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Indentifying And Understanding User Preferences In Generic Planning Tools

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IDENTIFYING AND UNDERSTANDING USER PREFERENCES

IN GENERIC TOOLS FOR PLANNING

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Dedicado a mis padres; Raúl y Rosa; a mis hermanas Julieta y Tania; y a mi esposo René por su amor, apoyo y comprensión en este paso importante en mi vida.

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ABSTRACT

Planning is an important cognitive work activity. To support this complex task, the development of planning tools is important to support people during decision-making and problem-solving tasks. Nowadays, a large number of manual and electronic tools support this complex activity; manual and electronic planning tools aid people in creating strategies for effective work performance. However, there is limited information on the design of generic planning tools people use for their activities, and why people choose to use the planning tool they do. Some examples of generic tools for planning are calendars, checklists, agendas, etc.

To answer this question, this research study identifies and understands user preferences in the selection of these types of planning tools, particularly when users can choose manual or electronic planning tools. Principles of design, such as affordance, are considered in this study to generate insight on users' preferences between manual and electronic generic planning tools. Usability evaluation techniques and qualitative analyses were used for the study. Eight engineering students, male and females, from the University of Texas at El Paso were recruited for an open-ended interview. Participants were asked to describe their planning process and their successes and struggles when using a particular generic planning tool for the creation of a plan. Participants were audiotaped during the interview. The data collected from audiotapes was transcribed and qualitatively coded to identify user preferences in relationship to the characteristics of planning tools they used. The analysis of transcripts obtained from participants' interviews from data analyses showed that user's preferences on generic planning tools are linked to principles of design such as affordance and visibility.

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CHAPTER 1

INTRODUCTION

In complex sociotechnical systems, urban planners, manufacturing schedulers, air traffic controllers and business planners, to mention some, plan extensively. In such environments, planners and plans must adapt to new situations and reduce the likelihood of problems when meeting their goals. For instance, in manufacturing organizations, scheduling is critical to maintain overall manufacturing system performance. The process of planning presents a high level of complexity due to the set of mental abilities and behavioral operations necessary in this task. However, planning is not exclusive of planners, schedulers and controllers. At every stage in human development, people have had the need to plan for complicated or simple situations happening in their daily lives; such activities range from grocery shopping to the creation of a life plan. Similar to planning in complex environments, planning for daily activities requires considerable amount of time an effort to achieve the desired outcomes.

The development of planning tools is an important element to support people during decision-making and problem-solving tasks. Such planning tools vary depending on the level of complexity of planning; there are specialized tools for tasks with high complexity, such as the ones mentioned before, and planning tools for less complex task such as creating a to-do list. However, the level of task difficulty does not make one planning tool better than others; what makes a planning tool better is how close a tool achieves its principal function, which in this case, is supporting users during their process of planning.

1.1 Problem Statement

With the technology and communication breakthrough in the last few years, numerous products that support the process of planning have been designed; from specialized and

sophisticated software to newer versions of traditional tools such as online calendars. In manufacturing environments, for instance, assembly planning is a crucial process through all the stages of product development; therefore the need of a computer-based planning approach is essential for the generation of feasible and optimal assembly sequences [1]. Same as specialized planning tools, the creation of electronic planners, online calendars and other web-based time management tools has become an important and essential part of people's lives; these electronic tools are an alternative from the conventional and purely manual calendars, planners and agendas.

The multitude of planning tools available in the market poses an important challenge: which tool will satisfy user needs and help users achieve the desired goals when planning for daily activities? Both manual and electronic tools for general planning aid people in creating strategies for effective work performance; however, numerous people prefer to work and rely on physical, manual planning tools rather than the electronic planning tools and viceversa. But the unanswered question is why?

1.2 Motivation for the Work

In recent years, technology has strongly impacted people's lives, making complicated tasks simpler. Technology has been beneficial in our daily life in countless areas, such as healthcare, aviation, research and more. Instances of such impact are often seen in healthcare area. On May 2011 X PRIZE Foundation and Qualcomm, a wireless technology provider, announced a 10 million dollars prize for the development of a mobile solution that can diagnose patients better or equal than to a panel of board physicians, according to Forbes magazine [2]. Thus, there are several examples on how high-tech tools have benefited or will benefit thousands of people. However, it is important to mention that tools from technology not always support users when performing a task. In the healthcare domain, for instance, research shows that the

percentage of drug prescription errors, such as duplicate prescriptions, made by a Computerized Provider Order Entry (CPOE) is 11.4% compared to 0.3% in the paper-based prescriptions [3]. Cases like this, the use of sophisticated software in healthcare and many other areas where risks are high, not always provide the expected results contrary to the idea that technology will be superior to human work.

A similar problem, but at a lower risk, occurs in data acquisition systems and communication media tools for time management in general terms. Systems or tools for general planning that are difficult to understand may lead to user frustrations and potential errors during the creation of a plan. Lately, the acquisition of the newest technology has become an important aspect in people's lifestyle. Advances in technology such as Internet, computer software, cell phones and e-mail have made the population more susceptible to technological dependency; one factor for this dependency is greater accessibility and ownership of this technology [15]. The dependence to these systems gets more people to increasingly turn to electronic planning tools to plan for everyday activities, useful or not. Yet, there are people that choose to use manual planning tools even if they are able to access to the mentioned technology; the use of paper and pencil is more appealing to them than the newest technology. Such preferences may be linked to the design of electronic planning tools, which is an essential element in the creation of any tool. To date, there is little information on the design of generic planning tools that people use for their daily activities and *why* people decide to use the tool they use.

Understanding user preferences for generic planning tools, both electronic and manual, is important to pinpoint possible difficulties during users' work performance. With such dependency to electronic tools, it is necessary to determine design features in electronic time management tools to ensure that they are both useful and usable. In this thesis, my purpose is to identify and understand the reasons that influence user preferences in selecting a planning tool for their daily activities.

In chapter 2, I discuss the background literature relevant to the problem of designing planning tools. Chapter 3 presents my research objectives. A description of the research methods is provided in chapter 4. I present the results of the work in chapter 5. In chapter 6, I discuss the results of the research.

CHAPTER 2

BACKGROUND

Literature in cognitive aspects of planning and user-centered designs is relevant to this research study. This chapter introduces concepts in cognitive psychology regarding the mental actions or processes necessary for the creation of a plan. Also, this chapter introduces concepts in user-centered design and their role in the design of tools.

2.1 Planning Implications

Planning is essential in almost every aspect of human development. People plan because they need meaning and direction for action. Planning can be considered as a process of developing a vision of the future so that we are in a better position to shape that future [5]. Research has commonly visualized the strategic planning process as an iterative series of states [6]. These stages may vary in number depending on information provided in the process of planning; the number of stages may increase as the information's detail increases. As mentioned, not all domains follow the same planning process; a planning process for an air traffic controller would not be the same as the one followed by an event planner. However, five core stages are present in every strategic planning:

1) Set goals. Planners outline or set objectives to have a clear vision on the required actions that will meet the desired objectives.
2) Evaluate environment. The evaluation of external and internal factors that may affect outcomes reveals opportunities and threats.
3) Create a plan. Planners formulate strategic steps that will meet the desired objectives.
4) Execute plan. Planners and other people involved in a problem-solving task implement and put into action step by step the formulated plan.

5) Revise or evaluate plan. Planners monitor, adjust or modify the plan for improvements in the process.

In engineering design and management environments, models created for strategic planning processes explain what actions each participant must perform to meet common goals; the five core steps in strategic planning adapt to planners needs and requirements. Advances in the development for better planning strategies, have elaborated a unified innovation process model in the areas of engineering design and management that let designers and management to review process flow and can be used as a communication tool [6]. The visualization of a process workflow shows where ideas, actions and testing phases should take place for an ideal work performance. Figure 2.1 shows the unified strategic planning process for engineering designers and management [6].

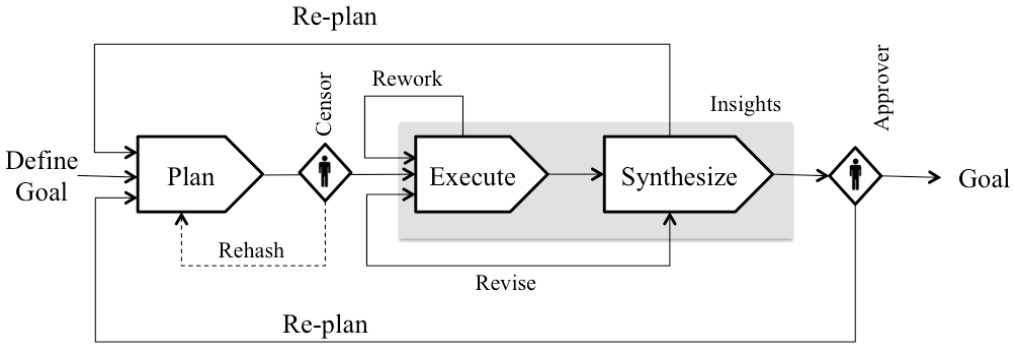


Figure 2.1 Unified innovation process flow for engineering designers and management

Individuals, like larger organizations, have the same need to cope with changing and complex situations. Yet, the mere act of planning is still confusing to individuals; when and how to create a plan is an issue that makes planning a complex task. Models for strategic planning provide details of actions during the implementation of a plan and the necessary actions when difficulties occur during the process of achieving a goal, but how to plan is still unsolved. Before all the stages of strategic planning can be performed, it is important to understand the cognitive processes involved in the task. Planning skill is central to all human behavior; humans are driven

by their capacity to crate symbolic representations of the past, present and future and employ them to shape things to come [7]. Planning is a skill that involves complex cognitive operations such as representation and sequencing skills. Six cognitive processes are involved in a skilled individual's planning process; successful planners have the ability to integrate all cognitive process and generate complex plans. There is no way an individual can engage in planning if he or she lacks of an adequate representation, working memory, processing capacity, attention. Here, we explain in more detail the six cognitive processes required during the planning process [8].

1. Representation is the process that allows the presentation to the mind in the form of an idea or image;
2. Sequencing is the process of arranging a task in a particular order;
3. Working Memory is the capacity or ability to hold information in the mind that lets you manipulate and monitor information;
4. Attention is the process of concentrating selectively on one aspect of the environment while ignoring other things;
5. Processing Capacity is the ability to recall information selectively to solve problems and make decisions;
6. Execution Function collects and manages all cognitive process required for planning.

External factors also affect an individual's behavioral operations, which are reflected in how a plan must be created; planner's social and cultural environment affect the development of a plan; societal norms about when and where planning is appropriate moderate individual's engagement in planning [9]. The complexity of the task and the level familiarity with the task also affect how people plan; if task is complex and/or unfamiliar, gathering the required information to increase the level of knowledge will adequately aid in the representation a planning strategy. Given this, individuals do not plan the same simply because not all situations

are the same; each person will create a plan according to what is available in his or her environment, each one has their own style or approach in problem-solving and decision-making situation. Figure 2.2 show the individual's planning process from a cognitive psychology perspective [7]. The figure shows how cognitive processes, behavioral operations, task complexity and environment factors, are fundamental in the creation of a plan; from individual's familiarity with the task to the individuals' ability to overcome adverse situations (coping skills).

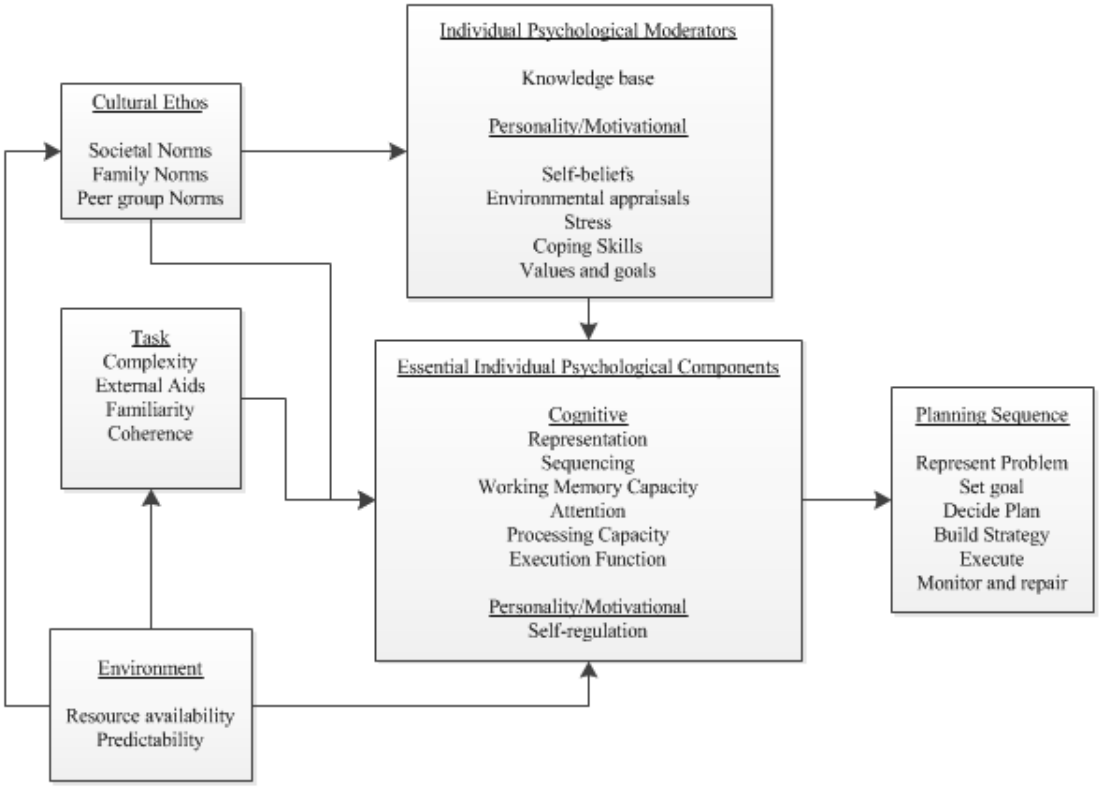


Figure 2.2 Individual's Planning Process [7].

2.2 Generic Planning Tools

In the previous section, we discussed why planning is a complex task and why it is essential in almost every aspect of human development. The act of planning requires a considerable amount of cognitive function and other behavioral functions affected by external factors such as task complexity and self-beliefs. However, when individuals are confronted with

tasks that life puts in front of them, they use artifacts as tools or create tools out of their understanding. Tools represent abstract objects and concepts as part of an individual's cognitive development [10]. Throughout time, individuals have created or used different artifacts to help accomplish numerous of tasks, including the task of planning. Ancient civilizations, such as Egyptians and Mayans, developed calendars as their systems for organizing religious and commercial events. These calendars have evolved into the current calendar where time is divided by years, months and days. Like calendars, other of tools for organization has been developed to aid individuals in the creation of plans; agendas, monthly or weekly planners and to do lists are some of the most common planning tools for general purposes. Each tool supports different individual's cognitive processes; these tools were created with the objective to represent ideas, sequence task and manage information necessary for planning.

Until today, the uses of calendars and agendas, among other tools, have played key roles in planning. These tools are, to a great extent, responsible for maintaining stability in future plans. In dynamic environments such as manufacturing, health care and air traffic control, where users must adapt to changing situations, the use of electronic versions of planning tools have been adopted. For instance, electronic calendars and monthly planners in manufacturing environments, to mention some, are essential to efficiently achieve production goals. A reason for using these electronic tools is because of the ease of data handling. However, this same situation has been seen in individual planning; people use electronic versions of generic planning tools for their activities in their daily life. Lately, generic planning tools are available in computers, mobile phones and other portable electronic devices. Electronic planning tools intend to mirror the planning nature and physical aspects but more efficiently; they organize, sequence ideas and tasks using similar format to paper-based tools.

2.3 User-Centered Design and Design Principles

In the design of specialized products, such as software and high-tech tools, we understand that a scrutinized design process is essential for good overall product performance. Product design affects directly the product quality and cost; is estimated that 85% of the problems with new products not working as they should, taking too long to bring to market, or costing too much are the result of a poor design process [11]. Objects present in our daily lives require the same meticulous design process; microwaves, elevators' buttons and telephones are some objects people use in their daily activities. However, the design of everyday objects is not always intuitive and at times it leaves the user frustrated and unable to complete a simple task [12]. This same situation may happen when people use planning tools for their daily activities. The large use of electronic devices such as mobile phones and computers has made people to turn to electronic planning tools for general purposes. Still, some people use paper-based planning tools to complete their task, and one reason may be associated with how electronic planning tools are designed and with the frustrations experienced during the use of electronic planning tools. Here, we introduce the term *user-centered design* as a main concept to understand user preferences regarding generic planning tools.

User-centered design (UCD) is a philosophy based on the needs and interest of the user with emphasis on making any type of product usable and understandable [11]. The purpose of UCD is to understand how people interact with things and the application of design principles that will ensure that products are useful and easy to understand to use. Usually, we hear of medical mistakes attributed to human error such as the incorrect administration of drug doses that leads to patient's severe or fatal effects. But what are the causes for nurses' faulty readings of drug doses? Is it entirely their fault? Can we attribute mistakes to the devices utilized for drug administration? Experienced users of such specialized devices are often accused of incompetence when tragedies like these happen and rarely attribute such events to the design of these specialized devices. The role of UCD in the design of any object is extremely important to avoid

poor designs; dealing with objects or devices that cannot be understood lead to user frustrations, and user frustration lead to errors.

In user-centered design philosophy there are psychological principles that can be followed to make these objects or devices usable and understandable. Knowledge of the psychology of how people cope with the information available from the appearance of objects and how they work becomes crucial during the design process [13]. These design principles are based on user cognitive aspects during the interaction with objects. In the previous section we clarified the cognitive and behavioral operations in the process of planning. The relevance of cognitive processes during planning and their role in the design of planning tools, from a UCD perspective, in this study is essential. Understanding such skills will provide insights in the generation of tools that can aid individuals in the creation of a plan. The next sections explain in detail each design principle.

2.3.1 Conceptual Models

By definition, a conceptual model represents ideas or concepts and the relationships between them. In UCD conceptual models play an important role for understandability and usability; conceptual models allow us to predict effects of our actions over any object, in other words the interaction between user and objects. Conceptual models structure the logic behind the objects we use in our daily lives, how they work, the possible actions we can take over those objects, etc. With appropriate conceptual models, users are able to determine the actions needed when using any type of object, such as tools and devices, with the minimal effort.

The development of clear conceptual models becomes a challenge for designers. In some cases, designer's mental model does not reflect user's mental model because it does not capture the important actions required in the functionality of a device. Literature suggests that the

development of accurate conceptual models lead to the creation of creative products and services, which can only be validated through real-world settings. [14]. In other words, clear conceptual models can only be formed through experience. Figure 2.3 shows a simple example of a conceptual model. Suppose that a manual activated switch must be turn on in order to light a dark room. Our mental model says that the switch lever must be pointing up in order to turn the lights on. Now, what if the switch works opposite from what we expected? Here, designer's mental model is not clear and inconsistent and ended up with a wrong mental model; poor design is directly attributed to inappropriate conceptual models.

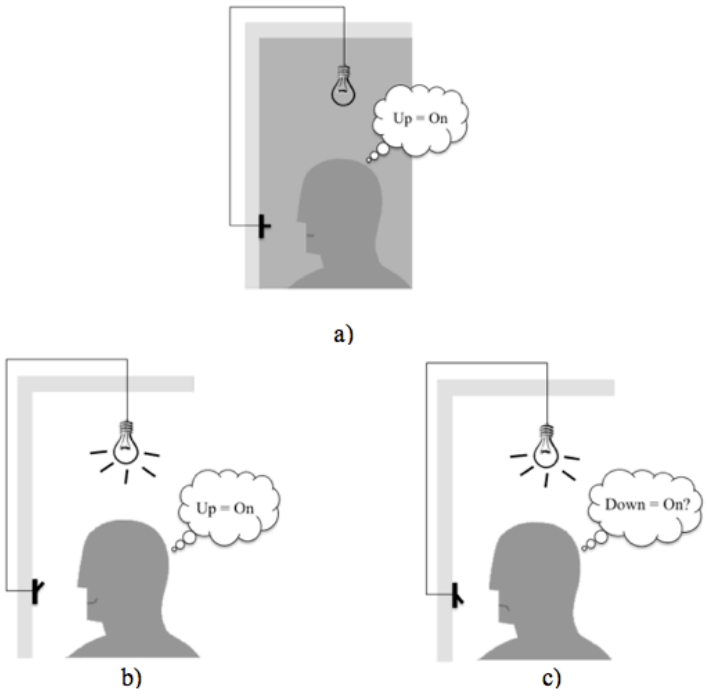


Figure 2.3 Light switch conceptual model a) user's mental model on how the switch works; b) appropriate conceptual model; c) inappropriate conceptual model

2.3.2 Affordance

The concept of affordance refers to the perceived and actual properties of objects, primarily those fundamental properties that determine just how objects could possibly be used [12]. Affordance indicates the functional properties of objects, in other words, affordances in objects provide clues that determine the actions the user can perform on an object. The information provided by an object in how it must be used depends on the nature of the object. Complex objects such as TV controls need instructions and pictures to know what to do with them; however, simple things should not. When simple things need pictures, labels, or instructions, the design fails [12]. How do we know that a building door must be pulled or pushed? A handle is a clue that the door must be pulled; a horizontal bar is a clue that the door must be pushed. A handle affords to pull a door; a horizontal bar affords to push a door. Examples like this are evidence that the properties of objects need to be clear enough in order to know what actions are required over a certain object. This concept is widely used in UCD to create or improve objects so they can be usable and understandable.

In air traffic control, the analysis of computer interactions is a priority to determine the operators' performance and possible improvements in the interface design of computer-aided systems [15]. One important task of air traffic control planners is to sort air traffic according to time or distance. A study performed on the effects of perceptual information integration in air traffic control showed that the provided electronic planning aid allowed planners to successfully integrate the current air traffic situation with the planned sequence information 6.3 seconds faster than the traditional planning aid, which was based on the utilization of paper-based strips. The study suggests that the electronic planning aid was able to incorporate the required information and the interface provided users with the adequate clues for the creation of a successful air traffic control plan. An affordance-oriented design philosophy could eliminate much of problems encountered when using objects and devices by direct representation of the functional properties [15].

2.3.3 Mapping

The definition of mapping in design refers to the relationship between two things, in this case, the relationship between actions and their effect on objects. The closer the relationship between the action and the effect is, the clearer the system is. When these relationships are clear enough, users are able to understand the actual system state; user intentions or expectations on how the system will work must be compatible with how the system actually works. Here, the concept of natural mapping emerges. In design, natural mapping mean taking advantage of physical analogies and cultural standards to lead users to immediate understanding [12]. Let's go back to the switch problem in section 2.2.1. Our expectation on how the switch will work is that the switch lever must be pointing up in order to turn on the lights. In cultural standards moving an object up represent an increase of amount, in this case, moving a switch lever up will result in an increase on room illumination. Then, users find natural to turn the switch lever up in order to turn on the lights. When mappings do not follow a logical relationship between the action and its effect, users find difficult to understand the system and lead to user misconceptions on how the system works.

2.3.4 Feedback

By definition, feedback is the transmission of evaluative or corrective information about an action, event, or process to the original or controlling source [16]. Feedback in design let users know what are the results of the actions taken over a system. The information provided by the system, let users know actions are needed next or when the system is not working as it was expected. Providing users with immediate feedback on their actions reduces uncertainty, promoting a more positive effective state [12]. Feedback must be visible at all times; the system should always keep users informed of what is going on, through appropriate feedback with reasonable time [17].

2.3.5 Visibility

Another concept important in UCD is the concept of visibility. This principle of design says that for an object become operational, all actions needed must be visible without distracting the user with unimportant or redundant information [12]. Good designs do not confuse users with unnecessary information. Users that find designs easy to understand and know what actions are required are because the system is clear. Here, the integration all principles of design explained in the previous sections result on adequate visibility of objects. Good conceptual models, affordances, natural mappings and good feedback in designs make objects or devices visible because users know what to do immediately and therefore, avoiding frustrations.

Designers face numerous challenges in the creation of electronic version of generic planning tools; the interface must show user-friendly representations of individual's planning process. Literature in UCD offers basic advice in how things must be designed [12].

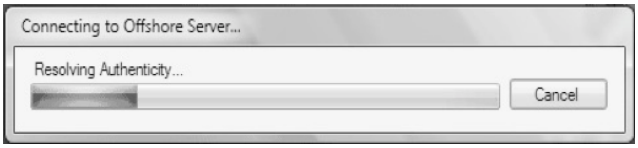
1. Make things easy to determine what actions are possible at any moment.
2. Make things visible, including the conceptual model of the system, the alternative actions, and the results of actions.
3. Make things easy to evaluate the current state of the system.
4. Follow natural mappings between intentions and the required actions; between actions and the resulting effect; and between the information that is visible and the interpretation of the system state.

2.4 User Preferences

User preferences play important role in the design of systems or devices. Research suggests that issues related to user preferences in World Wide Web interfaces are due to delays in information processing. It has been demonstrated that users can begin to lose interest in the task at hand with wait periods as short as 2 seconds [18]. User's frustration emerges because

delays could place increased demands on the user, reducing cognitive resources available or other task [19]. This same study suggests when web pages interface provide feedback confirming that the device is processing their request, users tend to be more satisfied. [19]. Feedback is portrayed as an important element in design improvement; still, users have preferences on how feedback is provided. The use progression bars is highly preferred by users instead of wait dialogs; users find it less frustrating and the process less confusing because it keeps users informed without increasing arousal or inducing the user to attend to temporal stimuli [19]. Figure 2.4 shows two examples of types of computer feedback. As suggested in studies, users are less likely to prefer static dialogs because it does not provide enough information about the system status. Contrary to progression bars, information about the system status is visible.

a)



b)

Figure 2.4 System status feedback a) static dialog box; b) progression bar dialog box

With a large variety of generic planning tools, manual and electronic, it is important to question whether they are effective or not. There is no doubt that technology such as computers, mobile phones and other electronic devices has changed not only the way we communicate but also how we organize ourselves. But, even in our days, where people are more dependent on this technology, people still show greater fondness to manual generic planning tools. Studies suggest that principles of design, such as feedback, have a high effect on user preferences.

2.4 Previous Research on Planning Tools

Literature has widely showed the importance of planning tools in different domains such as manufacturing and air traffic control. Researchers have questioned whether computer-based tools would solve, entirely, complex industrial scheduling problems and successfully manage air traffic control [15,20]. Computer-based planning tools provide solutions faster by using mathematical algorithms and reduce planners' time and effort during these tasks. The importance of human contribution in decision-making situations has been also identified in literature; humans still play an important role in the task of planning [20]. Studies have focused on the interface design of these specialized planning tools. Theories in user-centered design have been a platform for these studies. In air traffic planning, relatively simple modifications of the perceptual properties of an interface can decrease task difficulty and increase human performance without infringing on higher-level cognition; the interface improvement of planning tools then facilitates actions as the user perceives his or her goals mirrored in the affordances of the interface [15].

Despite research on the design of specialized planning tools and whether they entirely aid users in the creation of plans, research insights on the design of generic planning tool is missing. Let's not forget that people plan for their general activities too; it will be less likely that people use algorithm-based tools to plan for their weekly or monthly activities. Generic planning tools support important elements for planning such as sequencing. Similar to sophisticated tools, generic planning tools are also available as computer-based tools in which the challenge arises when trying to mirror the properties of paper-based generic planning tools. Another detail literature does not discuss is whether planners are inclined to use physical or computer-based planning tools. It is obvious to think that in dynamic environments, the use of computer-based planning tools will be the best choice. But even in highly demanding environments, planners will have their preference in whether to use the computer-based planning tool or the paper-based planning tool. Researchers have developed new scheduling models in manufacturing based on

the assumption that scheduling is a predominantly individual, cognitive, decision making function [18]. Similarly, with generic planning tools, people will have their preferences on which generic planning tool to use and in what format, either manual or electronic versions. But what is that determines user preferences? Can user preferences be tight to how planning tools are designed? The question here is what are some of the elements that model user preferences in generic planning tool choices. Identifying such preferences will provide insights about planners rational regarding planning tool choices and possible improvements in the design of generic planning tools.

CHAPTER 3

RESEARCH OBJECTIVES

Based on the background about the implications of planning, and the importance of user-centered tool design processes, this thesis focuses in understanding user preferences in relation to generic planning tools people use for their daily activities. Three major research questions emerge in the development of this research:

1. Why do people prefer a particular generic planning tool, particularly when they have a choice and can choose between manual and electronic generic planning tools?
2. Are user preferences influenced by the design elements in generic planning tools? If so,
3. What design principles play an important role when deciding which generic planning tool to use?

In this thesis, it is hypothesized that user preferences are modeled or driven by specific features in the design of generic planning tools. This research study aims to identify and understand key features in the design of generic planning tools that successfully assists users in the creation of a plan. Also, this thesis looks to determine whether electronic generic planning tools can replace manual planning tool in terms of usefulness. Answering these questions will generate insights for potential improvements in the design of new or existing generic planning tools and how people cope with the complex task of planning.

CHAPTER 4

RESEARCH METHODOLOGY

This chapter presents the methodological approaches for the development of this research study. The technical objectives of the proposed work are to capture, describe and understand the relationship between user preferences and design elements of general tools for planning.

4.1 Overall experimental approach

UCD contains a variety of techniques to test how usable products are; these techniques test usefulness, efficiency, effectiveness, satisfaction and accessibility of products [21]. In UCD, an exploratory study is conducted in early stages of product development to examine how well products support users in their tasks. An exploratory study uses techniques in ethnographic research; ethnographic methods focus on "uncovering and explicating" the ways in which people understand, account for and take actions over particular situations [22]. From this perspective, researchers are able to develop rich descriptions and explanations of processes of human behavior and reasons for such behavior towards a specific product, in other words, obtaining qualitative data. Because there is limited information relating user preferences and generic planning tools, an explorative or formative study was conducted in this thesis.

Usability testing techniques were selected as the general research approach for this project. Techniques such as open-ended interview questions will identify and examine user preferences with respect to generic tools for exploring planning design characteristics. There are three advantages of using this approach: 1) researcher creates a better understanding with the subjects leading to subject stronger commitment in the study; 2) subjects are more likely to show up for the session on time; and 3) researcher can ask follow up questions to expand or clarify important information in the study [22]. Conducting interviews with open-ended questions encourages a full, meaningful answer using the subject's own knowledge and/or feelings [23]. This qualitative study focuses on user's likes and dislikes of generic planning tools; the study will attempt to identify and understand why users prefer one planning tool to another.

4.1.1 Participants

UTEP Engineering students were selected as subjects in this study. Planning during college in the area of engineering and science is crucial for student success [24]; therefore, the idea in this study is to capture undergraduate and graduate students' preferences on generic planning tools when planning for activities at school. To describe student participants' planning process, the experiment selected a task within the academic domain that required planning; students' participants with plans to graduate in 2011 or early 2012 were selected. Subjects in this study were required to be regular planners and be familiar with the utilization of generic planning tools, both manual and electronic. Reasons for this criteria is because regular planners are more likely to provide better examples and description with the interaction of these tools and show tendencies over specific tools.

For this research study, the criteria for engineering student selection are:

1. Engineering students
2. Undergraduate and graduate students
3. Male and Female
4. Planning to graduate Fall 2011 or Spring 2011
5. Regular planners
6. Familiar with generic planning tools, both manual or electronic

Participants in this study were recruited in a period of two weeks by posting flyers, throughout the College of Engineering in The University of Texas at El Paso and class announcements made by researcher. For exploratory studies, the suggested number of participants in the study is ten [25]. Originally, ten participants enrolled in the study. Due to natural attrition, only eight participants were able to perform the study. The eight participants in this research study belonged to three different engineering majors: four undergraduate Civil Engineering students, one undergraduate Computer Science student, one graduate and two undergraduate Industrial Engineering students. The researcher worked with participants' agenda to schedule convenient dates and time for the study. Institutional Review Board (IRB) consents

were provided to all student participants; all student participants in this research study enrolled voluntarily and provided their consent to participate.

4.1.2 Design of Questionnaire

The main purpose of an open-ended questionnaire is to obtain full and meaningful data. The questionnaire was designed to contain unstructured questions to describe participants' planning process specifically how generic planning tools are used and why student participants decided to use that specific tool. Appendix A shows the questions followed by researcher during participants' interview.

The questionnaire was divided into three sections.

1. *What generic planning tools do participants use?* The first section in the questionnaire looks to find information related to participant's process when planning towards their graduation. General questions about participant's actions and the planning tool participants' used to create a plan are asked.
2. *How do participants use the mentioned generic planning tools?* The second section looks to explore how participants use the generic planning tools. This is to comprehend what cognitive operations, in the context of planning, the planning tool supports.
3. *User Preferences.* This last section in the questionnaire looks to obtain detailed information on why users like or dislike specific generic planning tools. Statements about likes and dislikes will provide clues on what users can or cannot do with particular generic planning tools.

A pilot interview was first conducted on a voluntary participant to determine the duration of interview, adjust questions, add or remove questions, and for researcher practice. Pilot interview results were not included in the analysis.

4.2 Data Collection Procedures

Data collection was conducted over a period of two weeks, after participants' recruitment. Researcher scheduled interviews according to participants' time convenience. An IRB consent were given to all participants before the experiment; each participant was informed about the purpose of the research study, permission to record interview and sign nondisclosure agreements. Signed IRB consents are kept under lock and key.

The researcher conducted interviews, asking the questions in the questionnaire and other follow up questions and probes for more detail on participants' comments. To record interviews, an Olympus VN-3100PC digital voice recorder was used. Interviews had an approximate duration of 20 minutes. All participants received an incentive for their participation in the study. After every interview, data recordings were transcribed for data analysis using qualitative software Transana 2.0. A total of eight interviews were transcribed.

4.3 Data Analysis Procedures

To analyze the collected data, the approach in this study was to code transcripts. Codes are tags or labels for assigning units of meaning to the descriptive or inferential information compiled during the study, in other words, assign meaning to words or statements [22]. To properly identify labels, it was necessary to listen and read audio recordings and transcripts, respectively, several times. Coding procedures suggest the following coding operations [22].

1. *Filling in.* Adding codes, reconstruction of a coherent scheme as new insights emerge and new ways of looking at the data set emerge.
2. *Extension.* Returning to materials coded earlier and interrogating them in a new way, with a new theme, construct, or relationship.
3. *Bridging.* Seeing new or previously not understood relationships within units of a given category.
4. *Surfacing:* Identifying new categories.

The category system used for coding was based on the hypothesis established for this research. It is hypothesized that user preferences are modeled or driven by specific features in the design of generic planning tools; therefore, the category system was divided into two sections: tools and actions. This approach was based on a mean-ends relationship that describes the actions (means) necessary to achieve a particular goal (end) [26]. This relationship is obtained by asking three important questions: what, how and why. For the purposes of this research, we want to know *what* generic planning tools participants' use *how* they used them and *why* they select that particular tool in terms of what the tool can or cannot do.

A list of possible planning tools, manual and electronic, was created before the experiment; however, during the data collection process and transcription process, participants mentioned other tools, such as degree plans, that were not considered in the initial list and were important for their planning process. Also, a list of actions related to their cognitive processes during planning was identified during the transcription process. These lists were employed as codes in the analysis. These codes were used to summarize segments of data, in other words, it classified what participants' actions were, with respect to planning, and what generic planning tool they used to accomplish their goals. Tables 4.1 and 4.2 show the categories, subcategories and their codes for more detail in the analysis.

The classification of tools and actions was the first step during the data coding. However, to reduce large amounts of data, pattern coding is required. Pattern codes are exploratory codes that identify emergent themes or explanation to the phenomena [22]. Observing repeatedly behaviors, norms or relationships can identify themes related to why participants did specific actions over specific generic planning tools. Table 4.3 shows the theme that was repeated throughout the transcripts and identified as a pattern code.

Table 4.1 Category 1-Tools

GENERIC PLANNING TOOLS	
ELECTRONIC	MANUAL
Excel Spreadsheets	Degree Plan
G-mail	Degree Plan Flow Chart
Google Calendar	Lists/Checklists/To-do lists
MP3 players	Notes/Notepad
Online Degree Plan	Sticky Notes
Outlook Calendar	Weekly Planner
G-mail	Whiteboard Monthly Calendar
Windows Live	
Phone Calendar	
Phone Sticky Notes	
Phone Lists/Checklists/To-do lists	

Table 4.2 Category 2 –Actions

HOW PARTICIPANTS' USE GENERIC PLANNING TOOLS	
ACTION	DESCRIPTION
Order activities according to time	Break down activities by hour, days, weeks or months
Check information	Knowledge of user position in a situation i.e. where he or she is at
Modify Plan	Manage to make changes in the plan
Prioritize activities	Arrange activities according to priorities or deadlines
Identify Information	Recognize specific information
Aware of situation	Knowledge of user position in a situation

Information input	Enter relevant information to describe activities in a plan
Recall information	Memory targets, reminders of activities or events

Table 4.3 Pattern Codes

Theme	**Causes and Explanation**
User Like over specific tool	Tool support the completion of a specific action – related to principle of design
User Dislike over specific tool	Tool do not support the completion of a action – related to principle of design

The coding process required the analyzer to go through transcripts and assigned the determined codes to participants' statements. An Excel Spreadsheet was used to perform the analysis. This process required approximately 2 weeks; the coding process varies in time depending on code's conceptual structure and complexity, quality of field notes and coder's skill [22]. This methodological approach will result in the extraction of meaningful information on why people prefer one planning tool to other from transcripts. The first set of codes in this research was intended to answer what generic planning tools most participants use, and for what actions these tools are used. Pattern codes were intended to understand why participants used specific types of tool.

CHAPTER 5

RESULTS

This chapter presents the results of obtained in this research study. This research study reveals that user preferences are driven by what they can or cannot do with different generic planning tools. These restrictions are tied to principles of design, affordance and visibility.

5.1 Identification of User Preferences

This section describes the results that answer the first research question established for this study. The first research question is to know why people prefer a particular generic planning tool. Eighteen likes and dislikes from the eight participants were identified in the analysis; these preferences were established based on tool capability to support users during the planning process. In other words, these preferences were identified based on what users could or could not do with a particular generic planning tool. Examples of these preferences are described in more detail in the next sections.

One of the identified preferences was the use of a desktop calendar or a weekly planner, both manual, because participants could easily identify some type of information necessary when creating a plan. This preference is related with the action “identify information”, which is an important action for the planning process and previously established as a code. Another example is the preference to use a phone calendar; reasons are because users can receive reminders of events. This preference was associated with the action “recall information”, which was also established as a code. Like this example, other seventeen preferences were classified according to the type of generic planning tool and the actions related to planning. Table 5.1 shows the eighteen user preferences.

Table 5.1 Identified User Preferences-Users' Likes

USER PREFERENCES BASED ON TOOL AND ACTIONS			
No.	LIKES	ACTION	TOOL
1	Recognize type of information easily	Identify information	Manual
2	Mark down information	Identify information	Manual, Electronic
3	Spontaneity	Information input	Manual
4	Big size	Information input/Aware of situation/Recall information	Manual
5	Reminders	Recall information	Electronic
6	Place information close	Identify information/Prioritize actions	Manual
7	Write things down	Recall information	Manual
8	Organize required things to do	Break down activities according to time/Prioritize actions	Manual, Electronic
9	Break down classes	Break down activities according to time/Prioritize actions	Manual
10	Enter as much as information as desired	Input Information	Electronic
11	Actualize information	Modify plan/ Aware of situation/Prioritize actions	Electronic
12	Have information in one tool	Check information	Electronic
13	Portable	Check information	Electronic

Table 5.2 Identified User Preferences-Users' Dislikes

USER PREFERENCES BASED ON TOOL AND ACTIONS			
No.	DISLIKES	ACTION	TOOL
1	Information input restrictions	Input information	Electronic
2	Slow information input	Input information	Electronic
3	Small size	Identify information	Electronic
4	Easy to forget	Recall information	Manual
5	Hard to remember events	Recall information	Manual

The next figures show the number of times the identified user preferences appeared throughout the analysis. In Figure 5.1, the numbers in the x-axis correspond to the user preferences based on likes from Table 5.1 and the y-axis is the number of participants that mentioned the identified preferences in transcripts. We can see that the most recurrent user preferences are: 2) mark special information, 5) reminders, 8) organized required things to do and 9) break down classes. All participants expressed these preferences especially number nine. The reason for this is because participants were asked how they plan towards their graduation; the action of breaking classes needed for graduation was performed with the help of a degree plan. Although user preferences two and eight were present in manual and electronic tools, participants were more inclined to use manual generic planning tools for these specific actions. User preference number five, reminders, was the exception; participants were more inclined to electronic generic reminder tools.

Figure 5.2 corresponds to the user preferences dislikes. We observed that user preference four, easy to forget, is the most recurrent participants' dislikes; this preference was present only in manual generic planning tools. This is because participants' forget to carry weekly planners or notes with them or because they forgot to use them due to the lack of reminders. Detailed

explanations of user preferences are provided in the next section on understanding user preferences.

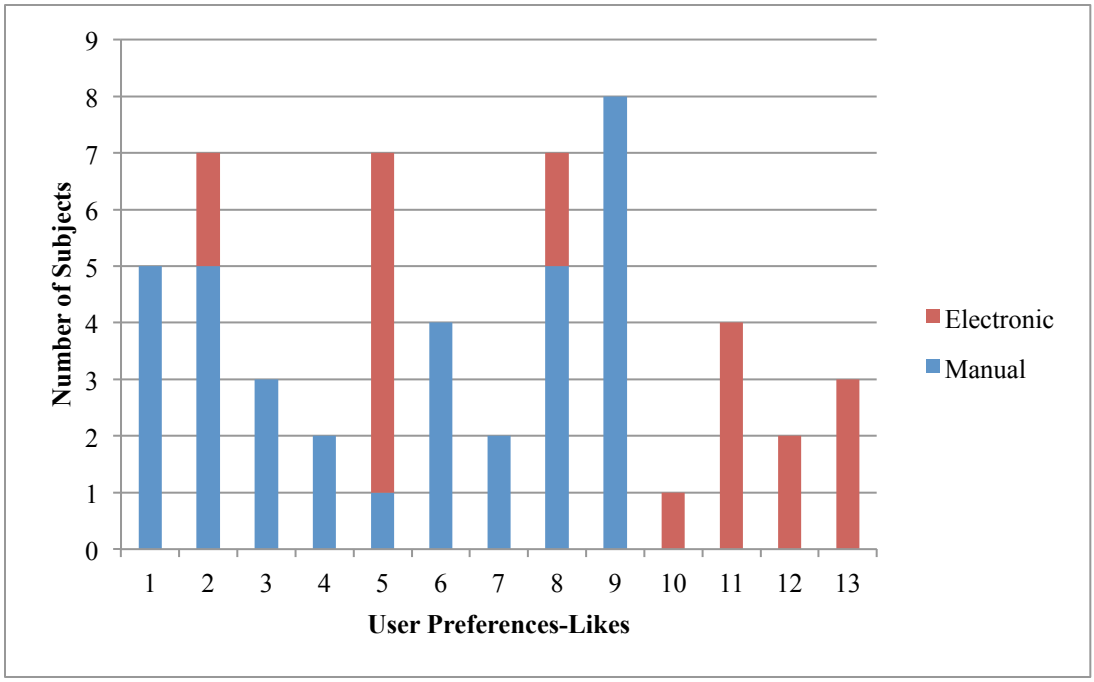


Figure 5.1 User Preference Graph by Number of Subjects- User Likes

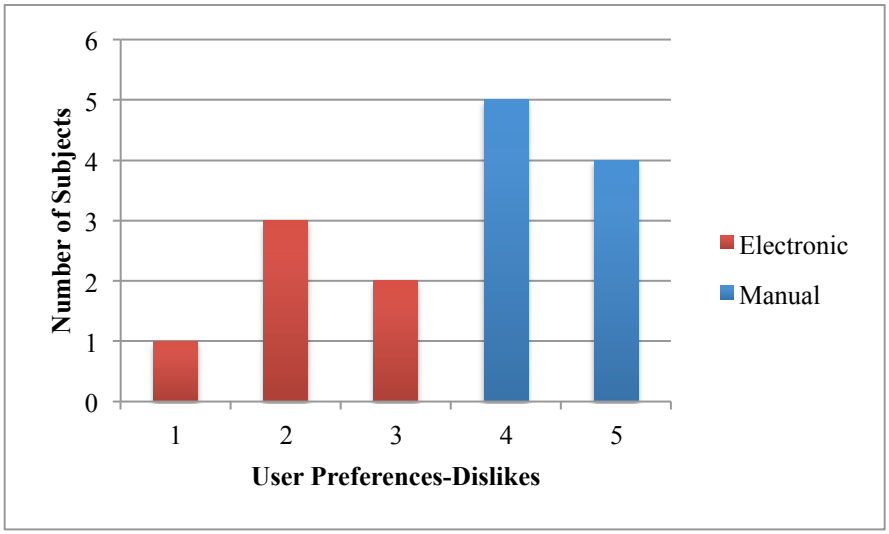


Figure 5.2 User Preference Graph by Number of Subjects- User Dislikes

5.2 Understanding User Preferences

Once user preferences were identified, results from analysis were used to answer the second and third research questions. The second research question asks if the identified user preferences are influenced by the design of generic planning tools and the third research question asks what principles of design play an important role when deciding which generic planning tool to use. During the interview, participants' were asked to describe exactly the reasons why they are more inclined to particular generic planning tools in their planning process. The description obtained from participants' statement showed that the actions that could or could not performed can be influenced by generic plan tools design.

First, let us describe participants' preferences towards manual generic planning tools. According to participants, when using weekly planners, notes, desktop calendars or wall calendars, they were able to recognize information easily by highlighting or underlining information they consider important. The reasons provided by participants' leads to the conclusion that weekly planners and other manual generic planning tools afford emphasis on important items in their plan from the rest. Also, by doing this, the visibility of important information does not distract users with irrelevant or less important information. For example participant number five stated the following; *"I use pen to write down fixed events, like work and class. And I use pencil to write down things that might change throughout the week".* Here, the participant was able to identify which activities was not part of his or her routine by using a pencil, therefore making the identification of particular information easy.

Spontaneity is another example of user preferences towards manual tools. By using sticky notes and whiteboards, participants were able to write down ideas as they come to their mind. Subject number seven stated the following; *"I write things in a notepad or sticky notes to randomly things that come out. I write it down before I forget the idea".* Four other instances about spontaneity were identified during the analysis. From this, we can determine that sticky

notes and similar tools, affords to capture ideas quickly that will later be part of a plan. Table 5.3 shows a summary of user preferences on manual planning tools and the relationship with principles of design. Refer to Appendix B for full tables

.

Table 5.3 Summary Manual Generic Planning Tool Preferences and Principles of Design

User Preference	Tool Used	Reasons for Tool Preference	Related Principle of Design
1	Weekly Planner, Desktop Calendar, Wall Calendar, Notes	Identify information by highlighting, marking, etc.	Afford to emphasize information, Visibility of information
2	Lists, Degree Plans, Desktop and Wall Calendars	Identify information by scratching/knowledge of user progress	Afford to emphasize information, Visibility of information
3	Sticky Notes, Notes, Whiteboard	Input information, write down ideas as they come to mind	Affords to capture ideas quickly
4	Desktop and Wall Calendars, Whiteboard	Information input/Aware of situation/Recall information right away	Visibility of information
6	Sticky Notes, Notes	Identify information/Prioritize actions	Visibility of information

Now, let us describe participants' preferences towards electronic generic planning tools. According to participants, when using Google calendar, e-mail and mobile phone in general, they were able to recall information such as events or pending activities. The main reason for this is because these electronic tools provide reminders in form of dialog boxes or auditive alarms that

let participant remember events. This user preference can be related to the principle of feedback; electronic tools provide the information necessary to know what actions are required next in their plan. For example, the following statement was from subject number six, *"I don't like to keep papers with me and I just rely on the email to remind me"*; and subject number one stated *"I do put like an alarm or something on my phone calendar to tell me I need to do that, so I don't forget"*. This preference was the most recurrent in the analysis; all participants in the study expressed their need for some type of feedback to remind them about specific actions.

Although auditory reminders were exclusively for electronic planning tools, two participants' mentioned the use of manual tools, such as sticky notes, to remind them about events. Participant number one mentioned, *"I write down notes in little sticky notes so I have them present, I have them in my computer, in my mirror so I can know what I have to do"*. In this case, we can say that users remember actions or events by having the information visible and no through feedback. Tools like sticky notes can be placed in areas where users can see the information at all times. Electronic tools remind users through feedback, manual tools remind users through visibility.

Another example of users' inclination to electronic tools is the ability to obtain actualized information. Participants' turn to electronic tools because that way they can be aware of changes in the information that can affect their plan. Participant number two stated that, *"the online degree plan helps because it gives you the updated class offerings for a particular semester. If you wanted to take it on spring and it's only offered in fall you need to see what other classes you can take…"* With the latest information, users are conscious of the situation they are in and need to be able to modify their plan, if necessary. Then, electronic planning tools afford to be aware of situations. Table 5.4 shows a summary of user preferences on electronic planning tools and the relationship with principles of design. Refer to Appendix C for full tables.

Table 5.4 Summary Electronic Generic Planning Tool Preferences and Principles of Design

User Preference	Tool Used	Reasons for Tool Preference	Related Principle of Design
5	Phone Calendar, Google Calendar, Outlook Calendar, E-mail, MP3 Players	Information recall by alarms	Feedback
10	Excel Spreadsheets	Input information without restrictions	Afford to input desired information
11	Electronic Tools in general	Aware of situation and modify plan if necessary	Affords to be aware of situations
13	Electronic Tools in general	Check information for knowledge of user position of in a situation; know where he or she is at	Afford to integrate information
14	Phone Calendar, MP3 Players	Check information	Afford to access information anywhere

5.3 Other User Preferences

The results from the analysis also identified user preferences that were not related to principles of design. These user preferences for manual or electronic generic planning tools were influenced by external factors such as technology limitations, technology availability and the environment where planning took place, among others. Also, there were two instances referring to the use of manual and electronic generic planning tools together in the creation of a plan. Table 5.5 shows the external factors that determined user preferences over specific generic planning tools.

Table 5.5 User Preferences and External Factors

External Factor	Tool Used	Reasons for Tool Preference	Instances
Personal Planning vs. Teamwork Planning	Google Calendar, Outlook, E-mails	Share of plans, plans need to be organized	*"We use Google calendar like when you have to share, we use that to know how are we going to coordinate activities together, it's more for teamwork"*
Privacy	Weekly Planner, Notes	Confidentiality of plans/Personal Style	*"If you look at my notes, you couldn't understand anything because I just write down things all over"*
Manual and Electronic Preference	Degree plans, Online Degree plans	Actualized information and input information by hand	*"I use a combination of the two. I can't just do the paper only or the online only"*
Technology availability	Manual tools in general	Electronic tools not available	*"I use my weekly planner because I don't always have access to a computer"*
Technology ownership	Phone Calendar	Do not own an mobile phone with planning tools	*"Probably if I had a Smartphone that would be a totally different, I would probably use that more."*
Environmental issue	Electronic tools in general	Preserve the environment	*"Another reason why I use my phone is because it's green, you know, going green, the environment, saving the planet."*
Technology Dependency	Electronic tools in general	Users are fond to electronic devices	*"...but honestly I ended up forgetting the planner and just put everything on the phone"*

CHAPTER 6

CONCLUSIONS

This chapter discusses findings in this research study and provides conclusions obtained from the work.

6.1 Discussion

This research study shows that principles of design such as affordance, visibility and feedback are factors that influence user's decision over the selection of a generic planning tool. But still, there are two principles of design that did not emerge during the study analysis; these design principles are mapping and conceptual model. One possible reason for this result is that generic planning tools already provide users with a good conceptual model and good mappings; in other words, users are able to structure the logic on how these tools work and how they are presented to them. The conceptual model behind each generic planning tool, electronic or manual, let users know the actions needed to use an specific tool e.g. notes and are meant to create lists, planners are meant for time organization. Also, some electronic generic planning tools provide users with physical analogies from manual tools; in other words, particular electronic planning tools provide users with natural mappings e.g. electronic calendars, like physical calendars and planners, are also divided by weeks, days and hour. This may be a reason why these two concepts were not evident in this research.

Even though the main purpose of the analyses in this thesis is investigation of user interaction with generic planning tools, manual and electronic, we need to consider other factors that influence user preferences when selecting a generic planning tool appropriate for their needs. The analysis of transcripts obtained from participants, identified seven new findings that supplement common principles of design. Some user preferences were detected only with manual generic planning tools and others only in electronic generic planning tools; however this does not mean that an action performed on a manual tool is exclusively for manual tools and viceversa with electronic planning tools. Spontaneity is one example. Nowadays, applications

such as “sticky notes” are available for Smart phones, which can allow users to be spontaneous when ideas come to their mind and write them down. External factors, such as user’s skill and ownership of technology may determine the inclination to use a manual tool. Another important factor is the environment where the planning takes place. Personal planning will not be the same as planning in a team. Electronic planning tools allow sharing important documents, information and other elements necessary in planning with other members in a team. Privacy also is an important issue. People prefer using weekly planners for their own activities; they do not like or want to share ideas with others about their plans. Still, this study provides clues about properties of sticky notes and why people like and prefer to use them. The data collected in this study provide insights on why people prefer one particular generic planning tool to others. It is important to mention that the results of this exploratory study were obtained from the statements of eight participants.

6.2 Conclusions

This research study identified and understands the preferences that people have about specific generic planning tools, especially the preferences when selecting manual or electronic generic planning tools. The qualitative analyses suggest that preferences to manual tools over electronic, and viceversa, are influenced by the design of generic planning tools. Principles of design such as affordance, visibility and feedback were identified as major factors in the selection of a planning tool that best fit people’s needs. The study also suggests that people are still fond of manual planning tools, such as weekly planners and calendars, even when the latest technology provides the same planning tools in electronic formats. However, we must take into consideration external factors that also affect in the selection of a planning tool. External factors, such as technology ownership and planning environment, may determine the type of generic planning tool planner’s use. Nevertheless, this research study was the first step for to improve how generic planning tools support users in the complex task of planning.

6.3 Future Work

This study provides insights on user preferences in generic planning tools. These insights are useful for the improvement existing generic planning tools or in the improvement, especially electronic tools. Nowadays, generic planning tools are available in mobile phones and other portable electronic devices making more people to turn to this new technology. With this phenomenon, it is imminent the necessity to design electronic planning tools that are useful and usable. However, other questions rose during the development of this research study.

Future work may focus on directly explore how people interact with electronic generic planning tools, and this is to support findings in this research study. Performing other type of usability testing, such as think aloud experiments, will capture preference and performance information simultaneously. Future work may also explore if the quality of plans are affected by the use of electronic generic planning tools. Are plans created better when using electronic planning tools? This exploratory study was a first step to determine the limitations of electronic generic planning tools and offer an opportunity in their redesign.

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APPENDIX – A

INTERVIEW QUESTIONNAIRE

INTERVIEW QUESTIONNAIRE

1. What generic planning tools participant's use?

- Do you have a plan for your graduation?
- Can you describe what is your plan?
- How did you create that plan?
    - What are the some of the things that you need to do in order to plan for your graduation?
- Do you use some type of tools to help you plan?
    - Which ones?

2. How do participants use the mentioned generic planning tools?

- How do you organize things that you need to do?
    - Why
- Can you give examples of the tools that you used?
    - Why
- How often do you look at your calendar or notes?
    - Why
- Which tool you feel let's you see how you're doing in terms of following your plan?
    - Why
- How do you recall the information necessary for your plan to make a decision?
    - Why

3. User Preferences

- What do you like about the tool that you mentioned?
    - Why
- What do you dislike about the tool you mentioned?
    - Why
- Why do you choose that tool?
- Do you think that the same tool but in other format (electronic or manual) will affect on how you plan?
    - Why
- How close do you feel you are able to create a plan with the tools that you use?
    - Why

APPENDIX – B

USER PREFERENCES AND PRINCIPLES OF DESIGN FULL TABLES

MANUAL GENERIC PLANNING TOOLS PREFERENCES AND PRINCIPLES OF DESIGN

User Preference	Tool Used	Reasons for Tool Preference	Related Principle of Design
Recognize type of information easily	Weekly Planner, Desktop Calendar, Wall Calendar, Notes	Identify information by highlighting, marking, etc.	Afford to emphasize information, Visibility of information
Mark down information	Lists, Degree Plans, Desktop and Wall Calendars	Identify information by scratching/knowledge of user progress	Afford to emphasize information, Visibility of information
Spontaneity	Sticky Notes, Notes, Whiteboard	Input information, write down ideas as they come to mind	Affords to capture ideas quickly
Big size	Desktop and Wall Calendars, Whiteboard	Information input/Aware of situation/Recall information right away	Visibility of information
Place information close	Sticky Notes, Notes	Identify information/Prioritize actions	Visibility of information
Write things down	Manual in general	Information recall	Affords to capture ideas by hand to memorize
Organize required things to do	Desktop and Wall Calendars, Weekly Planners, Lists	Break down activities according to time	Afford to arrange or sequence activities
Break down classes	Weekly Planner, Degree Plan	Break down activities according to time /Knowledge of user position of in a situation	Afford to arrange or sequence activities
Easy to forget	Notes	Recall Information	Tools do not provide auditive or other type of feedback
Hard to remember events	Manual in general	Recall information	Tools do not provide auditive or other type of feedback

ELECTRONIC GENERIC PLANNING TOOLS PREFERENCES AND PRINCIPLES OF DESIGN

User Preference	Tool Used	Reasons for Tool Preference	Related Principle of Design
Mark down information	Phone Lists, Phone Sticky Notes	Identify information by highlighting, marking, etc.	Afford to emphasize information, Visibility of information
Reminders	Phone Calendar, Google Calendar, Outlook Calendar, E-mail, MP3 Players	Information recall by alarms	Feedback
Organize required things to do	Phone Calendar, Google Calendar, Outlook Calendar, E-mail,	Break down activities according to time	Afford to arrange or sequence activities / Similar calendar conceptual model
Enter as much as information as desired	Excel Spreadsheets	Input information without restrictions	Afford to input desired information
Actualize information	Electronic Tools in general	Aware of situation and modify plan if necessary	Affords to be aware of situations
Have information in one tool	Electronic Tools in general	Check information for knowledge of user position of in a situation	Afford to integrate information
Portable	Phone Calendar, MP3 Players	Check information	Afford to access information anywhere
Information input restrictions	Phone Calendar	Restriction in information input/less or more information than needed	Do not afford to input desired information
Slow information input	Phone Calendar, Phone Sticky Notes,	Input information	Does not afford to capture ideas quickly
Small Size	Phone Calendar	Identify information	Small size: information not visible

CURRICULUM VITAE

Grisel Ventura-Luna was born on March 24, 1987 in Celaya, Guanajuato, Mexico. She is the second daughter of Raul Ventura Loya and Rosa Maria Luna Ramos. She graduated high school from el Colegio Lic. Manuel Concha "Marista" in 2004. In fall of that same year she enrolled at The University of Texas at El Paso. As an undergraduate student, she obtained experience in manufacturing working at ADC Telecommunications in Santa Teresa, NM as manufacturing intern. She graduated June 2009 with a bachelor's degree in Industrial Engineering. Upon graduation, she enrolled for graduate studies to pursue a master's degree in Industrial Engineering with concentration in Human Factors and Ergonomics. In fall 2009 she obtained a graduate research assistant position with Dr. Arunkumar Pennathur, under whom she authored and co-authored two publications and lectured at the HFES and IERC annual conferences. During her time as a master's student she was actively involved in student organizations at the university such as Alpha Pi Mu and HFES, where she served as president and founding president, respectively.

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