Personal Semantic Timeframe

A thesis submitted in partial fulfilment

of the requirements for the degree

of

Master of Science

in Computer Science

at

The University of Waikato

by

Muteeb Saad Alahmari

The University of Waikato

2012

THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

Abstract

Human memories are often not grouped around objective times and places but rather guided by subjective perception of these dimensions. Various techniques are used to recall personal information such as remembering names, conferences and numbers, but how different experiences or events or the event that has taken place two years earlier raises a question. Occasionally, having experienced an event, one may be asked about its absolute time in autobiographical memory. It is surprisingly difficult to predict the time when this date needs to be remembered. There is a tendency to use partial temporal information such as birthdays, parties or seasons to remember, rather than a specific date e.g. 21 September 1996. People need appropriate facts or personal semantics of their time to access to their past experiences while remembering.

A user study was conducted to explore the use of past personal temporal information and capture this information to be used as personal time search features in an augmented memory system called Digital Parrot. These features aim to make temporal dates more easily accessible while remembering.

A proposed design was made according to requirements that are derived from findings of psychology perspective, an exploration of the use of time study, and the visualizing time study.

To evaluate how effective these features in locating and recalling past experiences, a user study was conducted with post questionnaires. The result of this study indicated that the most beneficial personal time search features are personal timespans, personal and public landmarks, and personal images.

The findings from all studies of the thesis were used to provide recommendations for future work to develop and implement personal time search in Digital Parrot system.

Acknowledgements

In the name of Allah, the Most Gracious and the Most Merciful Alhamdulillah, all praises to Allah for the strengths and his blessing in completing this thesis. I would like to gratefully and sincerely thank my supervisor Dr Annika Hinze for her guidance, understanding, patience, helpful comments and her illustrations on earlier drafts. I really appreciate her help from the initial to the final level enabled me to develop an understanding of the subject.

It is difficult to overstate my gratitude to my parents for supporting me through my university years. Without them, none of this would even be possible. You have always been my biggest enthusiasts and I appreciate that. My special gratitude is due to my brothers and sisters for standing with me and encouraging me to achieve my study's goals.

I would also like to thank all of my friends for keeping me motivated and for providing me with some memorable experiences. I would like to thank my best friends Majed Alrowaily and Saeed Alqahtani and I'm grateful for all good and bad times we had together here in New Zealand.

My thanks to everyone who contributed to my study and participants who help me to conduct my studies.

I'm grateful to have a scholarship from the King Abdullah Bin Abdulaziz Programme and I would like to say thank you King Abdullah for providing me with the opportunity to be where I am.

Finally, thank you for every single person who has supported and encouraged me to achieve this point.

Table of Contents

List of Figures

List of Tables

Chapter 1

1. Introduction

Most people have excellent memory, but they sometimes fail to remember things. Interesting things can be easily remembered because they engage with people's interests. In addition, related events or normal activities such as eating breakfast daily are remembered better than new information. Various techniques are used to recall personal information such as remembering names, conferences and numbers, but how different experiences or events or the event that has taken place two years earlier raises a question (Darlington, 2011). Occasionally, having experienced an event, one may be asked about its absolute time in autobiographical memory. It is surprisingly difficult to predict the time when this date needs to be remembered. There is a tendency to use partial temporal information such as (birthdays, parties or seasons) to remember, rather than a specific date, e.g., 21 September 1996. Time is considered as an item that is easily forgotten (Jaimes et al, 2004). Using semantic and personal time makes temporal dates more easily accessible. Skowronski et al., (2003) believe that people need appropriate facts or personal semantic of their time to access to their past experiences while remembering. It is the objective of this thesis to support personal semantic timeframes for accessing information in an augmented memory system and to explore personal time facts that can be used to recall past memories and find appropriate personal time features to locate events temporally.

1.1. Human memory

This section reviews the categories of human memory and how they work to keep information. The reasons for losing information and how it can be retrieved when desired will be discussed. This section covers different points: a general view about human memory and the process of retrieving memories and to discover which part of the memory keeps the past experiences for a long period.

The human brain has different categories to store information in it and these categories can be defined according to that information and how long it is maintained. In addition, memory in the human brain has different sizes according to amount of time the memory is stored. Memories can be classified to three major types: sensory, long-term and short-term. Sensory memory can maintain information temporarily. Information is stored in sensory memory form in any of the five senses. Short term memory has limited capacity and it stores information temporarily in the mind and is related to working memory. Short term memory can hold the information for up to several minutes and it will disappear unless it is rehearsed. Different information is stored in long-term memory and it is much more complex. Thus, the long-term memory has different forms that can store different types of information such as procedures, life experiences, language, etc. Long-term memory is storage for anything that can be remembered and has happened over a long time but some long term memory forms are weak and due to the age and some clinical conditions, recall can be affected. However, stronger memories are those that help people to recall past events, procedures, or fact on demand, for instance the Opera house is located in Sydney. When the mind is prompting or reminding recall of an event, that kind of memory is called weaker memories. The two major subcategories of long-term memory are explicit memory and implicit memory. Explicit memory requires conscious recollection and that what most people have in mind when they think, for instance, remembering the time of an appointment or recalling an event a year ago. Implicit memory does not require conscious strategy for retrieving information (Schacter, 1987). For example, remembering the lesson of soccer skills is an example of an explicit memory, while developing and improving soccer skills as result of the lesson is called implicit memory. Figure 1.1 shows the structure of memory.

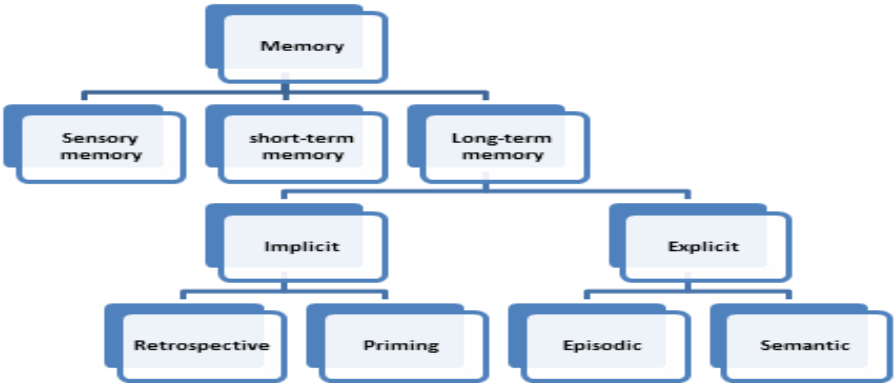


Figure 1.1 the structure of human memory

1.1.1. **Retrospective & prospective memory**

Prospective memory is where the content is to be retrieved or remembered in future ("The Human Memory ," n.d.). It helps to remember accomplishing an intended action. Cohen (1996) proposed that prospective memory is almost continuously active, things such as remembering to call relatives. This memory often needs cues and it may be either event-based or time-based, for instance, when remembering to attend a conference at 10am or remembering to deposit money when seeing a bank. In contrast, retrospective memory is remembering content from past experience and involves remembering experiences in the past such as people, words, events, etc. and it consists of semantic, episodic, and autobiographical memory (Lynch, 2011).

1.1.2. **Semantic memory and episodic memory**

There are two kinds of long-term memory: episodic and semantic. Generic and factual information such as name of object, the day of the weeks, language and words, etc. are called semantic memory. Whereas, episodic memory stores our past experiences such as storing what happened, where and when. In addition, semantic memory has no connection with time and places. Episodic memory is different from other kinds of memories in being clearly situated in the past and accompanied by the feeling of remembering (Tulving, 1972). Likewise, semantic memory includes all objective facts and episodic memory contains all subjective specific facts. It is hard to distinguish between episodic and semantic memories because semantic knowledge can build up by abstraction from personal experiences (Cohen, 1996). Semantic information is used among people to structure and restructure their experiences. Memories store massive amounts of semantic information but the information is not organized and needs some way to organize it to be retrieved. In educational psychology, some organizations have been identified to allow people to remember semantic information. Schema is one of these organizations. This refers to an organized body of information about some distinct domain of knowledge (Alexander& Winne, 2006). Mental framework will be provided by schema to guide perception and understanding. Schema allows the construction meaning of what is already known and what can be expected to happen providing that knowledge about the world. Also, it can affect the reconstruction of an event and understanding at a later time

(Alexander& Winne, 2006). If the information is organized hierarchically there can be easy access to information.

The third long term memory subcategory is autobiographical memory. From birth, each person encounters numerous events and information. These events are called experiences, and can include such as episodes in our mind, for instance, first kisses, while I was child, familiar places, etc. The combinations of episodes are made over time everywhere along the way. Scientists have conducted many studies to understand what we remember about our past and why we remember it (Posit Science, 2011). Autobiographical memory is built within a self-memory system (SMS) and that was proposed by Conway and Pleydell-Pearce (2000). Autobiographical memory stores different information about working self and self-knowledge. This kind of memory system provides information about knowledge of the self, for example what the self is, what the self was, and what the self can be (Conway & Pleydell-Pearce, 2000).

An autobiographical knowledge base consists of three areas: lifetime periods, general events, and events- specific knowledge. Lifetime periods are constructed of time in an individual's life such as the length of time spent at university, when one graduated from high school. Each events or times in life have a special beginning and ending but these dimensions maybe fuzzy and overlap. Lifetime memory reflects features of periods and personal attitudes or goals. Lifetime period contains temporal information about the duration of definite period and that period can last for years. Several lifetime periods may be integrated to form one theme of thematic knowledge such as work or relationship (Den Hoven & Eggen, 2007)

General events memory is more specific than lifetime and it works as triggers to recall other related events when one memory of general events recall. General events include repeated events (e.g., evening hikes) and single events (e.g., my trip to Paris). Sets of associated events can be represented by general event and different memories linked together in general event as one theme (Conway and Pleydell-Pearce, 2000).

Event-specific knowledge (ESK) has the recall events that have actually been experienced with vivid reminders of what occurred like I remembered when I

danced with Sara that leads to remind me of first time I met her (Conway, 1996). Conway and Pleydell-Pearce (2000) said that in the structure of autobiographical memory, items of ESK are part of general events that in turn are part of lifetime periods. The access to this knowledge is controlled by cues that are based as central control process and moderate output from them. In addition, ESK can be a summary of the content of episodic memories. As Figure 1.2 shows, the structure of autobiographical, long thematic division in one's autobiography memory represents lifetime periods such relationships theme with partner. Through the relationship theme, there is a short-term extended event which refers to a class of memory such as first meeting – the dance. At the base of hierarchy is the richness of autobiographical memory and events which may include perceptual and contextual information that can provide common sense of reliving past event (Belli, 1998). The ESKs are more likely to fade more quickly than the lifetime periods and general events when memory of past events is sought (Conway & Pleydell-Pearce, 2000). Figure 1.2 illustrates the hierarchical structure of the autobiographical knowledge base.

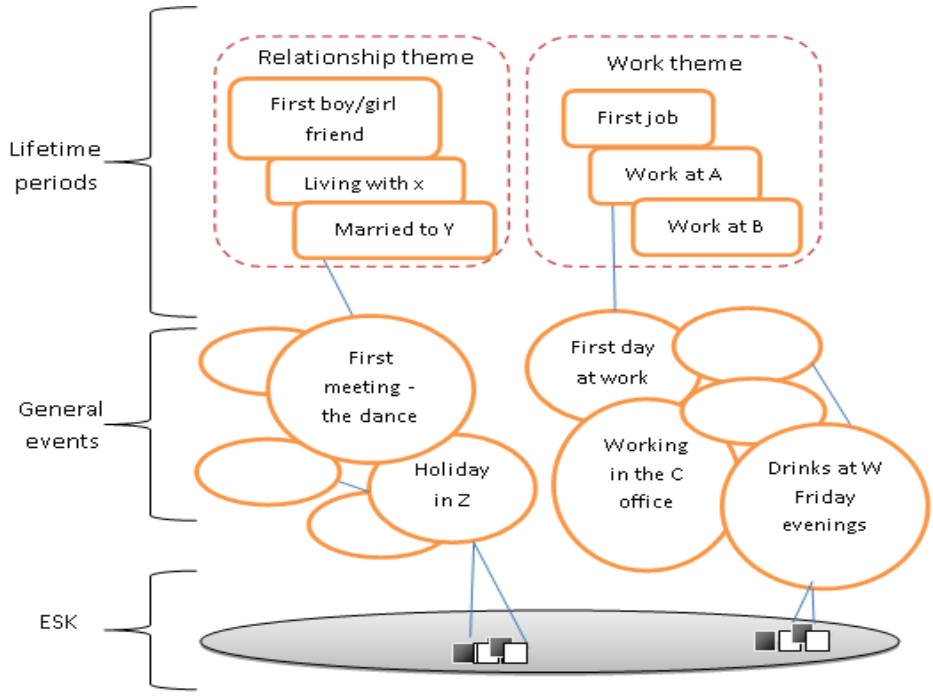


Figure 1.2 Hierarchical structure of the autobiographical knowledge base (Source: Belli, 1998, p.265).

1.1.3. **Forgetting**

Memory failures are an almost daily happening. Memories are still illustrated in the mind but on occasion they cannot be recall because there was not a correct stimulus to help memory to retrieve this information and that is called forgetting (van den Hoven & Eggen, 2005). Forgetting is losing information that was previously encoded in the long term memory. Memories have massive amounts of information since the events were experienced but from time to time the information cannot be recalled from memory storage. For example, if someone asks, "What were you doing on Thursday morning of second week in March one year ago?" you indeed will answer "I don't remember." Nevertheless, if an important event has happened in that day and you were reminded, "That was the day your brother had accident" you would perhaps remember immediately Coon, et al. (2007). It is noticeable; a less important event can be easily forgotten. There are several reasons for forgetting information and they can be identified. Original information of an experience or fact was not completely stored to memory and that is one of the reasons for being unable to retrieve some experiences. Moreover, sometimes it feels as if a piece of information has just disappeared from memory and we are unable to retrieve this information. There is a theory called decay theory (Cherry, 2005) which argues that information definitely will faded and replaced with newer information if the old information is not retrieved and rehearsed. Another reason for forgetting is interference. According to this theory (Cherry, 2005), some information is very similar to other information and when memory stores this similar information there will be two kinds of interferences: proactive and retroactive.

1. Proactive interference is that old memory struggles to remember new information.
2. Retroactive interference is when new information occurs; it will interfere with the ability to remember previous learned information.

1.1.4. **Remembering**

Remembering is to think about an experience again or to recall it to mind with effort. Remembering is about retrieving events or information from the past, which have been previously encoded and stored in the brain. There are

several strategies that can be used to assist remembering: cues, context, and emotional states.

Cues

When struggling to remember a forgotten name, if the first letter is given recall can occur immediately. Some events can appear in a person's mind any time just springing into the mind and sometimes aids are needed to trigger the process of remembering. As a result, without a stimulus, the remembering of an event never occurs spontaneously (Eich, 1980).

Context

Recall can be context-dependent. Context, such as location, weather condition, people nearby, is encoded in memories as a part of memory trace and these contexts can be used to enhance retrieval of other information in the trace. Physical context (such as the location for events, the weather, and who was there) is considered as a powerful cue (Farringdon & Oni, 2000). In general, when something has happened in particular situation and remembering that event is necessary, it is best remembered when in the same situation, for example, when something is learned when drunk it is better remembered when drunk (Den Hoven & Eggen, 2007).

Emotional states

Emotional events tend to be remembered and recalled more often. Emotional material has an impact on memory. For instance, people remember happier than sadder information. According to psychology, emotionally pleasant events are recalled better than unpleasant events (Oatley, Keltner, & Jenkins, 1996). Present mood can influence the memories that are available in mind, for example, if you are sad you may remember sad events.

1.3. Summary

This section has reviewed the differences between the parts of human memory. The literature reviewed emphasizes how important memory cues and semantics are to recall information. Retrospective memory keeps past memories and consists of semantic, episodic, and autobiographical memory. It described autobiographical memory which is built inside a self-memory system. The focus in this chapter is to understand how people remember forgotten experiences when

they are given a stimulus such as semantic information about time and time frame. These psychological results can be used to enhance the ability of our memories to judge the time of past event better through an augmented memory system.

1.4. Scenario for Digital Parrot and personal timeframe

The following section presents the need of Digital Parrot with a personal semantic timeframe that will help to solve the problem by using personal time. It will feature a personal semantic timeframe and show the situation of Digital Parrot search by subjective time.

Digital Parrot supports retrospective memory, and mostly in supporting autobiographical memory. It helps users to remember their past experiences by providing data model and "combining on text information with semantic concepts and associations between information items" (Schweer, 2010, p. 225)

> Mohammad is a professional worker and he has been working in Oil Company for 20 years. He always attends conferences in different countries. In each conference, Mohammad encounters new people and massive amounts of information since he started working. He has a problem sometimes to remember some people or some details of these conferences. His work requires him to get back to his past information but how can he remember information that has been used five yours ago? He uses the Digital Parrot system to help him to store his information and to retrieve his past experiences. He can remember few things but that can be related to his personal time.
>
> Mohammad travelled to New Zealand to attend a conference. He met new people, one of them called Mark. Mohammad and Mark discussed different topics and they shared their details. Five years later, he needed important information and he remembered when he was traveling to the North Island in New Zeeland he sent a paper to Mark which included the important information. He goes to his Digital Parrot system and uses the personal time search features. He clicks on one of the personal timeline features and search 'when I was in North Island' or '5 years ago' and then all the information related to that search or all his events that happened

five years ago, is displayed in a nice visualization on the timeline. He finds Mark's details and he contacts him to get the important information.

1.5. Focus of this project

This project aims to extend the conceptual model of the Digital Parrot system to support personal semantic timeframes by using subjective time and personal timeframes, the goal in the project is to explore an efficient way to retrieve past experiences. The first aim is to identify appropriate subjective phrases of time and time frames to be used for the search in an augmented memory system. A challenge is to encode the fuzziness of subjective time and places and display them back to the users.

1.6. Structure of this thesis

This thesis includes eight chapters. In first chapter literature about human memory been reviewed with Scenario of using Digital Parrot and personal timeframe and the focus and the structure of this thesis. Chapter two contains: psychological perspective about augmenting human memory and remembering past time and how memories measure the passage of subjective and identifying the requirements of this chapter with research questions. In Chapter three, study has been conducted to see how people refer to the past time and the outcomes of this study with some requirements will be presented in the end of this Chapter. In related work Chapter, studies are highlighted that have used the notion of time as memory cues and involved time representation and then requirements of this Chapter were addressed. In Chapter five, the requirements from pervious chapters have been generalized to come up with personal time features and determining the best way to display subjective time with personal features. Proposed designs and prototypes were presented in Chapter 6. The evaluation of the effectiveness of personal time feature process and its result will be discussed in Chapter 7. At the end, the conclusion and recommendations for further work chapter will summarize the assumptions of the thesis.

Chapter 2

2. Background

After the introduction of human memory types and how they work, this chapter illustrates an overview of relevant literature about augmented memory from a psychology perspective as relevant to this thesis. The process of time in human memory is reviewed and some facts that have been identified about retrieving dates from autobiographical memory are discussed.

2.1. Psychology perspective in augmented memory

Autobiographical memories can be augmented by using interactive visualizations of data captured during a user's experiences and there is a strong connection in psychological literature between autobiographical memories and visual image (Conway, 1996). Some studies in this area have been done to facilitate the ways of remembering and retrieving past experiences. The stimuli most often used are photos, songs, and text labels, but the virtual part is that there is a relationship between the cue and the to-be-remembered event. The psychological evidence suggests that to improve recall the best cues for recalling the event are needed. Psychology has indicated three dimensions of experience to be remembered: context of experiences, semantic information about items, and association between items. Some of these dimensions are subjective with vague and possibly floating boundaries. Subjective memories cannot be stored in an augmented memory system. Figure 2.1 shows a process view that is associated with human memory.

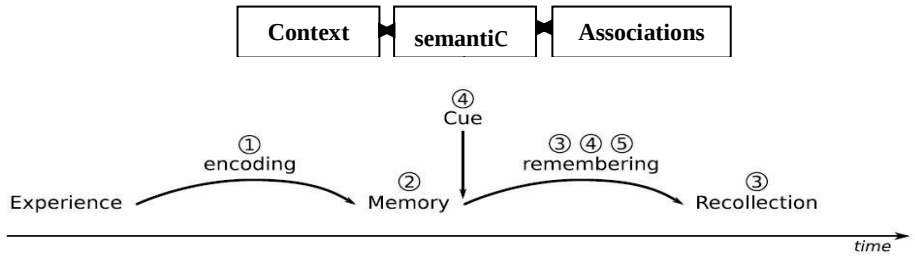


Figure 2.1 Memory lifecycle. Reprinted from *Augmenting autobiographical Memory: An Approach Based on Cognitive Psychology*(p.9), by Schweer, A. Copyright 2011 by Andrea Schweer. Reprinted with permission

Large amounts of personal information are encountered every day and memory is depended on to retrieve this information but it is hard to use the memory to manage the information. Instead special tools are used to arrange them. Personal information management (PIM) is part of people's everyday lives. From psychological perspective, finding information is different from re-finding it. Re-finding is the information that has been accessed before and needs psychological processes; while, finding needs understanding and recognizing information that is relevant. Personal information management depends on memory and users are sure about the information because they have seen it before (Elsweiler, 2007). People remember and forget their information because of memory limitations but how can their memory help them to solve information needs? Understanding memory needs plays a significant role in the designing of PIM tools (Elsweiler, 2007). Systems for the retrieval of personal information rely too much on user's memory to recall accurate information. Therefore, people search for information that they still remember by using key words, titles, and the exact time.

2.1.1. **Types of memory for time**

Three fundamental types of memory for time were identified by (Friedman, 1993). Human memory for time can be built on the following type of information: first memory, second memory and third memory.

- First memory is based on time and duration. For example, how much time has elapsed between its creation and the present (e.g. the architect of Sydney Opera House is 38 years old).
- Second memory is location with time; using location with time to recall memory (e.g. When I was in Auckland two days before).
- Third memory is clue-based memory, using any events as clues to recall memory and determine between two events which one happened before or after another. For example, I met my friend before I go to Auckland. We used one artifact as primitive to recall another artifact.

2.1.2. **Time in human memory**

In this section, understanding of how memories experience the passage of time is discussed. Social and institutional regulation of action can be interpreted as time. According to David Rubin(1986), we do not experience time as the arrangement

of uniform units of duration rather we experience time as action and the action can be repeated or changed from activity to another (C.Rubin, 1986). The period of time during activities is called subjective time and how long one was engaged in these activities can be determined by the attention to start this activity and end it. Episodic memories include information such as the location of an activity, what accrued before, during, and after the event (Ringel et al., 2003). Figure 2.2 shows the passage of time with examples of some activities. In our lives we do lots of activities and these activities, which may or may not be forgotten later.

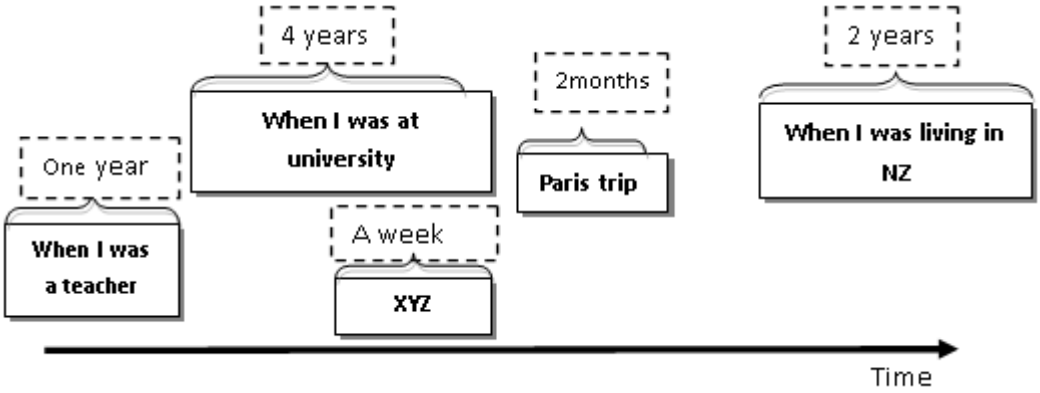


Figure 2.2 Time period construction

2.1.3. **Dating events in autobiographical memory**

This section investigates how memories can date some events that took place long time ago and what kind of process that can be used to support memory to retrieve past time.

Many real objects of time have been used to mark the time, such as clock and calendar, but human memory had an autobiographical memory even before the invention of clock and calendar. Time can be remembered in the memory, according to Huttenlocher and Prohaska (1997), by framing it in terms of other events, either historical or autobiographical. This study shows that events can be remembered in frames and human memory can remember a time period when it was narrowed down to be a day, a week, a month, or a year (Elsweiler, 2007). In addition, people date their event according to how much they can remember about it. Friedman (1992) proposed that:

> The most basic way of representing temporal location in children's memories is probably as independent categories to which events or

> attributes can be associated. Also, adults use locations like summer, my birthday, or weekend to represent temporal locations and that is because adults have a rich sense of where these times fall relative to other times. (p.172).

According to Campbell (1997), if autobiographical memory consists of past events, it needs to use a way of identifying time that is more primitive than clock and calendar, for example, children do not even know how to use the clock and calendar but they still develop their autobiographical memories. In our lives, we do not track how long ago past events occurred with enough accuracy to find them temporally. Time might be remembered by tracking its relationships to remembered events such as birthdays. Studies showed that when events were linked to personal time like "birthdays, holidays", recall improved (Cohen, 1996). Remembering a past day or the day after special event can be helpful to locate other events by their time-relations. For instance, remembering the day before Max's marriage or the day after that event can be used as a cue to retrieve information. Campbell (1997) said that it is not enough to remember this event happened on Max's marriage because there are other contemporaneous events and that added nothing to our memory (Campbell, 1997). Another study result that has been conducted by Ringel et al. (2003) indicated the importance of landmarks for recalling event .The Work events (meeting, due date, conferences, etc) were the most important landmarks that people use to recall memories.

In the Digital Parrot system, (Schweer, 2010) observed that personalising the timeline is a good idea to remember past experience, for example, an event such as attending conferences in New Zealand, instead of using objective timeline. (Schweer, 2010) introduced the idea of using personal time like "during the time in NZ, when I was in relationship with a partner" people prefer it and that would be helpful and make it easy to locate their past experiences (Schweer, 2010).

Thompson, Skowronski, and Betz (1993) classified four processes that temporal information can potentially be derived from "(1) the accessibility of the event in memory, (2) the details of the event Itself, (3) world knowledge or prototypical knowledge that allows a reasonable inference about some aspect of time, and (4) recalled temporal relationships between events" (p. 352).

Friedman (2005) showed that there are three different kinds of time information that are most closely associated with semantic representation of time, leading the memory to remember past events time. The first is a location of the event, for example recalling a particular city that has been visited during the late summer. The second way is remembering distance from present in the past like remembering when the event occurred about two months ago. The third way is the order of some events and relative time of occurrence, for instance one event happened before another or after (see Figure 2.3). Friedman (1993) assumed that the passage of time affects memories in a way that produces cues to their age.

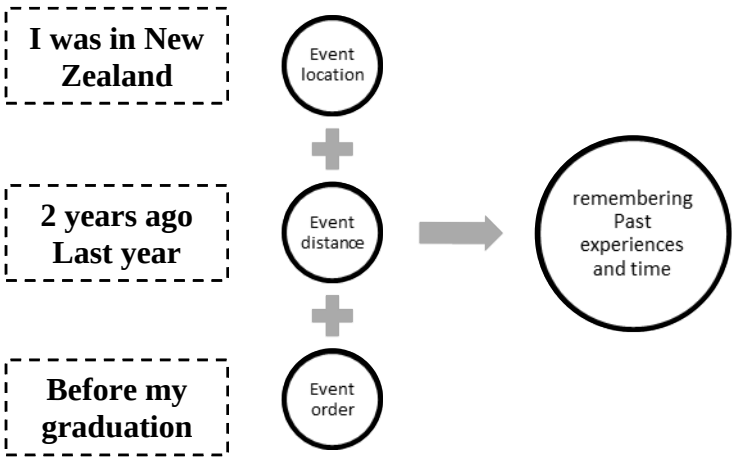


Figure 2.3 The structure of retrieving past time experience

Hasher and Zacks (1979) proposed that temporal information can be automatically encoded in the memory and marking this information by some references can play a significant role in remembering. Arranging time enables planning for the future and provides a framework for rebuilding the past. Domains differ from one to another in terms of events. There are different domains and that can influence the way of remembering, for example, school. Student timetables vary from worker timetables, therefore remembering can rely on routines and timetable. In addition, each domain has a variation of cues that are generated during events, for instance school year schema provides a variety of activities (e.g., summer vacation, graduation, etc.) and these activities can be used as memory cues.

2.1.4. **Identifying Objective Time & Subjective Time**

The aim in this section is to distinguish between objective time and subjective time in the memory and see how people deal with both of them. Objective time can be precisely measured with a clock and calendar. For example, the match between two teams will take 45 min for each half. But subjective time is different and humans are really poor at judging the passage of the time because the subjective impression of the match running time is needs attention-dependent. Subjective time is defined as a time interval measured not by mechanical, electronic, atomic or any other real device, but a person's inbuilt personal feeling and thought on how much time has passed since a certain moment. "Subjective time is a product of cognitive functioning and that time experience can be understood as a manifestation of temporal information processes" (Block, 1990, p59). There is a theory suggested by Thomas and Waver that any specific moment is shared between two brain processors: time processor and the cognitive processor. This theory indicated that if more attention is paid to cognitive activity and timing is neglected, the time will seem to pass more quickly. If more attention is paid to the time itself and less attention to the activity, the time will appear to be passing more slowly. Some experiences are too boring to keep attention focussed on them, therefore a parallel activity is followed during the experience and the time passes by quickly. Tulving (2002) said humans do not think about the subjective time but they take it for granted as the air that is breathed is taken for granted (Tulving, 2002).

2.2. Requirements of psychology perspective (A)

Here we summarise the previous research study requirements for comparison with this thesis' requirements in Chapter 3. After that we list suggestions for the design of the semantic timeframes for the Digital Parrot.

(S1) Personalizing the timeline is helpful to retrieve past experiences better than using fixed time.

(S2) Location needs to be provided with timeline better than just time itself.

(S3) The length of time between events needs to be illustrated so as to easily calculate period of time.

(S4) Time can be better retrieved when associated with temporal landmarks and it will be easy to order special event by using relative time of occurrence.

(S5) Time can be remembered by framing the event in terms of other events.

2.3. Summary

This chapter first reviewed the psychological perspective in augmented memory and the process of time in memory. Objective and subjective time was mentioned to distinguish between them and discover how people deal with them.

The three processes that were identified by Friedman need to be used as personal semantic time information to remember past events: location of the event, event distance, and the order of the events (Friedman, 2005) (see Section 2.1.3).

In addition, it was shown that past times can be remembered by framing them in terms of other events or associating those to temporal landmarks. Personal timespans are considered as a useful idea to recall past experience. These results need to be developed for use in personal timeframe system suggested.

2.4. Research Questions

The problem is that, it is difficult to find events temporally and fixed time may be not a valid cue to use to remember the past experience or retrieve memories (Campbell, 1997). Most of the augmented memory systems do not support the idea of using subjective time as memory cues. In this situation our questions are:

1. What kind of phrases that can be used as subjective time to search in an augmented memory system and help users to retrieve their past experiences?
2. How to encode the fuzziness of subjective time and places and display them back to the users?

We need to find out for personal time and timeframes phrases that can be used as search queries to locate personal past time. In next Chapter we conducted study that can help us to identify those subjective time phrases by interviewing people and see what they used to refer to past time.

Chapter 3

3. User study: exploring the use of time

To explore what types of phrases people use to express times and time frames, a user study was conducted. The study was executed using critical incident technique (CIT). The remainder of the chapter describes the study methodology (Section 3.3) and gives an overview and discussion of the data obtained in the study (Section 3.5). At the finish of the chapter, conclusions are drawn about how the results of the study influence the project.

3.1. Critical Incident Technique

Critical incident technique (CIT) was developed by John Flanagan during World War II. The purpose of this method is to analyse real incidents of success and failure to determine specific behaviour that led to positive or negative results (Hettlage, & Steinlin, 2006). The technique is explained here and purpose of the study. The critical incident interview focuses on participants' expressions of time. CIT provides a flexible method for gaining stories of people's personal experiences as related to specific incidents. The interview is based on questions of past time and autobiographical memory. The session of the interview took up to 20 minutes to complete. The interview was recorded to capture all participants' answers. Participants were asked to remember some events from their life and to discover how people refer to the times and places at which these incidents occurred. There was no probe for personal responses, but an attempt to find events that occur in people's lives and observe how they talk about the time and the place of these events. The questions are not to learn about the event itself but to identify event that can then be talked about in terms of time and place. Critical incident technique is used in here to provide real phrases of real personal story to solve the difficulty of finding events temporally and using subjective time instead of fixed time.

Regardless of the interview technique, the interview questions should be:

- Reflective of phrases derived from personal past experiences, and
- Open-ended.

3.2. Purpose of study

The purpose of this interview method is to discover how people refer to past time and to capture phrases that have been used to express times and time frames. The results of this analysis will inform the design of a system that can capture and encode these phrases to be used for search in an augmented memory system. The system stores autobiographical data.

3.3. Study Methodology

3.3.1. **Procedure**

People in this study were interviewed using CIT technique. Ethical Approval is required before were carrying out this study. We got the ethical approval from Human Research Ethics Committee at Department of Computer Science at University of Waikato (see Appendix A). Participants were given general information about the interview beforehand. Each participant was invited to the usability lab to conduct the study. The interview was recorded to revisit it later and analyse it. Some questions were asked relating to autobiographical memory. This was to identify events that happened in the participant's life (e.g., moving house, buying a car) to see how the participants refer to the times and places at which these events occurred. Table 3-1 illustrates examples of the questions: (an interview sheet is included in Appendix B).

Table 3-1 Questions for CIT interview

Q#	Question to identify events:
Q1	Did you ever have an accident?
Q2	Did you ever buy a new car?
Q3	Have you ever lived abroad?
Q4	Did your family move house when you were a child?
Q5	Did you ever change schools?

Q6 Did you attend an international conference?

Q7 Have you ever given a speech in front of an audience?

Q8 Did you ever act in a theatre play?

The questions participants were asked were to identify how they talk about the time and the place of these events. Information provided only to guide the interview. The questions are not to learn about the event itself but to identify event that can then be talked about in terms of time and place. For each event, the interviewer was then asked:

1. When was the event?
2. Where was the event /where were you when the event happened?

3.3.2. **Participants**

Fifteen participants were selected from Waikato University: two females (M age=35) and 13 males (M age=25). Three participants were members of academic staff and some of the students are doing PHD in Computer science departments. Other participants were chosen from different departments and from different cultures to get a variety of participant backgrounds (see Figure 3.1).

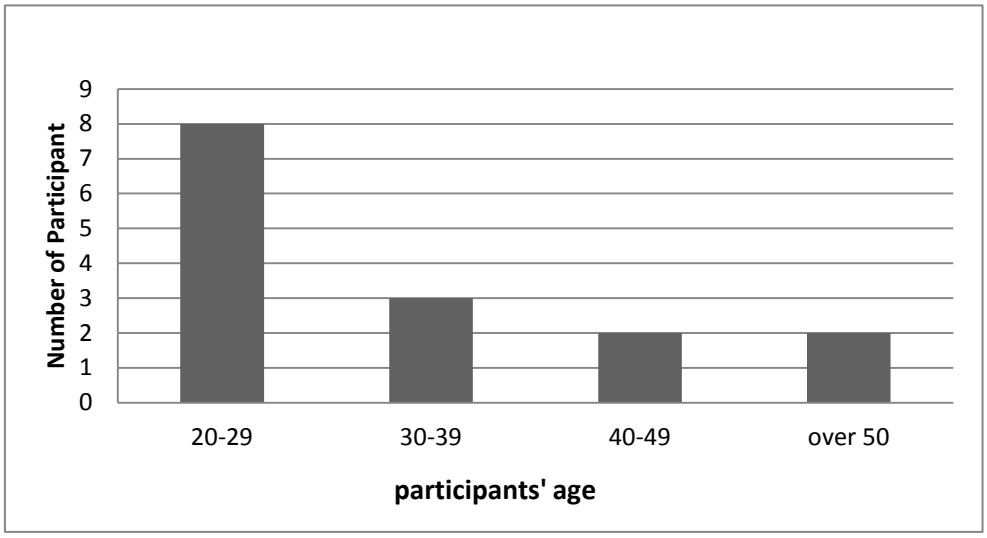


Figure 3.1 Age distribution of participants

3.4. Data collection and analysis

This section contains analysis of participants' responses and how they used their subjective time and how many times they used phrases to express past time. Table 3.2 is a collection of the phrases that people used when they answered autobiographical questions.

Table 3-2 Participants' responses and phrases

Participant	Phrases Used
Participant one (P1)	…when I was 13 years old.
	…16 years ago
	…last year
	…all the time in Holidays.
	…14 or 15 years old.
	…16 years old six month after.
	…yesterday.
Participant two (P2)	…during childhood was riding bike
	…last year in December
	…the end of October last year
	…Primary school and another one before I enter primary school last time were in third semester in college.
	…last year
	…last Summer
	…15 of October
Participant three (P3)	…last Monday.
	…in 2006.
	…12 years old.
	…8 years ago.
	…10 years ago.
Participant four (P4)	…when I was playing with my cousin.
	…when I was 6 years old.
	…it was in 2007 when I graduated from high school
	….last time was 4 years ago

	…when I was 12 years old
	…when I was in intermediate school in second year.
Participant five	…when I was 5 years old.
(P5)	…last year in 2010 in third of July.
	…it was when I finish my standard of school I think 1996.
	…it was 2008.
	…it was 2006 final presentation.
	When I was in standard second and recently in 2007.
Participant six	…it was in afternoon second year in secondary school.
(P6)	…first time when I was child.
	…it was when I was in secondary school from second year to third year
	…it was 2 years ago before giving the exams.
	When I was in primary school it was graduation.
Participant seven	…it was doing my PHD in New Zealand long than 2 years ago and less than 7 years ago it was in October because it was the birthday of my friend.
(P7)	…it was during my PHD before the accident.
	…first time when I was little to Denmark
	…it was last year.
	…it was 1985
	…it was 2005 before my father died.
Participant eight	…8 years old
(P8)	…was 20 years old.
	…it was 18-19years ago.
	…it was 2 years ago
	…it was 20years ago.
	…it was in 1983-1982
	…two hours ago.

Participant nine (P9)	…it was 2 years old I don't remember.
	…it was 2006.
	…it was in 2008 I went to Cambria on behalf of the university.
	…it was 2years ago.
	…it was in 2003
	…it was 2008.
	…it was in last year of high school
Participant ten (P10)	…it was 2 years ago
	…it was 3 years ago around 2009.
	…it was on Friday afternoon in march 24 /2008 because it was special time
	…when I was studying high school roughly last time 2002 and first time 1995 in primary school.
	when I finished primary school
	…it was studying Ramadan 6 year ago after Asha pray.
	…more than 15 years ago when I was child.
Participant eleven (P11)	…it was 3 years ago
	…it was 6 years ago.
	…it was on 5 weeks ago and the first was 12 years old.
	…when I was 21 years old.
	…2003/2004 it was first time for me to give a speech for people.
Participant twelve (P12)	…1999 when I was 14 years old we were celebrating Aid.
	…first one was in High school and second one was in second year of university.
	I was 20 years old
	…when I was 13 years old.
	…first year in my school
	…two years ago.

	…in beginner school
	…when I was studying high school.
	…when I was in first years.
Participant thirteen (P13)	…15 years ago
	…15 years ago in high school.
	…5 years ago
	…was before 25 years when I was at primary school.
	…was in primary school.
	…in 2003
	…two years ago.
Participant fourteen (P14)	…it was 7 years old.
	…when I was 17 when I left school
	…when I was 21 years old for my friend's birthday.
	…it was when I lift school.
	…when I was ten years old.
Participant fifteen (P15)	…when I was student at university 35 years ago.
	…when I was 2 years married 30 years old.
	…when I was 26 years old.
	…after high school maybe 18 years old.
	…when I was in job when 33 years old.
	…in high school.
	…when I was in elementary school under 12 years old.

3.4.1. **Frequency of use of time phrases**

Most of the participants used personal phrases when they have no possibility to recall the time to answer the question of when the event happened. Only some dates were mentioned if the events happened recently. Figure 3.2 shows how frequently participants use their subjective time instead of using fixed time, for example P2 used four different phrases to express his past time.

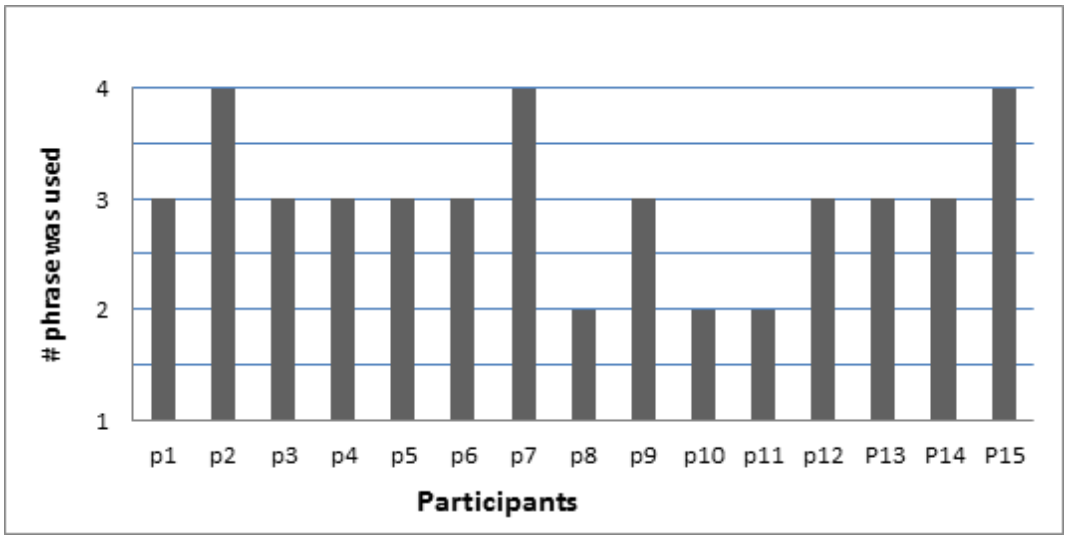


Figure 3.2 Frequency of use of time phrases

According to participants' answers, dividing people lives into stages like ages, school grade, and big events is quite useful for remembering past time because as observed, people have gone through these stages and they will remember personal times by using these stages. Figure 3.3 shows the overall phrases and how many times have they been used by participants. Study grade category ranks the highest percentage by (29%) of use. Most of the participants used the age and study grade as it can be seen in Figure 3.3.

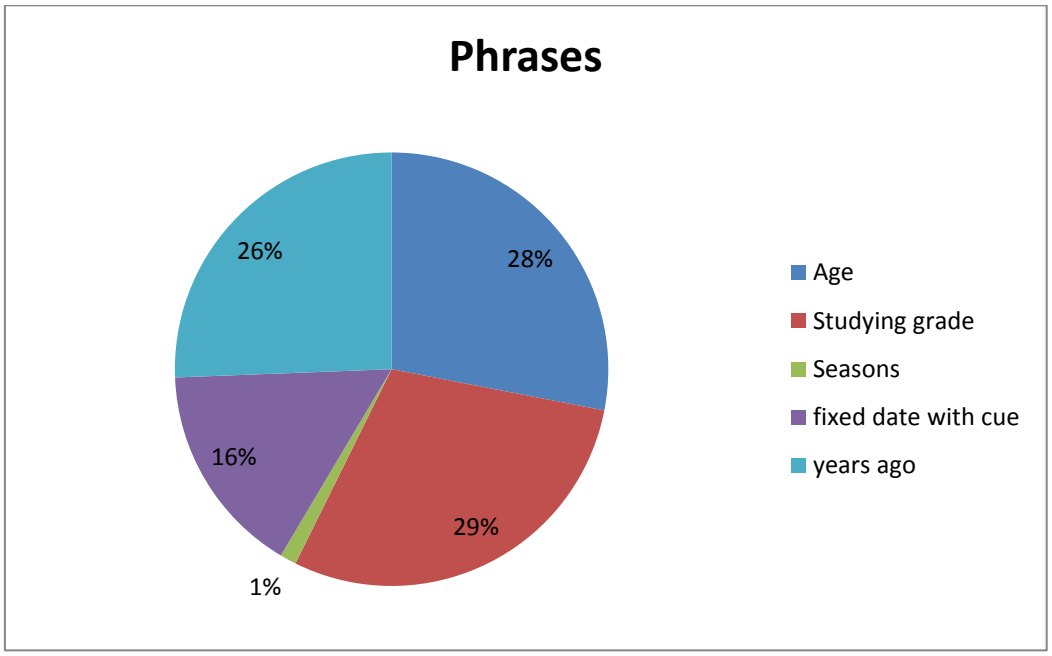


Figure 3.3 Phases used to express past time

3.4.2. **Relationship between age and phrases**

Figure 3.4 compares the relationship between participants' ages and phrases which have been used. The *grade study* phrase between age (20-29) occupied highest number and has been used seven times, whereas, age and *years ago* phrases are equal before fixed time with six times of participants use.

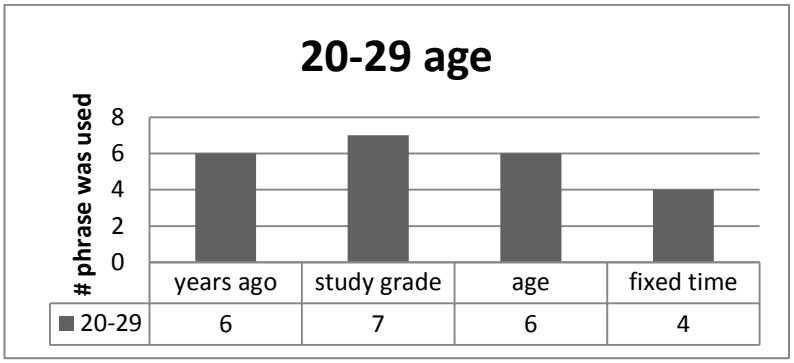


Figure 3.4 Relationship between 20-29 age group and phrases and how many times have been used age + phrase

In the chart below (Figure 3.5), three participants in the 30-39 ages used *years ago* and *study grade* with the same number four times. The use of absolute time was the lowest in this age range by two times of use.

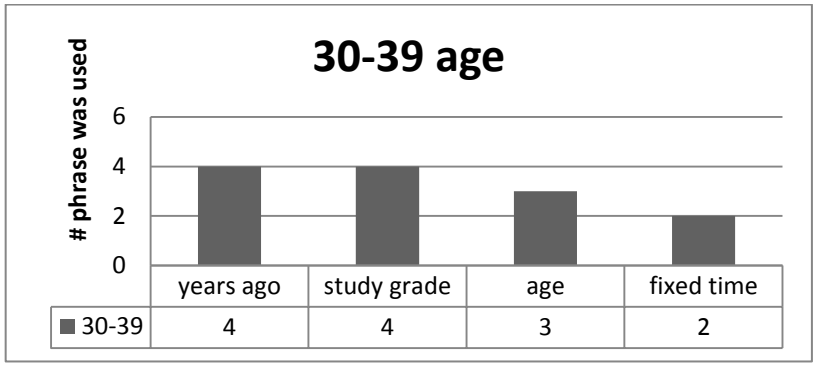


Figure 3.5 Relationship between 30-39 age group and phrases and how many times have been used age + phrase

In 40-49 age range, two participants were in that age group, some changed, fixed time was used by both participants (P7) and (P8) two times; similar to age number. The use of *years ago* phrase was behind with one number by participant (P7). In this group age (P7) only referred to his *study grade* once (see Figure 3.6).

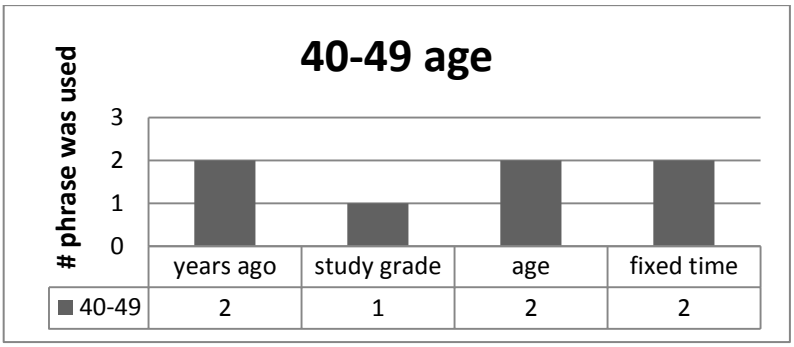


Figure 3.6 Relationship between 40-49 age group and phrases and how many times have been used age + phrase

In the over-50 age range there were two participants, both participants used *age* phrase and the *age* phrase occupied the highest number with four times (see Figure 3.7) and *study grade* phrase comes after with three time of participants use.

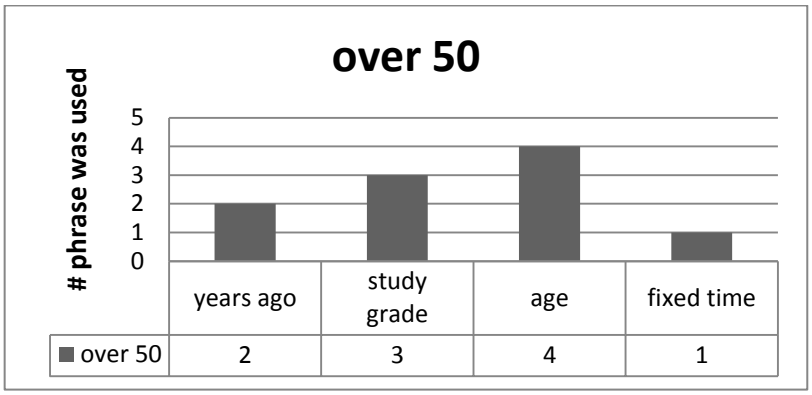


Figure 3.7 Relationship between over 50 age group and phrases and how many times have been used age + phrase

In conclusion, in all of ages from 20 to over-50 most of users use phrases (years ago, study grade, age) more than using conventional time except in one situation in age 40-49 because the number of participant was smaller than others.

3.4.3. **Using the age as phrase**

First phrase that participant have used to express their time is *age*. The majority of participants tended to connect the event to a period of time of their lives such as P12 who used "when I was 13 years old”. Figure 3.8 shows how many participants have used *age* phrase to refer to past time. All of the participants, except P13 have mentioned one stage of their age to answer questions.

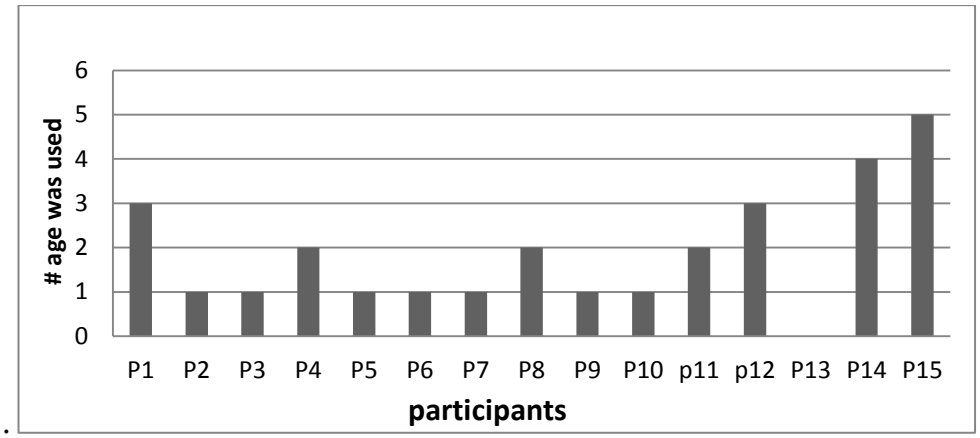


Figure 3.8 Age as subjective time for each participant

3.4.4. **Study grade as phrase**

The second phrase that has been mentioned by participants is *study grade*. When events happened more than three years previously, some participants calculate past period by referring to study grade, for instance P6 used “It was in afternoon second year in secondary school.” One participant (age=20-29) has used this phrase five times and four participants did not use it at all and they are over 30 years old. The percentage of people who refer to past time with study grade was 75 percent of participants and they were under 30 years old, whereas, 25 percent of participants were between 30 to 50 years old and they did not refer to study grade when they were answering autobiographical questions.

3.4.5. **Years ago phrase**

Third common phrase was *ago*. Participants found it helpful to use phrase *ago* with past years to estimate the period of time that have passed and find memories such as "I come to New Zealand five years ago." Two participants, P2 and P5, did not use this phrase. Figure 3.9 illustrates how many time participants used *age* phrase.

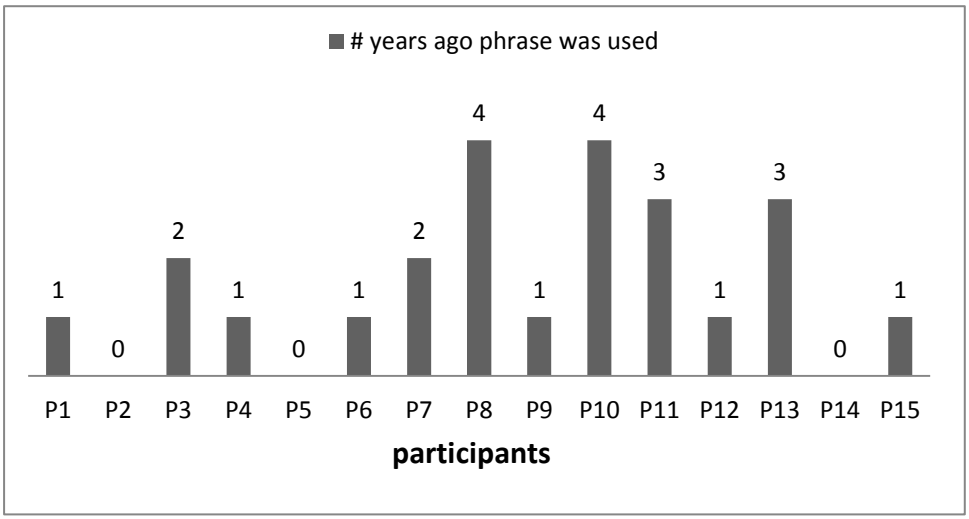


Figure 3.9 Use of phrase, years ago

3.4.6. **Time with cue**

The final phrase was *fixed time*. Figure 3.10 shows the different temporal landmarks that have been used as memory cues to remember past time. For example P1 still remembers exact date, and exact time of her father's death. P10 used a special month Ramadan as references (e.g. religious month of Ramadan or lent), the year of beginning of study such as in October, was used many times and because these months have a special event which is repeated every year so participants referred to them as time references. Also, interesting events category occupied the biggest percentage and it seems that people use interesting moments rather than a sad memory or tragedy to target past time because they engaged with their interests.

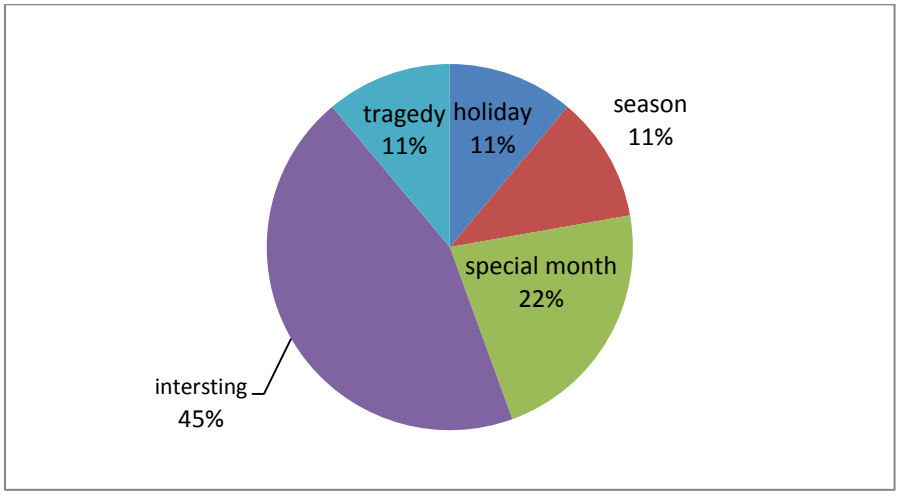


Figure 3.10 Personal time as memory cues

3.5. Findings and Discussion

This study aimed to explore types of phrases people use to express times and time frames to derive a preliminary design of semantic timeframes for the Digital Parrot. In the CIT user study, four findings are interesting. The phrases that have been used are divided to two themes: social aspect and education aspect.

The first theme is the social aspect which includes three types of personal time phrases: participants' age, ago phrase, and fixed time with cue. It was identified that connecting past time to the age of the speakers was used many times as phrases to measure a time period. If the event happened one or two years ago, human memory can provide exact months in which events occurred and that supported Elsweiler's (2007) findings that human memory can precisely recall past events when it is narrowed down to be a day, a week, a month, or a year. One study by Rubin in 1982 compared recollected event dates to personal diaries and he found that in 74 percent of cases the recollections of their memories were accurate to within a month. Friedman mentioned that "judging the time of a target event is a matter of gauging its distance from the present in the memory store" (1993, p.45). Despite people's attempt at providing an exact date, they have partial temporal information as reference in their memories and will say the event occurred five months ago to estimate the date. Thompson et al. (1993) argued that partial temporal information helps to reconstruct the event's date but this temporal information has to be inferred from some other aspect of memory.

Personal events in past time or landmarks like holidays, Mother's day, are really supportive to find information in details. As mentioned previously, when there are big events, fixed time can be easily recollected because there is a reference that participants use to locate their information. Similarly, evidence suggests that past personal events can be dated by associating those to temporal landmarks such as father's day and holidays (Skowronski, Walker, & Betz, 2003).

In a study conducted by Ringel et al. (2003), landmarks were added to timeline visualization to search for e-mail messages and the result was significant. The goal of this study was to test different timeline presentations. People retrieve information from personal landmarks +timeline visualizations better than using normal timeline (with date only). In another study by Ringel, Cutrell, Dumais, and

Horvitz (2003), personalizing an event significantly affects the way of retrieving past information. As well, using temporal landmarks as anchors to dating other events was supported by Thompson et al. (1993). Individuals in that study used different strategies to remember events and the most frequent strategies were to use a "reference event" or "reference period" (Shum, 1998).We found in our study that people use interesting moments as temporal landmarks to recall past events. In Ringel et al. (2003) study, most of the landmarks that have been used is work events and that is different from our study. The work events could be interesting and could be not. The differences between the results of explore the use of time and Ringel et al study in this point because people have different back ground and different domains.

The second theme is the education aspect. The results show that people tend to divide their lives into frames and use these as phrases to remember personal time such as *Study grade.* Similarly, a study has Huttenlocher and Prohaska (1997) found that framing the event in terms of other events is supportive to locating memories. Shum (1998), in Northwestern University, studied the temporal landmarks in people's lives. He asked people for the landmark in their lives from the previous year. School graduation was mentions 55 times in this study. We can infer from that academic and study frame play curial role in our lives. This study is different from our study in finding important landmarks which we still remember them and stay in our autobiographical memory to access it later. Based on our result and other studies, we have learned that we can use these landmarks as personal semantic timeframe to be used for search in an augmented memory system. Table 3-3 illustrates the study grades that have been frequently used by participants in this study to express past time.

Table 3-3 Study grade most frequently used

Study Grade	Times Events Mentioned
Primary school	7
High school	7
Intermediate school	3
Collage	3
Graduation	2
Undergraduate degree	1

3.6. Requirements of exploring the use of time study (B)

This section summarizes the requirements for a system that follows user study experiment. The requirements are classified into four components: educational experiments; people's age; past years and *ago* phrase; and fixed time with clues.

(U1) educational experiments: The user needs to be provided with past educational levels to be used as cues to retrieve information from autobiographical memory.

(U2) people age: People refer too much to their ages while remembering past events and the system can provide personal age on a timeline to recognize other events.

(U3) past years and *ago* phrase: The system should display the events with their ages by using kinds of visualizations.

(U4) fixed time with clues: this should provide some clues to users to help them to retrieve information by using absolute dates.

3.7. Summary

This chapter has contributed to answering first research questions identified in Section 2.4, what kind of phrases that can be used as subjective time to search in an augmented memory system and help users to retrieve their past experiences? by interviewing people and identifying what phrases they used to express past time. It was found that using semantic time has many advantages that would seem to facilitate locating events temporally and provide appropriate cues to remember past experiences. To find out when some events occurred, it is necessary to access to events semantics that are associated with time. The findings are that people are inclined to use subjective time more than objective time if they cannot remember the exact time. It was observed that, when a person has no chance to remember when some events occurred, he/she estimates dates based on certain things that they can recall and connect past experience or event to either an interesting moment with fixed date or one of the life's categories mentioned in the study. Also, it was observed that fixed time is retrieved only when there is a subjective cue, for example, P8 said "I traveled to America in 1998." He still remembers the exact date because his book was established in that year.

Chapter 4

4. Related work

The focus of this thesis is using semantic and personal time to make temporal information more easily accessible. In this section, related work will be evaluated and discussed the issues in existed augmented memory systems that support the concept of using the time to search for past experiences and the insight gained from the user study will be used with these systems.

4.1. Displaying and retrieving time in different systems

Human memory does not record life, and many systems have been created to augment human memory. Some of these systems use a database of information recorded by means of wearable computing devices. The wearable computing systems record audio, video, and face recognition by using sensors, cameras, and microphones. In addition, the location can be detected by a wearable system GPS.

There are a number of systems which have been developed to support augmented memory systems and help users to retrieve the information in different ways. Visualizations have been used to convey the concept of time to display past time experiences or events.

In some systems, temporal information is used to allow users to see events over a long time in the past and predict future events. Time based organization or chronological order is considered as an effective memory cue to retrieve personal information (Lansdale, 1988), but most of the current systems do not clearly support the concept of subjective time or timeframe search tasks. In related work section, some studies are researched that use the notion of time to recall information and identify whether the time was used as memory cues to help users to remember better. Also, how the time was displayed in these systems and whether any subjective time was used as trigger to past experiences needs to be researched.

4.1.1. **Facebook timeline**

Timeline in Facebook [1]provides a way to digitally document entire life, from birth until the present. It helps users to remember what was happening in past through wall posts, photos, announcements and events that are represented on personal time. People are able to see the change of their history and the can easily search for missing information such as people's names, posts, and photos. In addition, the user is able to create their life history on the web by going back through the timeline from the moment he was born and adding memories and some pictures. Facebook timeline is a website, allowing the user to scroll vertically through the greatest moments in their life-map using photos, notes, applications and more. The timeline in Facebook was generated from top to bottom in the middle of the screen. The advantage of using this timeline representation is to present past posts, photos, announcements and events in the screen in right and left the line. Past years from the user's birthday until the present are illustrated on the right side of the screen to direct the user to past memories and information when he/she clicks in a particular year.

4.1.2. **Augmented Memory System: Digital Parrot**

Digital Parrot supports retrospective memory, and mostly in supporting autobiographical memory. It helps users to remember their past experiences by providing data model and "combining on text information with semantic concepts and associations between information items" (Schweer, 2010, p. 225). Users are able to create their own network of memories and make relationships between these events to follow these connections. This kind of system helps users to remember by following the features of human long term memory as learned from psychology studies. Also, the information can be recalled by using context or following the associations formed with something they remember well.

The time was represented in this system by using timeline navigator. The time was stepwise refined and blocks used to indicate the number of events within the time frame. The problem in this system, objective time was supported in this system and users are not able to use any personal clues that help his memory to temporally locate past experiences. The timeframes that Digital Parrot uses are not

[1] www.facebook.com

sufficient for personal use and can be hard to follow these frames to identify other events Also, present time and future are not supported. Figure 4.1 shows the representation of time in Digital Parrot system.

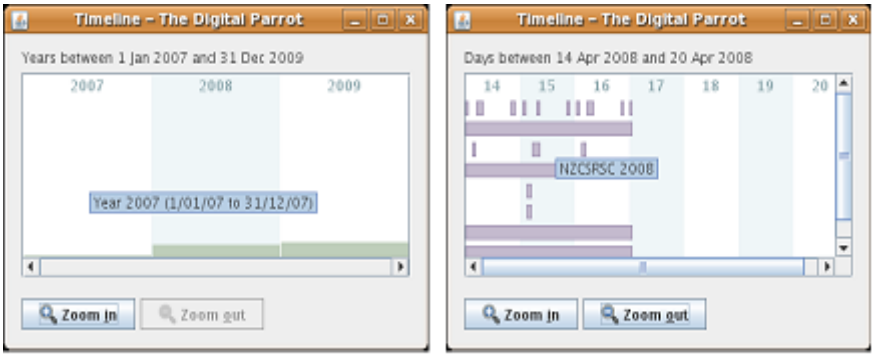


Figure 4.1Timeline in Digital Parrot system. Reprinted from *Augmenting autobiographical Memory: An Approach Based on Cognitive Psychology*(p.112), by Schweer, A. Copyright 2011 by Andrea Schweer. Reprinted with permission

4.1.3. **Memex system**

This system was generated by Vannevar Bush in 1945 and is a device that allows users to archive and retrieve their books and information by using a simple numerical code that has already been given to these documents. Nowadays, living in an information age and it is difficult to navigate and sort information.

4.1.4. **MyLifeBits**

This is a project to fulfill the Memex system and allow the user to store digital media including documents, images, sounds, and video (Gemmell, Bell, Lueder, Drucker, & Wong, 2002). This system helps the user annotate the collection and make it available for later retrieval. Also, the user is able to connect the items; for example, create links between pictures and the place that pictures were taken and people who were in these pictures. Much visualization has been supported to display query results in a timeline or list and to protect the user from many clicks. The time was used in this system as time interval to store the time range that the content of the object refers to. Timeline view (Figure 4.2) displays contents on a linear time scale or list. The graph at the bottom features the distribution in time. Time for each collection is capture automatically and user search for any item by using objective time.

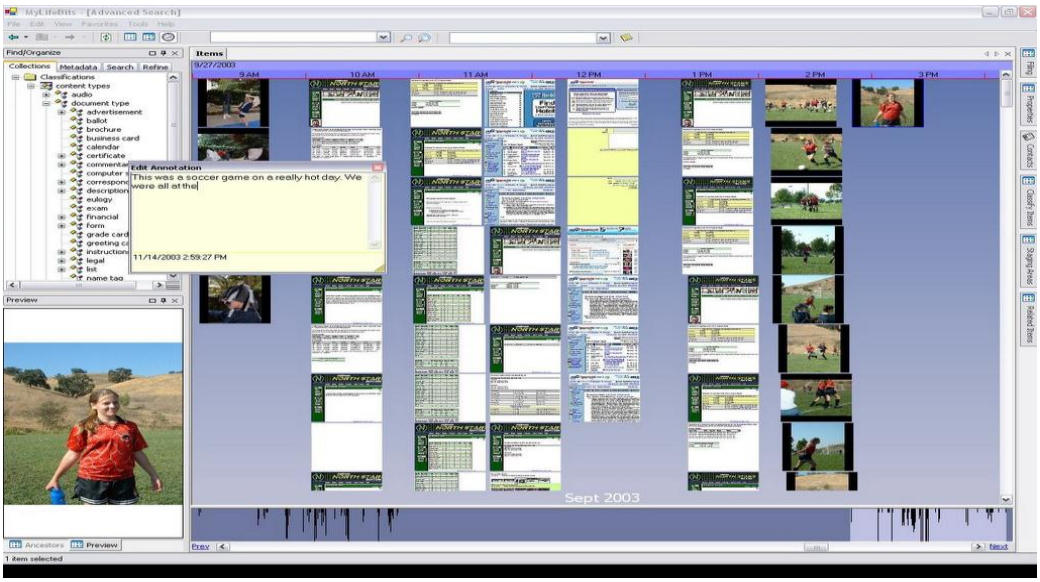


Figure 4.2 MyLifeBits query result interface. Reprinted from *MyLifeBits: Fulfilling the Memex Vision* (p 237) by Jim Gemmel, et al. Copyright 2002 by Jim Gemmel, et al. Reprinted with permission

4.1.5. **Lifelog**

This is another system to capture, recall and manage personal information such as digital documents, email, and paper mail, etc. Also, the system can record data from other everyday activities such as captured images, video, sound, and location and what is called Continuous Archival and Retrieval of Personal Experiences (CARPE) system. Sellen and Whittaker (2010) assumed in their article that people have a wearable sensor and this device stores personal information but this system requires massive technologies for its capture, management, and storage. In 2006, Czerwinski (Czerwinski, 2006) suggested in his outline that lifelogging could change how personal data used and shared by ensuring a search of past experiences. Also, lost objects can be found, names can be recalled, and discussion in meeting or conferences can be reviewed as well. Lifelogging system has two major classes: total capture which means everything is recorded including documents, images, videos, sounds, and locations. The other class is situation-specific capture that is more limited in scope than total capture and it aims to capture specific data in specific domains. For example, capturing specific activities in particular places such as recording information during conferences or lectures. Overall, instead of capturing everything, Sellen and Whittaker said "the system design should focus on the psychological basis of human memory" (2010, p.70). In fact, cues could help memories to remember things need to be identified.

In addition, deeper understanding of memory problems that people have can lead designers to create an ideal system. Some data is considered as treasured information to people and by concentrating on these data a better lifelogging system could be created (Whittaker, 2010). Life logo (Aizawa, Hori, Kawasaki, & Ishikawa, 2004) users can use context (location, weather, news) from sensors and database as keys to retrieve past video by imitating the way a person collects experiences from his memory. The retrieval keys can be also added by the users (annotation) to easily access to information later. The time was used in this system as key to retrieve past information. Time is recorded by the system and the content of life-log videos associated with the time when they were captured. For example, "I was in NZ to attend a conference and I met Mark and we had a good conversation, when the conference was held."

4.1.6. **Forget-me-not**

This is another system that helps people to recall their events by capturing context such as location and person's everyday life, as a cue for remembrance. It gathers all information about daily events from other devices in the environment (Lamming et al., 1994).

4.1.7. **Lifestream Personal information system**

Another system called Lifestream (Yale University) was developed by Eric Freeman and David Gelernter (1996). A Lifestream is "a time-ordered stream of documents that functions as a diary of your electronic file" (Fertig, Freeman, & Gelernter, 1996) (p. 410). It visualises personal files in a timeline format. This idea was taken from David Gelernter's book, *Mirror World* (1992). The concept of this system is a time-ordered stream of documents and it works as diary of a personal electronic file. In this system, chronology was used as a storage model and Lifestream includes helpful functions, such as named files, directories, and explicit storage that enable users to structure and retrieve their documents. Lifestream stores every document created by or sends by other people. The past of the users' documents is depicted as the tail of the stream that contains past documents (starting with an electronic birth certificate) and users can specify where the far tail begins. Present and recent documents are stored between the tail and present, moving away from the tail and toward the present. To move from the

present to future, the stream has documents that might be needed in future work such as reminders, calendar items, to-do list. Figure 4.3 shows a stream of documents with timeline.

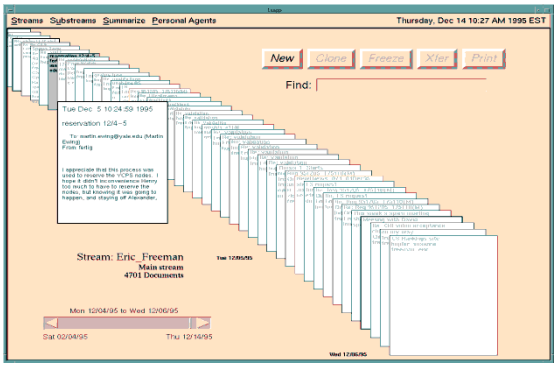


Figure 4.3 Lifestreams Interface. Reprinted *from LifeStreams: an alternative to the desktop metaphor* (p 410) by Scott Fertig, et al. Copyright 1996 by ACM SIGIR. Reprinted with permission

The timebase displays sequence of time along with slots which are highlighted to indicate documents. The time was shown in this system as objective time for the day each document was created and the month with the year and the date is displayed for the first document created each day to reduce the complexity in the interface. Time was showing as horizontal scrollbar to navigate through the past and the user is able to navigate the timeline by scrolling the mouse to move from the past to the future. Users are able to narrow down the search by using the time range (see Figure 4.4). Personal time search was not supported in this system. It is difficult for human memory to remember when was exact date of saving the documents especially when those documents were stored long time ago. Personal time search techniques were not provided in this system and users browse back in time by specifying their search by a fixed date.

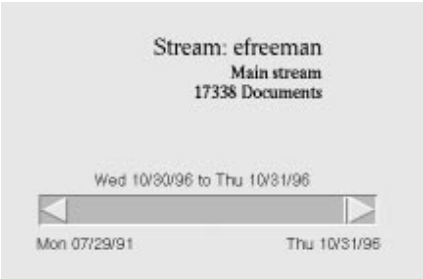


Figure 4.4 Browsing back in time Reprinted from *LifeStreams: an alternative to the desktop metaphor* (p 410) by Scott Fertig, et al. Copyright 1996 by ACM SIGIR. Reprinted with permission

4.1.8. **Stuff I've seen system**

Stuff I've seen is another study on a search engine for accessing personal information such as document files, e-mails, and web browsing history. This system helps and reminds users to find and re-use previously seen information. This study found that the date was a more useful attribute than others for retrieving personal information (see Figure 4.5). Date was a filter function in the system to narrow down the result and then the result would be visualized in a timeline presentation with personal landmarks. For example, a personal landmark is created by the user using the calendar to generate a personal event (appointments, holiday) then these events will be visualised in timeline (Dumais, 2003) (see Figure 4.6). The concept of this system is using landmarks either personal or public as memory cues to help users to retrieve personal content. Figure 4.6 shows some check boxs that include semantic time which are used as memory cues to allow users to specify their search. The result was shown as textual list ranked automatically by relevance. This thesis can benefit from this system in order to search by using personal landmarks.

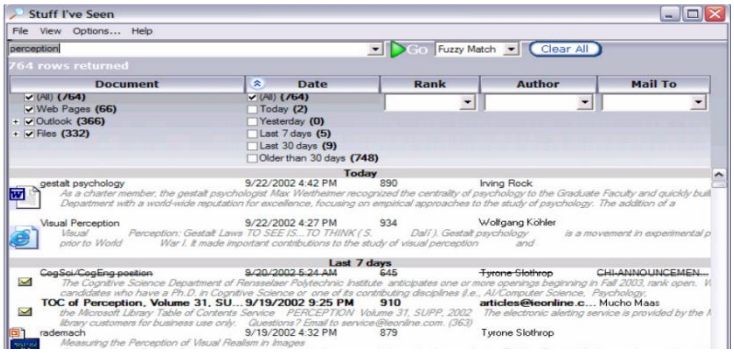


Figure 4.5 Stuff I've Seen interface. *Reprinted from Stuff I've Seen: A System for Personal Information Retrieval and Re-Use* (p 74) by Susan Dumais, et al. Copyright 2003 by ACM SIGIR. Reprinted with permission

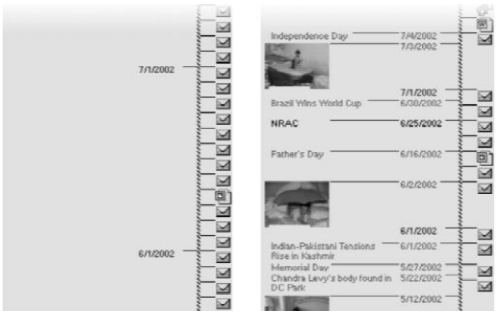


Figure 4.6 Landmarks + Dates Reprinted from *Stuff I've Seen: A System for Personal Information Retrieval and Re-Use* by Susan Dumais, et al. Copyright 2003 by ACM SIGIR. Reprinted with permission.

4.1.9. **MediAssist system**

The MediAssist is a system to store and access personal digital photo collections. Groups of photos are taken in different times and sometimes hard to remember captured time. This system has a function that enables users to filter all time by using time-based queries. It also allows users to decide the range or period of the capture time. For example, photos taken in the evening, at the weekend, during the summer or within date ranges. Simple representation of timelines for months, days, day of week, and hour allow users to indicate their search. Figure 4.7 illustrates the concept of time-based queries. Photo locations and time are recorded in this system to be used in retrieving additional contextual information such as daily light status, weather, indoor/outdoor arrangement (Neil O'Hare et al., 2006). In a search result, the timeline was depicted with color schemes to indicate which date the picture was taken. In this system user can benefit from time filter functions to narrow down his search but some of these functions still impersonalized.

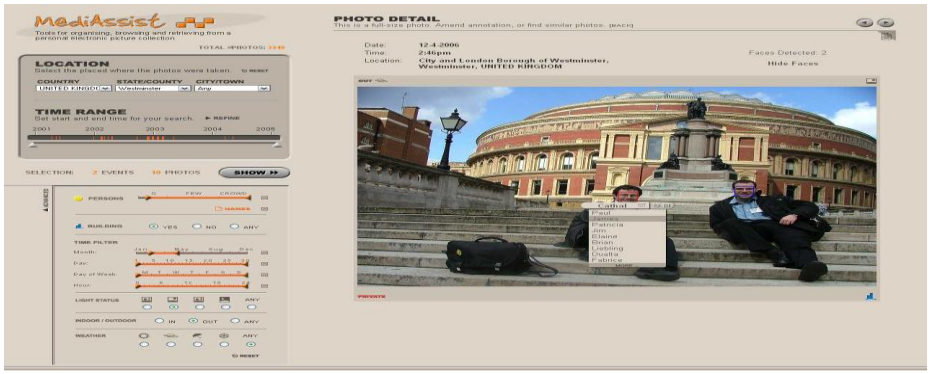


Figure 4.7 MediAssist system interface. Reprinted from *MediAssist: Using Content-Based Analysis and Context to Manage Personal Photo Collections* (p 2) by Neil O'Hare et al. Copyright 2006 by Neil O'Hare et al. Reprinted with permission.

4.2. Previous study requirements

The author performed an earlier study aiming to determine a good model to visualise time. Following is a brief summary of some of the results of visualizing time work; an extended discussion can be found in (Alahmari, 2010).

(P1) Best time representations are those which have a notion of the flow of time, a time before, now, and a time ahead (past, present and future);

(P2) It is better to base representation on real artefacts which have some association with time, rather than on abstract images; and

(P3) It would be better to represent the passage of time as lines.

4.3. Criteria

This section describes selections of augmented memory systems by applying criteria stated below. Using the concept of time to search and retrieve information in these systems is summarized in Table 4-1 with some criteria that are derived from the current research results in both studies section (3.6) and section (4.2). The results of (visualizing time) study and the result of (exploring the use of time) study are used as criteria for systems analysis. These are , time in real objects, notion of the flow of time and subjective time.

Time in real objects (C1)	A type of time representation using one of real artifacts like calendar or clock with a notion of the flow of time.
Notion of the flow of time (C2)	Whether the system allows its users to see the flow of a time before, now, and a time ahead (past, present and future).
Subjective time (C3)	Whether the system allows its user to use personal time and time phrases to search past experiences when remembering an experience with the system's help (i.e. age, study grade, landmark, years ago).

Table 4-1 Use of time and visualisation

System	C1	C2			C3			
		past	present	future	Years ago	Study timeframe	age	Temporal landmark
Facebook	-	+	+	+	+	-	+	+
MyLifeBits	+/-	+	-	-	+	-	-	+/-
Lifelog	-	+	+	-	+	-	-	-
Forget-me-not	-	+	+/-	-	+	-	-	-
Digital Parrot	-	+	-	-	+	-	-	-
Lifestream	+/-	+	+	+	+	-	-	-
Stuff I've seen	-	+	-	-	+	-	-	+
MediAssist	-	+	-	-	+	-	-	+/-

Legend: (+)is found, (-)is not found, (+/-)there is limitation.

4.3.1. **Notion of the flow of the time**

The review in this chapter showed that most of the analyzed systems support representing past time to the user. All systems that were analyzed allow the user to see overview of the past and search for past events. Most of systems analyzed use different visualizations as query result of past experiences.

To retrieve information from the past, present time is an important cue to be represented in any system to be used to calculate a past period of time according to present time and to specify the search. The majority of reviewed systems, with exception of Facebook timeline, did not allow the user to see his present time in the timeline and they do not explicitly support this idea. This is may be because the system can be used to show past memories, and users already knew their present time. As it mentioned in Section 4.2, the best time representations are those which have a notion of the flow of time, a time before, now, and a time ahead (past, present and future). Most of these systems, except Lifestream, did not enable the users to create reminders and see them later as future events. The Facebook timeline shows the time in a vertical line in the middle of the screen with the best moments of the user's life-map with location, picture, and comments. Past experiences and memories are retrieved in Facebook timeline through clickable items with a direct effect. The Digital Parrot displays time by using timeline navigator blocks to indicate the number of events within the timeframe and past time can be retrieved by using absolute time. Lifestream shows the time of documents as a horizontal scrollbar to find the information through the past and the user is able to navigate the timeline to search for information by mouse scrolling to move from the past to the future. The Stuff I've seen system uses a timeline and personal landmark to help users to locate past event temporally and find personal content faster than other ways. The MediAssist system allows users to filter all times of digital photo collections by using time-based queries to remember captured time.

4.3.2. **Time in real objects**

Using real objects such as calendars is considered as the best way to present the time and a common way for people. It can be used in an augmented memory system as timetables to organize users' events by associating references in that

calendar as cues to refer to while remembering. Also, the calendar can be used to search for a past event by using a real date that is still remembered. Real object time was only used in two of systems analyzed with some limitations. Users can refer to calendar only to arrange reminders.

4.3.3. **Subjective time**

All systems that were analyzed, except the Facebook timeline, allow the user to perform simple retrieval of information by browsing using a range of methods: textual search, real time, and customized query techniques. Using objective time is not a good memory cue for remembering past events. Facebook timeline and Stuff I've seen systems used personal time and public landmarks as cues to help the user to search past time. MediAssist system also used some query techniques to narrow down the result but is still using real time to retrieve information. None of these systems support the area of using personal age and study grade as a personal time query to display the result. Only Facebook timeline indicates users and their family birthdays on the timeline. As mentioned in section 3.5, four common phrases have been identified which should be used to help user to remember a past event. These systems did not use some of these phrases to support memory retrieval, except using years ago and fixed time with cues. Also, personal and public landmarks were used many times to remember past events in the study. The literature review results show that temporal landmark plays significant role in augmenting memory.

In contrast to previous efforts, this system will provide approaches that support personal semantic timeframes and identify the best personal time features to help users recall their own past experiences. These approaches will personalize the time as memory cues to retrieve information better than using fixed time as result of earlier studies. Also, the notion of time which has been proposed in previous study will be used to provide easy browsing for personal information wanted in one of visualizations which have some association with time.

4.4. Conclusion

This chapter demonstrated related work with some systems that help to augment memory system using the concept of time. As summary of these systems that to augment memory system, we should find a good connection between memories

and cues and that could be implemented by using semantic information, context experiences or association between events. Of the analyzed systems, Digital Parrot, Memex system, MyLifeBits, Lifelog, Forget-me-not, Lifestream, and the MediAssist enable users to search for information by using, for example, real time, key word, file name, path, file size, but do not explicitly support the concept of subjective time or timeframe search tasks. These systems which aim to support memory for past experiences focused on objective time such as the years and months and that can be easily measured and is difficult sometimes for human memory to locate past events. The results of previous study (Alahmari, 2010) have been identified to be used as criteria.

The time was represented in these systems by using abstract objects not real object, such as calendars.

Stuff I've seen and Facebook timeline allow the user to use his personal time and temporal landmarks to recall past information, using, for example, names, pictures, notes, and public landmarks. The time was represented in these systems as a vertical timeline and it was easy for the user to locate an event temporally because the timeline was personalized.

The next chapter will review the personal time system requirements that are raised from Chapter 2 and Chapter 3 and will then discuss general requirements with different time visualizations.

Chapter 5

5. Requirements for personalize time representations

This chapter summarises system requirements A in Section 2.2 and B Section3.6 and then compares them to previous studies (Alahmari, 2010) to identify the best visualization that will fit the requirements to display the time with a personal timeframe and features.

5.1. Combined requirements of psychology and user study (A + B)

Requirements A and B are combined to identify the differences and similarities between them and to choose important requirements that can be compared with different time visualisations. Table 5-1 illustrates A and B requirements that are almost similar. Education and age (U1) and (U2) requirements from user study are kinds of time personalization (S1). It was found participants tended to use ago phrase (U3) which, from the psychology perspective, means the distance of time (S1). Also, in the user study, people mentioned some dates (U4) and that was because they connected past events with clues or landmarks (S4).

Table 5-1 Combining requirements A+B

Requirements	
Psychology	**User study**
Personalisation	
(S1)	(U1)(U2)
Localisation	
(S2)	
Distance of time	
(S3)	(U3)
Temporal landmarks and clues	
(S4)(S5)	(U4)

5.2. General requirements

To solve problems of finding past information temporally, a personal time and time frame system has four requirements that are derived from recommendations A and B. These four requirements are: personalisation (G1); localisation (G2); distance of time (G3); and temporal landmark and clues (G4).

5.2.1. **Personalization (G1)**

Psychologists suggest that past memories can be better recalled when events are personalised in a timeline in terms of other events (S1). The user study found that personalising events in a timeline plays a significant role in facilitating remembering (U1). A system can be provided associating personal information in a timeline such as personal timespans, educational level, age, work level, images in past time or it can be through providing personal expressions to these past events to be temporally ordered.

5.2.2. **Localization (G2)**

Location is already provided in Digital Parrot and it can be used to make it more personal. The location of the experience was used in Digital Parrot to illustrate information that connects to an experience. Also, it was used to filter information items. Location in this system can be more personal (S2) such as presenting past events in the map; for example, using the search engine to search for holidays and then the location of holidays is indicated on the map.

5.2.3. **Distance of time (G3)**

The system must acquire duration information of past experience in its augmented memory system to make retrieval information more meaningful and to help the user to judge an item's time occurrence (S3) & (U3). For example, information about an experiences' age and the amount of time that has elapsed since the creation of the experiences, can be add to time navigation in Digital Parrot.

5.2.4. **Temporal landmark and clues (G4)**

The system has to provide landmarks that happened around personal life (e.g. weddings, holidays, death, news, nation's Liberation Day) some significant and some not so, in the timeline to help people recognize when some events occurred.

The results of the user study (U4) show that people tend to use some landmarks and clues in their lives as cues to recall past times and memories.

5.3. Ways to display time

This section illustrates an overview of relevant literature about ways displaying the time to see what an effective way to provide the user with an overview of query result with time representation. Some of this work is repeated form a previous study in visualizing time (Alahmari, 2010).

There is a difference between perceiving the time and displaying it. The familiar calendar is a visualization of time and can be used to reckon time over extensive periods. It is considered as theme to serve and cue memories to remember past events and arrange future events. It is organized in units of time that can be used in any year. A calendar has different themes and was developed to assist people to recall their dynamic pasts. The most common example of a matrix– style timeline is a calendar. Typically, a calendar has the smaller unit of measurement (days of the week) starting from left to right along the top and larger unit (weeks of the month) starting from top to bottom along the left side.

Some calendars repeat astronomical cycles according to fixed values, others are arranged in terms of astronomical observation. In the present day, digital technology has facilitated ways of representing events visually. By using technology, users can set any events or appointments in the calendars and, later on, the computer system will remind him/her of upcoming events (again, an illustration of a computer-based calendar). There is a positive aspect of the calendar which is large position of time, for example, months are divided into weeks and weeks are broken into days. The purpose for which a calendar is to be used and preferences among individuals, lead to various design representations of calendars and those representations depend on people's usage. For instance, business people use special calendars that represent the beginning of week on Monday and some people have calendars for private usage. Differences also between cultures have changed the way of calendar representations. For example, festivities are different from culture to another and these events need to be arranged according to individuals. But thinking about subjective time, everyone

has his own personal measurements of time and that relies on where he is and where his is moving.

People represent time as a circle to show the continuity or cyclic nature of time: time never stops and always goes in the same direction. Hours and minutes and seconds repeat themselves every day. The primary reference point on the clock is the 12:00 at the top of the clock and that position was based upon the position of the sun at noon (Mitchell, 2006). Campbell (1997) noted that "the clock seems to be general purpose in what the phase of the day to expect this or that new phenomenon" (p.113). The clock purely gives representation of what happened during whole period and it is not enough to keep in time with the period as it passes.

Tulving (1972) mentioned that in our memory specifications of temporal information do not need to be based on clock and calendar forms but could be founded on other forms of organizations like charts or timeline. Figure 5.1 is an example of temporal information was depicted as charts or timeline instead of using calendar.

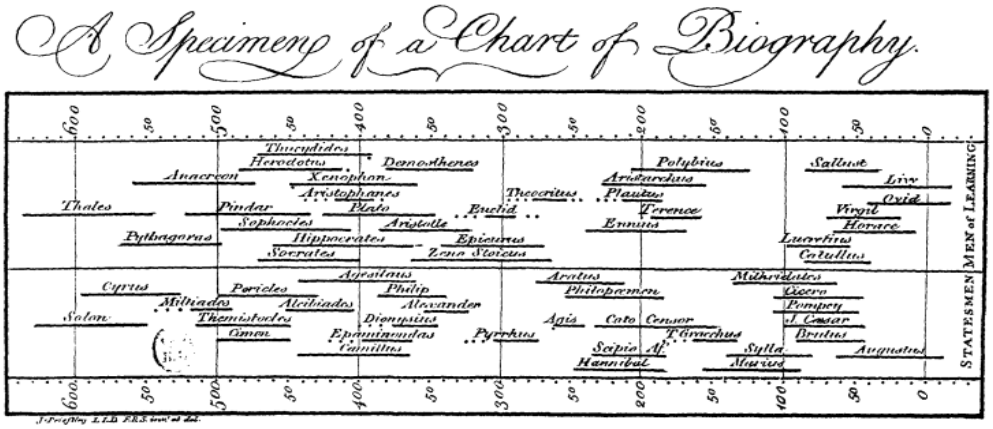


Figure 5.1 William Playfair chart: Life spans of 59 famous people. (Reproduced from William Playfair (p 37) by Spence & Wainer, 2005).

Basically, the most common feature of individual subjective time is an arrow when past time is recalled in our memory, the future lies before us, the past lies behind us, and we stand at now (Mitchell, 2004)(see figure 5.2). The conception of time as linear structure in autobiographical memory was hostile in psychology but in physicists take time to be linear (Campbell, 1997).

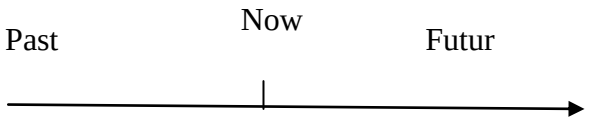


Figure 5.2 Representation of the passage of time

In a fundamental way, representation of time reflects time itself. Therefore, timelines can be formalized in a variety of ways including lines, horizontal lines, vertical lines, spiral and lines that move back and forth or up and down. Some basic features can be included within a timeline's interface; it can allow the user to scroll the timeline horizontally to see a different time. As it obviously can be seen in some representation, the majority of timelines are horizontal and run from left to right along the line. Additional timelines are vertical timelines which can run from bottom to top or from top to bottom. In fact, people visualize the time not only how they see it, but how they experience it (Mitchell, 2006).

Timeline representation examples are vertical line, horizontal line, arrows, linear, tree design, spiral, matrix, layers and abstracts. Each of these representations reflects special data; for example, linear can be used to display time and representations which contain many events from the past toward the future and these events need descriptions. A tree design form can be used like diagrams to show multiple paths of time from earlier to later. In addition, time can be represented in a circular design if there is continuity in some events. A spiral form is used most frequently for long periods of time, such as evolution and the most common representation is matrix, used for calendars and timetables. Other forms are layers and storyboards which are used to indicate maps, process, and to represent how things work in time (Mitchell, 2006).

Many years ago, time was represented and displayed in different forms. Time was depicted as a river by Newton (Novikov, 1998) when time flows from the past toward the future and a person passes through events. In fact, the visualization of time as river originated in ancient Egypt (Ast, 2006). Leibnitz (Novikov, 1998) said that "the world is described by a sequence of phenomena following one after the other and that is what people call time an arrow" (p.34). *Koin ga no gotoshi* is

a Japanese proverb which means in English “time flies like an arrow.” Recently, the visual image of time as an arrow has become ubiquitous in literature, philosophy and science. The main point of both representations is that no point returns to beginning point. It is generally understood that time flies from the past to the future and behaviour of objects that change over the time can led to knowledge of the direction of time (Ast, 2006).

Timelines have long been used to represent temporal information in visual form. William Playfair (1759-1824), a Scottish engineer, wrote on politics and economics (Spence, & Wainer, 2005). He was the first to try to represent time on a Cartesian graph. He found the best way to illustrate economic data with line graphs. In addition, the statistical line graph, the bar chart, and pie chart were invented by him and people still use them. Huge volumes of data were hard to understand until Playfair invented useful schemes to visualize large amounts data within a period of time in graphs. In the past, some people have shown important events in their lives by using timelines and others indicate information about events which covered a long period of time such as diseases or wars, for example, the visual history of Napoleon’s Russian Campaign (Timelines and Visual Histories, 2009)(see Figure 5.3 below)

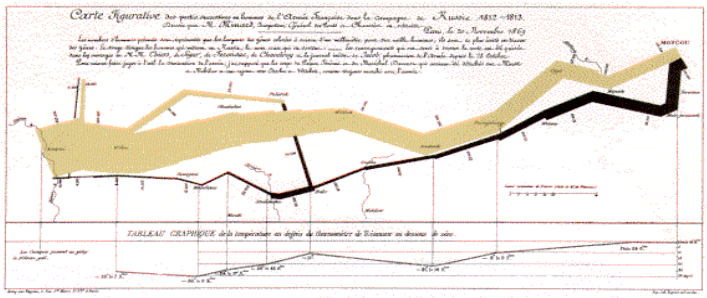


Figure 5.3 Minard's map showing Napoleon's invasion of Russia (Source: Tufte, 2002)

In Figure 5.4, data were depicted in an ideal way and many consider Minard's original the best statistical graphic ever drawn (Tufte, 2000) because there were six variables on it: location (x&y), time, the size of Napoleon’s army, temperature and direction. Some people visualized the time as a horizontal line running from the left to the right.

Bederson (2003), has developed a number of interactive timelines. One of these is a large table that enables users to see overview through using combination of zoomable features. Users also can easily navigate the calendar structure. This calendar has been designed to handle a large amount of data in a small display area by using the idea of fisheye views. Figure 5.4 illustrates the approach of FishCal (Spence et al., 2003).

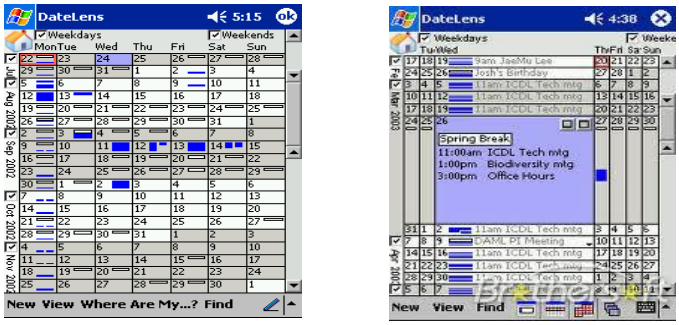


Figure 5.4 Two views of the FishCal calendar. Reprinted from *DateLens: A Fisheye Calendar Interface for PDAs* (p 3) by Spence. Copyright 2003 by Benjamin B. Bederson, Aaron Clamage. Reprinted with permission.

Alonso, Gertz, Baeza-Yates (2007) identified three categories of temporal information to express the time and represent it on a timeline: explicit temporal expression; implicit temporal expression and relative time information.

- Explicit temporal expression can be easily identified and mapped straight to a timeline (e.g. September 2003).
- Implicit temporal expression depends on the underlying time ontology. When there is imprecise information about time such as names for events or holidays, we already knew when it going to be and map it on the timeline (e.g. Labour Day 2008 will be September 1, 2008).
- Relative time information temporal expressions can be represented in a timeline with references to other explicit or implicit temporal information. For example, next week expression or last Friday can be used if a reference for these expressions such as today's date is known.

5.3.1. **Summary**

In the previous section, shapes of various time visualisations in previous work were reviewed. The requirements A and B will be applied to them in next stage to see which time representation shape can be used to display the personal timeframe

with our requirements. In a previous work, different means of displaying time evaluated, an extended discussion can be found in Alahmari (2010).

5.4. Comparison

This section will describe each time representation form with its applications in terms of data and time display. Table 5-2 shows selected different time visualization shapes from the previous study with comparison to overall requirements in Section 5.2. Finally, the outcomes of comparison with time displaying shape that meet our requirements are summarised.

5.4.1. **Calendar**

The calendar is typically used for timetables and people can personalize their time on it. Also, the user can navigate the calendar to see past experiences one year ago. In addition, landmarks, either personal or public, can be added to it. But this form cannot be used to represent location. Nevertheless, the calendar has limitations in personalizing past events to be used as memory cues to retrieve information for more than one year. For example, the calendar does not show how many years ago for past experiences.

5.4.2. **Circular design**

A circular design is always used to show continuity like an analogue clock. Personalizing events on this form is sometimes difficult and that is because there is no room to fit in a lot of personal activities. Location could not be supported in this shape. Distance of the time period is limited in this form and the user is able to see only the past 12 hours. But rather than using hours, months or year can be used to display past periods in a circular form.

5.4.3. **Tree display**

Tree display is commonly used to describe the evolution and structure of generations to display multiple routes as from before to after. Events can be personalized in this shape with distance of the events. This shape does not fulfil the location requirement.

5.4.4. **Spirals**

The spiral is often used for an extended period as geological time. It can be personalized by adding a few individual events and also allow the user to view the length of time. Spiral shapes do not comply with location. This form fulfils the temporal landmark needs with some limitations in presenting these events.

5.4.5. **Linear representation**

Linear representation is best suited for representing linear (uni-orientation) time, and for representations that include many events that involve description. It allows the user to see and add events along the timeline starting from left to right. For example, people use timeline to indicate past information and experiences that covered a long period of time such as diseases or wars.

5.4.6. **Layers**

Layers are typically seen in charts, map and processes. Layer representations comply with location and time period distance and there are a few limitations to viewing personalization and landmarks.

Table 5-2 Comparing requirements A+B to previous work

types of time visualizations	**G1**	**G2**	**G3**	**G4**
Matrix and calendar design	-	×	√	√
Circular design “analogue clock”	√	×	-	√
Tree design	√	×	√	-
Spiral design	√	-	√	-
Linear representation	√	√	√	√
Layers design	-	√	√	-

Notes: (√) supports requirement :(×) does not support: (-) limitations.

5.5. Summary

Four requirements of personal time search were identified (see section 5.2). A comparison was made between different kinds of time representations and our requirements. It was found that, the majority of these visualization forms support personalizing time whereas, except linear representation and layer design, they did not fulfil the location requirement; Table 5.2 shows all the time representation forms mentioned which comply with distance of time with some limitations in supporting temporal landmarks.

Overall, spiral design, layers, and linear representation are the time shape displays that meet the majority of requirements.

In next Chapter, designs will be proposed according to our findings in previous studies and will then discuss personal time features with displaying personal time forms.

Chapter 6

6. Proposed design

Based on implications and results from the user study and previous work discussed in the previous three chapters, a design of personal time features is suggested based using the psychology perspective in augmented memory, a user study to explore the use of time and on recommendations of using time to augment an autobiographical memory system.

6.1. Design Focus

The objective of this design, as outlined in Section 1.5, is to extend the conceptual model of the Digital Parrot system to support personal semantic timeframes and find appropriate techniques and subjective phrases of time and timeframes to be used for searching in an augmented memory system. After the phrases and techniques have been identified, the system requirements are made in Section 5.2 to conduct the next step which is the prototype design of the personal time and timeframes for the Digital Parrot.

6.2. Design sketches

This section presents the ideas for using personal time and timeframes in an augmented memory system by showing some drawings and applying the results of personal time features on them. Firstly, personal time features will be presented by different visualizations. Then an illustration of using the improved personal timeline during retrieving experiences will be discussed.

6.2.1. **Personal time features**

Three types of time visualisations that almost fit with personal time features will be analysed. According to comparison results in Section 5.4, the three types to test personal time features on them are line form, circular form, spiral form.

Based on the findings in Section 3.5 and the general requirements in Section 5.2, the personal time features that can be displayed on timeline and used to search in

autobiographical memory are personalisation, period of time, age, personal temporal landmarks, and image.

Personalisation: This allows the user to search by using personal phrases and giving personal clues to find information. One option is to use a "personal timespans" feature. A list of timespans with a short summary describing each event or keyword can be used for searching in an augmented memory. Examples are "studying" and "UK business trip". Personal timespans such as "during the time in NZ" may help users to remember important events that occurred during that period. As result of the user study (see Section 3.4.4), educational experiences were common timeframes amongst users to remember past time and that because the majority of people in the study are still studying and under 29 years old. Grounded on this result of using educational experiences as timeframes, timeframes in this system should be personal education levels.

Age: This allows the user to use his or her age to find memories and view history. One option is to use "user's age" feature. The system allows the user to insert his date of birth and the system automatically recognises user's age in the timeline by giving a small message to inform him/her with their ages. Using the age of people was a common way in our study of exploring the use of time (see section 3.4. 3). Consequently, an age feature should be provided automatically with each year or provide the user with individual timeline that shows his or her age at the time of the event.

Period of time: This allows the user to search by how long ago the event occurred, for example three years ago. It can be implemented by providing the user with current time. The user can use optional search to retrieve past experiences by using a period of time. Examples of period of time option search are "3-5 years ago" 6-9 years ago" these examples can be added to the design as a checkbox. The distance of time from any event being helpful to enable the user to locate memories was result of our study (see Section 3.4.5). Age of any events gives a clue to the user to remember what happened during this period of time.

Personal temporal landmark: This allows the user to add his or her own landmarks to be used later as references to locate memories in the timeline. The system should enable users to tag either personal or public landmarks to his

experience at the time of saving those experiences. In the user study, (see Section 3.4.6) using a personal temporal landmark is a useful feature to easily remember events and locate events temporally. To search for past time experiences, the system will provide a list of landmarks that can give hints to retrieve wanted information. The design needs to be provided with a calendar that includes public landmarks to be used as memory cues while remembering. Different options can be used in the design. The first one is a calendar, with different colours or with different representations, which visualises individual personal time and landmarks. The user sometimes has no chance to recall events with an exact date, so the calendar can help by indicating public temporal landmarks on the calendar with different colours. The user is able to choose more than one year from the past. In addition, the calendar can be annotated with personal phrases. In the second option, landmarks can be shown in a timeline as a messages box with brief descriptions when user selects the required year. In addition, world news can be used as supportive keys on the timeline to assist user to remember events that are related to these news items or which happened before or after the memory needed.

Image: This would allow the user to add and view images of his experiences on the timeline to be used as memory cues. In psychology, photos are considered as the stimuli most often used to remember past events (see Section 2.1). One way to implement an image feature is that the timeline can be annotated with pictures for each event and displayed back to the user when he clicks on any year.

6.2.1.1 Personalising time features in line form

The system can allow users to annotate a timeline to view a list of dates along with personal events or a short summary describing each event or keywords to be remembered later or to be used for search in an augmented memory.

These timelines either vertical or horizontal, show personal timespans, such as “during the time in NZ”, to help users to remember important events that occurred during that period. Figure 6.1 illustrates personalizing events on horizontal timeline.

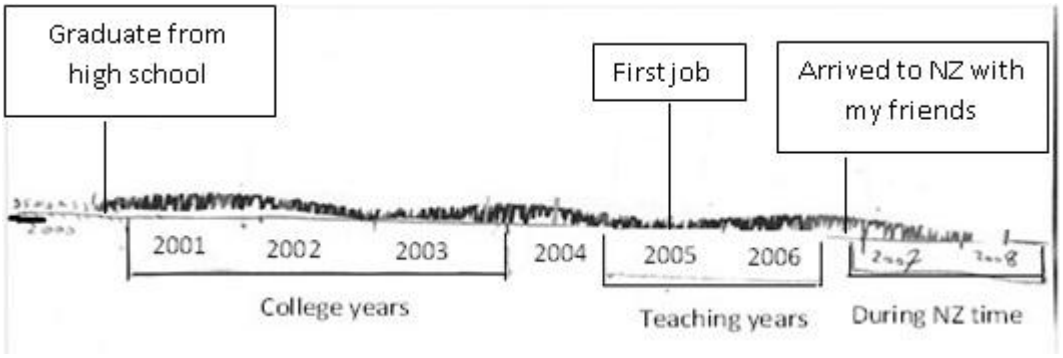


Figure 6.1 Horizontal timeline with personal timespans

Results of the study showed that educational experiences were common timeframes amongst users to remember past time, probably because majority of people in our study still studying and less than 29 years old.

> **Timespans feature:** The system will automatically add these on the timeline as frames as shown on Figure 6.1. The timespans will be indicated as blocks to allow user to see the beginning and ending for each timespan on the line (Figure 6.2). Different techniques can be used to represent personal timeframes and add different layers in the timeline. The user can switch between different layers that have different personal timeframes. For example, the user can switch between two timelines, one for a personal educational timeframe and another for personal timeline with a business timeframe (Figure 6.3).

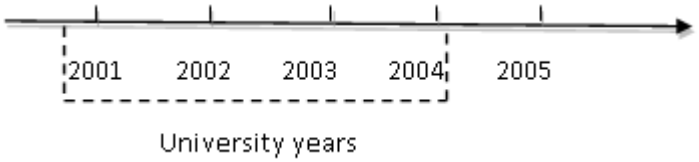


Figure 6.2 Representing timespans with an educational timeframe

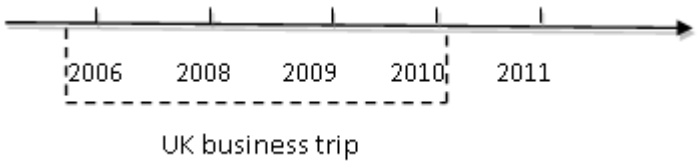


Figure 6.3 Representing timespans with a business timeframe

It is possible to take advantage of the Facebook vertical timeline and use people's photos, videos and other items as cues along the line from top to bottom of the screen. Also, the user is able to add any information and photos, and events along with his personal timeline.

- **Age features:** user's age will be given in the timeline as phases. This can be added as a keyword above each year. Figure 6.4 shows the age on the timeline.

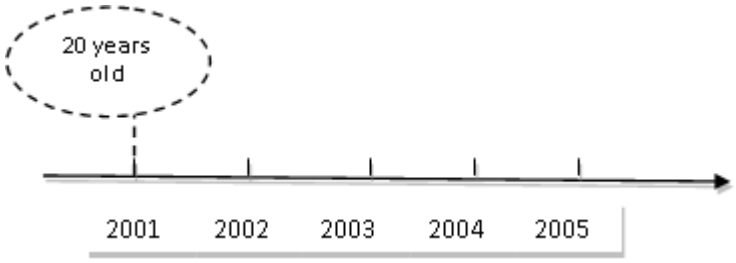


Figure 6.4 timeline with age features

Another option is that the user can click on any year on the timeline and then a box message appears to give him details about his age.

- **Personal temporal landmark feature**: The line form can hold numerous events. Personal landmarks on timelines can be added as memory cues. Figure 6.5 shows the temporal landmarks that can be used to search for information. To get rid of overlapping between age features and landmark features, a landmark feature will be displayed underneath the timeline in each year. The user can see some pictures attached to his personal landmarks through the passage of time.

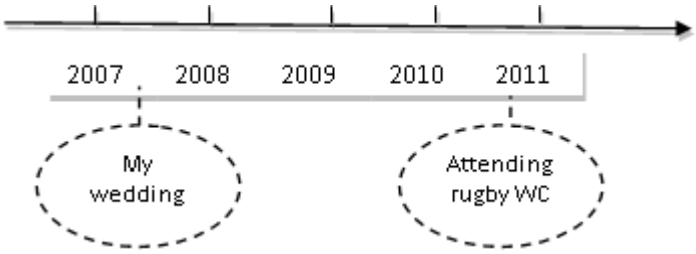


Figure 6.5 Timeline with landmarks

- **Period of time feature**: A period of time can be specified when the user narrows his search in the line by scrolling the sliders. The user can choose events or present time as reference to calculate past years. For example, a user chooses graduation as the experience that he still remembers near event wanted and then move another arrow to past period of time to search for event wanted. All events that happened between selected events will be displayed to the users as blocks to indicate the number of events within the timeframe. Figure 6.6 illustrates the idea.

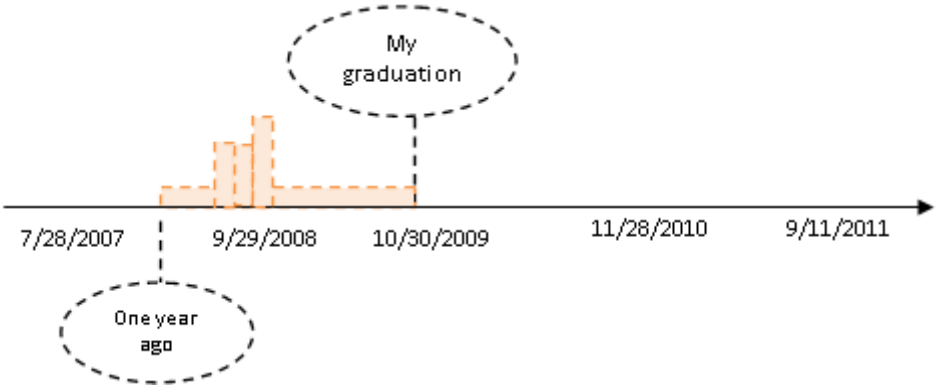


Figure 6.6 Memories as chart lines

- **Image feature:** An image is one of the best cues to remember past experiences. This feature can be added on the timeline by allowing the user to tag pictures to his or her events. When users search for information or an event, they can see some indications that there are pictures associated with events and the user can click on the event which is on the timeline to view the picture.

6.2.1.2 Personal time in circular design

In a previous study (Alahmari, 2010), it was found that most people prefer to see time in a simple design and in that experiment it was proven that the most common design to visualize the time is the face of analogue clock. Consequently, to show personal time, the face of an analogue clock can be used to illustrate personal time features because people are familiar with it in normal life. When user wants to look up a past experience, he can use an analogue interface to move between past years in his search. The features will be listed next to circular visualisation and the feature which can help to retrieve information can be selected (see Figure 6.7).

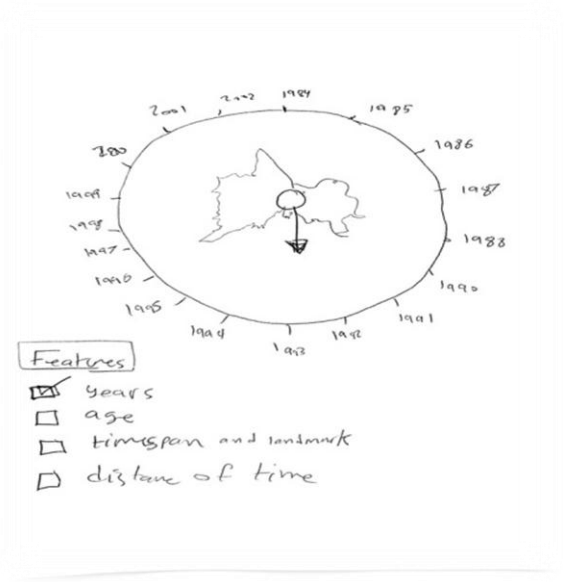


Figure 6.7 Personal time search: main view in circular design

- **Timespans feature**: Inside the circle there will be kinds of visualizations to indicate the timeframe for each event in each year. For example, the user can click on timeframes features and the design automatically changes to provide personal timeframes in each year. Figure 6.8 shows a timeframe representation.

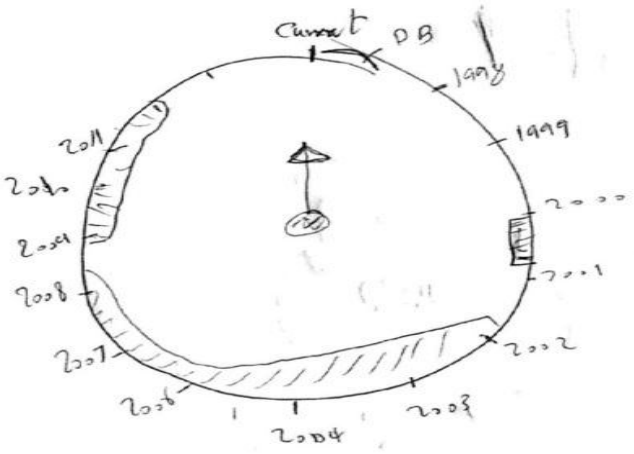


Figure 6.8 Personal timeframe in circular design

- **Age features:** In the user study, people tended to use their ages to remember past time. In this situation, the system allows the user to specify his search by switching the view to use an analogue interface that indicates the user's date of birth and current time as a circular design. When the user selects age feature, the circular visualisation will be organized

automatically according to user age (see Figure 6.9). There will be fixable clock hand to enable the user to choose the age that includes some memories that user wants.

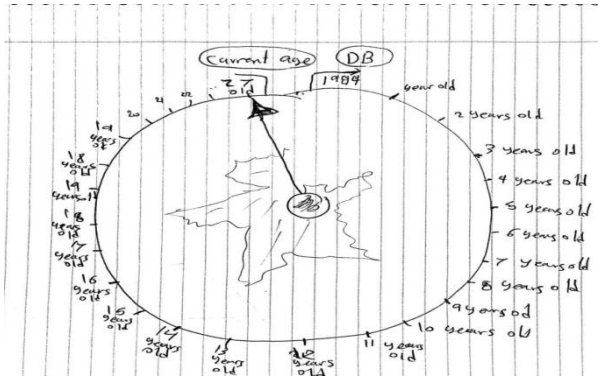


Figure 6.9 Analogue clock face to illustrate representation of memories by using age to find information.

- **Period of time feature**: In the user study, people used the phrase ago with period of time when they wanted to recall past memories. Visualisation can be used to illustrate a past period and give suggestions to the user. The same idea of age search, but in different way, will be used to facilitate locating past memories via the passage of time. A circular form will be used to indicate the years according to user timespans and birth date. Day and exact time were omitted in this design because human memory sometimes cannot remember time periods more than three years previously unless there is a cue (Elsweiler, 2007). When a user wants to retrieve an experience that took 13 years ago, he can move the two arrows to past 13 years by present time. Different colours can be used to indicate different events inside the circular visualizations. Figure 6.10 illustrates this idea.

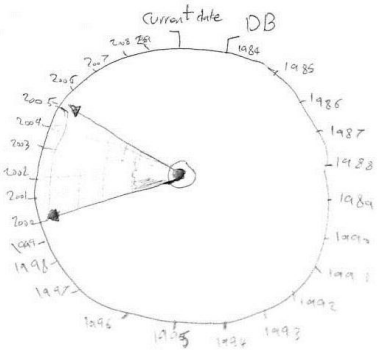


Figure 6.10 Analogue clock face to illustrate representation of memories by using time period to find information

There will be two arrows inside the analogue face. The first arrow allows the user to indicate the beginning of time duration. The second arrow allows the user to locate the end of the time period to view the events during this period.

- **Personal temporal landmarks feature:** As shown in Figure 6.11, some personal landmarks are added to time shape as important events through the user's life. These personal temporal landmarks can be displayed when the user clicks one specific year.
- **Image feature:** In this form, a picture can be added as a cue above each event to allow the user to choose the event by looking at the picture. Figure 6.11 shows the idea of using temporal landmarks feature and using image features.

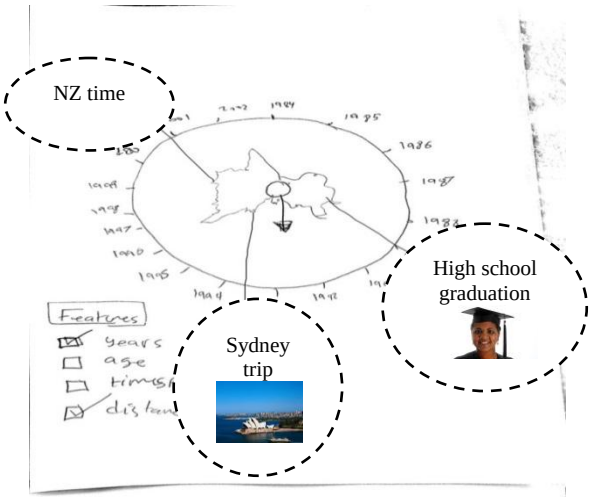


Figure 6.11 Time representation with landmarks

6.2.1.3 Personal time features in spiral design

As discussed in Section 5.4.4, the spiral design can be extended to accommodate much information moving outwards from the centre. So the user can utilise this form to add annotations or pictures on spiral visualisation from birth until the present.

- **Timespans feature**: A personal timeframe can be presented in this form by highlighting blocks through personal timespans. For example, a personal timeframe can be presented in spiral form with different colures to indicate memories as shown in Figure 6.12.

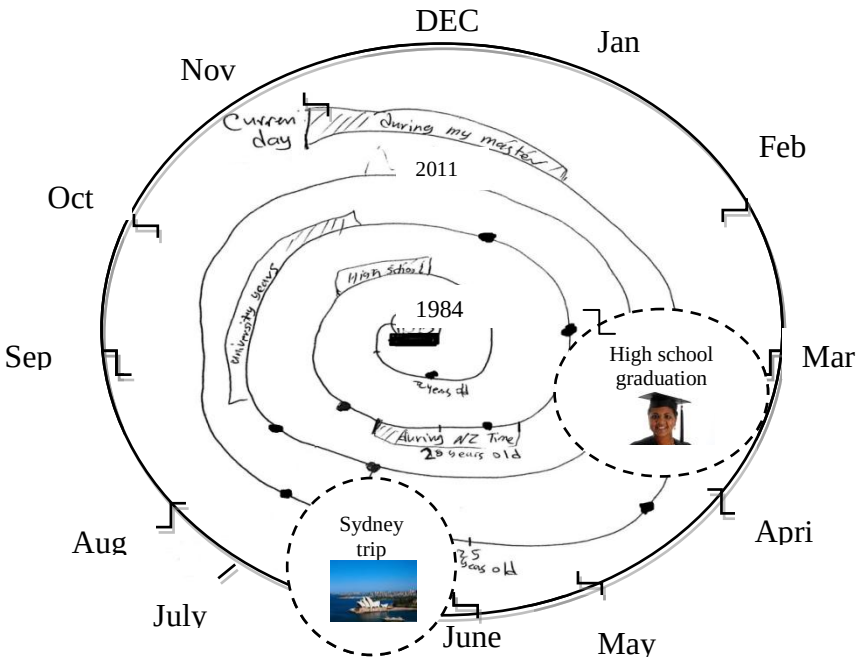


Figure 6.12 Spiral form with personal time representation

- **Period of time feature**: In this form of time representation, a period of time can be easily represented. Months of the years will be above the circle and the spiral line represents the passage of time with years. Also, the shape can give the user a chance to see events that occurred in one month in different years.
- **Age features**: The user's date of birth will be presented as the beginning of the spiral shape so users are able to use this feature as a clue to locate events. For example, as it can be seen in Figure 6.12, the age of the user will be presented inside the spiral for each year and under the same month of user's birth, so the user can see his/ her birthday each year by presenting any indication to that day.
- **Personal temporal landmark feature**: The user can add keywords or personal temporal landmarks as it shown in Figure 6.12. The small black dots mean some events or temporal landmarks that the user can click on to see the events or some pictures.
- **Image feature**: The same idea can be used in a circular design. The user is able to tag any picture on the design and it can be shown as small dots

with different colours to indicate that the event includes a picture and the user can click on the dots to maximize the event to see the pictures and event details.

6.3. Localisation

Map navigator is already included in the Digital Parrot system. The location feature was used in the Digital Parrot to filter items by the location of the represented experience (see Figure 6.13). Also, to help user to remember, experiences can be found by using location. In this system user can ask for an information item with geospatial data to be shown on the map. We can improve this idea in our suggestion design to make it more personal and use personal time to be shown in the map.

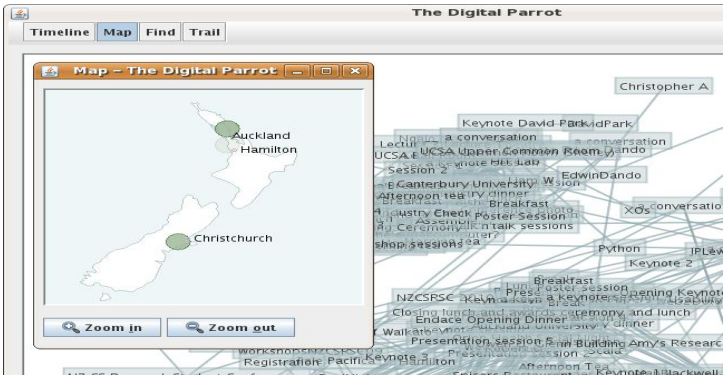


Figure 6.13 Map navigator. Reprinted from *Augmenting autobiographical Memory: An Approach Based on Cognitive Psychology*(p.183), by Schweer, A. Copyright 2010 by Andrea Schweer. Reprinted with permission

6.4. Prototypes design

This chapter gives details of making prototypes of personal time search techniques that focus on the retrieval phases in the Digital Parrot system. These prototypes were designed to illustrate the ideas that arose out of the study.

After the suggestions and sketches, a design could be suggested that is focused on applying personal time features in the Digital Parrot timeline. Due to time constraints, it was not possible to implement the design formally, instead prototypes were created. These prototypes were designed to illustrate the idea of using personal time features and help to evaluate the usefulness of personalising the timeline in remembering past experiences.

6.4.1. **Description**

The main view is quite similar to Digital Parrot interface with some additional in search technique controls. Figure 6.15 shows the interface design sketches for personal time features. A personal semantic time interface will be added to the Digital Parrot interface as a sub-interface after the user has clicked on the personal time search button. Above the main timeline visualisation view, there are five radio buttons for personal time features: temporal land marks, personal age, personal time period search, and a personal timeline with annotations and images. There will also be a text box to search by typing personal queries. The locations of these features and visualisations in the interface can be rearranged later.

To begin with, the main screen shows all user current information and current time. The user then can determine which personal timeline feature can help him to recall past experiences by clicking on a corresponding radio button in personal time search interface.

After the user has clicked on the educational feature radio button, the timeline view will be changed to give educational levels on the timeline according to the first educational information that the user provided at the beginning of using the system.

In the age search situation, instead of an absolute date on the timeline, the user's age will be displayed along the timeline since the user's birthday until the present, with some interties in each age if there are events. In the period of time button, the timeline's first interface will be replaced with another one to allow the user to narrow down his search by specifying the range of the period of past time, such as searching for an event that took place three years ago or by searching for events between 2001 and 2003, for example.

In the temporal landmarks and images features, when the user clicks on these features the timeline will be annotated with all user landmarks either public or personal with a small description for each event. In image radio buttons, instead of a description above each event there will be an image related to each event to help user to remember better.

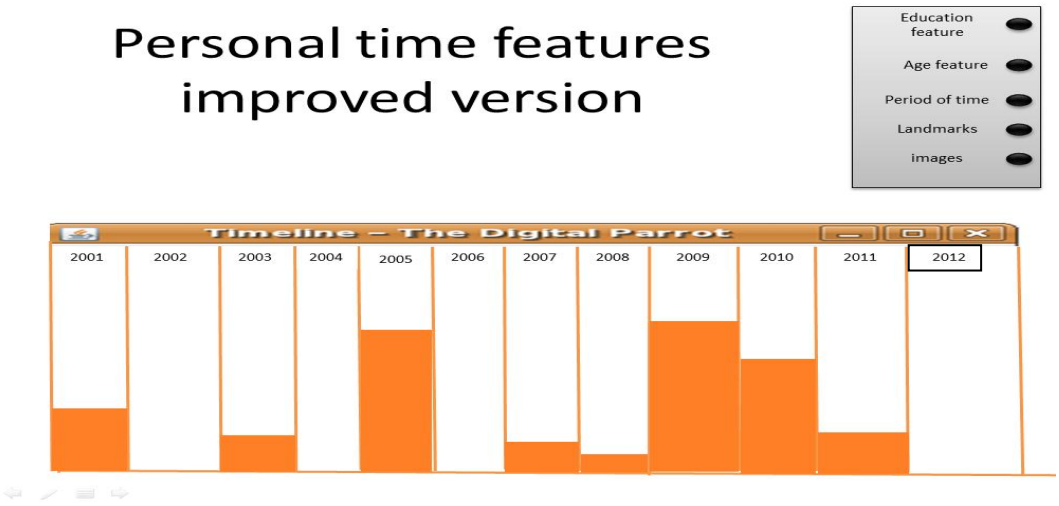


Figure 6.14 Design sketch: Main view and controls.

6.4.2. **Scenario**

Bill is a master's degree student. He is using Digital Parrot to store his memories and his past experiences. The system allows him to add all his past events and experiences since his birthday. He has five features to locate his past memories through timeline. The first one is, he wants to find some information that he still remembers when he was at university but he does not know where is, so he just clicks on the educational feature search to see all events that happened while he was studying at university.

Secondly, Bill cannot remember information that has taken place a long time ago but he still remembers that the experience happened when he was 22 years old. The system allows him to search by his age by clicking on the age search feature and then the Digital Parrot timeline interface will be replaced with his age on the timeline with some entries. The third option is, he was looking up information that happened nine years ago so he can click on period of time features and locate his information in another interface. The fourth option is, he is still remembering temporal landmarks that occurred near to the information that he was looking for: landmark feature helps him by showing all his temporal landmarks and news on the timeline. Finally, the system allows him to recognize events by using images on the timeline. Simply, the improved Digital Parrot timeline provides him with different features that can help him to use his personal time and timeframes to locate events and information temporally

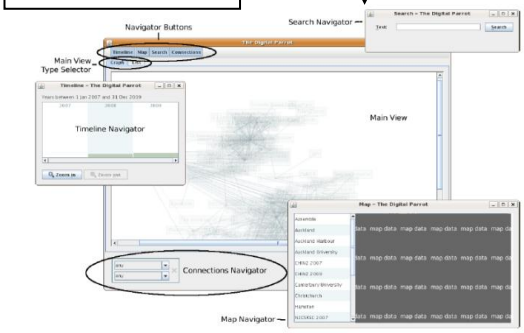
6.4.3. **Visuals**

Original timeline navigator

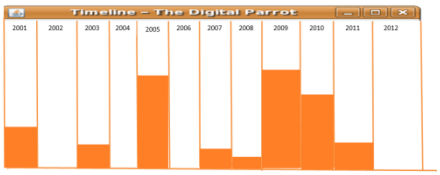
Digital Parrot interface

Modified timeline navigator

Personal timeline features

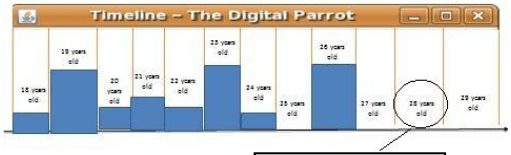


Personal time features improved version

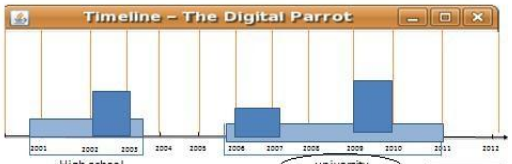


Age feature

Educational timespans



Users Age



User Educational level

Period of time

User past time period

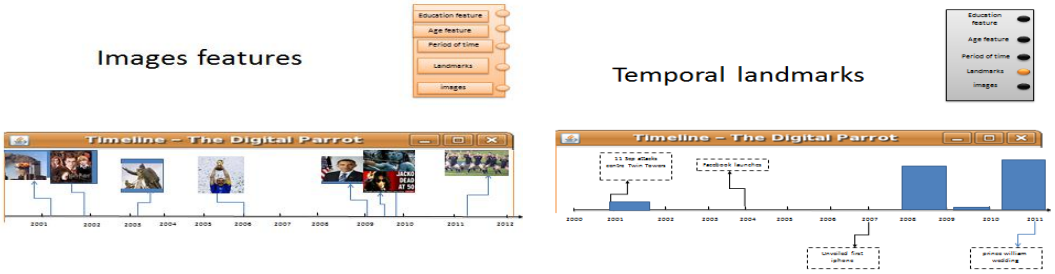


Figure 6.15 Digital Parrot Main view and Visual images for using personal time features to search on the digital parrot system. Reprinted from *Augmenting autobiographical Memory: An Approach Based on Cognitive Psychology*(p.105), by Schweer, A. Copyright 2011 by Andrea Schweer. Reprinted with permission

6.5. Summary

This chapter has helped to answer another research issue identified in Section 2.4, how to encode the fuzziness of subjective time and places and display them back to the users, by suggesting the conceptual visualizations and design of such a system. The design suggestions are grounded in findings from a psychology perspective, a user study, and a previous study visualizing time. The sketches and prototypes were made to convey the ideas of using personal time expression and personal search to evoke memories. Different forms of time representation have been selected to perform personal time on them. The timeline was personalized with people's educational levels to promote remembering past time. To help locate past experiences in autobiographical memory temporally, the educational timespan, age, past period, personal landmarks, and images were added to the timeline.

Chapter 7

7. Evaluating the effectiveness of personal time features

The previous two chapters described the personal semantic time requirements and described the proposal design for retrieving past experiences from autobiographical memory by using personal time features. The aim of this study, following the thesis objective, is to help users in remembering past experiences and information by using personal time and personal expression and comparing it with the original Digital Parrot timeline. To determine whether the personal time features achieve this goal, the features need to be evaluated.

7.1. Approach

The first step of this study was capturing some world events and news that people are familiar with but may not be sure about their dates. Ethical approval was required before doing this study. Ethical approval was given by Human Research Ethics Committee at Department of Computer Science at University of Waikato (see Appendix C). In this study, there were two phases. In the first phase, the participants were asked do tasks on the Digital Parrot timeline. In the second phase, participants were also asked to do other tasks on our proposed design by using personal time features. Finally, the participants were given a questionnaire to evaluate both designs. We need to gain data of how effective using personal time features is in recalling memories by comparing two timelines of Digital Parrot timeline with personal time features and then evaluating the usefulness of using personal time features.

7.1.1. **Method**

This part contained a guided open-user study and doing tasks with individual participants. No time constraints were placed on the study. The potential benefit from this study is focusing on participants' perception of what kind of personal time features can help them in evoking memories rather than on an efficiency analysis.

7.1.2. **Purpose**

This research proposes an improved design to support the Digital Parrot search in an augmented memory system by using personal time and requires some evaluation of its usefulness. The purpose of this study is to gain user feedback on our proposed personal timeline features and their usefulness to the user in remembering past experiences.

7.1.3. **Procedure**

In total up to 10 participants were involved. The participants were from different cultures to get different ideas. Age was not considered in this study, but it is most likely that participant's age would only range from about 18 to 40. There was no necessity for the participant to be a student in Computer Science department. The participants were from campus grounds. Participants were invited by word of mouth (talking to them) on campus and they were given general information about the study beforehand. Each user was invited to the reception area of the usability lab to conduct an individual study on different days. The questions to the participants were about past events that the user might, or might not, still remember. The participant was given a brief introduction to the goals and strategy of the study. We used two phases in this study, in first one participant were asked about some questions if they can answer them or not. In second phase participants were asked to do tasks by using Digital Parrot timeline and personal features timeline to evaluate both of them.

Phase 1

Participants were provided with a list of questions about the Rugby World Cup 2011, top 10 news stories, big movie, releases, events around 11/09 (see Appendix D). Participants were asked first if these questions are known then known questions were used as tasks in comparing Digital Parrot timeline and improved version of timeline with features. The events that we are asking questions about are displayed in Table 7-1.

Table 7-1 Questions used to test the design

Event	Questions
Rugby World Cup 2011	When and where did New Zealand play against Argentina?
	When and where were the semi-finals of Rugby World Cup 2011?
	When and where was the bronze final?
	When and where was the final?
	When did Ireland play their last game in the World Cup?
Top 10 news in different years	When did Barack Obama become United States president?
	When did Chilean Miners trap themselves in a collapsed shaft 2,300 ft. (700 m) under the earth?
	When was the death of Michael Jackson?
	When did New Zealand container ship Rena accident in Tauranga happen?
	When and where did the latest earthquake hit New Zealand?
Big movie releases	When was *Avatar* movie released?
	When was the movie of *Harry Potter and the Philosopher's Stone* released?
Events around 11/09	When was the war in Iraq?
	When was the war in Afghanistan?

The reason behind selecting these questions was that we hoped that a majority of people still remember these events.

For each question, participants were first asked whether they thought they could answer it immediately. If not, then this question was ignored. Once this had been completed for all questions, we asked participants to return to those questions that had been ignored in the first phase.

For each of these questions that could not be answered in Phase 1, participants were asked again if they knew the answer already (because participants could get some idea of the response from other questions/answers in the meantime).

Phase 2

We then asked them to use the Digital Parrot to attempt to answer the question that had been ignored in the first phase. Once the list of questions had been

worked through using the Digital Parrot, we then asked participants to use timelines with personal features to perform the different tasks to see how useful it is using these features.

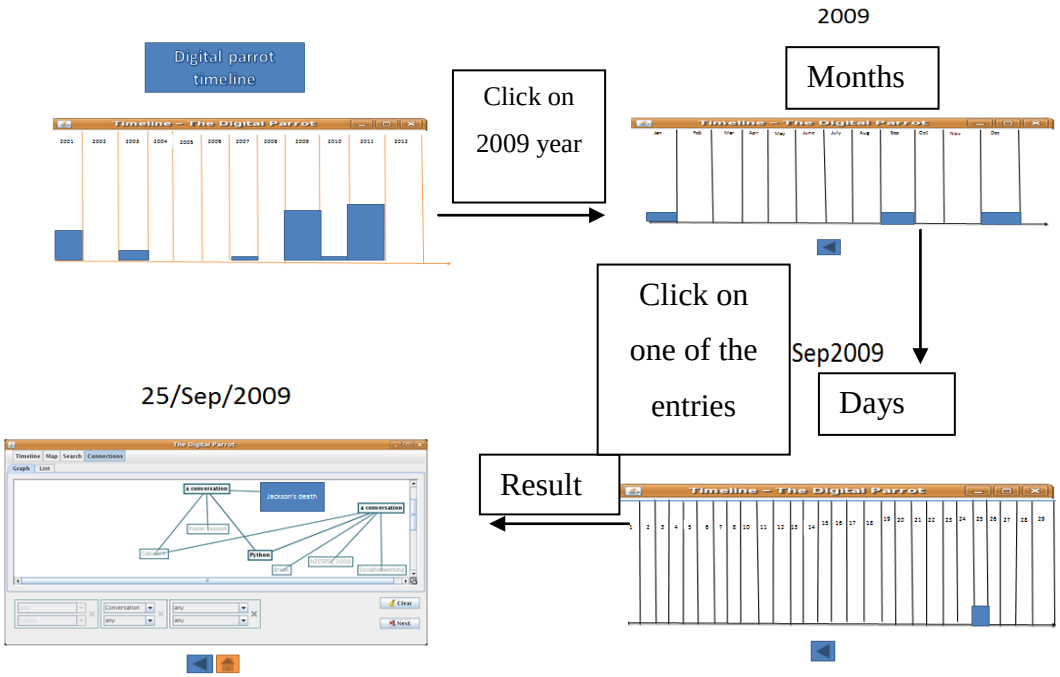
Finally, we used post-questionnaires (see Appendix E) to ask participants to reflect on their experiences when using the Digital Parrot timeline navigator with the focus on participants' opinion on the usefulness of using personal time features that we provided to the participants as prototypes after using the Digital Parrot timeline navigator. The following is an illustration of paper prototypes that we used during our user study.

Digital Parrot timeline

Participants were asked to preformed tasks on Digital Parrot timeline, they found some entries and they clicked on 2009 then the timeline changed to display the months of selected year with other entries. Then the days will be shown on the timeline and participants click on of the entries to see the result.

Task

1. When did Barack Obama become Unite States president?



Personal timeline with features

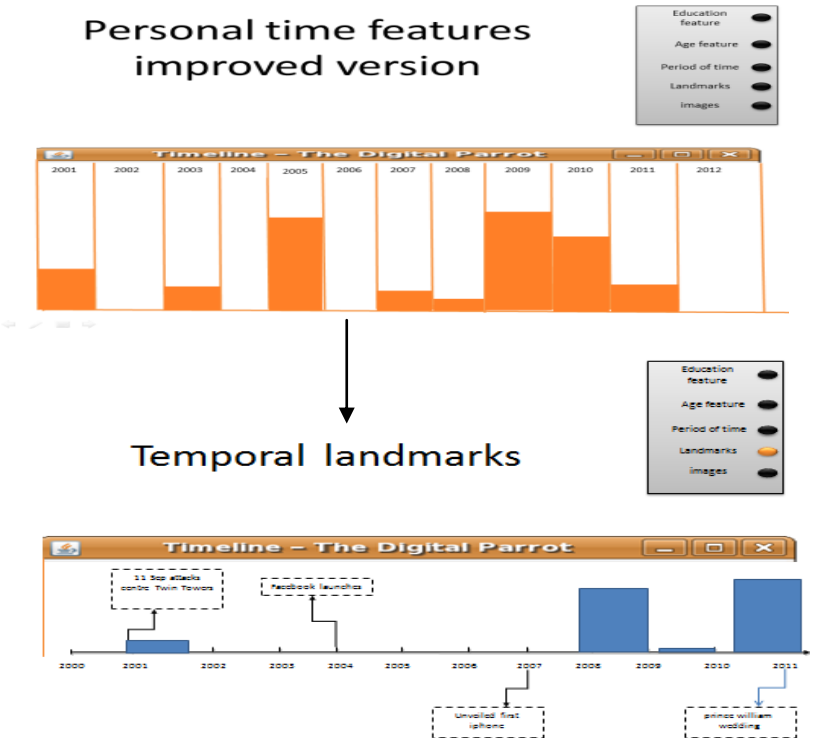
We used Microsoft PowerPoint2010 to design paper prototypes of personal time features. Participants were able to use the slides with clickable buttons to answer our tasks.

Following is illustration of one task that participants were performed during our study.

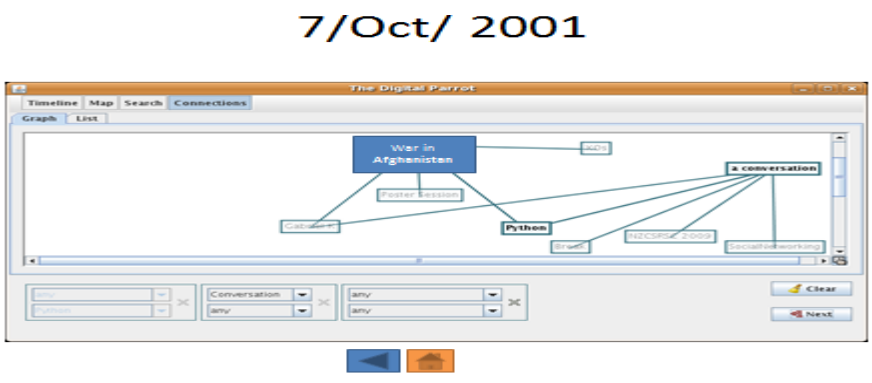
Task

Use temporal landmark feature:

When was the war in Afghanistan?



User found landmarks on the timeline and then decided which entries he should click on after or before the landmarks



7.1.4. Challenges

It was a big challenge to find events that a majority of people is familiar with. People have individual personal information and there was difficulty in testing the effectiveness of personal time features with general information.

The second challenge was that the system used in this study was not fully functional and prototypes were used instead to convey the idea of using personal time features. Participants liked the idea of the age feature but because of using prototypes there was difficulty to indicate each user's real age in the timeline but this did not mean they did not evaluate this feature.

7.1.5. Pilot study

To assessing the feasibility of the study, a pilot study with a single participant was carried out prior to the main study. The pilot study led to the improvements in proposed functionality and the participant offered some ideas. Based on the pilot study, some questions have been changed.

7.1.5.1 Results

The participants were interviewed and asked about international events that they had heard about. The slides that we have showed participants needed to be organized and there were some errors when participants searched for events on the timeline.

7.2. Participants

Up to 10 people participated in this study. Six graduate and master students from the Computer Science department at the University of Waikato were invited to participate. Some of the participants were selected from university campus. Two Master students from Management Department were selected to participate and two other participants were from outside of the university.

Participants were chosen from different departments and from different cultures to get a variety of participant backgrounds: two females (M age=35) and 8 males (M age=25). Figure 7.1 shows the range of participant ages.

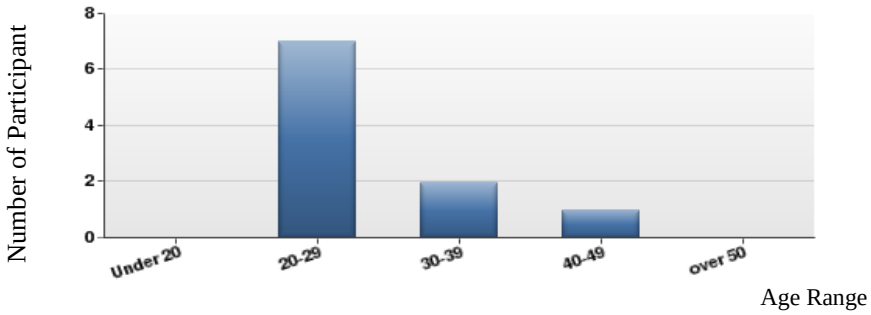


Figure 7.1 Age distribution of the participants

7.3. Findings

The previous sections discussed the approach and the method that was used to collect the data participants' responses and thoughts about using the Digital Parrot timeline and personal timeline features. In this section, the findings from the study are illustrated. The next section will discuss these findings.

In the beginning of each interview, all the participants were asked to complete an initial questionnaire about their background. Participants were asked to do tasks that related to events, and world news in the both designs of the Digital Parrot timeline and the developed timeline. Before representing the results of this study, the analysis survey of this study will presented.

7.3.1. Digital Parrot timeline

In the first phase, the participants were asked to do some tasks by using the Digital Parrot timeline design. Then, they were asked if the design using the Digital Parrot timeline helped to find the answers for the questions. Three participants strongly disagreed to use this design because they encountered many entries in the timeline without any information to help them to decide which entry they should click on.

The disagree response to using the Digital Parrot timeline become the first place, four participants disagreed to use this design and one of them said it could be used to display the number of events in each year but it did not help to remember past events' details.

The rest of the participants acknowledged that it is helpful to see the timeline with some entries because it gives some clues that let them know there are some

events, although, they are still unsure what is inside entry box before clicking on it. The different responses to using the Digital Parrot timeline design are shown in Table 7-2.

Table 7-2 Participants' responses if using Digital Parrot timeline helps to find the answers for previous questions better than the personal timeline.

#	Answer	Response	%
1	Strongly Disagree	3	30
2	Disagree	4	40
3	Neither Agree nor Disagree	3	30
4	Agree	0	0
5	Strongly Agree	0	0
	Total	10	100

7.3.2. **Personal time features**

The personal semantic timeframe design has been evaluated by using a variety of personal time features resulting from a psychology perspective in augmented memory, a user study to explore the use of time and the recommendations of using time to augment an autobiographical memory system. The personal time features that have been evaluated are educational timeframe, the distance of time, age, temporal landmark, and image.

Educational timeframe feature

In improved design of the personal timeline phase, firstly, the new timeline was introduced to the participants to show them how to use it. Participants were asked to do different tasks by using personal timeline features.

The first task was using the educational timeframe to answer the questions given. When the participants finished answering the questions by using this feature, they were asked if personalizing the timeline with personal educational experiences helped to locate their answer for the questions.

A strongly agree response ranked the first place by five of the participants responses. Participants said the educational timeframe gave them a clue if they

could not remember in which exact year the event occurred. Three participants were neither agree nor disagree to use this feature.

One participant stated that it definitely helped but they had encountered the same problem as the first time in Digital Parrot when they clicked their high school timeframe they did not know which month and day they should choose. Also, another participant said that it would be more helpful if there were different personal timeframes in addition to an educational timeframe. Participants' responses to how effective the educational timeframe feature are shown in Table 7-3.

Table 7-3 Participants responses of Personalizing timeline with personal educational experiences helps to locate the answer for previous questions better than the simple timeline.

#	Answer	Response	%
1	Strongly Disagree	0	0
2	Disagree	0	0
3	Neither Agree nor Disagree	3	30
4	Agree	2	20
5	Strongly Agree	5	50
	Total	10	100

Distance of time feature

The participants were then asked to do another task by using distance of time feature. The same question was asked, whether displaying or searching for past memories by using this feature (e.g. 3 months ago, 2 years ago, and 5 years ago) helped to find the answer. Five participants strongly agreed that feature helped them to narrow down their searches and bring the memory back, especially when the events had occurred a long time ago.

Only two participants strongly disagree that feature helped them and one of them suggested that this feature is not a good idea to be displayed it on the timeline, it would be useful if user typed this phrase in the search engine and memories of that date displayed (see Table 7-4).

Table 7-4 Participants responses of the period of time in timeline (e.g. 3 month ago, 2 years ago, and 5 years ago) helps to find the answer for pervious questions.

#	Answer	Response	%
1	Strongly Disagree	2	20
2	Disagree	0	0
3	Neither Agree nor Disagree	1	10
4	Agree	2	20
5	Strongly Agree	5	50
	Total	10	100

Age feature

Four participants were not sure if the age would give them clues to answer the questions. They had problems while using this feature on the timeline. One participant said they had to subtract my years to remember their age and this is not an easy way. Another said that she found it a bit hard to guess her exact age to remember when the event happened. She said that it would have been great to have her exact age in the timeline. As previously mentioned, we encountered a challenge to use each individual age in the design instead, we asked participants to imagine their age as 27 years old to do the same tasks with all users.

Table 7-5 shows that the biggest number of the participants, partly agreed to use this feature. Only three participants advocated the use of this feature.

Table 7-5 Participants responses of Providing user's age on the timeline gives a clue to find the answer for previous questions better than the simple timeline

#	Answer	Response	%
1	Strongly Disagree	1	10
2	Disagree	2	20
3	Neither Agree nor Disagree	4	40
4	Agree	2	20
5	Strongly Agree	1	10
	Total	10	100

Temporal landmarks' features

The participants' responses to using personal and public temporal landmarks (e.g. birthdays, wedding, relationships, public vacations, and news) on the timeline were significant (see Table 7-6). All participants agree that the temporal landmarks feature is a helpful feature to recall and locate memories.

A participant said that if there was a big event represented in the timeline they could temporally answer the question of whether it had happened after or before the big event.

Table 7-6 Participants responses to Indicating personal and public temporal landmarks (e.g. birthdays, wedding, relationships, public vacations, and news) on the timeline helps to find the answer for previous questions better than the simple timeline

#	Answer	Response	%
1	Strongly Disagree	0	0
2	Disagree	0	0
3	Neither Agree nor Disagree	0	0
4	Agree	3	30
5	Strongly Agree	7	70
	Total	10	100

Image feature

Different images have been shown on the timeline that are related to the events. Images were added to the timelines to see if they helped participants to find answers for the questions better than the simple timeline. The majority of the participants easily located the answer and like this feature. One participant said that they remembered by using image much more easily and better than texts or writing.

Only one participant partially agreed that feature would help him to locate events temporally. His objection was about the kind if image in the timeline. He said if the images were more personal he could agree to use this feature (see Table 7-7).

Table 7-7 Participants responses to using personal images on the timeline helps to find answer for previous questions better than the simple timeline

#	Answer	Response	%
1	Strongly Disagree	0	0
2	Disagree	0	0
3	Neither Agree nor Disagree	1	10
4	Agree	2	20
5	Strongly Agree	7	70
	Total	10	100

7.4. Discussion

This study aimed to compare two timelines to discover the effectiveness of using personal time features in recall memories. It helped also to evaluate the usefulness of each personal time feature.

In order to improve the Digital Parrot timeline design in future, the timeline needs to be modified to include the most useful features which are personal timespans, personal and public landmarks, and images. The reason is that the results showed that these features are valuable to assist users to retrieve and remember past experiences.

Digital Parrot timeline

The findings reported in Section 7.3.1 illustrate that the Digital Parrot timeline is not an efficient design to help the user to remember and retrieve past experiences. In Schweer's (2010) observation, the timeline was confusing the user in how to interact with the timeline and the main view. Also, the user in that study suggested indicating personal timespans on the time line should help to locate past events.

Timespans feature

In this study, educational timespans was meaningful to the participants. The timespans differs from one to another in terms of events. The differences in timespans can affect the way of remembering. Hasher and Zacks (1979) indicated that every domain has verity of clues and timeframes that are generated during the events and these timeframes will be used to remember other events. Equally, people in this study prefer to use timespans to retrieve information but some

participants mention that educational timespans only are not a good idea for people who are in other domains.

Distance of time and age features

The distance of time feature and age feature were not beneficial for the users while comparing the tasks to other features. The age feature was more complex, despite the majority of the participants having referred to this phrase in exploring the use of time user study (see Section 3.4.5). In the psychological perspective, the distance of time information allows memory to locate events in the timeline. In this study, we found the same results but with different responses by the users. This might refer to a variety of issues such as the difficulty of using real personal information on the timeline and the difficulty of choosing a good way to illustrate these features on the timeline to the users.

Temporal landmarks and image features

The findings reported in Section 7.3.2 show that personal and public temporal landmarks allowed the participants to retrieve information normally from the timeline. The result of this study is similar to Ringel et al. (2003), which indicated that using personal and public landmarks and personal images features has a significant impact on retrieving information and saving time for searching on the timeline. People who participated in this study believe that these features help them to remember and search for events.

Use of images on the timeline appeared in this study to have advantages for users in recalling memories.

As we noticed in our study, adding personal pictures and personal temporal landmarks on the timeline is one of the best keys that help user to remember temporal information.

7.5. Summary

The result from the study shows that the original Digital Parrot timeline did not help participants to remember when some events happened. People usually like to see some entries on the timeline that can help them to identify where the information is. But using timeline without any personal details would not be supportive to remembering and locating other events temporally.

Participants liked to use a personal timespans in the timeline either educational or some other timespans to help them to locate past experiences.

People find it complicated to use the age feature to locate past events. They preferred to use the distance of time feature but they suggested that ago phrase only can be used on a search engine rather than displaying it on the timeline.

People were found it very helpful to use personal temporal landmarks and images on the time line to remember temporal information and retrieve memories.

The timeline was formalised in here as horizontal line to distinguish the past from the future and because users are familiar with it and Majority of timelines are horizontal and run from left to right along the line. Also, this form was used to indicate the direction of our memory and how we remember the past.

Finally, all features that have been identified earlier in this thesis are helpful but the most beneficial features in terms of locating and retrieving temporal information are personal timespans, personal and public landmarks, and image.

Chapter 8

8. Conclusion and Further Research

In summary, this research aimed to explore the users' need of personal time techniques and a personal timeframe to facilitate searching in an augmented memory system and suggest timeline design recommendations for the Digital Parrot system.

8.1. Conclusion

In the initial sections of the thesis, the psychology perspective has been reviewed to address human memory needs to remember temporal information. In order to answer the first research question, a user study was made to discover how people refer to past time. The findings from this study were discussed to find system requirements.

Related work was reviewed to evaluate and discuss the problem in existing augmented memory systems that support the concept of using the time to search for past experiences.

After identifying the problems in the Digital Parrot system, requirements were integrated to shape the design of personal search in Digital Parrot system. To answer the second research question, different approaches to time representation were tested by applying them on personal search requirements and then finding appropriate forms to display personal time back to the user. The three approaches and the proposed design of personal semantic timeframe were described in detail in Chapter 6.

Due to time constraints, it was not possible to implement the design. Also, due to limitations of the information that have been provided on the timeline to participants in last study, it was hard to evaluate age feature and people need to see their real information on the timeline. Instead of implementing the design, paper prototypes were made to evaluate the Digital Parrot timeline and evaluate the effectiveness of personal time features. A user study was conducted to see which technique or feature helped the user to remember past memories and

retrieve information. The result of this study was used to develop recommendations to support personal time search in the Digital Parrot system. In exploration of the use of time study, it was found that people can locate temporal information in their memories if there are good memory clues. Objective time was not a good memory cue to remember past events; instead people prefer to use their own phrases as anchors to locate when past experiences occurred. People's expression of past time varies according to personal background and domains. The result of this study showed that the majority of participants used educational timeframe, distance of time phrases, personal temporal landmarks, and their ages to recall past memories.

This study results helped to shape requirements to develop a search engine in an augmented memory system. The results of psychology perspective and exploring the use of time study indicated that most of the requirements that were summarized in Section 5.2 are essential requirements to develop the Digital Parrot timeline. To visualize the time with temporal information, the design should follow the requirements in Section 4.2. In addition, the best forms to display the past experiences and memories along the timeline should be one of the three forms: line, circular, and spiral.

Also, this research helped to identify the techniques and features that can be used on the timeline to help people to search in an augmented memory system to locate a past event temporally. The three essential personal features that help participants to retrieve information are personal timespans, personal and public landmarks, and personal images.

Personal timeframes and timespans need to be added to the timeline in terms of users' domains. This feature needs to be included in the Digital Parrot timeline as personal timespans to help the user to easily locate and remember past events. In addition, Adding public and personal landmarks to the Digital Parrot timeline will have a potential value to recall memories. The Digital Parrot timeline should include personal images as images are one of the best stimuli to help the memory to retrieve past information.

8.2. Future Work

The psychology perspective and related work have been reviewed to identify how human memory and systems retrieve past events by using the notion of time. The use of the time and personal time features have been studied to identify what techniques and phrases people use to refer to the past time while remembering. These phrases and techniques are suggested as personal search techniques to develop the Digital Parrot timeline in further work.

- The first future work is to implement personal time features on the Digital Parrot timeline based on proposed recommendations from studies results. To solve the difficulty of using objective time to find memory or past experience in future work, the design is supposed to use personal time features that we have identified, and customized query techniques with time visualisations.
- The suggestions for personal semantic timeframes are based on the requirements in Chapter 5. Figure 8.1 shows the conceptual design that can be implemented in future work. It shows the process of how to use the system to retrieve information and how to use this design to help the user to remember better by using personal time features.

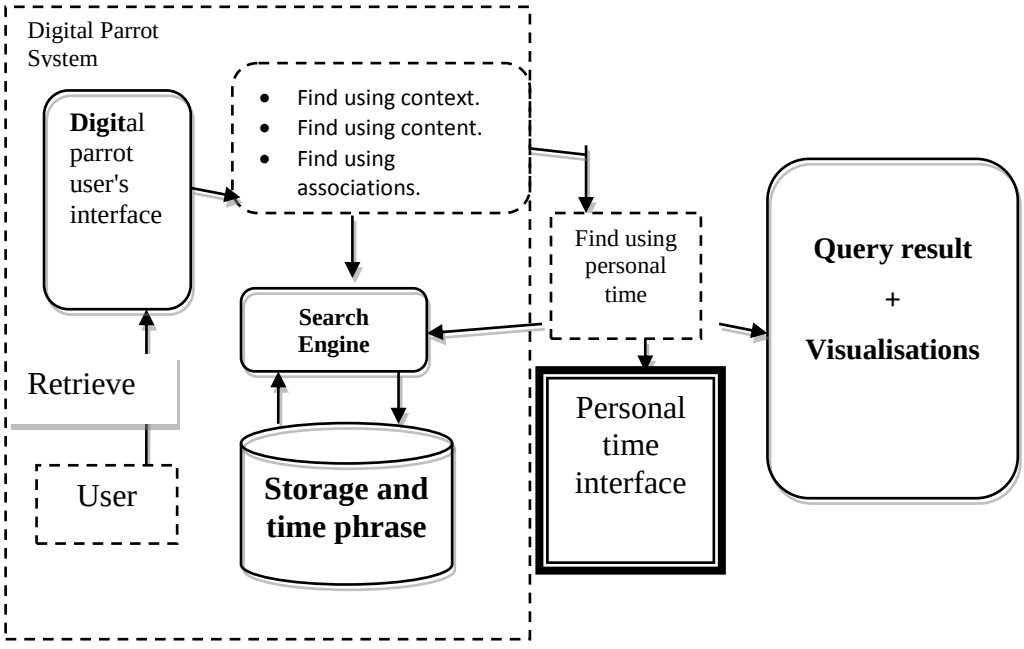


Figure 8.1 Conceptual designs using personal time and timeframe

- Additional future work that will be the most challenging is finding a way to use the distance of time and age features to be used in search engine instead of displaying them on the timeline because we believe these two features will help in searching in autobiographical memory. These two features need to be further explored to improve a personal semantic timeframes search.

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Appendices

Appendix A

First Study: Ethical Approval

Computing and Mathematical Sciences
Rorohiko me ngā Pūtaiao Pāngarau
The University of Waikato
Private Bag 3105
Hamilton
New Zealand

Phone +64 7 838 4021
www.scms.waikato.ac.nz

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

20 June 2011

Muteeb Alahmari
C/- Department of Computer Science
THE UNIVERSITY OF WAIKATO

Dear Muteeb

Request for approval to conduct a research survey involving human participants

I have considered your request to conduct a survey for your research project "Personal semantic time frames" for your COMP594 course where you are planning to interview participants about past events using the Critical Incident Technique.

The procedures described in your request are acceptable.

I note your statement that confidentiality and participant anonymity will be strictly maintained. Raw data gathered will be used for statistical analysis only and no names or other identifying characteristics will be stated in the final or any other reports.

Data will be confidentially stored in the FCMS data archive for three years and then destroyed.

The research participants' information sheet, consent forms and questionnaires meet the requirements of the University's human research ethics policies and procedures.

Yours sincerely,

Mike Mayo
Human Research Ethics Committee
Faculty of Computing and Mathematical Sciences

Appendix B

Interview sheet and questions

Initial questionnaire

Ethics Committee, Faculty of Computing and Mathematical Sciences

Before going further with this session, it would be beneficial for us to learn more about your experiences with time. Please answer the questions below to the best of your ability.

1. Age

a. Under 20 b. 20 - 29 c. 30 - 39 d. 40 - 49 e. Over 50

2. Gender

a. Female b. Male

3. Which country do you come from?

4. What is your original language?

Ethics Committee, Faculty of Computing and Mathematical Sciences

During the interview, the following kind of questions will be asked. We will not probe for personal responses but try to find events that occur in people's lives and see how they talk about the time and the place of these events.

Example questions:

1. Question to identify event:
   Did you ever have an accident?
   Did you ever buy a new car?
   Have you ever lived abroad?
   Did your family move house when you were a child?
   Did you ever change schools?
   Did you attend an international conference?
   Have you ever given a speech in front of an audience?
   Did you ever act in a theatre play?

   (Note that the questions are not to learn about the event itself but to identify an event that can then be talked about in terms of time and place.)

For each event, the interviewer will then ask:

2. When was the event?

3. Where was the event /where were you when the event happened?

Appendix C

Second Study: Ethical Approval

Computing and Mathematical Sciences
Rorohiko me ngā P'ūtaiao Pāngarau
The University of Waikato
Private Bag 3105
Hamilton
New Zealand

Phone +64 7 838 4021
www.scms.waikato.ac.nz

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

23 January 2012

Muteeb Saad Alahmari
C/- Department of Computer Science
THE UNIVERSITY OF WAIKATO

Dear Muteeb

Request for approval to conduct an experiment involving human participants for your COMP594 paper

I have considered your request to conduct an experiment involving human participants in February this year to take place in the Usability Lab, Computer Science Department, University of Waikato. The purpose of this study is to obtain an idea of the value of using personal time features on timeline to help to remember past experiences.

The procedure described in your request is acceptable.

I note your statement that identities of participants will not be disclosed in the final report, no names will be requested and the data collected will remain confidential, only being accessible to the researcher and supervisor.

The research participants' information sheet, consent form, introduction/instruction sheets and questionnaire meet the requirements of the University's human research ethics policies and procedures.

Yours sincerely,

LA Hunt.

Lyn Hunt
Human Research Ethics Committee
Faculty of Computing and Mathematical Sciences

Appendix D

Second user study: Tasks and questionnaires

Initial questionnaire

Ethics Committee, Faculty of Computing and Mathematical Sciences

Before going further with this session, it would be beneficial for us to learn more about yourself. Please answer the questions below to the best of your ability.

1. Age

a. Under 20 b. 20 - 29 c. 30 - 39 d. 40 - 49 e. Over 50

2. Gender

a. Female b. Male

3. What is your main occupation?

◦ Member of academic staff

◦ PhD student

◦ Other (please indicate):

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Tasks

During the interview, the following kind of questions will be asked. We need to find events that people might know about them and see how they locate the answer of the questions by using the Digital Parrot timeline first and then using personal timeline features. Then we will ask you to fill in a questionnaire about using Digital Parrot timeline and personal timeline features.

Using Digital Parrot timeline:

Task 1:

1. When did New Zealand play against Argentina in Rugby World Cup 2011?

2. When was the Semi-Finals of Rugby World Cup 2011?

Task 2:

2. When did Barack Obama become United States president?

3. When did Chilean Miners trap themselves in a collapsed shaft 2,300 ft. (700 m) under the earth?

Task 3:

1. When was *Avatar* movie released?

2. When was the movie of *Harry Potter and the Philosopher's Stone* released?

Task4:

When was the war in Iraq?

Using personal timeline features "improved version":

Task 1: **Use educational feature:**

1. When was the Rugby World Cup 2011 Bronze Final?

2. When was the final of Rugby World Cup 2011?

4. When did New Zealand container ship Rena accident at Tauranga happen?

Task 3: Use age feature:

Imagine that your age is 27 years old and answer the following two questions:

1. When did *Iron man 1* movie release?

Use period of time feature:

2. When did *The Lord of the Rings* release?

Task4: Use temporal landmark feature:

1. When was the war in Afghanistan

Use image feature:

2. When did Italy win the last World Cup?

Appendix E

Questionnaire

Please check one of the options that reflect your perceptions to each statement. You can ask for clarification in any statement.

1. **Using Digital Parrot timeline helps to find the answers for previous questions better than the personal timeline?**

○ ○ ○ ○ ○

Strong disagree Strong agree

2. **Personalizing timeline with personal educational experiences helps to locate the answer for previous questions better than the Digital Parrot timeline?**

○ ○ ○ ○ ○

Strong disagree Strong agree

3. **Using the period of time in search engine (e.g. 3 month ago, 2 years ago, and 5 years ago) helps to find the answer for previous questions?**

○ ○ ○ ○ ○

Strong disagree Strong agree

4. **Indicating personal and public temporal landmarks (e.g. birthdays, wedding, relationships, public vacations, and news) on the timeline helps to find the answer for previous questions better than the Digital Parrot timeline?**

○ ○ ○ ○ ○

Strong disagree Strong agree

5. **Providing user's age on the timeline gives a clue to find the answer for previous questions better the Digital Parrot timeline?**

○ ○ ○ ○ ○

Strong disagree Strong agree

6. **Using personal images on the timeline helps to find answer for previous questions better than the Digital Parrot timeline?**

○ ○ ○ ○ ○

Strong disagree Strong agree