to load and it's not really space-efficient.



Figure 2.19: Interface design of the game Far Cry

This is what you see most of the time. Things like health indicators and ammo count fade in and out as users need them, but in general the HUD leaves users alone.

2.5.4 Example of Games with Good UIs

Morrowind is a game example with good UI which is also agreed by most of the players.



Figure 2.20: Interface design of the game Morrowind

The following are the basic elements of this screen. All these elements are helping the users to play the games with good immersion with a good interface design. A button, a menu screen, an icon will affect the users feeling when playing the games.

- It's a single screen with four different, un-tabbed windows. Clockwise from topleft users have the character details, the map (which users can zoom), the list of spells and magic items, and the inventory (with tabs for sorting items).
- At the top-right of each of these windows is a small raised square. If users click this square, then that particular window will remain on-screen even after users exit Menu mode. They can keep the map window open if they want to completely map the coast, for example, or users can keep the Magic window open to keep an eye on the number of charges left in your Ring of Healing.
- Users can drag these windows anywhere on the screen, and can resize them or minimize them to tailor the UI to users needs.
- At the bottom-right of the screen are some status icons. If you see an unfamiliar icon there you can hover over it in Menu mode, and a tooltip will tell users what it is. The same icons appear at the top of the Magic window too.
- The inventory is laid out in a space-efficient grid, and users can adjust the number of items it displays by resizing the inventory screen.

Crusader Kings 2 is the kind of complex, multi-layered game that makes you feel dumb. However, its interface does its best to help you through it all. Firstly, there are many Help boxes that pop up until you're comfortable enough with that part of the game to tell it to stop. Secondly, there's this wonderful feature where if users want to know the icon of coins represent, just hover over it.



Figure 2.21: Interface design of the game Crusader King 2

2.6 RELATIONSHIP BETWEEN HCI AND GAME DESIGN

2.6.1 The Process of Human Computer Interaction in the Games

According to Don Norman, *Interactive Cycle* model for the HCI procedures in computer software is the universal model describing HCI or Human Machine Interface. All types of WIMP (window, icon, menu, pointer) interfaces are based on this model. (Tonya Barrier,2002 ,Human Computer Interaction Development & Management, pp210-211)

Games have similar processing operation like computer software. For game output, the images, sounds and other perception manners would be presented to the users through the virtual game environment. Players can to make decision based on the received information and referring to the rules of the game. This step can be called players' processing. For players' input, players can express their intentions through operating the hardware input devices. Computer calculates the corresponding scores of players' action according to the rule of the game. This step can be called computer's processing. After this step finished it will return to Step one and enter into the next round of HCI cycle. The cycle of processing of these four steps compose of the human computer interaction in game. (XinyuanCai, 2009, Principles of Human Computer Interaction in Game Design, pp.92)



Figure 2.22: The HCI Game Cycle

As we can see in the figure 2.21, from the procedure of HCI in the game, we can see that the process of game is actually a cycle of HCI: as the participants, players and computer play a motive role in the cycle. Software and hardware are the pipelines for cycling while the game content is the transferred information in the cycle. Therefore, HCI plays a main role in the game and is the link of other game component elements. In order to improve the quality of the game, the HCI in the game should be improved first. . (XinyuanCai, 2009, Principles of Human Computer Interaction in Game Design, pp92-94)

2.6.2 Design Principle of Human Computer Interaction in the Game

Presently, human computer interaction in design field is still lacking of theoretical system. Actually, there is a close connection between HCI field and design field. "Usability" is an important research of HCI areas while games field is concerning about gameplay, which is also depends on the usability of the game software. There are a few principles that should be considered in game design. (XinyuanCai, 2009, Principles of Human Computer Interaction in Game Design, pp92-94) *Simple Principle*

Simple principle refers to the process of HCI in the game should be as simple as possible. If the game design is too complicated, then it will cause the users difficult to understand and control the game but also will interrupt the gaming experience of the users. Therefore, game designers should focus on the gaming experience instead of just focusing the interaction process. To reduce the interference of interaction on the users' thought, the game should bring the users out from the complicated interface of human computer interaction.

Different type of games requires different kind of operations depends on the theme and the type of games. During the process of users' input, the simple principle that should be applied to the game is that whether there is appropriate number of actions for the users to reach each purpose, but for the game, the operating button number is not the less the better. The goal of the game is actually bringing the users a kind of entertainment experience instead of completing a specific job. If all the operation is simplified then it will directly reduce the fun of the game. (XinyuanCai, 2009, Principles of Human Computer Interaction in Game Design, pp92-94)

Natural Principle

Natural principle refers to the process of the user's experience and cognitive habits should be kept in line with human computer interaction in the game. One of the goals of the game is to create a world into which a player can be fully immersed. If the user experienced completely different in the game with their real life, the user will feel that they are excluded from the game, this will lead to the loss of entertainment eventually. What we need to do is to include the natural principle into the game design which can conform to people's habit. Natural principle requires the design of input device must take the physical and mental habits of user into account. For the game, the physical habits correspond to the shape design of the device while mental habits corresponding to the function design of the input device. In the game output, natural principle embodied in the game whether the output information is in line with people's cognitive habits or not. As we know the virtual world created in games is not real, but in fact it has a deep connection with real life naturally.(Malone. Th.W, 2005, What makes things fun to learn? A study of intrinsically motivating computer games, pp167-168) The game output in line with players' cognitive habits will help them quickly immerse the experience in life with the virtual world, and the users will integrate into the virtual easily. (XinyuanCai, 2009, Principles of Human Computer Interaction in Game Design, pp92-94)

Friendly principle

Friendly principle refers to the contents and forms of information output from computer and it plays an important role in aiding to the player's understanding, therefore the computer should have a certain degree of inclusiveness for the entering of form and content of users. Natural principle is mainly including some of the points.

• Reasonable forms of information

It is about taking information to be displayed to let the players know. Taking visual information as an example, visual information should be grouped logically and displayed to users with a good arrangement and in different areas to show important information.

• Giving automatically correction or tips to the inputs do not conform to the rules of the game

This is a most common error that usually we can see where a virtual character in the game when come near to the wall, if the users continue to make the virtual character walk, then the character will continue walk down to the wall. In fact, this problem can be solved better by correct the users' operation and ignore the users' command to go to the wall but remain stationary. The design should have corresponding input processing to users' irrational input in order to prevent the occurrence of unreasonable operation result.

• The main state and information must be given

User should make a lot of decision according to some specific circumstances during the game. Therefore it is needed to give enough information as possible and show them through relevant senses. For example, in many shooting games, the virtual character controlled by the users has the life value where the life value will be reduced when the virtual character get injured. When the life value reaches zero, the game is over. In fact, good design should give the players some tips when the virtual get injured, for example, there should be blood with screen red shown on the screen for a few second visually when the virtual character controlled by the users get injured. This is to ensure that the users can clearly receive the message that the virtual character without paying much attention to the life value.

• Provide comprehensive help system

Some designers think that the users can play the game smoothly without helping. This is the wrong view perspective as users should have full set of help system. However, the traditional type of help is different with the virtual world. It is because help will interrupt the progress in playing the game and reduce the users' devotion.

• The operation which can be configured and many operations for the same function

The default operation may not comply with the habits of the players. Therefore it is important to make the operation modes that can be configured, such as the mapping relations between the keys on the keyboard and the actions in the game can be defined by the users themselves.

• Adequate feedback

Any operation from the users should be given a feedback from the computers. Any type of feedback can be given to inform the users that they are successful by giving a sound, text and etc to give them a sense of achievement. (XinyuanCai, 2009, Principles of Human Computer Interaction in Game Design, pp92-94)

Consistency Principle

The principle of consistency meaning that the output of the computer and the input of the users should be maintain in a consistent appearance and also logicality. By ensuring the consistency in the process of interaction then the users can easily gain the communication process with the computer and engage in the entertainment experience of the game.

Human Computer Interaction is a main factor in affecting game quality. According to the HCI interaction theory described by Don Norman, the principle of "Simple, nature, friendly, and consistent" should be applied in every aspect of the progress in game. A good design will results in a good channel of communication between the users and the computer. At the same time, entertainment and the goal of the game can also be achieved.(XinyuanCai, 2009, Principles of Human Computer Interaction in Game Design, pp92-94)

2.7 SUMMARY

Human Computer Interaction (HCI) is the study on how users interact with computers and what extent the computers can be developed to make successful interaction with human. HCI rule is actually can be applied to many fields such as computer science, psychology, design, entertainment, ergonomic, engineering and etc. The topic of "HCI in game design" is mainly focused in this research.

Three types of HCI heuristic usability rules is reviewed. The first one is Jakob Nielson's 10 Usability rules, the second one is Shneiderman's Eight Golden Rules, and the third one is Don Norman Principles of design. These three types of usability rules are mainly about the principles that should be applied to any system in order to improve its usability and functionality based on human needs. Another review will be done on

principle of user interface design, it is main about the interface design instead of usability. Rule of interface design is to make an interface that is structured in design so that the system becomes more user-friendly and comfortable to be used. It is different from the three HCI heuristic rules mentioned. There is also a research on the example of good and bad game design. Type of games that are considered to be good or bad and the criteria that needs to be considered when designing games. There is a close relationship between HCI and game design. Actually all games have similar operations like computer software. The process of game is actually a cycle of HCI. Therefore, before we want to improve the quality of the game, we should improve the HCI in game first by applying the design principle of Human Computer Interaction in the game.

From all the HCI heuristic rules and Interface design principles studied, we can know that user interface is not just about button and menus but it also includes the interaction between the user and the application or devices in many cases. It is all about interaction between multiple users through that device. When the user interface design applied to the computer software then user interface (UI) is known as HCI. A good user interface will increase the satisfaction of user as it able to help user to find information. Therefore, the development of HCI in game design is important to ensure the effectiveness of application to help in the gaming process.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Methodology can be defined as a guideline system for solving different problems within a scope of particular discipline, with certain components such as techniques, methods, or technology and tools in developing an application. This chapter contains an explanation of the steps, methods and procedure when developing the system prototype. Through this chapter we can know that the methods that would be used in implementing the prototype by following the steps of Multimedia Development Life Cycle from the beginning until the end of the development process. We have to know the requirement of users on a particular game design, it is important to ensure that we are able to obtain enough data from the respondents in UMP and then the data will be analyzed to get the results.

Other than that, methodology can be defined as the use of standard process to achieve objectives of the project that will accomplish a perfect result which consists of the entire step necessary i.e. analyze, design, implementation and testing. After analyzing the data obtained together with the HCI rules studied before, it should be come out with a set of design framework. The storyboard will be designed and prototype will be developed based on the framework and finally comes to testing phase and again respondents have to do the questionnaires and give feedback. Besides, the software and hardware that are being used will be described in this chapter. Software and hardware are important in developing the system prototype in the development phase.

3.2 MULTIMEDIA DEVELOPMENT LIFE CYCLE

An application development process includes set of steps that involves certain methods, tools and procedures. These steps refer to the life cycle model. The life cycle begin from the conceptualization and ends on retirement of the particular product. A life cycle model enforces a discipline in the development process and generation of documents at every stage. Life cycle model is important to produce an application that good in quality and meet the user requirement together with its designed framework. (Ranjan Parekh, Ranjan Tata McGraw, 2006, Principles of Multimedia, p.652)

Actually there are various types of development methodology that can be used in developing an application. Each approach should be appropriate to the project to be developed. Multimedia Development Life Cycle is used for guidance. It provides a framework for the application project development process where it is highly adaptable and measured according to a specification and a project development.

The life cycle has six phases start from data collection, requirement analysis, planning, design, development, and followed by testing. Evaluation will be done after every phase to make sure that there is no error and improvement can be done in order to proceed to the next phase. Each of the phases involved in the development helping this study and it also involved as a basis of every development model methodology. By following this life cycle it can facilitate the project be managed according to the flow effectively and efficiently. The methodology used in this study has been modified slightly by adding another method in the Multimedia Development Life Cycle phase involved based on the needs of developing a prototype application based on the new designed framework. This is to ensure that the development process is more effective and worked well. The figure 3.1 below shown is the life cycle model with six phases.



Figure 3.1: Multimedia Development Life Cycle

3.2.1 Data Collection

Data collection is an important aspect in this research. Inaccurate data collection can give impact to the results of study and consequently lead to invalid result. There are two types of data collection methods which are Quantitative and Qualitative Data Collection methods. In the beginning of the cycle, the data collection phase, survey methods chosen are Interview (open-ended) and Observation (open-ended).



Figure 3.2: Survey Method

Qualitative method is collecting, analyzing and interpreting data by observing what people do and say. It is more subjective than quantitative and uses very different methods of collecting information, mostly individual, in-depth interviews and also focus groups. This type of research is exploratory and it is open-ended. Qualitative research does not start with specified research questions to be tested, but it will be formulated after open-ended field research has been completed (Lofland et al, 1995, p.267). Closed-ended questions limit the answers of the respondents to response options provided on the questionnaire. In open-ended questions, there are no predefined options or categories included. The participants should supply their own answers.

In this phase data is collected from fifteen students from UMP, the fifteen respondents are picked randomly from year one to year three students. Each of the students will be given five particular types of Arcade games according to the selection of researcher. Researcher will choose games that are low rating from the website. This is because low rating games usually not popular among community the game would be aborted after some times. Games that are not nice to play usually will get low rating from the user. The two big predicted factors that make the game have low rating would be caused by the interface design and its usability. Interview and observation methods can be carried out at the same time as interviewing is an important way for a researcher to check the accuracy of the impressions he or she gained through observation.

(i) Interview

Interviews is a data collection method that involves face to face between the researcher and the respondent for information about the focusing area that they are using, opinions, and problems when using the application study. Through interviewing respondents, more detailed information can be obtained without ambiguity. Each respondent will be asked to play the five particular games given and observe the games, and they can point out the disadvantage or the thing that they feel not comfortable when playing the game or the can give feedback on what they like or dislike about games. They can freely comment on the games based on their experience in playing that particular game. After that, researcher will try to interview them according to some aspect like layout, color, image, feedback, movement and etc. Questions will be asked mainly is the interest application style and design concept needs. The structured interview questions will be prepared by the researcher to ask the respondents, so that necessary data can be obtained from the respondents. Through this interview, it will assist in developing the application prototyping based on the user requirement need.

(ii) Observation

A checklist will be provided to record the observations of respondents. Observation is an additional data obtained because indirectly it helps developers to explore the reality of data. All the gestures when respondents are using the application will be observed and evaluated. Assessment through regular observations made continuously according to the specified time period, it can help the researcher to get feedback on the effectiveness. For example, based on the case like respondents do not understand what is trying to present in the game, we can know that we can know that through their gesture and face expression. Then, we should know we have to improve a particular aspect on that game design.

A checklist of questions asked is used to collect requirement needs and comments from the respondents. So there would be mainly opinion-typed questions which can be divided into two parts: User Interface and Usability. Respondents will be asked to give comments and rate on each question by using the rating scale 1- very disagree, 2disagree, 3-agree, 4-very agree. (Refer to Appendix A)

Interview questions:

- 1. Do you play game frequently?
- 2. What do you like about this game?
- 3. What do you dislike about this game? State.
- 4. Opinion-typed questions : Criteria

User Interface

- Is the layout design consistent and organized?
- Clarity of overall design?(symbol, button, image, text)
- Can function of the games is easily found?

Usability

- Are you able to control the game and do you know what is going on?
- Is there sufficient feedback to let you know what will be the next?
- Is there enough information to let you know where you are?
- Do you know the clue on how an object is operated?

3.2.2 Requirement Analysis

There will be two stages of analyzing part in this phase, the first stage is analyzing the needs of users based on interview session whereas another stage is analyzing on the previous HCI rules studied to come out with a set of HCI framework which is suitable for the arcade game prototype.

3.2.2.1 Needs Analysis

In the analysis phase the analysis used is based on interview session and observation to the respondents. Based on the questions that the researcher has asked the respondents, researcher basically already has the information on the requirement of the user from the previous phase. All the information will be compiled and analyzed according to the needs. The analysis requirement obtained several aspects as matter relating to the user interface such as layout design, menu style, color, image, suitable button, text representation, icon and usability of the game such as the feedback, movement that appear in that related prototype application.

Based on the data information collected from data collecting phase, researcher has to gather the raw data and filter it, after that we need to calculate the number of criteria (usability and functionality). From there we can find out criteria that are accepted the most by users for each particular game. There is a set of questions (Refer to Appendix A) used to interview respondent during data collection phase. Name and Contact number is required as the same respondents will be invited to test the game prototype with improved design at the last phase which is the testing phase.

The data will be classified into categories of criteria. The number of respondent that disagree with certain criteria is recorded, therefore we can know that the criteria that need to be improved in that particular arcade game. The data will be presented using table so that we clear on the number of respondents that like and dislike the certain criteria in a particular game overall. There is a table with calculated number of respondents that has the rating of each game from different types of Arcade games for Game1, game2, game3, game4 and game5. From the table, one out of five types of arcade sample games that gained the highest number of bad criteria will be used as a sample to design the game prototype of the new framework design rules. For example in the table shows that the criteria "No feedback" has the highest percentage so its "Offer Informative Feedback" will be used as one of the design rules framework of arcade game. The design rules of framework are designed to improve the existing low rating games.

3.2.2.2 Rules of Framework Analysis

After analyzing the requirement of the user based on the data collected, researcher should know the problem of users when playing the games. Another stage of analyzing part can be started which is the HCI rules for the application prototype framework. The resources are mainly taken from the literature review where all the comparison of rule will be studied again. All the rules that suitable for the game prototype application will be listed down and apply to the game prototype design. Set of framework that is specified to the problem of users when playing the games in the previous phase. The frameworks are based on the usability and user interface criteria of the game. The principles that will be analyzed are the heuristic rules, Don Norman rules, the eight golden rules of Shneiderman's, games principle, user interface and user experience. All these rules will be the guideline to set a new framework based on the suitability of user on Arcade games.

After the evaluation of usability and user interface criteria in the previous phase, we suppose have to set a framework that suitable for the game prototype. The rules will be set according to the data information collected in the analysis phase. These rules will be used as a guideline for the researchers to develop their own game prototype in this study. Moreover, these set of framework is as a theoretical system in the game design field in Human Computer Interaction. HCI rules includes the usability and user interface criteria that can make the game better in HCI field. The example of framework will be as below:

Draft of Rules:

- ✓ Rule 1 : User control freedom
- ✓ Rule 2 : Informative Feedback
- ✓ Rule 3 : System Consistency
- ✓ Rule 4 : Clarity of design
- ✓ Rule 5 : Aesthetic and minimalist
- ✓ Rule 6 : East to understand
- ✓ Rule 7 : Affordance
- ✓ Rule 8 : Design dialog to yield closure

3.2.3 Design

The main thing to be considered in design phase is the human computer interaction framework that suitable to be applied to the Arcade game. Human computer interaction is not just emphasis on user interface but also its usability. When discuss about user interface, it would include layout design, menu style, button, text that used in the game design, usability would touch on the movement of object, feedback and consistency of function. All these criteria would be analyzed from the early stage. The entire game prototype has to be designed based on the framework set in planning phase. That set of framework is analyzed based on the requirement and the needs of users after evaluation.

Human Computer Interaction is a main factor in affecting game quality. According to the HCI interaction theory described by Don Norman, the principle of "Simple, nature, friendly, and consistent" should be applied in every aspect of the progress in game. A good design will results in a good channel of communication between the users and the computer. At the same time, entertainment and the goal of the game can also be achieved. All the design can be produced when development phase has been started. A draft a storyboard according to rules of framework will be designed as follow:

Table 3.1: Draft of storyboard of prototype based on design rules of framework

Stroryboard scene	Description
Duck Shooting	 [Front page] It has mainly two buttons PLAY and INSTRUCTION. Title : Duck Shooting It has clarity design in terms of layout, text and color.
LEVEL 1 LEVEL 2	 [Menu page] After clicking START button at front page It will come to menu page Menu page provide user to choose the difficulties level of the game, easy medium or hard
LEVEL 3	 It fulfilled the rules User control freedom



3.2.4 Development

From design phase the development has been started and in development this phase is the prototyping of system model. Application prototyping refers to building application prototypes which display the functionality of the product under development but it may not actually hold the exact logic of the original application. In this stage, a working model of application with some limited functionality should be produced. The prototype here is used to allow users evaluate the game and to test whether the framework is work when applied into the game. This phase is to be a very important part as it can produce results of selected studies. Through the development that met the criteria and good design will determine the results of the study. What has been planned in design phase should be changed into reality prototype application. The application development should be determined based on the use of selected software.

Actually there are many software also can be used in developing the game prototype. Stencyl is a software that suitable to develop the game application because it does not need coding which is easy to control. It can accelerate the workflow of developing the game. It is essential as important thing can be focused. Moreover, Stencyl supports iOS, Android, Flash Windows, Max and Linux, different platforms.

3.2.4.1 Software and Hardware Tools

Appropriate and suitable software and hardware should be selected to develop this prototype application because it is very important to ensure that the processes to develop the system will run smoothly. All the activities to develop the application require software and hardware, tools need to selected carefully to ensure a smooth process later on.

(i) Software requirement

Software is a general term for many kinds of programs used to operate computer and related devices. Software is important for computer because without software, computer is just nothing. Without software, computer is just like a book full of blank pages, therefore computer needs software to make the computer useful because we have the words to make meaningful book. Table 3.2 below shows the details of software that used to develop this prototype system.

T	able	3.2 :	Software	Req	uirem	ents
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Туре	Name	Purpose	
Operating System	Microsoft windows 7	As an operating system	
	Home premium		
	Microsoft Word 2007	Documentation work	
	Microsoft Office	To generate Gantt Chart	
Software	Project 2007		
	Microsoft Power Point	To do presentation slide	
	Stencyl	To do game design prototype	
		application. A software which	
		does not need coding and it can	
		produce game application and	
		can be used in different platform.	
	Photoshop	To design the game actor in the	
		game.	
1	1		

(ii) Hardware Requirement

Hardware is a device that physically connected to the computer or something that can be physically touched. The example of hardware is LCD screen which enable people to see what is going on the computer screen. Mouse is used to control the system function in the computer. Without hardware, software would not be run. The Table 3.5 below show the hardware requirement during the development phase.

Table 3.3: Hardware Requirement

Hardware	Specification	Purpose
Laptop	2GB DDR2 RAM	Development of prototype,
	1TB Hard Disk	run application,
		documentation work
Printer	HP Deskjet Ink	Print documentation sheet
	Advantage 2060	
USB flash drive	Apacer 8GB	Transferring and backup data
CD	700 MB 48x	Backup data and data delivery

3.2.5 Testing

After the prototype successfully developed, now is the time to test the prototype. It needs the help from students to test it. Quantitative data collection methods rely on random sampling and structured data collection instruments that can be used in different kinds of experience in predetermining response categories. The results they produced would be easy to compare, summarize, and generalize. There are large number of respondents are involved and the measurement have to be objective, quantitative and statistically valid. Questionnaire method is a commonly way done.

Respondents are given instructions to begin the game. One-to-one evaluation session will be organized in an environment similar to the one where they would play the game. The questionnaire will be given to the same 15 respondents one by one. Close-ended questionnaire will be asked the users after they played the game prototype that designed according to the framework previously. Each questionnaire specified on a few important items which are layout design, color, image, button , text, icon, image

position, object size, movement of the object, feedback, key movement, consistency. The questions mostly are opinion-typed questions. There is positive player experience where the game increased their pleasure, immersion and challenge of the game. Negative player experience is the situation where the player is bored, frustrated or want to quit the game.

Questionnaire:

- 1. Do you like the game?
- 2. Do you like the layout?
- 3. Are you satisfied with this game?
- 4. Do you feel immerse into the game?
- 5. Do you feel frustrated when playing the game?
- 6. Opinion-typed questions : Criteria

User Interface

- Is the layout design consistent and organized?
- Clarity of overall design?(symbol, button, image, text)
- Do you think it focuses on the main object?
- Can function of the games is easily found?

Usability

- Are you able to control the game and do you know what is going on?
- Is there sufficient feedback to let you know what will be the next?
- Is there enough information to let you know where you are?
- Do you know the clue on how an object is operated? Is clickable? Is it touchable?

After the questionnaire with the respondents done, the data collected will be filtered and analyzed. Researchers supposed have results data to show that the changes or the enhancement of the game has increased the satisfaction when playing the games that applied the framework of game design rules. If most of the users agree that the designed prototype is better than the previous low rating arcade games in terms of interface design and usability and they have high satisfaction when playing the game, it proved that the design rules of framework can be used to enhance and improve the specified arcade games.

3.2.6 Evaluation

Evaluation is testing whether a multimedia program fulfills the objectives set, a suggestion of improvement will be made to make an application useful for its target audience. Evaluation phase is important in the whole research study. During this phase, all the activity which will be carried out in the next steps must be clearly identified and plan it thoroughly. The process of thinking about the activities required to achieve the desire goals is one way to achieve that goal. At the same time, the scope, objective and problem statement of the research will be used as a guideline to develop this game prototype. Besides, software and hardware selection are also important in this phase. Suitable software will be chosen to develop the game prototype.

Process of each stage in the Multimedia development life cycle will be evaluated to ensure that there is no error and no problems to proceed to the next stage. If there is a problem occur then it will be improved before proceed. In addition, the detailed project schedule is planned with activity timeline shown so that we can know what step should be carried out after that and to ensure that the application can be finished develop, testing and evaluate and finally completed the entire task within the time period specified in the schedule.



Figure 3.3: Gantt Chart of methodology phase

3.3 COMPARISON OF EXISTING LOW RATING GAMES

Types of arcade games	Description
	Fish Shooting
	A big fish called Johnny has been build around for a while by the other big fishes in the ocean. So, he needs to stand up and defend his territory. When there are fishes comes into his area, he shoot and kill until a certain amount of fish to advance to the next level. The game has less menu button to choose. Users do not know how to play the game as it has no instruction provided. The progress of the game level is not clear. The score achieved by the user is not shown clearly on the top of bar.

Table 3.4: List of arcade game that has low rating





Space Hunter

The space hunter game is to destroy all the enemies. Keep destroying units until reached the end. It is harder to kill and destroy your ship if you crash into them. Watch out the ship's Health Bar. When it is zero, the game is game over. The menu page has no main object image to get the user into immersion of the game. There is no design dialog to let users know how the progress of the game is. The information is not clear, so the users do not know what to do next.

Bubble Contest

Destroy the colored ball by shooting them into groups of three or more. All the balls have to be cleared to proceed to the next level. It is not use-friendly as it has no INSTRUCTION button to let user choose. Besides there is no other information to let users know where they are, and they just able to view the score but cannot see the progress of the game. There is also no proper design dialogs to yield closure of users to the game.



3.4 SUMMARY

The multimedia development life cycle is used in the research methodology. The five stages in the process are data collection, requirement analysis, design, development and prototype testing. Data collection will be done by collecting opinion and comments from respondents. After that, the data will be filtered and analyzed. The result obtained will be used to design and develop the game prototype. Respondents will be invited to test the game prototype developed. Each stage of development life process will be evaluated and improved, make sure there is no error to proceed to the next stage. In the next chapter, the stage of design and the flow of the game prototype will be further explained.

CHAPTER 4

DESIGN

4.1 INTRODUCTION

This chapter briefly describes the design of arcade game design based on the requirement of users with the combination of the new designed framework. The framework designed mainly is to enhance the interface design and also the usability of the game. The design also used to determine the game interface and its usability which will be evaluated by the students in UMP. The game prototype will be implemented later on after the storyboard of the game has been illustrated and designed. This chapter describes the framework of the game design and the workflow of the whole game design.

As discussed in Chapter 3, there are two stages of survey would be carried out. In the first stage of survey, fifteen respondents are picked randomly from UMP to play five similar types of arcade games and they will be interviewed. The results are analyzed later to do the new framework design which meet the perception of users. Another stage of questionnaire will be carried out after the new game prototype has been designed based on the new framework according to HCI rules.

4.2 INFORMATION GATHERING FROM INTERVIEW

Questions for interview are prepared for fifteen UMP students. Five particular types of arcade games are downloaded into computer and let the respondents to play. Fifteen students are picked randomly in UMP to carry out this activity.

During the interview session, respondents may able to give some comments about the game. But the comments may be not very accurate as some of the respondents only play the game in half way and they did not fully immerse into the game and play it. Especially for those respondents who do not like to play game or some of the respondents do not like to play arcade game. Most of the respondents unable to give comments as may be they do not pay much expectation to the sample games. The problem is overcome by asking them many questions the purpose is to get a more comments from the respondents. But for some respondents that like to play game, they would spend their time to play the sample game that they interested until they finished all the levels. The mood of respondents and their attitude during the process of playing games is important to get accurate result.

4.2.1 General Respondents Results

Table 4.1: General Res	ults Information	from the	interviewee
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Total number of sample games	5
Total number of respondent	15
Number of respondent that play game frequently	5
Number of respondent that seldom play game	10

There are fifteen respondents all together and they are picked randomly from UMP. Each of the respondents played five types of similar arcade game. The low rating arcade games are downloaded from online game website (<u>www.y8.com</u>). The low rating games has been rated by the gamers according to the websites information. Low rating games are the games that dislike by most of users with any factors. Such as the game function not good, interface not user-friendly, design not attractive and etc. In order to prove that the five types of game chosen is low rating games, after interviewing the fifteen respondents, most of the respondents also dislike the game after playing based on the results. From Table 4.1, number of respondents that played games frequently has the number of five out of fifteen people, whereas number of respondents that seldom play games has total ten.

Character elements preferred by respondentGame character elementTotal NumberAnimal8Cartoon Character8Aircraft5Shape3Insect1

 Table 4.2: Games character elements that preferred by respondents

Based on the interviewed results, the game character element most preferred are Animal and Cartoon character as their comments are animal and cartoon character is more attractive.

4.2.2 Results of Interview from Respondents

Elements in the each game LIKED by respondent					
	Game 1	Game 2	Game 3	Game 4	Game 5
Levels	4	0	12	8	0
Character ability	6	5	2	3	3
Enemies	7	7	3	5	5
Live and health	3	7	2	4	2
Graphics and interface	8	2	8	5	4
Scoring	3	6	8	4	2
progress	3	6	5	4	3

Table 4.3: Elements in each game LIKED by respondents

Elements in the each game DISLIKED by respondent					
	Game 1	Game 2	Game 3	Game 4	Game 5
Levels	3	1	0	0	2
Character ability	5	5	4	3	7
Enemies	1	1	0	3	3
Live and health	4	2	3	2	6
Graphics and interface	3	6	5	6	4
Scoring	3	2	1	2	4
progress	5	2	3	5	4

Table 4.4: Elements in each game DISLIKED by respondents

According to the interviewed results in Table 4.3, there are five types of game, Game 1 (Fish Shooting), Game 2 (Space hunter), Game 3 (Bubble shooting), Game 4 (Spheroids), Game 5 (Simple Shooter). The seven elements levels, character ability, enemies, live and health, graphic and interface, scoring and progress, must be included in each arcade games but some of the games has the elements or some of the games do not have. Table 4.3 and Table 4.4 listed the elements and frequency of the game elements that liked and disliked by respondents.



Figure 4.1: Game1(Fish shooting) game interface
For Game 1(Figure 4.1), Graphics and interface has the highest frequency meaning that most of the users like the Graphic and interface design of Fish shooting. From the comment from the user is they like the colorful design and graphics with cute and attractive character element inside the game.

In contrast, the most disliked by respondents is the 'character ability' and 'progress' elements. From the results of interview, users comment that they do not know the function of the character on how to attack the enemies as there are no instructions to tell them. For the progress of the game, users do not like the progress as they do not know when the enemies will die. They also feel that the character's 'live' is not appropriate as the live bar shown is 100 life, they thought if character attacked by enemies will decrease one marks but in fact the live will decrease 20 marks for each attacking.



Figure 4.2: Game 2 (Space hunter) game interface

For Game 2(Figure 4.2), most of the respondents like the enemies and live health in the game. As their comment, they like the 'Live and Health' that will decrease the red power if the character attacked by enemies. This showed to the user that when they will die, the power becomes zero then the character life straight away gone and game over. In contrast, the most dislike elements in the game is Graphic and interface. As from respondents' comment, they do not like the graphic design that is dull in color and not attractive.



Figure 4.3: Game 3(Bubble contest) game interface

From Game 3(Figure 4.3), most of the respondents like the 'levels' in the game as compare among the five games, Game 3 has 'level' that shows very clearly to user they are in which level now. Users may prefer element that clear enough for them to see and understandable.

In contrast, the element that gain the most disliked by respondents is the Graphic and interface. Respondents think that the design and color not that attractive. Besides, some game elements inside the game interface that make them confuse and they do know its function.



Figure 4.4: Game 4(Spheroids) game interface

From Game 4(Figure 4.4), most of the respondents like the 'levels' in the game .Game 4 has 'level' that shows very clearly to user they are in which level now. Users may prefer element that clear enough for them to see and understandable. At the same time, each level of the game also challenging.

In contrast, the interface design in Game 4 is too plain and it gains the most disliked by respondents in its interface elements. Respondents give the comment that the interface design not attractive.



Figure 4.5: Game 5(Simple Shooter) game interface

From Game 5(Figure 4.5), most of the respondents like the 'enemies' in the game. As the respondents' comments, Game 5 has 'flies enemies' that coming to attack the character. The speed is fast and challenging. Most of the respondents prefer game that has more speed as it is more challenging.

In contrast, most of the respondents dislike the element of 'Character ability' in the Game 5. From the comments, users comments that they unable to control the function of the character. For example, they press button to right but seems like there are no response feedback to the users. Besides, users also do not know when the scores can be gained when attacked by enemies.

It is a must for the arcade games to have the seven elements, levels, character ability, enemies, live and health, graphic and interface, and also progress. These elements are important to design a perfect game which able to meet the requirement of the users. If there is missing one of the elements, users might cannot play the game comfortably as they do not know how to play if there is no clear instructions, they do not know what is going on if no sufficient feedback during the game progress, if no levels for them to see they unable to know which level they are, of course scoring is very important as every action in attacking the enemies in the game should be scores to let user know. Besides, progress is important to let the user know when the game will come to the end.

In order to let game users play comfortably and increase their satisfaction when playing the game, these seven elements must be improved by using Human Computer Interaction rules. The main objective is to improve these games is to enhance interface design of game prototype based on the proposed framework. Besides, the usability of the game design prototype has to be designed based on the applied design rules of HCI framework to the game design. After studied about the HCI rules by Jakob Nielson, Shneiderman and Don Normans and carried out the results study from the interviewee about game design, the suitable HCI rules should be applied in developing games.

4.2.3 Results of questionnaire from the respondents

	Game 1			Game 2				Game 3				Game 4				Game 5								
	1	2	3	4	1	1	2	3	4	1	1	2	3	4	1	1	2	3	4	1	1	2	3	4
1 Challenging game	3	6	5	1		4	5	4	2	1	1	6	7	1	1	0	0	9	6		5	8	1	1
2 Like the game	2	7	3	3	1	1	7	4	3	1	0	4	7	4	1	1	7	7	0		9	5	1	0
3 Clear instructions	7	5	1	2	1	0	2	6	7	1	4	4	4	3	1	2	2	5	6	1	11	4	0	0
4 Appropriate feedback	6	2	2	5	1	1	3	5	6	1	3	3	2	7	1	1	6	3	5		7	8	0	0
5 Sufficient feedback	4	2	5	4	1	0	5	6	4	1	2	3	6	4	1	1	6	3	5		6	7	2	0
6 In control of the game	1	7	5	2	1	1	5	8	1	1	0	1	7	7	1	3	5	3	4	1	5	9	1	0
7 Consistent layout	2	5	4	4	1	3	7	4	1	1	0	1	9	5	1	0	4	8	3		2	11	1	1
8 Overall design clear	1	4	8	2	1	1	6	5	3		0	4	4	7	1	0	2	10	3	1	3	10	2	0
9 Need to recall info	2	3	2	8	1	1	5	3	6	1	2	0	5	8		1	1	6	7		2	3	5	5
10 Function easily found	2	5	5	3	1	1	2	7	5	1	0	1	6	8		1	3	6	5		6	9	0	0
11 Confuse when to proceed	4	4	2	5	1	3	4	6	2	1	0	3	4	8	1	1	4	7	3		4	4	3	3
12 Easy reversal button	7	7	1	0	1	4	7	2	2	1	5	5	2	3		9	3	2	1		9	3	2	1

Table 4.5: Results of questionnaire from the respondents

Table 4.5 is the results of questionnaire gathered from the fifteen respondents. Every questions regarding to the game design is rated by the respondents according to the rating scale of 1-very disagree, 2-disagree, 3-agree, 4-very agree. In this research study, rating scale of 'neutral' is not considered as it is meaningless to the study results. It is because in this study the usability function of the game and interface design is more concerned about in order to get the results of most affected elements rated by the users. Then the most affected elements will be chosen to enhance to get a better game design.

4.2.4 Other comments on each of the sample games by respondents

Table 4.6: Other comments from respondents for each sample arcade game

Game	Comments on the game from respondent
1. Fish Shooting	- Instruction
	- Position of score bars is not correct
	- Not attractive
	- Fonts not clear
	- Instruction and pause button not provided
	- No exit button
	- Interface design can be improved

	- Position of score bars should be at bottom
	- Position of score bars can be bigger
	- No clear instructions provided
	- Hotkey may add more
	- Levels, scoring and progress not obvious
	- The live bar confusing
2. Space hunter	- Distractive object
	- Character ability not powerful
	- Instruction not clear
	- Game out of control (no play also can score)
	- Pause button not provided
	- No exit button
	- Font need to be improved
	- No second life given
	- Score bars make it on top or at right
	- This game is not interesting
	- Should give time limitation for the power of
	character ability
	- Interface can be improved
3. Bubble contest	- Size of enemy too big
	- Easy game over
	- Certain button no function
	- Shooting function can be upgraded
	- No exit button
	- No reflect angle in the function
	- Interface design can be improved
	- No instruction
	- No time limit alarm
	- Some confusing game design(the two hole)
4. Spheroids	- Distractive object
	- Instructions too long, may present in video format
	- No exit button

4.2.5 Comparison of three types of HCI rules with questionnaire results

Jakob Nielson	Shneiderman	Don Norman
Visibility of system	Strive for consistency	Visibility
Match between system and the	Enable frequent user to use	Feedback
real world	shortcuts	
User control and freedom	Offer informative feedback	Constraint
Consistency and standards	Design dialog to yield closure	Mapping
Error prevention	Offer simple error handling	Consistency
Recognition rather than recall	Permit easy reversal of actions	Affordance
Flexibility and efficiency used	Support internal locus control	
Aesthetic and minimalist	Reduce short-term memory load	
Help user recover from errors		
Help and documentation		

Table 4.7: Comparison of three types of HCI principles

Table 4.7 shows the comparison of Jakob Nielson's 10 usability heuristic for user interface, Shneiderman's Eight Golden rules of interface design and Don Normans Principles of design respectively. The highlighted HCI rules are the rules that suitable to be applied in the game development design.

According to the results from interview and questionnaire (Table 4.5), all the elements of game design bring effect to the game users. Besides, the elements also related to some of the HCI rules. For example, the first one is the clear instructions needed to let users know how to play the game. This element is related to the *Help and documentation* rules of Jakob Nielson saying that system can be used without documentation, but it may be needed to provide help and documentation. With the document in hand, we can search information easily. It can also help users have of the best experience in using the system as some of the users might curious and would like to know more about why they do a particular task. So, instructions or help information should be provided to users to let them have the best experience using the system.

The second one is the appropriate feedback which is important to tell the users when the level up, when will game over or there must be a response when fire shoot out. Shneiderman's Eight Golden rules stated that *Offer informative feedback*, for every action there should be system feedback. This feedback should be proportional to the seriousness of the action. For frequent and minor actions, the response can be modest, whereas for infrequent and major actions, the response should be more substantial. For example, when shooting fire toward the enemy, when the level up or failed to complete the level, feedback will be pop out to let users know it.

The third one is the sufficient feedback to let user know what will be the next for example restart option, play again option, current scores, progress and etc. This element related to the rules of *visibility of system status* of Jakob Nielson saying that the system has to keep on informing the users what is going on and to give appropriate feedback in a reasonable time. For example, there is restart options, play again option, current game score, the progress should be let user know it.

The forth one is the control functions and the keyboard functions making the users in control of the game. *Support internal locus of control* by Sneiderman refers to giving users the sense that they are in full control of events occurring in the digital space. Supporting the development of an internal locus of control is achieved by ensuring users are the initiators of actions in the virtual space, as opposed to reducing their involvement to system response. For example, users able control all the functions of the game efficiently.

The fifth one is the consistent layout design in terms of font, color, layout, design, this is important to make the layout and organization of the game easy-to-use. It is a must to keep the design simple and more user-friendly making sure that the user would ever need. The rule of Sneiderman, *Strive for consistency* is the consistent sequences of actions should be required in similar situations. For example, menus, prompts, help screens, consistent color, layout, capitalization, font and others should be applied throughout the system designed. Consistency performs an important role by aiding users become familiar with the digital landscape so they can perform goal-based actions with confidence.

The sixth element is to prevent the user from recalling the info or instructions from one part to another part. According to Sneiderman rules of *Reduce short-term memory*, human attentional resources are limited and we are only capable of maintaining around five items in our short-term memory at one time. Therefore, interfaces should be as simple as possible with information condensed, categorized and as much help offered to memorize and become au fait with system operations when users navigate through the digital space.

The seventh is to make sure users able to proceed to the next goal when playing the game. *Design dialog to yield closure*. Action sequences should be teleological i.e. leading to an ultimate goal or satisfying conclusion. These sequences should be organized in to groups that satisfy the human inclination for task paths with a beginning, middle and end. When the dialogue is complete this should be clearly indicated so that users know they can proceed to their next goal, or whether they must revise, revisit or return to their previous action.

The eighth is the button function that permits the easy reversal of actions such as back button and undo button. *Permit easy reversal of actions*. This feature relieves anxiety, since the user knows that errors can be undone; it thus encourages exploration of unfamiliar options. The units of reversibility may be a single action, a data entry, or a complete group of actions.

The ninth element is the function of the game has to be found easily and understandable for example symbol represent back to main menu, home button back to home page, music symbol is to adjust music setting. In the principle of V*isibility* by Don Norman, the user can tell the state of device and the alternatives for action by just looking at the system interface design. In some of the design, the crucial part of information has been hidden away. The important information is left out due to some distractive design. Therefore, it will minimize the significant cues that should be known by users. The more visible functions are, the more likely users will be able to know what to do next. In contrast, when functions are out of sight, it makes them more difficult to find and know how to use.

4.2.6 The Nine rules of framework

After a deep analyze to the three types HCI rules and evaluation has been done throughout the research, finally a set of new framework consists of Nine rules of HCI framework to the game design has been found. The applied design rules of HCI framework to the game design can meet the requirement of usability and interface of the game design prototype. The Nine HCI framework for arcade games as shown in Table 4.8

Framework	Explanation
1. Help and documentations	Clear instructions in the game to let user know
	how to play the game. In terms of function
	and also keyboard key.
2. Visibility of system status	Keep informing users what is going on and
	appropriate feedback (e.g current scores,
	progress)
3. Offer informative feedback	For every action there should be system
	feedback (e.g fire shoot then gain scores)
4. Support internal locus of control	Let users feel that they are in control of the
	game.
5. Strive for consistency	Consistent in layout, font, color, design to
	help users become familiar with the condition
	and perform with confidence.
6. Reduce short-term memory	Avoid users recall the functions in the game.
	(e.g options, shortcut key, obstacles, ways to
	gain marks)
7. Design dialog to yield closure	When the dialogue is complete this should be
	clearly indicated so that users know they can
	proceed to their next goal, or whether they
	must revise, revisit or return to their previous
	action.

 Table 4.8: The Nine HCI framework for designing arcade games

8. Permits reversal actions	Functions that enable user to undo something
	or back button. (e.g. user accidentally clicked
	the mute button then clicked second time will
	open the sound again)
9. Visibility of design	The user able to know the state of device and
	alternative for by just looking at the system
	interface. More to visible functions

The scope of the research is focused in designing a new design framework rules based on user requirement by applying HCI principles, then a game prototype will be designed based on designed framework. The storyboard is explained step by step from one scene to another scene on its interface design and secondly will be the explanation on the usability of the game design. From the game prototype storyboard, we can know how the human can interact with computer using interface which able to interpret the information in the application and the design helping users to achieve their goal and increase satisfaction when playing the games.

Based on the results that collected (Table 4.5), Game 5 (Simple Shooter) is the lowest rating games from respondents. This is because most of the elements in the game also have the low rating and bad comments from the respondents whereas Game 3 (Bubble contest) has the very high rating from respondents for most of the elements inside the game. However, there are also certain elements that need to be improved for example, the instructions in the game need to be improved, the pause button, the font small font size, the progress bar, the help button and etc. Therefore, the Nine rules of HCI framework have to be applied in the arcade game design in order to enhance the arcade game to become more perfect in terms of usability and interface design. This is important to increase the satisfaction of users during the process of playing games.

4.3 STORYBOARD OF GAME PROTOTYPE DESIGN

The design of game prototype storyboard is a complete description about the application to be developed. It includes all the interaction between the users with the application. The table 4.9 below is the storyboard scene one until scene seven. Interface design and its usability are described for each scene. For game design it does not have specific location to locate its elements but as long as it let the users feeling comfortable when looking at the game interface and playing the games with satisfaction. Game 3 (Bubble contest) will be chosen to be improved by applying the Nine rules of framework.



Table 4.9: Storyboard of game prototype application



The main function of instruction page is to let users know the way to play the game in order to achieve goal. The MAIN MENU and NEXT button is to let users navigate from one page to another page of instructions. User will feel that they know what to do at the next stage. The clear instructions fulfilled the of Help and documentation. Whereby HELP is needed by user whenever they need it.

[Instruction page 2]

The more detail description on the function of each element in the game. This is good to let users know what and how goal would be achieved when playing PREVIOUS game. The button and MAIN MENU button fulfilled the rule of Permits the reversal of actions as users able to go back to see previous shown information.



[Menu page]

This is the menu page to let users choose which level they want to play. There are 3 levels with different difficulties which EASY, **MEDIUM** and are HARD. This function would let user to be in control in the game they can choose their as favorable difficulties based on their own ability. Users will not confuse on which level are they in the game and they know when should proceed which fulfilled the rules of Design dialog to vield closure.



[Main page]

Here is the interface where user can interact with the computer through the game. Users will know how to play using a specific tactic to achieve the goal when playing the game. The right-hand side, there are the level of the users achieved, the score they obtained, the progress to reach the next level. These function is good to let users know where they are and until what progress. This design fulfilled the rule of Offer informative feedback as there will be response such as the ducks or bird will be destroyed after clicked and score will be gained and shown.



[Pause the game]

The word 'Game Paused' is shown when the user press on the space bar on the keyboard. The function pause is to freeze the flow of game whenever the users need it. The Pause function can be used in every level of the games. This design fulfilled the rule of *Support internal locus of control* as it enable user to control the game by pressing space to pause the game.



[Final page]

When user unable to achieve the specific goals set, meaning that they failed to continue the next level of the game. Therefore, a notification box will pop-out to inform the users that they are GAME OVER. The total score is shown. The users name would be stored into the database online to record the score achievement. Users may go back to MAIN MENU or choose to RESTART the game. The design fulfilled the rule of Visibility of system status where users able to know their final score and they can choose to play again or any other options.

4.3.1 Content Diagram



Figure 4.6: Content Structure of the Game prototype Application



Figure 4.7: Context diagram of the game prototype application

4.4 DIFFERENCE BETWEEN EXISTING GAME AND GAME PROTOTYPE

Based on the Nine framework rules, some elements have been added to the game prototype design in order to improve the interface design, usability and functionality of the game. Table 4.10 shows types of elements and ideas based on the applied design rules of HCI framework that has been applied to the game prototype design.

Framework	Sample Games	Prototype Game
Help and	There is no clear instruction to	Clear instructions in the game
documentations	explain to user on how to use	to let user know how to play
	the function in the game, way	the game. In terms of
	to achieve goal and scores.	functions and way to score.
Visibility of system	User do not know when the	Keep informing users what is
status	game will end as there is no	going on and appropriate
	progress bar or time remain to	feedback such as current
	let user know.	scores and progress.
Offer informative	When the enemies or target are	For every action there is a
feedback	fired but there has no feedback	system feedback. There will
	for example, no signal to let	be a sign of -10° or $+5^{\circ}$
	user know the scores has been	appear when enemy or target
0 11	deducted or added.	IS Shoot.
Support internal locus	User might not able to control	User able to control the
of control	the function of the game, for	functions of the game, for
	that has no function not	key buttons and symbol
	response when the enemy is	button
	heing shoot	button.
Strive for consistency	Consistent in layout font and	Consistent in layout font
Surve for consistency	color in the same scene level	color in different level scene
	User able to adapt to the	design to help users become
	familiar condition and perform	familiar with the condition
	confidence.	and perform with confidence.
Reduce short-term	There is no instruction or	There is instruction and
memory	shortcut key to recall. Users do	keyboard key in the game.
5	not need to recall the functions	But, users do not need to
	in the game, such as options to	recall the functions in the
	choose, shortcut key,	game, such as options to
	obstacles, ways to gain scores.	choose, shortcut key,
		obstacles, ways to gain scores

Table 4.10: Comparison between the design of existing sample games and game prototype

Design dialog to yield closure	There is no clear dialogue to inform users what score they gain in each level to proceed to the next goal, users do not know whether they able to return to the previous action.	When the dialogue is complete this should be clearly indicated so that users know they can proceed to their next goal, or whether they must revise, revisit or return to their previous action.
Permits reversal actions	There is no BACK button for users to go back to previous function. There is no MENU button to navigate back to main page.	Function of button that enable user to undo something or back button. Users can read different page of instruction and they can go to next page and also return to previous page.
Visibility of design	Some function in the game is to destroy enemies, however its design is not that visible but in fact it is an important element function in the game. Consequently, user cannot perform well when playing the game.	The user able to know the state of device and alternative for by just looking at the system interface. They know the functions of the element and able to perform well when playing game.

4.5 SUMMARY

The elements that must be included in each arcade game are levels, character ability, enemies, live and health, graphic and interface, scoring and progress. There is no specify position for the element but its layout consistency and organization has to be considered. Of course font must be clear and color chosen as layout must be matched to the game environment and attractive enough as today's users usually will view the attractive design first before playing the games according to the comments by the respondents. Besides interface design, usability and function of the game also play a very important role in an arcade games, this is because the functions in the game will affect more the satisfaction of user when playing the games.

The Nine Rules of framework is designed specifically for arcade games. It may or may not applicable to other games. At least it can be used to develop a game with improvement design which able to increase the satisfaction of users and at the same time decreases the number games that would be aborted in the market.

CHAPTER 5

DEVELOPMENT AND IMPLEMENTATION

5.1 INTRODUCTION

For development and implementation phase, the game prototype is developed based on the design which met the user requirement. What has been planned in design phase should be changed into reality prototype application. A working model of application with some limited functionality is produced. The prototype here is used to allow users evaluate the game and to test whether the framework is work when applied into the game. This phase is to be a very important part as it can produce results of selected studies. There are a few software have been selected to develop the game prototype which are *Stencyl*, a software mainly to develop the game, *Photosho*p is used to design the actor type images, text and buttons with different color and design.

For this Stencyl software to produce game, coding is not required as the coding will be auto generated behind for each button actor type, actor behavior and scene behavior. The main things that need to do is to drag the logic element and properties into the work space in order to make the flow of the game run smoothly without error.

Based on the questionnaire and interview result to the 15 respondents, there are Nine Rules of Framework that have to be added into the arcade game. The scene in the game will be shown one by one together with the further explanation on how to implement for each levels, characters ability, enemies, scoring, progress, graphic interface and etc.

5.2 EXPLANATION OF DEVELOPMENT ON EACH SCENE



Figure 5.1: Main menu page

Table 5.1: Description of elements in Scene 1 in terms of Design and Functionality





MusicON



MusicOff

As shown in Figure 5.1, the 'music ON/OFF' button located at the right -up corner of in the Main menu page (Scene 1). When the user first play the game, the game is in silent mode where the music button is off. Users have to click it once to ON the music before they start the game. These buttons are edited using Photoshop and save as .png format then it is imported into the Actor type category in Stencyl. The 'music ON/OFF' button is added into the Main page menu scene (Scene 1) at the same time the function of the button also added into the actor

the same time the function of the button also added into the actor behavior of the 'music button' so that user able to control the function to choose ON or OFF the music when playing the game. The logic functions and properties are shown as below.



	<pre>when drawing ** if Music and Sound On or Off = 0 * switch animation to 1 for Self : if Music and Sound On or Off = 1 * switch animation to 2 for Self : when created if Music and Sound On or Off = 1 * stop all sounds 4 Loop : bg : 4</pre>
Title'Duck	The title is designed as larger font size as possible so that it is clearly
Shooter'	presented to the user by using Photoshon element 6.0
	presented to the user by using I notoshop clement 0.0
Environment	The elements in the Main Page Scene such as the river, stone, trees, the
	frame as shown in figure 5.1 are created using the tiles which already
	provided in the software. It is just needed to choose the pattern of tiles
	that suitable and then drag it into the scene and arrange the design of
	the scene. The background color is edited in the Stencyl 'Edit Scene
	Properties' to change the background color to vertical gradient with
	light blue and white color.



Figure 5.2: Instruction Page 1 on 'How To Play'

Table 5.2: Description of elements in Scene 2 in terms of Design and Functionality

Functionality and Usabili	ity
	As shown in Figure 5.2, the 'NEXT' button is located at the
NEXT	bottom of in the Instruction Page1 and also the 'MAIN
	MENU' button. These buttons are edited using Photoshop
	and save as .png format then it is imported into the Actor
	type category in Stencyl. The 'NEXT' button and 'MAIN
MAIN MENU	MENU' button are added into the Instruction Page scene
	(Scene 2) at the same time the function of the button also
	added into the scene events of the buttons so that user able
	to control the function to choose to navigate to the next
	instruction page (Scene 3) by clicking the 'NEXT' button or
	go back to the main menu page (Scene 1) by clicking

	'MAIN MENU' button. The logic functions and properties
	are shown as below.
•	when drawing if mouse is over + next0 6 + + switch animation to 1 + for next0 6 +
	if not mouse is over next0 6 switch animation to 0 for next0 6
	if mouse is over imain_menu0 9 imain_menu0
	if not mouse is over to main_menu0 9 to main_
	always if mouse is down on i next0 6 i i Fade Out i for 0.5 secs, then switch to M Helpmenu 2 and Fade In for 0.5 secs, then switch to M Front and Fade In for 0.5 secs, then switch to M Front and Fade In for 0.5 secs
Interface Design	
Aim on the yellow duck or bird by using red cross eim Use year mouse be shoot. Aweld shooting blue bird.	The text fonts and graphic are edited using Photoshop element 6.0. Then the text and graphic is imported into the Actor type category and added into the Instruction Page1 scene (Scene 2). The background color is edited in the Stencyl 'Edit Scene Properties' to change the background color to vertical gradient with light blue and pink color.



Figure 5.3: Instruction Page 2 on How To Play

Table 5.3: Description of elements in Scene 3 in terms of Design and Functionality



	when drawing 🍲
	if mouse is over 💠 prev0 7 🗧 🔮
	switch animation to 1 v for prev0 7 ÷
	if not mouse is over 💠 prev0 7 🛊 😁
	switch animation to 0 🔻 for prev0 7 🕴
	if mouse is over 💠 main_menu0 8 🗧 🗳
	switch animation to 1 v for main_menu0 8 ÷
	if not mouse is over 💠 main_menu0 8 💠 🗳
	switch animation to 0 - for main_menu0 8
	always 🙀
	if mouse is down on t prev0 7 t
	Fade Out for 0.5 secs, then switch to File Helpmenu thand Fade In for 0.3 secs
	if mouse is down on 👘 main_menu0 8 📫 🔮
	Fade Out for 0.5 v secs, then switch to 🗮 Front 🗧 and Fade In 🕴 for 0.3 v secs
Interface Design	
Galacor lase in the earne	The text fonts and graphic are edited using Photoshop element
Jorn 10 Cross alut	6.0. Then the text and graphic is imported into the Actor type
🤟 Seren - till 🧥 (Refs. to and all amain	category and added into the Instruction Page2 scene (Scene 3).
	The background color is edited in the 'Edit Scene Properties' to
Via Joore 45	change the background color to vertical gradient with light blue
	and pink color.



Figure 5.4: Menu Page to choose level of difficulties

Table 5.4: Description of elements in Scene 4 in terms of Design and Functionality

Usability and Functionality		
EASY	As shown in Figure 5.4, the 'EASY' button, 'HARD' button and 'MEDIUM' button are listed in the Menu Page (Scene 4) to let the user choose the level of difficulties of the game. The 'MAIN MENU' button is used to go back to the main page (Scene1). These buttons are edited using Photoshop and	
HARD	save as .png format then it is imported into the Actor type category in Stencyl. The four buttons are added to the Menu Page scene (Scene 4) at the same time the function of each button also added into the same superior of the button also added	
MEDIUM	control the function to choose the level of difficulties or go back to the main menu page (Scene 1) by clicking 'MAIN MENU' button. The logic elements and properties are shown as below.	

MAIN MENU	when the mouse is released on Self Self Self Self Self Self Self Self
	<pre>when drawing ** if mouse is over : easy01 : * switch animation to 1 * for easy01 : * fi not mouse is over : easy01 : * switch animation to 0 * for easy01 : * switch animation to 0 * for medium02 : * switch animation to 1 * for medium02 : * switch animation to 0 * for medium02 : * switch animation to 0 * for medium02 : * switch animation to 0 * for medium02 : * switch animation to 1 * for medium02 : * switch animation to 1 * for medium02 : * switch animation to 1 * for medium02 : * switch animation to 1 * for medium02 : * switch animation to 1 * for medium02 : * switch animation to 1 * for medium02 : * switch animation to 1 * for medium02 : * switch animation to 1 * for hard03 : * switch animation to 1 * for hard03 : * </pre>
Interface Design Title ' Choose level of difficulties'	always is down on is easy01 is and Fade In is for 0.3 secs if mouse is down on it medium02 is and Fade In is for 0.3 secs if mouse is down on it medium02 is and Fade In is for 0.3 secs if mouse is down on it hard03 is and Fade In is for 0.3 secs if mouse is down on it hard03 is and Fade In is for 0.3 secs if mouse is down on it main_menu0 8 is and Fade In is for 0.3 secs if mouse is down on it main_menu0 8 is and Fade In is for 0.3 secs The text fonts and graphic are edited using Photoshop element 6.0. Then the text is imported into the Actor type category and added into the Menu Page scene (Scene 4). The background color is edited in the Stencyl 'Edit Scene Properties' to change the background color to vertical



Figure 5.5: Level 1 Game Scene

Table 5.5: Description of elements in Scene 5 in terms of Design and Functionality

Usability and H	Usability and Functionality	
Usability and H	As shown in Figure 5.5, two rows yellow ducks actor type are coming out from right and left screen. This actor is edited using Photoshop and save as .png format then it is imported into the Actor type category in Stencyl. Then the actor type is added to the Level 1 Game Scene. Each yellow duck shoot will gain 10 marks. The speed and direction of the movement of each duck also adjusted as shown as the functions and properties as below.	
	kill Self +	

	always set x-speed to 24 for Self : push Self : gently towards (xDir: 3 yDir: 2) at 7 force always if stered = true if time + 1 for time + 1 for time = 50 for the set time to time + 1 for time = 50 f
	set time to time - 50 - create Duck L : at (x: x : of Self : y: y : of Self :) at Back : otherwise stop
Donit	As shown in Figure 5.5, two rows blue bird actor type are coming out from right and left screen. This actor is edited using Photoshop and save as .png format then it is imported into the Actor type category in Stencyl. Then the actor type is added to the Level 1 Game Scene. Each blue bird shoot will minus 10 marks. The '-10' will appear every time a blue bird is shoot. The speed and direction of the movement of each bird also adjusted as shown as the functions and properties as below.
	always % kill Self : after leaving screen if mouse was released on ; Self ; # create 10 minus_10 : at (x: x : of Self : y: y : of Self :) at F set Score to Score - 10 kill Self :
	always 2 set x-speed ‡ to negate 24 v for Self ‡ push Self ‡ gently ‡ towards (xDir: negate 3 v yDir: 2 v) at 7 v force



	when Fade Thappens if not Fading set Fading to true fade out to Self to over Fade Time sec using None to do after Fade Time seconds if Kill After Fade kill Self to the second second to the second second to the second second to the second second to the second to
	When Self 1 is killed : & if Fragment Actor Type : has value : repeat Number of Fragments times - current loop count & create Fragment Actor Type : at (x: 0 y: 0) at Front : set Direction to random number between 0 and 260 ; set x : to x center : of Self : half-width : of Last Created Actor : + Offset x cos : (
	set y : to y-center : of Self : half-height : of Last Created Actor : + Offset × sin : (set velocity to (dir: Direction degrees , speed: Minimum Speed + random float between 0.0 and 1.0 × Maximum Spe set turning speed to negate Maximum Turning Speed + random float between 0.0 and 1.0 × Maximum Turning Spee
	if Explosion Actor Type ‡ has value ‡ create Explosion Actor Type ‡ at (x: ① y: ①) at Front ‡ set x ÷ to x-center ÷ of Self ÷ - half-width ÷ of Last Created Actor ÷ for Last Created Actor ÷ set y ÷ to y-center ÷ of Self ÷ - half-height ÷ of Last Created Actor ÷ for Last Created Actor ;
Score 40	As shown in Figure 5.5, at the right hand-side there is a score bar to let users know how many marks they gained in the process of shooting the ducks or birds. For the first level (Level 1) of the game, it requires user to gain 400 marks and above in order to pass the level 1 and proceed to level 2. A screen of 'You Win' is shown if the user successfully gain 400 marks otherwise 'You lose' screen shown.

	do every 1 seconds 🕒
	if time not = 0 -
	set time to time - 1 -
	otherwise
	create game over ; at (x: 228 v y: 126 v) at Front ;
	do after 💵 seconds 🕒
	kill actor :
	kill actor2 =
	kill actor3 🗘
n	kill actor4
	in score < 400 and time = 0 a
	if not scene is transitioning
	Fade Out for 1 v secs, then switch to kind lose screen1 and Fade In for 1 v secs
	IT Score > 400 -
	if not scene is transitioning
	Fade Out i for I v secs, then switch to Ex Level 1 Next i and Fade In i for I v secs
	when drawing 🇀
· · · ·	set current font to Numbers Only ‡
	draw text Score at (x: 689 v y: 130 v)
Time Remain	As shown in Figure 5.5, at the right hand-side there is a time progress bar to
15	let users know how much time they remained in the process of shooting the
12	ducks or birds. Users have to shoot the target score before times up. For the
	in a limitation time of 20 seconds in order to pass the level 1 and proceed to
	level 2 A screen of 'You Win' is shown if the user successfully gain 400
	marks in 30 seconds otherwise 'You lose' screen shown
Game Menu	when created istered to false set stered to false istered istered switch animation to if for self: do after is seconds if is switch animation to if for self: do after is seconds is istered to if is seconds is switch animation to if for self: istere is seconds is istered to if is seconds is set time to for self: when drawing is set time to for self: istered to true set time to for self: istered to true set current font to itumbers only: if do after is seconds is set time at (x: 659 y: 250 i) As shown in Figure 5.5, at the right hand-side there is a 'Game Menu' button after the score bar and the time progress bar. The 'Game Menu' button is clicked then navigate into the scene 'Main Menu Page' (Scene 1) where user able to choose to play again the game or read the instruction of the game. These buttons are edited using Photoshop and save as .png format then it is imported into the Actor type category in Stencyl. The button is added into the Level 1 Game scene (Scene 5) at the same time the function of the button also added into the event of the button. The logic functions and properties are shown as below.
--------------	---

	when drawing 🛣			
	if 🛛 mouse 🕼 sover 👘 🖓 game menu board 14 👘 🖉			
	switch animation to 1 🔻 for game menu board 14 🛟			
	if not mouse is over 🕴 game menu board 14 🔅 🔮			
	switch animation to 0 - for game menu board 14			
	always			
	Fade Out ; for 0.5 secs, then switch to Front ; and Fade In ; for 0.3 secs			
Interface Desig	gn			
'Level 1'	The text fonts are edited using Photoshop element 6.0. Then the text is			
' Hit the target	imported into the Actor type category and added into the Level 1 Game			
score of 400'	scene.			
Frame	The frame with brown color is a tiles set drag into the scene to design and do			
	arrangement.			
Blue	The background is edited in the scene background in level1. The blue sky			
background	background is a background image.			

Scene 6



Figure 5.6: Level 1 Completed Scene together with scoring

Table 5.6: Description of elements in Scene 6 in terms of Design and Functionality

As shown in Figure 5.6, the 'CONTINUE' button is located at the bottom of in and also the 'MAIN MENU' button. These buttons are edited using Photoshop and save as .png format then it is imported into the Actor type category in Stencyl. The 'NEXT' button and 'MAIN MENU' buttons are added into the Level 1 Completed scene (Scene 6) at the same time the function of the button also added into the scene events of the buttons so that user able to control the function to choose to navigate to the next game level by clicking the 'CONTINUE' button or go back to the main menu page (Scene 1) by clicking 'MAIN MENU' button. The logic functions and properties are shown as below.	Usability and Functionality					
	CONTINUE MAIN MENU	As shown in Figure 5.6, the 'CONTINUE' button is located at the bottom of in and also the 'MAIN MENU' button. These buttons are edited using Photoshop and save as .png format then it is imported into the Actor type category in Stencyl. The 'NEXT' button and 'MAIN MENU' buttons are added into the Level 1 Completed scene (Scene 6) at the same time the function of the button also added into the scene events of the buttons so that user able to control the function to choose to navigate to the next game level by clicking the 'CONTINUE' button or go back to the main menu page (Scene 1) by clicking 'MAIN MENU' button. The logic functions and properties are shown as below.				

	when the mouse is released on 🔹 Self 🕴 🔮
	Spotlight Out + for 0.5 v secs, then switch to = and Spotlight In + for 0.5 v secs
	set time to 30 -
	Fade Out for 0.5 secs, then switch to state and Fade In for 0.3 secs
	Fade Out = for 0.5 Secs, then switch to Front = and Fade In = for 0.3 secs
	when drawing 😕
	if mouse is over 🕴 continue0 5 🔅 🔮
	switch animation to 1 of continue0 5
	if not mouse is over 💠 continue0 5 💠 🗳
	switch animation to 0 🗸 for continue0 5 🗧
	if mouse is over + main_menu0 10 +
	switch animation to 1 for main_menu010
т •	not mouse is over
	switch animation to 0 - for main_menu0 10
	when created A
	stop all sounds 💶
	As shown in figure 5.6, the total score showed in Scene 6 is
Your Total Score is 150	retrieved from the score that achieved by users in the previous
	level. The position of the text is adjusted. The type of font is set.
	The functions and properties are shown as below.

	when drawing 2 set current font to Game Font draw text Score at (x: 470 v y: 203 v)
Interface Design	
You Win !!!	The text fonts and graphic are edited using Photoshop element 6.0. Then the text and graphic is imported into the Actor type category and added into the scoring page scene (Scene 6). The background color is edited in the Stencyl 'Edit Scene Properties' to change the background color to vertical gradient with light blue and pink color.
Level 1 Completed	

Scene 7



Figure 5.7: Level failed Scene and total score gained

Table 5.7: Description of elements in Scene 7 in terms of Design and Functionality

Usability and Functionality				
	If user unable to score 400 marks and above, it means that user failed to proceed to the following game levels and a screen ' You lose' will be shown together with the total score they gained			
RESTART	As shown in Figure 5.7, the 'RESTART' button and the 'MAIN MENU' button is located at the bottom of the Level failed scene (Scene 7). These buttons are edited using Photoshop and save as .png format then it is imported into the Actor type category in Stencyl. The 'RESTART' button and 'MAIN MENU' buttons are added into the Level Failed scene (Scene 7) at the same time the function of the button also			
MAIN MENO	added into the scene events of the buttons so that user able to control the function to choose to replay to the failed level by clicking the 'RESTART' button or go back to the main menu page by clicking 'MAIN MENU' button. The logic functions and properties are shown as below :			

	always if mouse is down on : restart0 5 ; ; ; Fade Out : for 0.5 r secs, then switch to : and Fade In ; for 0.3 r secs if mouse is down on : main menu0 2 ; ; ; Fade Out : for 0.5 r secs, then switch to Front ; and Fade In ; for 0.3 r secs		
	when drawing 😤 if mouse is over + restart0 5 + + switch animation to 1 T for restart0 5 +		
	if not mouse is over + restart0 5 + * switch animation to O V for restart0 5 +		
	if mouse is over		
	switch animation to O v for main_menu0 2 +		
	when created A		
Interface Design			
You Lose !!!	The text fonts and graphic are edited using Photoshop element 6.0. Then the text and graphic is imported into the Actor type category and added into the Level failed page scene (Scene 7). The background color is edited in the Stencyl 'Edit Scene Properties' to change the background color to vertical gradient		
Level Failed !!	with light blue and green color.		

Scene 8



Figure 5.8: Game Pause on space bar

Table 5.8: Description of elements in Scene 8 in terms of Design and Functionality

Usability and Functinality	방상 방법은 사람은 것은 것은 것을 가지 않는 것이 없는 것이 없는 것이 없는 것이 없는 것이 없다.
Game Paused	As shown in Figure 5.8, the word 'Game Paused' is shown when the user press on the space bar on the keyboard. The function pause is to freeze the flow of game whenever the users need it. The Pause function can be used in every level of the games. The functions and properties are shown as followed.
	when drawing set current font to Copy of Game Font ; if game is paused draw text Game Paused v at (x: 166 v y: 161 v)

always %
if game is paused
otherwise
pause ; game

5.3 SUMMARY

Each elements and functions in the 'Duck Shooting' arcade games are designed based on the results of questionnaire and interviewed done in previous chapters. The game design also refers to the HCI rules in order to complete the usability and functionality as well as the interface design of the game. Now, the game is ready to be tested by the same 15 respondents previously done the first stage of interview. Results and data that show the changes or enhancement of the game might increased the satisfaction of user when playing the game will be further explained in the next chapter of results and discussion.

CHAPTER 6

RESULT AND DISCUSSION

6.1 INTRODUCTION

This chapter reflects on the main findings of the research of Human Computer Interaction in terms of its interface design, usability and functionality. Human computer interaction theory is not only applicable in the web page design and system design, this aspect is also important in designing a game as many game designers create games by using their own intuition. Game designers are struggling on how to design a better game. Due to limitation of data and lack of theoretical foundation in game design, most of the games have been developed based on own experience and intuitions.

In this research, theoretical of human computer interaction is studied such as Jakob Nielsen's 10 usability heuristic rules, Shneiderman's eight golden rules and Don Norman principles of design. However, based on my research not all the HCI rules are suitable to be applied in the game design. Arcade flash game design in the PC platform is the main focus in this research study. After the first stage of interview and questionnaire regarding to the sample games, the basic requirement to design an arcade game is known, together with the review on the human computer interaction principles. A game prototype has been designed based on the HCI frameworks and user requirements which is suitable to be applied in the arcade game design.

The testing results obtained from the 15 interviewed respondents will be discussed in this chapter. The result is obtained from the second stage interview where the 15 respondents are given the game prototype implemented based on the 'Nine framework of Human Computer Interaction' as discussed in Chapter 4. A set of questions (refer to Appendix B) is set to ask the respondents after they have played the game prototype. The result obtained from the game prototype is important as its result is compared with the result of 5 sample games that the respondents played before. The results of perception from the game prototype application among the respondents are discussed.

6.2 THE OBSERVATION FINDING

The observations have been done during the respondents using the game prototype. The purpose of the observations is to observe the behavior performed by the respondents when they are testing the game prototype application. From the observation can be seen that if students left alone, they can use the application on their own, they understand how to control the game from reading instruction until they start to play the game level by level. They have no problem in viewing the game progress and the score displayed. 14 out of 15 respondents they enjoy to play the game as they feel that the game is challenging.

6.3 EVALUATION ON GAME PROTOTYPE APPLICATION

Two types of evaluation are done during the game prototype testing. The first evaluation is interview to know what kinds of elements they like or dislike in the game. Their comments are recorded. The second evaluation is to obtain the response from each respondent where each respondent is given a set of questionnaires that requires them to give rating after finish playing the game application. The set of application requires them to access the perception of aspects of user interface design, usability and functionality of the views given.

6.3.1 The Results of Interview from Respondents

Table 6.1: Frequency of elements in the prototype game LIKED by respondents

Elements in the game LIKED by respondent				
Elements	Sample Game	Prototype Game		
Levels	4	8		
Character ability	6	7		
Enemies	7	5		
Live and health	3	4		
Graphics and interface	8	9		
Scoring	3	8		
Progress	3	5		
Total	Total 34 46			

Elements in the game DISLIKED by respondent				
Elements	Sample Game	Prototype Game		
Levels	3	0		
Character ability	5	1		
Enemies	1	3		
Live and health	4	2		
Graphics and interface	3	1		
Scoring	3	0		
progress	5	1		
Total	24	8		

Table 6.2: Frequency of elements in the prototype game DISLIKED by respondents

There are seven elements levels, character ability, enemies, live and health, graphic and interface, scoring and progress, must be included in each arcade games. In this game prototype application, the seven elements have included in it. According to Table 6.1 listed the elements and frequency of the game elements that liked by respondents in sample game and prototype game while Table 6.2 listed the elements and frequency of the game elements in sample game and prototype game while Table 6.2 listed the elements and prototype game.

As shown in Table 6.1, most of elements in the game prototype have high rating by the respondents meaning that they like the elements in the game. The element that the respondents like the most is 'Graphic and interface' element. According to the interview to the respondents, they like the graphic and interface due to the attractive design of game character (e.g the yellow ducks) and its interface design of each level is consistent and comfortable when viewing each scene level. Besides, the design is consistent in terms of color, layout, fonts which aiding users to adapt to the environment and familiar to each level enable them to achieve their goal easily. Followed by the elements of 'level' and 'scoring', respondents like the levels and scoring because the game has provided the level of difficulties and the respondents can play the game level by level and at the same time they can gain their highest scoring. As shown in Table 6.1, compare the game prototype and sample game, the frequency numbers prototype game gained more LIKED by respondents meaning that users like the elements in the prototype game compare to the sample game.

For the number of game elements that gained low rating by the respondents is less as shown in Table 6.2, in the prototype game, the most dislike elements rate by respondents is the enemy element. The reason given by them is that they do not like the enemies (e.g blue bird) which will cause the decrement of their total score in each game level. For the sample game, the most disliked by respondents are the character ability and progress as both of the elements gain frequency of 5 respectively. Users comment that they do not know the function of the character on how to attack the enemies as there are no instructions to tell them. For the progress of the game, users do not like the progress as they do not know when the enemies will die. They also feel that the character's 'live' is not appropriate as the live bar shown is 100 life, they thought if character attacked by enemies will decrease one marks but in fact the live will decrease 20 marks for each attacking. As shown in Table 6.2, compare the game prototype and sample game, the frequency numbers sample game gained more DISLIKED by respondents meaning that users dislike the elements in the sample game compare to the prototype game.

6.3.2 Results of questionnaire from the respondents

To analyze the level of acceptance of the game prototype applications, we have to know the number of respondents that agree or disagree with the elements inside the game prototype in terms of interface design, usability and functionality. Respondents asked to provide responses to the statement submitted by using four scales levels of **very agree-4**, **agree-3**, **disagree-2**, **and very disagree-1**. The four scales levels, easier for respondents to determine their response. If they agree with the statements, options very agree-4 or agree-3 will be chosen. If they disagree with the statements, options very disagree-4 or disagree-3 will be chosen. In this research study, rating scale of 'neutral' is not considered as it is meaningless to the study results. It is because in this study the usability function of the game and interface design is more concerned about in order to test the level of acceptance of users to the game prototype based on the interface design, usability and functionality.

Statements	1	2	3	4
1 Challenging game	0	1	8	6
2 Like the game after playing	0	1	5	9
3 Clear instructions	0	1	4	10
4 Appropriate feedback	0	0	9	6
5 Sufficient feedback	0	0	9	6
6 In control of the game	1	0	9	5
7 Consistent layout design	0	0	6	9
8 Overall design clear	0	1	5	9
9 No need to recall info	0	2	5	8
10 Function easily found	0	0	5	10
11 Not confuse when should proceed	0	3	4	8
12 Permits easy reversal button	0	0	11	. 4

Table 6.3: Results of questionnaire from the respondents for prototype game

Table 6.4: Results of questionnaire from the respondents for sample game

Statements	1	2	3	4
1 Challenging game	3	6	5	1
2 Like the game after playing	2	7	3	3
3 Clear instructions	7	5	1	2
4 Appropriate feedback	6	2	2	5
5 Sufficient feedback	4	2	5	4
6 In control of the game	1	7	5	2
7 Consistent layout design	2	5	4	4
8 Overall design clear	1	4	8	2
9 No need to recall info	8	2	3	2
10 Function easily found	2	5	5	3
11 Not confuse when should proceed	5	2	4	4
12 Permits easy reversal button	7	7	1	0

As shown in Table 6.3, 8 respondents agree that the game is challenging where they have to use tactic to gain enough score to enter each level. 9 respondents very agree that they like the game in terms of usability and functionality. 10 respondents very agree that the game has clear instructions so that they can know the way to play the game clearly. 9 respondents agree that the application give appropriate feedback to them so that they know when the level up, game level failed or game over. 9 respondents agree that the application gives sufficient feedback to them where they able to restart the game, they know the progress to when the game end. 9 respondents agree that they are in control the functions of the game as they able to use the function available in the game. 9 respondents very agree that the layout is consistent enough in terms of font, color, layout and design. 9 respondents very agree that the overall design is clear such as the symbol, buttons, menu, image and text are clear for them to proceed to the game. 8 respondents very agree that they do not need to recall the information from one part to another, the instruction is clear, the function easily used. 10 respondents very agree that the function of the game is easily found, its function is clear to let user know the position of the functions. 8 respondents very agree that do not confuse on what is going on and when should proceed to the next level. 11 respondents agree that the game permits the easy reversal actions such as back button enable them to go back main menu any time when needed.

Framework	Low Rating Sample Game (%)	Improved Game Prototype (%)
1. Help and documentations	20 (3 ppl)	93.3 (14 ppl)
2. Visibility of system status	<mark>60</mark> (9 ppl)	100 (15 ppl)
3. Offer informative feedback	46.7(7 ppl)	93.3 (14 ppl)
4. Support internal locus of control	46.7 (7 ppl)	93.3 (14 ppl)
5. Reduce short-term memory	33.3 (5 ppl)	86.7 (13 ppl)
6. Design dialog to yield closure	53.3 (8 ppl)	80 (12 ppl)
7. Permits reversal actions	6.7 (1 person)	100 (15 ppl)
8. Visibility of design	53.3 (8 ppl)	100 (15 ppl)
9. Strive for consistency	53.3 (8 ppl)	100 (15 ppl)

Table 6.5: Result Comparison between Sample Game and Gam	ame Prototype
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Based on the results obtained, most of the respondents choose the rating scale of agree and very agree showing that respondents can accept well the interface design, usability and functionality of the game prototype application which designed based on the 'Nine HCI framework'. The applied design rules of HCI framework to the prototype game design can meet the requirement of users. Table 6.5 showed the comparison of result in percentage between sample game and game prototype after the Nine HCI rules has been applied into the game. By comparing the result obtained from sample games, obviously, there are higher percentage of respondents agree and satisfy on the game design that applied the nine HCI rules.

As compare to the sample arcade games which have been tested by the respondents, from their comments there are a lot of limitation in terms of the interface design such as color, font, layout, where users may feel not comfortable when viewing the distractive color matching and objects, fonts not clear. Another aspect is the usability and functionality of the game for example the response and feedback given by the system when playing the game such as response of scoring, time remain, game level failed or passed and etc. Therefore, the game design of game prototype has to be enhanced based on the proposed human computer interaction framework in order design game which has the high acceptance by most of the users.

Besides human computer interaction principle that has to be applied to enhance the game design in terms of usability and functionality, from the findings, all the elements are equally important however graphic design is the most affected elements that should be considered as based on the comments from respondents, users usually will judge a game based on its attractiveness before they start to play the game then followed by other elements such as levels, scores, character ability, enemies, live and health and the rate of difficulties of the game.

6.4 SUMMARY

The proposed framework is an important finding to game designers or game makers in order to help them design a game with enhanced interface design, usability and functionality. The framework is not specifically used in all game design but at least it can give a better understanding to the game developers on how to make a game design that has higher acceptance rate of by the users. HCI in game design is still a new idea and it should be done more researches on this topics.

HCI applied in game design is different from designing any usable interactive software application. In game design focus mainly on system performance over consistency and it is always been designed in different kind of environment based on the game theme. The environment does not have restriction on how the element must look or how interaction must be carried out with the users. The driving force is the satisfaction of users when playing the game and the game performance. A better game design is to create a game which is easy to learn, effectively played and enjoyed the real challenge.

CHAPTER 7

CONCLUSION

7.1 INTRODUCTION

This chapter explained in detail about the entire result that obtained from the research. There are five main things are discussed including the gist of study explain the abstract of this research, implication is the outcome that obtained from this research, contribution is the produced outcome that able to assist game developer to design arcade games and propose result explained in detail for the contribution in the next research.

7.2 GIST OF THE STUDY

This study is to find the perception of users in using game design which the game design has been applied Human Computer Interaction (HCI) rules into it. There are two important elements that should be considered in HCI which are the interface design and its usability and functionality of the game.

Human Computer Interaction (HCI) refers to the interaction between a human and a machine. Usually when designing systems, HCI will be left behind without consideration as mostly game designers would mainly emphasize on the coding and the bugs rather than the interface design of the system. It causes there might be the case where users do not really understand what Human Computer Interaction is but in fact it plays an important role in Computer Science field. HCI rules should not be limited to be applied in website design but it can be applied in gaming field as its knowledge is really needed in order to design the system with a good interface design with high usability and functionality. By using the rules HCI, we can enhance our game design interface and to increase the satisfaction of user in using the application.

In order to implement the research the, multimedia development life cycle (MDLC) is used to conduct the research study in order to develop a game prototype

application based on the HCI framework. The life cycle has six phases start from data collection, requirement analysis, planning, design, development, and followed by testing. Evaluation will be done after every phase to make sure that there is no error and improvement can be done in order to proceed to the next phase.

Data collection is carried out through interview, questionnaire and observation. In the first session of interview, each respondent has to play the five particular low rating games given. Ouestions are set to ask them such as the layout design, color, image, movement, feedback. Necessary data is obtained to assist in developing game prototype based on user needs. Data collected will be analyzed based on the data collected. The problems of user facing when playing the game should be known and the criteria should be improved in the game design based on the nine HCI rules framework. A review is done on the Human Computer Interaction (HCI), the Heuristic Usability Rules, HCI in games, comparing types of games and its interface design and usability and relate the human computer interaction with game design. The game design of the prototype game application is improved in terms of usability and interface design based on the specified HCI framework. In the second stage of interview session, respondents have to test the game prototype with improved HCI and again they have to give comments and also do some questionnaire regarding to the game design. Results are collected and compare with the analyzed result obtained from first interview session. The result is important as it can prove that the nine rules of HCI framework should be applied into the design of game design. The framework is important for game developer to have better understanding to the game design.

7.3 IMPLICATION OF STUDY

HCI rules including Jakob Nielsen's 10 usability heuristic rules, Shneiderman's eight golden rules and Don Norman principles of design has been studied and evaluated and it should be applied in developing games. The framework has been designed based on the users' requirement and together with the rules of HCI is applied into the arcade game design. It is not suitable for all game design as it is developed based on arcade game sample requirement but it can be the reference guide to the others games design. It

gives a better understanding to the reader or game developer on how to make a game better in terms of interface design and usability.

Interface design of game prototype has been enhanced based on the proposed framework. The matching of fonts, color, layout and design is important to make sure the interface design is user friendly. The seven important elements such as levels, character ability, enemies, live and health, graphic and interface, scoring and progress, must be included in each arcade games but some of the games has the elements or some of the games do not have. Combination of the elements in the game design are important let user know where they are and how is the progress when playing the game. After the nine HCI rules has been applied into the game design, all these elements should be shown in the interface of each scene in the game clearly. This has increase the satisfaction of user when playing the game.

After the game prototype has been designed based on the nine framework of HCI rules, the usability and functionality of the game design prototype has too be tested based on the applied design rules of HCI framework to the game design. The nine rules that has been applied into the game are help and documentation, visibility of system status, offer informative feedback, support internal locus of control, strive for consistency, reduce short-term memory, design dialog to yield closure and permits reversal actions.

Based on the result obtained, the prototype arcade game application that has the seven game elements with the applied HCI rules gain a high rating games by users. 9 out of 15 respondents very agree that they like the game after playing based on usability and functionality. 6 out of 15 respondents agree that they like the game too.

Besides, in terms of interface design, 9 of 15 respondents very agree that the game design has a consistent layout such as font, color, layout and design. Same amount of respondents also very agree that the application has overall clear design such as the symbol, button, menu, image and text.

According to the analyzed result of interview and questionnaire, user of the game prototype application has a high satisfaction on the game design that has applied suitable HCI rules. A good game design with a good interface design and usability gained high rating from user as it able to give a clear direction, flow, navigation and

information to the users besides giving high satisfaction to the user during the gaming process.

7.4 CONTRIBUTION OF STUDY

HCI in game design is still a new idea and it should be done more researches on this topics. For this research study, it provides a guide for developer in designing an arcade game application. A suitable interface design such as layout, font and color identified based on user requirement. It also gives a guide on designing a game with good usability and functionality such as clear navigation, clear instruction and direction.

It provides a foundation study before designing a game. In this research study, the information and data is suitable for designing arcade game however it also can be the reference of designing other flash game such as strategy game, puzzle game, action game. The elements needed in these games actually are almost the same concept like arcade game, the interface design have to be clear enough and attractive, it must have a high functionality and usability to enhance playing experience.

From the result, it can assist researcher to do research on the Human Computer Interaction in game design. The information of HCI rules can provide a new data which reveal about human behavior and its relationship to technology. The information can be obtained from formal experiments, field studies, interview, questionnaire, case studies, data collection and etc. Moreover, it also contribute in methodological research where the a new discoveries enable designers and developers to apply their craft to greater effect. The goal of methodology contribution is to convince readers that the new method is useful, valid and reliable for its intended purpose.

7.5 LIMITATION OF THE RESEARCH STUDY

In this research study is mainly focus on human computer interaction in arcade game design. Based on the result analyzed from the data obtained from users' interview, questionnaire, and also review on three types of HCI principles, the nine most suitable HCI framework is designed to be applied into the arcade game development. However, only arcade games sample are chosen to be tested by respondents. Therefore, the result obtained is based on arcade game design and it is only suitable to be applied in arcade game design. Its theory may or may not applicable to others game type such as action game, puzzle game, strategy game, racing game, sports game, racing game, fighting game and etc. For the future research there should be wide variety of research area on different types of flash game but not just limited to arcade game only.

Moreover, the arcade game design is designed limited to certain hardware such as mouse, keyboard and PC. Nowadays, there are a lot of new technology that can apply to game development in different platform such as touch screen in tab or smart phones, and from the PC through consoles such as Xbox 360 Kinect, Sony Playstation3 and handhelds such as Nintendo DS and sony PSP. On these platform not just the interaction of human and computer but also involve a range of physical activities. In this research is studying about how the user use hardware such as mouse and keyboard together with computer behavior interact with human. The platform chosen is limited to computer, either desktop or laptop. In the future, there should be a further research study on human computer interaction in game design in modern gaming platform.

Furthermore, the respondents chosen to carry out this research study are students from UMP and they are in the age range of 20 years old to 24 years old. Therefore the comments and result of interview, questionnaire is analyzed based on the category of young adults. The research study result is limited to youngsters but not to other age category like kids (age range from 6-9), pre-teen (age range from 10-12), teenagers (age range from 13-18). In the future research can be done on different age of group for kids and teenagers from different schools.

7.6 SUMMARY

Interface design, usability and functionality are actually very important in application design, not only applicable in website design but also important in game design application. However, game interface design is an afterthought, developers think that the most important part of application development is the coding and bugs, the interface can come later. Consequently, there is insufficient time for designing interface design and finally cause production of poor quality interface. A poor interface can affect the game experience of users. For example, the users are confused and do not know how to navigate the menu or if they cannot find the information while playing the game. The games become less enjoyable when users try to search so much of information. Contrary, if the game has a good interface, it can enhance the playing experience and can be fun to use. The most important thing is game sales can be boosted up. (Hung Nguyen. 2012. *Human Computer Interaction in Game Design*)

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Appendix A

Information of Respondent	Name :				
•	Contact number :				
Game	Game 1	Game 2	Game 3	Game 4	Game5
Questions	Shooting	Space Hunter	Contest	Spheroids	Simple Shooter
Do you play game frequently?					
	Yes	No 🗆			
What elements do you like about					
to be used in arcade game?	Shape An An Other:	nimal Airc	raft Cartoo	on Character	
What do you like about this					
game? Please state numbers. You					
may give reasons.					
2. character ability					
3. enemies					
4. live & health		10 A.			
5. graphic & interface					
6. scoring					
7. progress					
what do you dislike about this game? Please state numbers. You					
may give reasons.					
1.levels					
2. character ability			а. А.		
3. enemies					
4. live & health			с. "А		
5. graphic & interface					
6. scoring	$C_{\rm eff} = 1 + 1 + 1$				
7. progress					
Is the game challenging?					
Vou like this game overall after					
playing (based on usability and					
functionality)					
Clear instruction to let you to					
instructions on how to play the game.)					
System give appropriate					
feedback to you (e.g. There is no					
response when you shoot the fire to enemy and no scores gained, to tell you that your					
level up, you failed the level, game over, etc)					

Sufficient feedback to let you know what will be the next (e.g. got restart option, play again option, your current or total scores, the progress, time remaining, live remaining, etc)			
You are in control of the game e.g. you able to control the functions (object, options, keyboard, button, symbol) of the game.			
The layout design consistent and organized (font, color, layout, design)			
The overall design is clear (e.g. symbol, button, menu, image, text)			
You do not need to recall the info from one part to another part (e.g. objects function, actions of objects ,options, shortcut key, functions, way to gain marks, obstacles that should be avoided, etc)			
Function of the game easily found and understandable(e.g. symbol represent back, home button, music symbol, pause button, etc)			
Not confuse on what is going on and when should proceed to the next goal when playing the game			
The game permits the easy reversal of actions (e.g. back button, undo, etc)			
Do you have any other comments about the game? (e.g. position of score bars, fonts not clear, sound effect not good, distractive object, not challenging, confusing on some information displayed, etc)			

Appendix **B**

Information of Respondent	Name : Contact number :
Game	Duck Shooting Game Prototype
Questions	
Do you play game frequently?	Yes 🗆 No 🗆
What do you like about this game? Please	
state numbers. You may give reasons.	
2. character ability	
3. enemies	
4. live & health	
5. graphic & interface	
6. scoring	
7. progress	
What do you dislike about this game?	
Please state numbers. You may give	
reasons. 1.levels	
2. character ability	
3. enemies	
4. live & health	
5. graphic & interface	
6. scoring	
7. progress	
Is the game challenging?	
You like this game overall after playing (based on usability and functionality)	
Clear instruction to let you to play the	
game (e.g. rules and terms of instructions on how to play the game.)	
The system give appropriate feedback to	
YOU (e.g. To tell you that your level up, you failed the level, game over,etc)	
Sufficient feedback to let you know what	
will be the next (e.g. got restart option, play again	
You are in control of the game e.g. you able to	
control the functions (object, options, key, button, symbol) of the game.	
The layout design consistent and organized (font, color, layout, design)	

The overall design is clear (e.g. symbol, button, menu, image, text)	
You do not need to recall the info from one	
part to another part (e.g. objects function, actions of objects ,options, shortcut key, functions, way to gain marks, obstacles that should be avoided, etc)	
The function of the game easily found and	
understandable(e.g. symbol represent back, home button, music symbol, pause button, etc)	
You do not confuse on what is going on	
and when should proceed to the next goal	
when playing the game	
The game permits the easy reversal of	
actions (e.g. back button, undo, etc)	
Do you have any other comments about the	
game (e.g. position of score bars, fonts not clear, sound effect not good, distractive object, not challenging, confusing on some information displayed, etc)	

Appendix C

Gantt Chart of PSM 1

	Task Name	Duration	Start	Finish	1	Mar '14	Apr'14	May '14
					16 2	3 02 09 16 23	30 06 13 20	27 04 11 18 25
1	Concise of Introduction, objective, problem statement and scope	1 day	Wed 19-02-14	Wed 19-02-14	1			
2	Meet up with new SV	1 day	Tue 11-03-14	Tue 11-03-14		h		
3	Planning schedule PSM1 and start doing Chapter 1	4 days	Wed 12-03-14	Mon 17-03-14				
4	Submission of Chapter 1 to moodle	1 day	Mon 17-03-14	Mon 17-03-14		h		
5	Study papers and related information about thesis topics	2 days	Tue 18-03-14	Wed 19-03-14		6		
6	Edit Chapter 1 and concise literature review	3 days	Thu 20-03-14	Mon 24-03-14		Č		
7	Submit Chapter 2 and SV mark Submission	6 days	Mon 24-03-14	Mon 31-03-14		(
8	Midterm break , find and study journal papers	6 days	Mon 07-04-14	Mon 14-04-14				
9	Briefing of methodology	4 days	Mon 14-04-14	Thu 17-04-14				
10	Discussion methodology, submit draft and submit chapter 3	7 days	Tue 22-04-14	Wed 30-04-14			1	
11	Submit final report, logbook, turinitin report	10 days	Mon 05-05-14	Fri 16-05-14				
12	Preparation for PSM1 presentation	3 days	Mon 19-05-14	Wed 21-05-14				Ĭ
13	PSM1 Presentation	1 day	Wed 21-05-14	Wed 21-05-14				
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Gantt Chart of PSM 2

Task Name	Duration	Start	Finish	tember 2014	October 2014	November 2014	December 2014
				05 08 11 14 17 20 23 26 2	9 02 05 08 11 14 17 20 23 26 29	01 04 07 10 13 16 19 22 25 28	01 04 07 10 13 1
Data Collection	14 days	Tue 01-07-14	Fri 18-07-14				
Filter raw data collected	7 days	Mon 08-09-14	Tue 16-09-14				
Evaluation	3 days	Fri 12-09-14	Tue 16-09-14				
Analyze data collected	10 days	Wed 17-09-14	Tue 30-09-14				
Analyze design rule framework	10 days	Wed 01-10-14	Tue 14-10-14				
Evaluation	10 days	Mon 06-10-14	Fri 17-10-14				
Plan the rules of framework	5 days	Mon 20-10-14	Fri 24-10-14				
Plan what to do next	2 days	Wed 22-10-14	Thu 23-10-14				
Evaluation	3 days	Wed 22-10-14	Fri 24-10-14		_		
Design storyboard	5 days	Mon 27-10-14	Fri 31-10-14				
Development of prototype	5 days	Mon 03-11-14	Fri 07-11-14				
Testing & Evaluation	4 days	Mon 10-11-14	Thu 13-11-14			E	
Evaluation on prototype testing	12 days	Fri 14-11-14	Mon 01-12-14			Č	
Data collection and analyze	5 days	Tue 02-12-14	Sat 06-12-14				Č