5-1-2008

The Importance of Technology Design and Usability

Jonathan R. Deutsch
University of Pennsylvania, jon@jondeutsch.com

Submitted to the Program of Organizational Dynamics in the Graduate Division of the School of Arts and Sciences in Partial Fulfillment of the Requirements for the Degree of Master of Science in Organizational Dynamics at the University of Pennsylvania
Advisor: Larry M. Starr

The Importance of Technology Design and Usability

Abstract

Technology is playing an increasing role in our daily personal and professional lives. While the capabilities of new technologies (i.e., “hi-tech” solutions) have enabled people to be more productive at work and at home, I argue there is an increasing gap between hi-tech capabilities, and how hi-tech solutions interface with end users. This gap has the potential to negatively affect human and individual capital, which is why it is important to highlight the issues, challenges and impact of the usability and design of these hi-tech solutions. This thesis will take the humanistic perspective and argue that technology design has not kept up with technology capabilities, creating undesirable effects on people’s productivity -- and enjoyment -- as they interact with hi-tech devices, software and information systems. In addition, suggestions for how to overcome this gap are offered through the analysis of existing organizational dynamics, as well as offering new models from which to base usability and hi-tech design.

Comments

Submitted to the Program of Organizational Dynamics in the Graduate Division of the School of Arts and Sciences in Partial Fulfillment of the Requirements for the Degree of Master of Science in Organizational Dynamics at the University of Pennsylvania

Advisor: Larry M. Starr

THE IMPORTANCE OF TECHNOLOGY DESIGN AND USABILITY

by

Jonathan R. Deutsch

Submitted to the Program of Organizational Dynamics
in the Graduate Division of the School of Arts and Sciences
in Partial Fulfillment of the Requirements for the Degree of
Master of Science in Organizational Dynamics at the
University of Pennsylvania

Philadelphia, Pennsylvania

2008

THE IMPORTANCE OF TECHNOLOGY DESIGN AND USABILITY

Approved by:

____

Larry M. Starr, Ph.D., Program Director and Advisor

ABSTRACT

Technology is playing an increasing role in our daily personal and professional lives. While the capabilities of new technologies (i.e., “hi-tech” solutions) have enabled people to be more productive at work and at home, I argue there is an increasing gap between hi-tech capabilities, and how hi-tech solutions interface with end users. This gap has the potential to negatively affect human and individual capital, which is why it is important to highlight the issues, challenges and impact of the usability and design of these hi-tech solutions. This thesis will take the humanistic perspective and argue that technology design has not kept up with technology capabilities, creating undesirable effects on people’s productivity -- and enjoyment -- as they interact with hi-tech devices, software and information systems. In addition, suggestions for how to overcome this gap are offered through the analysis of existing organizational dynamics, as well as offering new models from which to base usability and hi-tech design.

ACKNOWLEDGEMENTS

Appreciation is extended to Dr. Larry Starr, my capstone course advisor, for his insights, interest and guidance during the preparation of this document. I would also like to thank Brenda Kinnear for her support, advice and encouragement throughout my tenure in the Organizational Dynamics program.

LIST OF TABLES

LIST OF FIGURES

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

Background

As a member of “Generation X” and growing up in a middle-class lifestyle in the United States, I have been fortunate to live through an exciting and dynamic phase of the technological revolution – a time when personal computing, business management software and personal devices made substantial inroads into most societies worldwide. According to the CIA World Fact Book (2007), there are over 2.1 billion cell phones used worldwide, and according to the Computer Industry Almanac (2007), there are nearly 1 billion personal computers in use worldwide – and these are just two examples of the depth of technological penetration since these technologies initially emerged in the late 1970s. To help set the context and to make this change more tangible, consider what has transpired since I was an adolescent in the 1970s.

Before the remote control, I needed to get up off the couch to change the station on the television. Before the automatic teller machine (ATM), I had to go to a local bank branch to retrieve money. Before the mobile phone, I was only accessible to others when I was at home or work, near a landline phone. Before the World Wide Web, I was unable to quickly and easily locate up-to-date information for use in my personal and professional life. Before e-mail, I could only communicate with remote friends through writing letters or making expensive long-distance telephone calls. Before global positioning system devices (GPS), I was more hesitant to drive to places that I was not familiar with. Before the video cassette recorder (VCR), and well before the modern digital equivalent (DVRs, TiVo and similar digital video recording devices), I needed to time my entertainment schedule to the marketing decisions of the major television network programmers. Before the personal computer (PC), I had no single tool to support my interest in communicating, processes and managing information. The list could go on, but this provides a representative sample of the impact that the trajectory of technology has had on my life, as well as the lives of millions of others in and around my age group and socio-economic status.

Technology is a broad subject, and its scope can vary greatly based on context. Yet, there is little existing research on pre-conceived hierarchical or taxonomical literature that encompassed the various types of technology. An empirical taxonomy of advanced manufacturing technology (Jonssen, 2006) exists, but is not comprehensive enough. Due to the lack of a commonly accepted taxonomy of technology, I will define a specific area of technology to ensure clarity and scope. For the purposes of this thesis, "high technology" (or "hi-tech") is the collection of technology that includes personal computing hardware and software, enterprise-wide business management software and digital devices. The common threads among this collection of technology is that each are designed to be used by a significant number of individuals or groups to accomplish a required or desired task (Table 1).

Table 1. Defining "Hi-tech"

	Personal Computing	**Business management software**	**Digital devices**
Scope	Hundreds of millions of individuals	Employees in medium-to-large sized organization	Billions of individuals
Examples	PCs, Macs, PC Operating Systems, PC software, peripherals, networking	Employee Intranets, Customer Relationship Management Systems (CRMS), Human Resource Management Systems (HRMS), Travel & Expense systems (T&E)	Mobile phones, personal digital assistants (PDAs), portable media players (PMPs), digital cameras, televisions, home theater systems, automatic teller machines (ATMs)

Purpose of Thesis

Through this thesis I will argue that hi-tech solutions have experienced such a rapid trajectory in increased capabilities since the 1970s, that the focus, orientation and discipline of the user experience for the people interacting with these technologies has fallen far short of standards set by other types of technologies. And I will further argue that this gap in hi-tech usability is putting a strain on human capital potential that reduces efficiencies, as well as quality of life.

In Chapter 2, I frame the problem of poor hi-tech usability and design in the context of a “design gap” (Deutsch, 2007) by first summarizing the fundamental concepts of the design gap, and then apply the design gap principle to the field of hi-tech usability. In Chapter 3, I use the television series Star Trek as an instrument to help describe how then-future hi-tech usability was seen through the lens of science fiction writers who were basing usability expectations on existing mechanical-electrical technology in the 1960s. In Chapter 4, I review the brief history and current state of the World Wide Web with respect to usability, and suggest how open standards and bottom-up design naturally creates more usable outcomes. In Chapter 5, I provide context and relevancy through examples and case studies of existing hi-tech tools and the state of their usability. In Chapter 6, I propose a non-linear model of the technology usability environment, describing the interrelated elements and their relevance to one another. Through this model, I identify the issues that are creating the problems in high technology usability we experience today. In Chapter 7, I conduct an analysis and present my opinions on the specific issues driving the problems currently faced in the domain of hi-tech design. In Chapter 8, I examine the costs of poor usability in the context of human capital (people as resources) and individual capital (people as consumers), and argue that hi-tech usability problems are not limited to organizational and design inefficiencies, but extend to end-users becoming a more active part of the solution. In Chapter 9, I propose recommendations for hi-tech vendors, technology designers, and end-users based on the findings and concepts presented, and argue that change is required by all of these stakeholders to ensure that usability keeps up with the rapid pace of hi-tech capabilities.

CHAPTER 2

HI-TECH USABILITY ISSUES AS DESIGN GAP

Design Gap

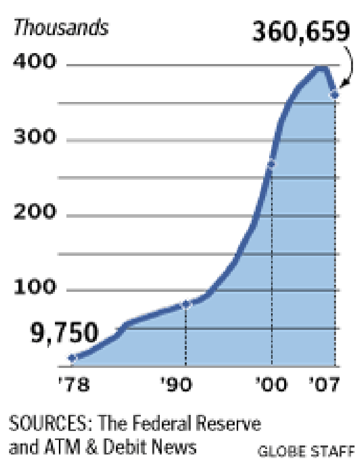
In 2007, I considered a design gap the bridge between “what is available” and “what is needed or desired.” When a gap exists between these two states, it is a result of two primary factors: a focus on “what is available” and a lack of effort in assessing what is truly needed or desired. “What is available” is an umbrella term that includes existing knowledge, accessible materials and technology, which, combined, provide us with existing and potential capabilities. In the hi-tech sector, the trajectory of “what is available” is represented by Moore’s Law -- the hyperbolic growth of digital computing power combined with an inversely proportional size and cost (Schaller, 1997). Over the past forty years, the rapid introduction of new hi-technology capabilities created so many new opportunities that the very technology – no matter how usable or well designed – was substantive enough to flourish in the free market. A case can be made that there is little need to invest in a design process if the raw capabilities available are all that are needed to solve a problem.

In the context of the design gap, high technology has not needed to be as usable as other technologies due to the overwhelming capabilities the raw technology has thus far brought to people, problems, and society. The free market helps to ensure that competition spurs innovation, but does high technology follow the trends of other technologies? To explore the similarities across hi-tech solutions, two examples are presented demonstrating design gap dynamics over the product lifecycle.

Automatic Teller Machines

In 1973, Automatic Teller Machines (ATMs) were launched as a new technology designed to transform personal banking and reduce the cost of operating bank branches. Despite the fact that early ATMs were not able to access financial information from a network (they were "off line"), only dispensed cash, and were difficult to use (Kendrick, 2001), the rate of adoption and proliferation surged from 3,000 in 1973 to 396,000 in 2005 (Hall, 2006) (see Figure 1).

Figure 1. ATMs in the United States



With such an unusable system in its early stages of the product lifecycle, it might seem surprising to see the initial growth from 3,000 in 1973 to 9,750 in 1978. One way of explaining this is the overwhelming advantage this new device brought to the market. In essence, the innovative capabilities that the base technology of ATMs brought to consumers was substantial enough to overcome any usability hinderances. Even though ATMs enjoyed steady growth for years, it was not until the mid-1990s when ATM machines became fully networked, inter-compatible and globally available. The argument can be made that these new, key ATM features enhanced usability of the base technology enough to help spur an era massive adoption from 1995 through 2005.

Personal Computers

The first IBM personal computer (PC) was commercially released in 1981, initiating the personal computer market for businesses and consumers. Up to this point, home computing was limited to niche industries of hobbiests who would build their own computer, and business computing was limited to using “dumb terminals” that simply displayed text sent to them by a central mainframe. With the release of the first mainstream PC came, for the first time, a standard computing platform that software developers could rely upon to invest in. This standard platform would be deployed in businesses, enabling a reliable platform for business tools and information systems to be developed. Similarly, this same PC architecture would standardize the computing platform in homes, enabling a standard environment to write personal productivity software for personal computing.

With all of these fundamental technological and environmental advantages over the prior state (i.e., no standard PC platform), the fundamentals offered by the technology (or “what was available”) was all that was needed or desired at the time. In other words, the design gap between “what was available” and “what was needed or desired" was addressed by the very nature of the technology itself – there was no competitive rationale to conduct a full design analysis to optimize the user experience because what was available was "good enough."

But it was only "good enough" until competitive threats in the form of usability focus and innovation challenged the status quo and alerted users that they could, in fact, expect more from their personal computers. In 1984, the Apple Corporation released the MacIntosh PC which significantly raised the bar on what PC users felt they should expect from a PC experience: a graphical operating system, a mouse to navigate the screen, and the ability to run several applications simultaneously. These user-centric innovations almost instantly shifted, in the context of the design gap, what *was needed or desired*. Almost immediately, the Microsoft Corporation (which up until this time was satisfying PC users with a text-based operating system called MS-DOS, an operating system that relied on function keys to navigate interfaces) responded in November, 1985 by introducing a graphical version of MS-DOS called Microsoft Windows. Microsoft was able to respond so quickly to the MacIntosh because there were pre-MacIntosh offerings from Apple (i.e., the Apple Lisa) that also had the graphical operating system and mouse controls. The dynamic between Apple resetting the bar of *what was needed or desired* and Microsoft advancing the base technology of *what was available* has been in play ever since this initial competitive battle. This dynamic has steadily increased both ends of the design gap, ensuring that personal computing would advance at a historic pace (Table 2) for non-trivial technology (where non-trivial is defined as an average cost of over $500 US Dollars).

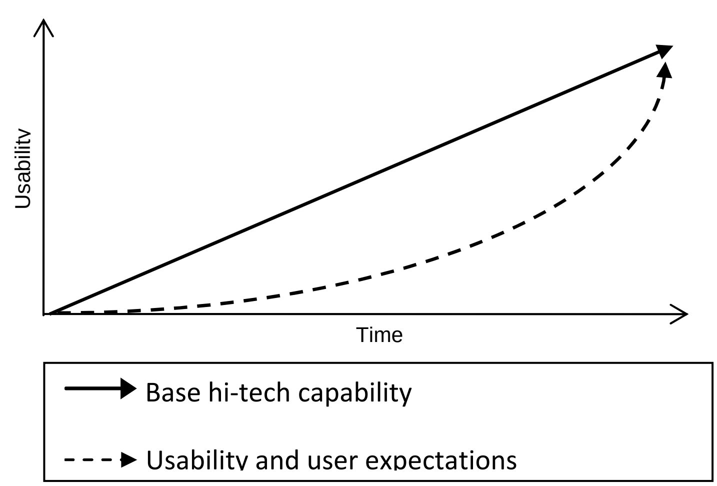
Table 2. Number of PCs Sold

	1985	1990	1995	2000	2002	2007
USA:						
PCs-in-use (#M)	19.8	48	86	177	206	255
PCs-in-use per 1,000 people (#)	82.9	192.2	323.9	629.5	712	831.3
Cumulative PC Sales (#M)	21.4	64.5	139	317	403	661
Worldwide:						
PCs-in-use (#M)	31.4	98	226	523	663	1,069
PCs-in-use per 1,000 people (#)	6.5	18.7	40	86.2	106.4	161.8
Cumulative PC Sales (#M)	35.6	129	329	815	1,077	1,952

Souce: Computer Industry Almanac, Inc.

While hi-tech usability does drive growth and advances over the evolution of a product lifecycle, usability itself is not required for success of a technology, at least at its beginning stages where the base technical capabilities of the offering are substantive enough to overcome any usability hurdles (see Figure 2). As well, once expectations are raised, the market responds with updated offerings that satisfy these expectations (i.e., what is needed or desired).

Figure 2. Observed Trajectory of High Technology vs. Usability in Product Lifecycle



CHAPTER 3

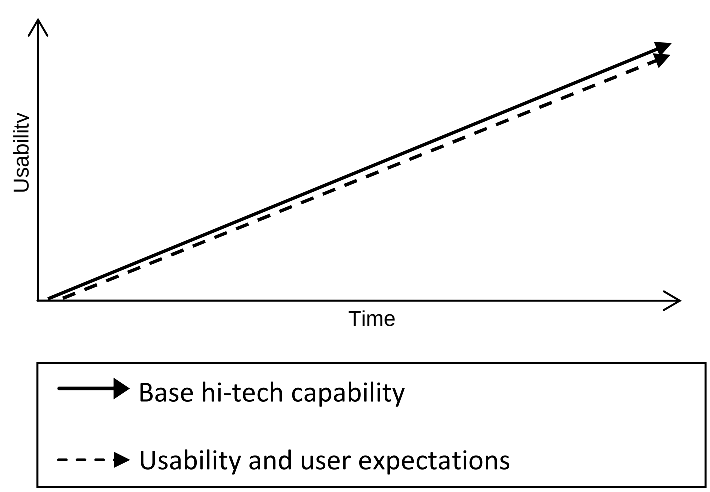
USABILITY EXPECTATIONS ACROSS TECHNOLOGIES

Trajectory of Technology and Usability

In Chapter 1, “hi-tech” was defined as a specific subset of technologies that are the focus of this thesis. In order to draw meaningful contrasts to other types of technology, I will now define another technology phylum: mechanical-electrical technology. Mechanical-electrical technology encompasses mechanical devices that are powered by electricity. Examples include cathode ray tube-based televisions, radios, home appliances, copy machines, and similar items that do (or at least did) not require digital, integrated circuit-based technology to function. I am defining this particular phylum of technology in order to demonstrate the observation that there is a distinct usability contrast between high technology and mechanical-electrical technology. In Chapter 2, the concept of a design gap was explained, and two examples of hi-tech design gap dynamics were presented to show how the gap shrinks throughout the hi-tech product lifecycle. In this chapter, a contrast is drawn through a comparison of hi-tech design gap dynamics and mechanical-electrical design gap dynamics.

At the turn of the 20th century, communications, transportation and storage technologies rapidly progressed due to the broad reach and accessibility of electricity. Technologies such as the radio, television, telephone, recording devices (i.e., tape recorder), cameras, record players, and the like emerged as mainstream technologies that improved the quality of life for those who could afford them. These technologies helped drive an economic boom in the United States through the 20th century: adjusted per capita income rose from an adjusted $4,200 in 1900 to $33,700 in 1999 (U.S. Bureau of Labor Statistics, 2001). While mechanical-electrical technology certainly had a significant impact on modern American (and global) life, what is of interest is the apparent natural usability of such technologies for people. The very nature of mechanical devices lend themselves to interactive models that map more naturally to the physicality of people. Nevertheless, the usability of mechanical-electrical devices do not seem to follow the trajectory model of high-technology tools as indicated in Figure 2. Instead, these mechanical-electrical devices not only started off being relatively usable as new, innovative products, but remain consistently usable throughout the product lifecycle. I propose the trajectory in Figure 3 to demonstrate the usability of mechanical-electric technology in contrast to hi-tech usability.

Figure 3. Mechanical-Electrical Technology and Usability Trajectory



High Technology As Seen Through the Mechanical-Electrical Lens

In the mid-1960s, high technology was entering the realm of the possible. Digital devices based on semi-conductor technologies were being developed in hi-tech research and development facilities such as Bell Labs. While most people still interacted with mechanical-electrical devices, there was a growing understanding and excitement about a digital future where semi-conductor technology would unleash a new, hi-tech future. With this excitement came the belief that high technology could solve meaningful problems facing our society, a common dream of futurists and optimists. Gene Rodenberry, a screenwriter and producer, dramatized his vision of how high technology would create a human utopia in the television series Star Trek (1966). He presented a future where the human race had transcended worldly problems, and thanks to the "wonder of technology," had enough resources to explore the universe just for exploration's sake.

The enormous popularity of Star Trek led to several commercial films and additional television series as well as a global cult following. It also has entered our cultural lexicon as a metaphor for technology with high usability and functionality, and is commonly credited as a source of inspirations for inventors world-wide. Yet one of the more fascinating views into Star Trek does not seem to have been researched through my scholarly searches: the inherent usability of the hi-tech tools in the Star Trek version of the future.

Star Trek Usability

The Starship Enterprise was the space vessel that the protagonists of Star Trek occupied as they explored "strange, new worlds." Unlike any vessels designed in or around 2008, the fictitious Enterprise was managed by a central "operating system" computer that had full operational control of all aspects of the vessel. As a result, the Enterprise was a fully integrated system, incorporating transport, environmental, security, weapon and hull integrity management, as well as occupant, sustenance, and health support systems. All of this is easy enough to dream up for a science fiction writer, but what is striking is that all of this control was accessible through natural language control. In other words, the captain (or anyone with the right set of permissions) could instruct the ship's computer to conduct an activity through natural English language commands (i.e., "Computer, shut down all life support systems." or "Computer, what is the chemical make-up of the atmosphere of the planet in front of us?"), and the ships' operating system would do the work of converting these requests into the various sub-routines that the computer needed to in order to execute commands. In 2008, we have access to high technology not so far removed from the dreams of the visionary science fiction writers in the mid-1960s, yet we have not put enough focus and efforts into creating such human-centric operating systems. We are still typing primarily as an input device for our operating systems (PCs, phones, PDAs, iPods, remote controls), and we are still expected to understand the inner command structure of computerized systems (i.e., selecting menu/tools/calendar on a mobile phone to see what day of the week May 19, 2008 lands on).

The crew of the Enterprise would always leave the vessel with two devices: a "communicator" and a "tricorder." These hand-held devices performed essential tasks for crew while they were remotely exploring uncharted territory. The "communicator" resembles today's cellular phones. In fact, the design of the first Motorola flip-style cellular phone, named the StarTAC, was inspired by the Star Trek communicator device (see Figure 4). The imagined user experience for the Star Trek communicator is remarkably similar to what cellular phones offer people today. In this example, user experience rooted in the mechanical-electrical age mapped reliably to today's hi-tech counterpart. This should not be a surprise, as both the communicator and today's cell phone share a common lineage with the mechanical-electric telephone. The wirelessness and speakerphone of the communicator were some of the visionary aspects of the original communicator that have been fulfilled by hi-tech progress. However, it is worth noting that the functions not based on the mechanical-electric foundational technology (texting, appointments, web browsing, etc.) in today's cell phones do not share the same level of usability as the fundamental phone functionality.

Figure 4. Motorola StarTAC and Star Trek Communicator

The tricorder, however, has no hi-tech equivalent to-date. The tricorder, as envisioned in Star Trek, acted as an all-purpose scanner/analyzer device, automatically performing an ad-hoc scan and analysis on whatever it was pointed towards by its operator. The specific type of usability inherent in the tricorder that does not exist in many of today's hi-tech devices is what I term physical context-sensitivity -- an orientation towards the physical space versus the virtual space. Context-sensitivity is a usability attribute that is rarely applied to today's hi-tech tools because hi-tech tools are generally not designed to interact with physical space and their mechanical-electronic counterparts. For example, automobiles are designed to interact with physical space, so a natural technology to evolve in cars is the shock absorber. Conversely, the majority of today's hi-tech tools (cell phones, software, PCs, iPods, GPSs, etc.) are designed to primarily interact only with the virtual, hi-tech world (i.e., with other hi-tech tools, technologies and networks). As a result, the context sensitivity of most hi-tech devices is limited to their interaction with each other in the virtual world.

To help demonstrate the contrast between physical and virtual world context sensitivity, two features of the Microsoft Zune (Microsoft's equivalent of Apple's iPod) personal media player will be described: wireless information access and anti-skip technology. Using wireless internet technology (WiFi), the Zune can access information and synchronize a music library from a remote database when WiFi is available. This context-sensitive feature is focused the virtual world (the device, the network, and the database), not the physical world where the users of the Zune spend most of their time. Anti-skip technology is essentially a "shock absorber" technology designed to protect the internal hard drive from shocks as the device is moved about in the physical world. The anti-skip technology helps ensure smooth playback by avoiding skipping from the physical jolts to the unit. These two technologies help illuminate how different types of technologies (hi-tech and mechanical-electric) impact the usability of a hi-tech device. This comparison also demonstrates that the anti-shock feature that involves physical world usability is more core to the fundamental function of the Zune, and that the virtual world-focused feature of WiFi-synchronization is not only value-add, but requires a complex process to ensure security and access are configured properly. In addition, the virtual-world feature would not be of much use if the physical-world usability issues weren't already addressed. These two Zune features serve to underscore the difference between a physical and virtual context-sensitive usability.

Beyond the Zune and its brethren of portable music players, there are plenty of examples of contemporary technology design omitting physical world context sensitivity. For instance, most personal computers do not automatically respond to user proximity to control their on/off/sleep states, most televisions do not respond to hand gestures to control power or channel changes, and most stereos do not automatically mute when a phone rings in close proximity. These are just a few examples of where physical context-sensitivity could be employed in our current slate of hi-tech devices.

Similar to the Zune's anti-skip functionality and the "missing" physical-context innovations above, the tricorder's extensive orientation towards physical context sensitivity arguably renders it a more innately usable device for its users. Of course virtual context sensitivity features and functions can add value, and that devices require both contexts to remain competitive in the marketplace. But the emphasis on virtual context sensitivity appears to be out of balance in high technology: In researching today's equivalent to the tricorder, I have not found any devices of similar ilk that have progressed beyond the research and development stage.

From this perspective, I suggest that "Star Trek usability" is a result of visionary science fiction writers who were basing the future abilities of technology on what was immediately on the horizon in terms of digital technology, but grounded in the relatively ease of usability inherent to mechanical-electrical technologies they lived with at the time.

CHAPTER 4

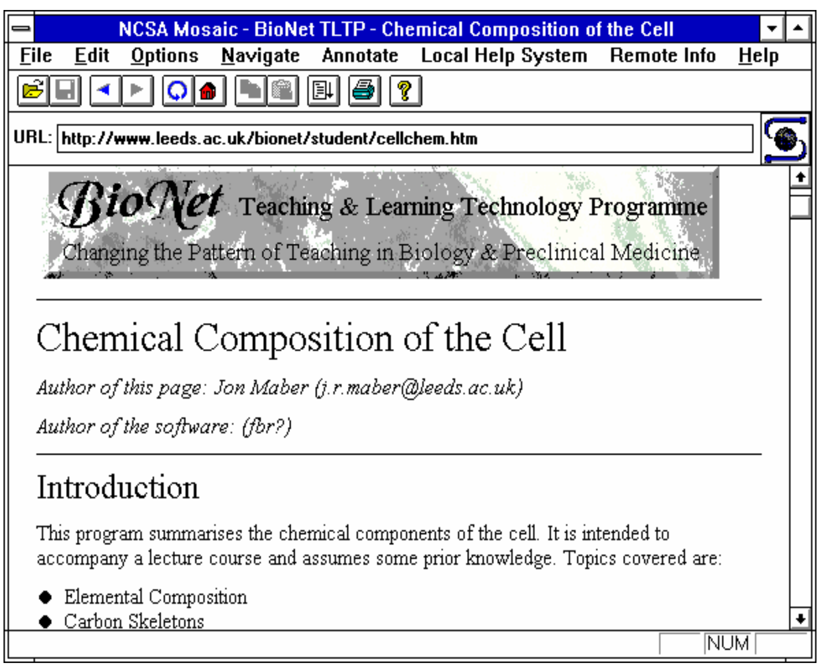
THE WORLD WIDE WEB AND ITS IMPACT ON INTERFACE DESIGN

The World Wide Web was initially released for public use when the first web browser was launched in February 1993 (World Wide Web Consortium, 1995). The web browser was a revolutionary piece of software in that it was simply a formatter of information that existed on remote servers. Because the web browser rendering standards were based on previously devised standards for formatting text and linking content items to one another, simplicity drove the architectural ethos of the web browser. This simplicity allowed the web browser to be easily adopted by not just the engineers who developed it, but most anybody who had any experience using personal computer software.

Web 1.0

When inspecting the first generation web browser (see Figure 5) written for Microsoft Windows, there are clear examples of how user interface simplicity lent itself to one of the fastest adoption rates in history – from 50 users in 1993 to 45 million users in 1999, merely six years later (Crowston, 1997). The first example of user interface simplicity is that the menus on the top of the application are, for the most part, task-based. Contemporary user interface practices dictate that task-based navigation “solves many problems in user interface design” (van Welie, 2006). The next example is that the toolbar (the row of icons below the menus) replicated the existing interaction model of tape player or VCR; with “back,” “forward” and “stop” navigation. While it might seem obvious to map an interaction scheme to something that already exists, it is, oddly, a rare occurrence in computer software. Another usability success included a graphical icon on the top-right of the window that indicated when content was loading, and when it had finished loading content. This icon helped set expectations of performance and status at a time when the World Wide Web was much slower than it is today. Finally, a critical component to a user-friendly interaction model is forced simplicity. During the early years of the World Wide Web, the primary purpose was to navigate to and access published content, which helped enforce this one-directional model of information access simplicity. In Figure 5, a graphical banner followed by formatted text represents the content. The complexity of the formatting in the window was variable, and could range from simple to the complex; but despite this, the content was still limited to images and text in various styles.

Figure 5. First Generation Web Browser



There were several additional factors in the continued rapid adoption of the web browser. According to Hsiang Chen and Kevin Crowston's study on the web's rate of adoption (Crowston, 1997), four factors were considered seminal. The first factor was the "cost-benefit dynamic"; i.e., the browser and the information accessed was free. The second factor was "compatibility:" the browser was a standards-based interpreter of formatted information, and the information on servers was formatted by pre-existing standards. The third factor was "trialability:" the browser was accessible to anyone with an internet connection. The fourth factor they identified was "observability:" the items that enable the web browser to exist are innately observable: a computer, modem, monitor and phone line. In their analysis, Chen and Crowston acknowledge what is being asserted here – that the lack of complexity of the software and the information being accessed helped enable rapid adoption.

Web 2.0

Web 2.0 was coined by Tim O'Reilly (CEO, O'Reilly Media) in 2005 to describe the second generation of web technology and applications. This second generation of the web is multifaceted, but the areas of Web 2.0 that are of interest to advance the ideas in this thesis are the interactive components. By interactive, I am referring to the web's increasing ability to capture as well as broadcast information. In Web 1.0, the World Wide Web was primarily a broadcast medium: a user decided which site to visit, and would then read and/or experience the content on the website. In fact, until 2005, the vast majority of communication was one-directional -- from web server to browser. To demonstrate this dynamic, studies on internet traffic as late as 2003 only looked at "browser requests" which are essentially "clicks" in a web browser (Hernandez-Campos, Jeffay & Smith, 2003). One of the most significant models that define Web 2.0 is that site visitors could do a lot more than simply click on links – they could interact with sites in new ways. These new interaction models helped transform what the World Wide Web could be and could do, which is why the "2.0" moniker has been a widespread organizing principle.

One of the many ideas introduced with Web 2.0 was a "web site as an application," where web sites transformed from static entities that conveyed text and graphical information into dynamic, interactive destinations for visitors. Two of the most influential and defining Web 2.0-style web applications to emerge are blogs and wikis (Strategic Finance, 2008). According to Webopedia (2006), an on-line encyclopedia dedicated to computer technology, a blog is:

> Short for web log, a blog is a Web page that serves as a publicly accessible personal journal for an individual. Typically updated daily, blogs often reflect the personality of the author.

According to Webopedia (2006), a wiki is defined as

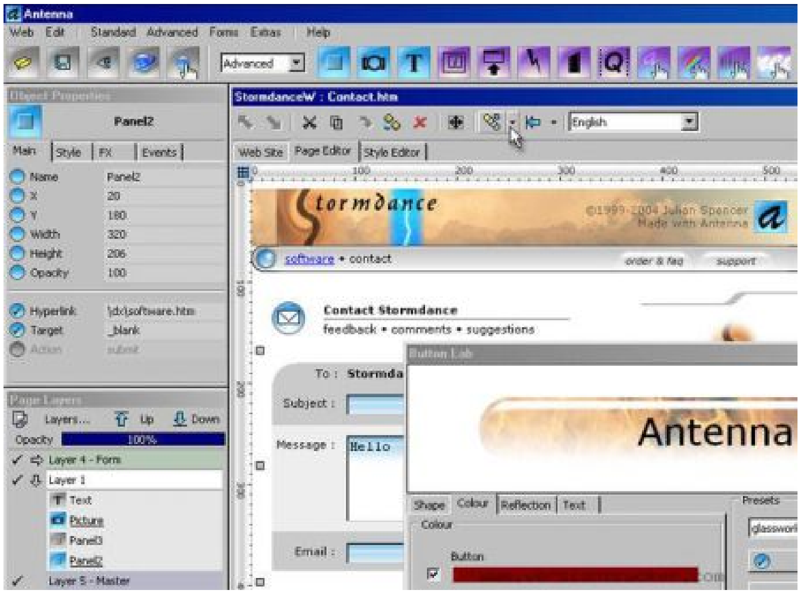
> A collaborative Web site [which] comprises the perpetual collective work of many authors. Similar to a blog in structure and logic, a wiki allows anyone to edit, delete or modify content that has been placed on the Web site using a browser interface, including the work of previous authors. In contrast, a blog, typically authored by an individual, does not allow visitors to change the original posted material; only add comments to the original content.

These Web 2.0 applications are important components to the topic of hi-tech usability because their very success is, at least in part, predicated on the usability of the management tools built-into these applications.

Blogs and Usability

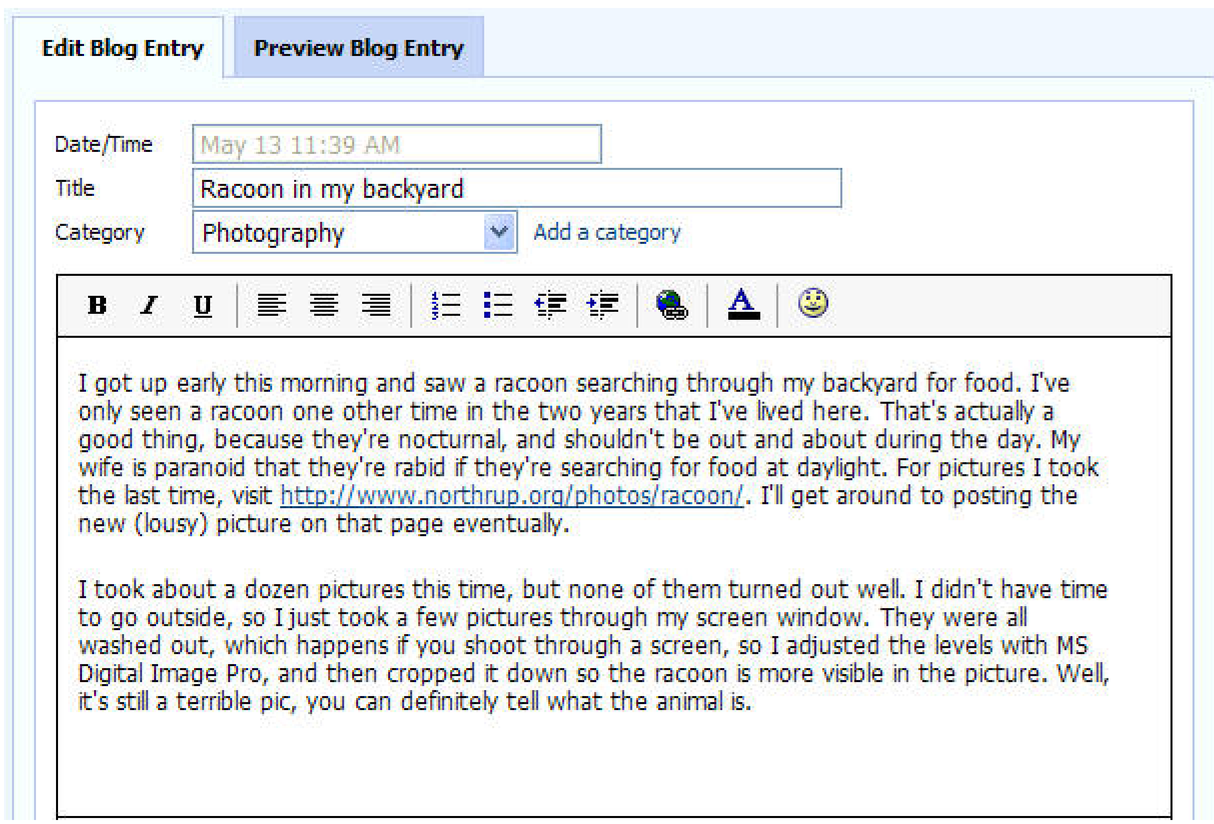
A blog might seem like just another type of website, and in many ways, it is. Like websites, blogs have content, graphics, navigation, hyperlinks, and all the standard elements of websites. But what makes blogs very different from other types of websites is the user interface for contributing content. Creating a website from the outset requires planning, and, at a minimum, some technical savvy as well as a design sense to ensure the page appears presentable and attractive to visitors. These barriers to entry limit the number of potential website creators to a very small segment of the population. Figure 6 presents an example of the complexities involved in creating a traditional web site.

Figure 6. Website Builder User Interface



A fundamental differentiator of the blog is its content management user interface. While it is understandable that the mainstream media and the public's interest in blogging is focused on the bloggers themselves (i.e., the content is what is interesting to the general public, not the technology), one of the great untold stories in my view is that the usability of a blog's "back end interface" (i.e., management interface) is remarkably simple and easy to learn without training for people already familiar with PCs (Figure 7).

Figure 7. Blog Content Entry User Interface



The blog entry user interface is simple enough to allow and enable people who are not technical to publish their content with very little training, knowledge, or technical skills. This significantly lowers the barrier to entry for non-technical people, enabling a new dynamic: writers who might not be technical now have access to technology to self-publish. "Traditional" websites still require people to have a modicum of technical and design savvy, which serve to erect technical and design barriers that limit pure writers' ability to self-publish, at least on their own. Over 218 million blogs exist as of Feb. 2008, and according to the American Political Science Association (2008), blogs now "occupy an increasingly important place in American politics." I argue that the rapid growth, success and impact of blogs is directly related to the usability and design of the management and user interfaces of blog software.

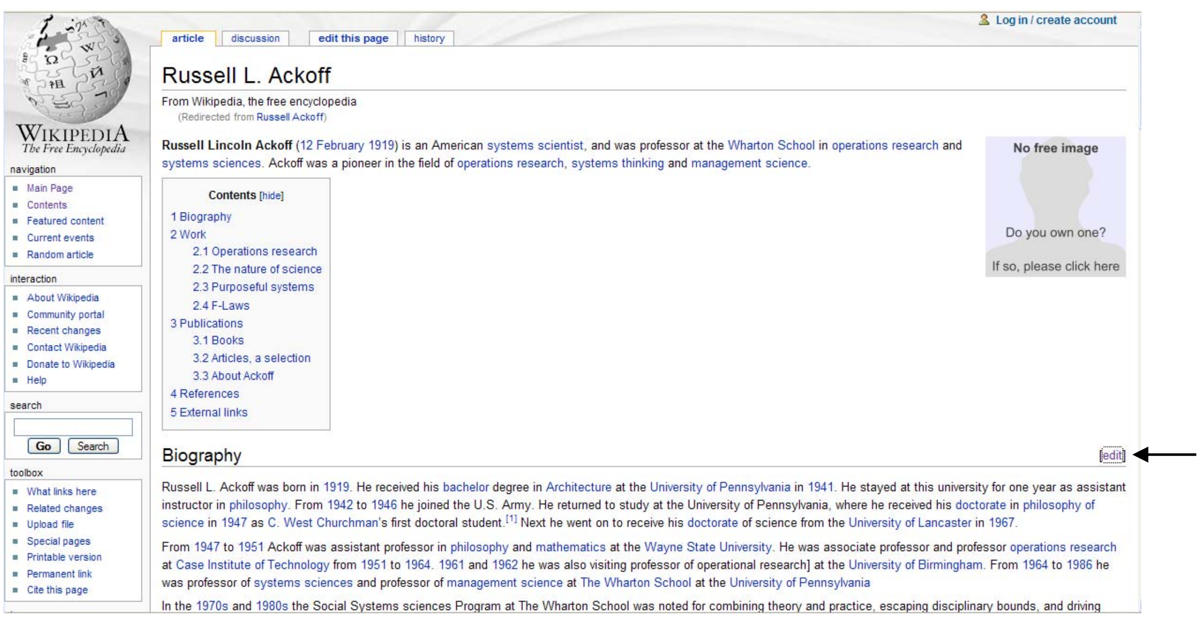
One of the reasons for this inherent usability may be a result of what design and usability expert Donald Normal calls a "natural mapping" to an existing, obvious relationship to an existing model (Norman, 1990). Blogs are the digital children of paper journals or diaries, which is an existing publishing model that most writers are already familiar with. In fact, recall the definition of blog above: the name "blog" comes from the term "web log," meaning a personal log or journal for the web. This lineage to the simple personal journal might help explain the usability success in this Web 2.0 application. Further, it is interesting to consider that when a high technology has a "natural mapping" to an existing model, that this existing model is likely in the physical space, and may have a relationship to an existing mechanical-electric (or even less technical) tool.

Wikis and Usability

Another hallmark Web 2.0 application is the wiki. In the context of Web 2.0 technologies, wikis and blogs are commonly grouped together as new tools that have enabled a new type of use of the World Wide Web. Yet, these are in fact very different types of applications: a blog is a tool for writers to journal their thoughts in reverse-date order, and a wiki is a tool for groups to collaborate in updating web pages.

It is not functionality, but Web 2.0 usability that blogs and wikis have in common. Wikis, like blogs, break down the barrier to content entry. In a wiki application, editing a page of content is almost as simple as reading a page of content: Simply navigate to a page on a wiki-driven site, click on the “edit this page” link, and begin editing the page by typing, deleting, or modifying existing content. Wiki-style web sites naturally become quite collaborative due to their simplistic and implicit editing metaphor. Below is a screen capture of Wikipedia, one of the pre-eminent wikis on the web.   As of April 8, 2008, Wikipedia is comprised of 2,324,371 pages of information similar to Figure 8. Unlike traditional web pages where content is read-only, wiki pages have “edit” links that allow most any visitor to edit the page they’re on (Figure 8).

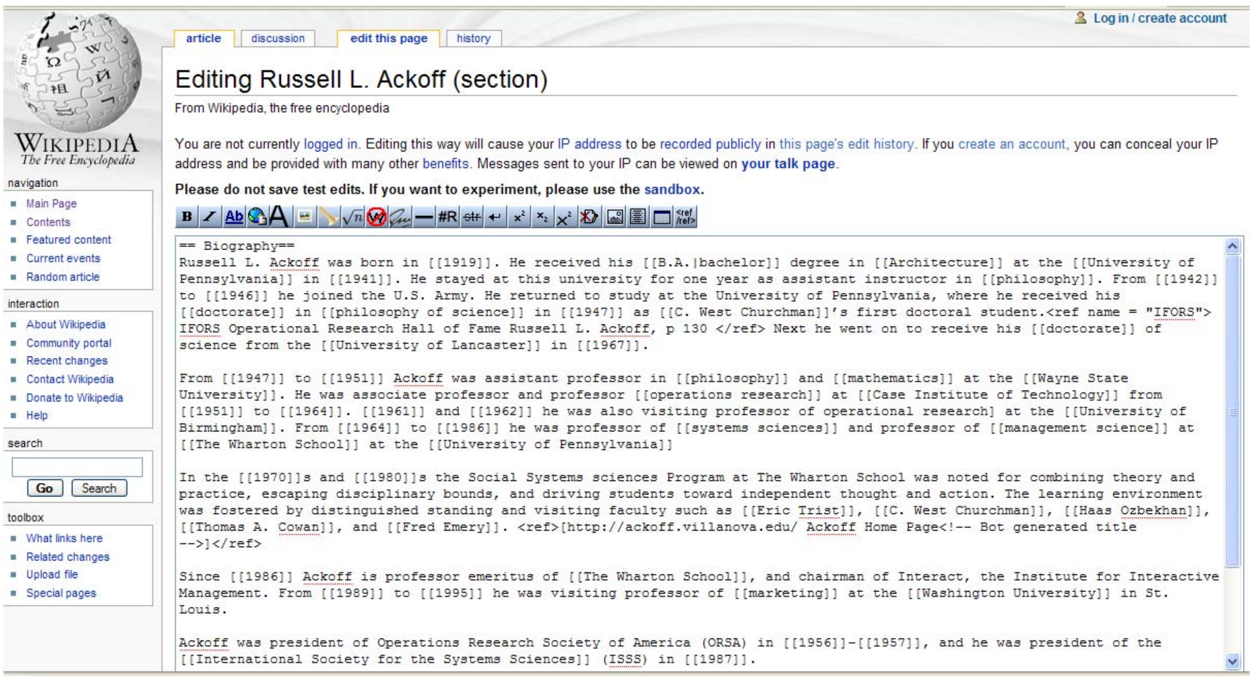
Figure 8. Viewing a Page on a Wiki Site*



*Notice the [edit] link near the bottom-right

Once a visitor clicks the edit link, they are immediately brought to an updated view of the same page: the wiki edit view (see Figure 9). This “in place” editing is another example of Web 2.0-style usability in the management interfaces of web applications.

Figure 9. Editing a Wiki Page*



*After clicking [edit], the same page loads, but is now editable by the visitor

The World Wide Web as a Unique Facet of High Technology Usability

Web 2.0 applications like the blog and the wiki are re-defining the expectations of usability in high-technology solutions. At its core, the original World Wide Web is a publishing platform, which was able to leverage decades of design expertise built up in the mature publishing industry. In fact, the language that described the visual standards of the web, Hyper Text Markup Language (HTML), is based on Standard Generalized

Markup Language (SGML) – a standard developed in 1985 to create industry-standard printing documents (internet.com, 1997).

I argue that Web 2.0's usability is a result of an interrelation of two distinct advances: advanced web technology which enabled users to more easily enter and manage content, combined with an "ethos" within the web software community of working toward democratizing access to publishing content online. In fact, the original architect of the World Wide Web, Tim Berners-Lee, originally did not differentiate between the use and creation of information (Tredinnick, 2006). The evolution of web technology, bolstered by its open-source, democratic ethos helped lead the evolution of the web from one-directional (Web 1.0) to bi-directional interaction (Web 2.0).

CHAPTER 5

CONTEMPORARY HI-TECH USABILITY ISSUES

Frustrated users, frequent need to contact technical support departments, and underutilized features are all indicators of hi-tech usability and design problems. Yet what I've observed is that people are quite adaptive and resourceful, and will work around usability issues at a cost to their personal efficiencies. The result is a consistent occurrence of frustrated users, long waits for technical support and a host of valuable features that are never utilized as intended. Why do people decide to work around usability issues instead of taking another path? One answer is that the base technology is so compelling that it need not be designed well to have a net benefit. But I argue that because hi-tech is evolving at such a rapid rate and is still relatively new to our culture, as a result, many do not know what the expectation should be from hi-tech design, and fall back into either accepting what is offered to them, or limiting their interaction to the most basic set of features. This dynamic breaks the process of free-market capitalism, where consumers/users demand and vendors supply what is demanded. In this particular case, if the customer doesn't know what they can demand, how can vendors respond effectively? While there are always complaints around hi-tech usability (YouTube.com hosts hundreds videos of office workers experiencing technology rage, where they destroy hi-tech equipment with fervor), after the frustrations are taken out on the machine, oneself, or an unsuspecting third party, people generally go back using the very same technology that just frustrated them as a path of least resistance. I argue that this "usability gridlock" needs to be addressed, and that the first step in addressing this problem is re-setting the usability expectations of pervasive contemporary hi-tech solutions. The following examples of common hi-tech solutions are provided from the perspective of not accepting the status quo of usability, and challenging some of the very fundamental usability concerns that the majority of users have simply accepted as part of the price to pay in exchange for the benefits of the base technology.

Information Management Software: The Web Browser

One of the most important advances in information technology is ability to browse the World Wide Web through a single piece of software called the web browser. There are many web browsers available, but they are all similar in terms of the user experience. As mentioned in Chapter 4, the web browser is an example of a good user-centric design for software. There are minimal controls, and the primary controls “map” to cognitive models that are familiar (click, back, forward, stop). This user-centric design is likely a tremendous factor in the unprecedented success of the World Wide Web. Just imagine how successful the web would be if it were difficult to access. But for all of the success of the web browser, there are still many aspects in the design of this critical tool that do not pass the test of being user-centric.

Users are still expected to type in a “URL” to access a website. First, there’s a terminology problem – the primary access paradigm of the web browser is focused on a “Universal Resource Locator.” Is this user-centric and meaningful to most users? Of course not. This is a left-over from the engineers that first designed the web browser. Is this a big deal? I argue it is, especially if we introduce context: the original television engineers were savvy enough to call the options on the dial “channels.” They refrained from calling these dials “frequency attenuators,” which would be the corollary to “universal resource locators.”

When a web page does not load properly, users are expected to hit the “refresh” button to give it another go. To someone who understands what’s going on behind the scenes, it’s easy to understand the need for a refresh, and one could even say that the engineers were quite user-centric in labeling this function in easy-to-understand English. Yet, there is no “metal map” for a refresh function like there is for “back, forward, stop” and other related browser navigation options. Browsers could rather easily dissolve this problem by conducting an automatic refresh if a page does not load in a certain amount of time by itself. Why hasn’t this already been done? It could be that browser developers suffer from anchoring bias (Kahneman, Tversky & Slovic, 1982) – it’s just not in the ethos of the web to have the browser exercise any intelligence on its own. Browsers were initially designed to be “dumb terminals” not so different than the “dumb terminals” that connected to mainframes decades ago.

The sizing of the contents within the browser is not elegant. Currently browsers rely on the actual web site itself to gracefully size itself based on size of the browser window. The result is a very inconsistent experience with regard to how web sites fit within browser windows. Why don’t browsers allow sizing options similar to Adobe PDF files, which gracefully shrink and expand pages, keeping all the information on the page within the window, by simply shrinking and expanding the size of all elements within the document?

Printing documents within browsers is not well designed. Users should expect a print function to properly format the content being printed in a way that is readable and valuable. Web browsers act “dumb” and simply print out what is on the screen. No pagination options, no re-sizing options, no ability to format the web for paper. This is related to the aforementioned ethos – that the browser should not interfere, it should merely be the new “dumb terminal.”

Computer Software: Microsoft Windows Operating System

According to OneStat (2006), an online market research firm, over ninety-six percent of all computers sold worldwide run the Microsoft Windows Operating System (Windows). A personal computer operating system at its core, the Windows operating system software was designed to allow people to operate a computer, as well as create a platform and graphical environment for other PC applications. When Windows was initially developed and designed (from 1983-1985), the PC was primarily used to aid in business and personal productivity – spreadsheets, word processing and finance applications. It was early in the evolution of the PC, and at the time, the PC was acting as a replacement for existing technologies like the typewriter and the centralized mainframe computer. This environment influenced the development and design focus of the Windows operating system, and formed the basic user interaction model for people and computers – a keyboard, a mouse, a point-and-click interface, file folders and draggable application windows on a screen.

Since the original release of Windows in 1985, the software has gone through many revisions (Windows 3.0, 3.1, WFW, 95, 98, Me, XP, Vista), and has dramatically improved in its stability and functionality through its evolution. However, its fundamental user interaction model has experienced only small, iterative updates.

This evolution and heritage of Windows helps explain a design gap between people and personal computers: the Windows operating system was designed to allow people to operate the computer itself, not the applications on the computer. Windows does allow a user to launch an application loaded on a computer; but once launched, the operating system falls back to its primary job of manipulating windows and operating the computer. Windows takes a device and window-centric view of usability instead of user-centric usability. What is missing in this technology design is a redefinition of what an operating system could be – an abstraction layer between the user and the applications being used.

The implications of this shift in design perspective have tremendous potential to improve the efficiency – and even delight – in people's usage of personal computer technology. Today, computer users are forced to see things from the device's perspective. For example, in today's operating systems, files exist in folders on hard drives, on the local area network, on a thumb drive, or online… and the user needs to know these different aspects of the technology ecosystem in order to locate information. Most users have been acclimated enough to Microsoft Windows to understand our responsibility to understand such technical complexities. But what if we, as end-user stakeholders, step back and ask a broader, hypothetical question: is it our responsibility to understand these complexities, or should this be the job of the operating system? In fact, one could argue that the very name of the software is an indicator of the design focus: "operating system" indicates a focus on the PC device (i.e., the software operates the system), whereas an "operator system" would indicate that the operator is the focus of the software technology. Imagine an operating system designed around the needs of the user (an "operator system") that abstracts these complexities from the user. An operator system might be designed to help bring the files (no matter where they are located) to the user based on what the user needs. With this systemic shift in technology design focus, future PC users would no longer be required to understand files and folders, LANs, WANs, and hard drives any more than users of televisions are required to understand the complexities around broadcast or cable television. Television has traditionally been a good example user-centric design around a complex technology. For instance, it has been quite a long time since users of television have had to understand the difference between VHF and UHF. Why do PC users still need to know the difference between a hard drive and a network drive?

Digital Devices: Remote Controls

In more affluent areas of society, people who enjoy home entertainment assemble a number of audio/vision devices that work together to form an entertainment system for their homes. A typical entertainment system might include a television, a DVD player, a CD player, a receiver/amplifier, and possibly a cable set-top box, and a few other devices. One of the side effects of this assemblage, however, is a poorly designed user interface – a collection of remote controls; one for each device purchased. One of the common complaints of people who have entertainment systems is the complexity and learning curve to figure out which remote control to use for which device, not to mention the negative aesthetic impact of having a slew of remote controls on the coffee table.

Many innovative firms have attempted to come to the rescue with "universal remote controls" that are designed to replace all the individual remotes amassed through the purchases of these audio/video devices. Universal remote controls do succeed in combining the functionality of multiple remote controls into a single device. This is a good step, but most of these universal remote controls still make the user select the device they want to control, and then press the appropriate buttons to control said device. This situation resembles the above example of the Windows operating system – it still remains device-centric, and not user-centric. One remote control manufacturer has finally transcended this device-centric model, and truly enabled a user-centric approach to remote controls. Logitech has broken the mold in remote control design, and has created a software and hardware solution that is oriented toward common activities: "Watch TV," "Watch a DVD," "Listen to the Radio," Listen to a CD" are the primary options displayed on the remote control. When a user selects one of these activities, a series of commands are sent to the appropriate devices to enable this activity. The user does not have to worry which device needs to be turned on or off, selected, deselected, or configured. The user only has to know what he/she should need to know: what they want their entertainment center to do for them. This is an example of how technology can be designed to better serve the needs of the user.

It's also exemplifies that technology can do more than what we've been conditioned to expect. In a bit of irony, per the discussion boards on remotecentral.com, some purchasers of these Logitech universal remote controls end up confused and disappointed because it does not conform to the traditional device-centric approach that many of us have been conditioned to expect from remote control technology.

Evolutionary Technology Challenges: The Television

The television was offered as a comparatively well-designed piece of technology that is able to effortlessly simplify the complexity of broadcast television into a straightforward channel metaphor. Yet, despite this strong fundamental design head start, there are serious problems on the horizon for television.

As a result of legislation that was signed into law on February 8, 2006, the U.S. government is mandating a nation-wide conversion from analog television (also known as NTSC, which was the original broadcast technology) to digital television (ATSC, which is the new, digital way to broadcast stations) on February 17, 2009. Yet, while the U.S. government has mandated and set technical standards for the transition, usability design was not mandated. The result is a new era for television – an era of unprecedented complexity. This complexity affects different types of television owners – who do not want to buy a new television set – in different ways:

"Over the air" broadcast viewers consist of about 12% of television users in America (Consumer Electronics Association, 2005). Television users whose current television sets were purchased prior to 2006 and receive their channels over the air will need to either purchase a new digital television with a digital ATSC tuner built-in, or buy a digital tuner converter box for their existing televisions. In order to ensure that every American has access to television programming, through the same piece of legislation the government is offering $1.5 billion in coupons so that these digital tuners are affordable to everyone. But, every person who used to simply have a television hooked up to an antenna will now have to install and setup a set-top box beside each television set in their house, and will have to use the set-top-box's remote control (in addition to any other remote controls). The end result: more boxes, more connections, and more remote controls for no appreciable difference in viewing experience for these "antenna television" users.

Cable television viewers represent over 66% of television users in America, and the cable television users with existing analog (NTSC) televisions will not be affected, as the digital transition is limited to "over the air" signals. As a result, Cable Companies will add a "user experience" layer to the equation, automatically converting the digital ATSC broadcasts back to analog NTSC for those viewers still using conventional analog televisions. Ironically, due to the percentage of cable television viewers vs. over-the-air television viewers, this grand, centralized move from analog to digital will not affect the vast majority of television owners. Or will it? There are already several ad campaigns being launched by cable companies trying to convince their customers that the big digital push by the government will not affect them. This indicates that at least a sizeable number of cable users think that this national transition will affect them even though it will not.

With regards to people who buy new digital televisions – shouldn't this transformation make it easier for these owners? If the owner of a television purchased 2006 or later uses an antenna to watch over-the-air programming, then, the transition will be fairly seamless. The new digital television will tune in stations just like the old analog television pulled in stations over the air. There is no requirement for any additional hardware or remote controls. But if a new digital television owner has cable television, there are new complexities compared to that of the original analog/NTSC television. Digital televisions that are ready to receive digital over-the-air transmissions (ATSC) can also receive digital transmissions over cable (QAM), yet, due to copy protection embedded in some cable feeds, only channels that are unencrypted (or "in the clear") are able to be viewed from a digital television tuner without a cable box. These unencrypted digital cable signals (or "clear QAM") are interwoven with the ATSC signals being picked up over the air.

In an effort to minimize the technical jargon, let us just step back and make an observation that the original analog television user experience was quite simple and nearly universally easy to understand. The new era of digital television incorporates so many new standards, restrictions, and potential new components that television risks changing its current broad accessibility for those who are not cable customers.

If this were not complex enough, on the horizon is "IPTV" – internet protocol television. This type of television station will be hosted and sent through the Internet, enabling a nearly endless amount of content channels from which to choose. This will require yet another type of "tuner" that will resemble a computer more than a television.

The challenge for the industry will be to encapsulate all of these new options and requisite complexities into a user experience that is comprehendible to the same broad audience that television technology penetrates today.

Organizational Dynamics Case Study: Enterprise Business Software

Medium and large businesses are increasingly reliant on enterprise business software (sometimes referred to as enterprise resource planning systems, or ERPs) to help manage, route, and communicate information surrounding the business. These internal business systems are generally managed and deployed by internal Information Technology (IT) and Management Information Systems (MIS) organizations, and are designed to be utilized by employees.

As an MIS professional for six years, I was thoroughly integrated into the MIS mindset of focusing on implementing software solutions that automate processes, develop standards for data collection, and generate valuable business reports. My time and energy was focused on software evaluation, process establishment, software implementation, and training. I was rewarded by buying software that streamlined processes; there was no consideration about the training effort or cost that was required for any software solution I was responsible for rolling out. In fact, I found the process quite rewarding, as I was able to be a subject matter expert for this new software, and employees (end-users) looked to me to help them figure out how to navigate the software to get their jobs done. I would get glowing reviews for my training ability, which would translate into good customer satisfaction, good performance reviews, and good raises.

Yet there was a problem that I was not yet aware of: I was implementing everything wrong. To be more specific, I was embedded in a larger MIS culture that developed and matured in the 1970s and 1980s, and the culture (and resulting focus) has not sufficiently or adequately shifted with the times.

As IBM mainframes began to be an integral aspect of business decision support systems, MIS departments emerged as the group that managed these mainframe information systems, and supported the terminals that employees needed to use (and be trained on) to enter in their critical business information for processing. Beginning in the 1980s, PC technology took hold in the business enterprise, and MIS evolved from supporting "dumb terminals" (the connected terminals that accessed the mainframe software) into supporting highly functional PCs that every employee needed to use to do their respective job. Throughout these times, however, the paradigm did not change much: most employees were well behind the MIS and technical professionals in their technical savvy, and relied heavily on central technology teams to orient, train and support them.

But technology has evolved, as have people's savvy around using technology. Unlike business systems users of the 1970s and 1980s, newer generations of employees have become much more comfortable with technology, and do not require the hand-holding of a central MIS function to operate their PC, or to use basic business productivity software like word processors (MS Word), spreadsheets (Excel), and presentation software (PowerPoint). One of the reasons behind this shift is the orientation of technology leaving the “back office” to the “front office,” and, importantly, the home. While there was a point in time when computers and software were the explicit domain of back office engineers, technology has been democratized – which directly affects modern employees’ interaction with business technology.

Yet this democratization of technology – and the requisite comfort levels of many modern employees – has not yet fully permeated the business system environment. For instance, enterprise business systems are still designed and built by software companies focused explicitly on automating processes and collecting data. The result is enterprise software that is process-centric instead of user-centered. The orientation of business systems software lulls MIS staff into the traditional roles of implementing these systems like they historically have, which continues to protract a culture of “implement the solution, and train the employee.” This process- and information-focused design is aimed toward efficiencies in data collection, yet may work against the users. The result of this dynamic is twofold:

Employees who are required to use this new software to do their job may need to spend their otherwise productive time learning how to use new software if it’s not user-friendly. This typically requires initial training, as well as regular calls to ‘technical support’ to resolve problems, challenges and questions they incur while using the software.

Employees who are encouraged – but not required – to use this software will end up avoiding these internal tools. This opt-out approach is natural – people simply will choose not to engage in a frustrating experience if they have any other option. This is a result of people optimizing their own work by using the tools that they are comfortable with and feel work the best for them. A consequence of this dynamic is a situation where a company's investment and strategies are tied to business systems software that will not be fully realized by the employee base.

As a result of many of these environmental factors, I, as an MIS employee, continued implementing things "wrong" in my job. Deeply immersed in a culture where MIS was a back-office technology operator, combined with the nature of the business systems software available, I was focused on my (and my department's) optimization – not my clients. This was a flawed strategy for two reasons: First, because MIS was investing in its own optimization at the expense of the users, our one-time expense was trumping the on-going expense of inefficient application management and utilization. In a system where there is a one-time cost and an on-going cost, the on-going operational cost should be a primary consideration when designing the initial system. In MIS, our optimization strategy was on our operational costs, not the user community's (or company as a whole). And, second, MIS employees like me were rewarded for training employees on a difficult system, ensuring that our expertise was needed to roll-out an information system. This "king-maker" strategy was seen as quite positive within the MIS culture, but from the broader organizational perspective, this is an indicator of an inefficient system. Complex, process-centric software continues to be purchased that is not intuitive to users, enabling “king-maker” MIS employees who will provide training and support to the user community.

This approach to internal management information systems might not intentionally create inefficiencies in the corporate workforce, but I argue that there are tremendous costs to this status quo that are simply not identified in process and system diagnostics. Which begs the question: why are they not identified? One possibility is anchoring bias (Kahneman, Tversky & Slovic, 1982) – that those who conduct such analysis are already so familiar and acclimated to the status quo of business systems design that it doesn’t even occur to them that it could be an area to analyze. Another possibility is selection bias (Kahneman, Tversky & Slovic, 1982) – most business process analysts do not put a very high premium on the value of usability and user-centric design.

Hi-Tech Usability Issues: Context and Rationales

Usability in hi-tech tends to improve slowly over the product lifecycle due to the overwhelming advantages of the base technology being introduced. But, more mechanical technologies do not require this same “ramp up” time in usability. I have argued that this is due to the physical interactions that are required to manage these more mechanical technologies. This contrast drives the comparative question: Does hi-tech usability need to be slowly and incrementally improved over time, or can it be designed more user-centered from the beginning, like mechanical-electrical technologies? It might appear that hi-tech usability currently works in accordance to fundamental supply/demand models i.e.; only when there is a demand do producers supply the desired product. But this conclusion would be misleading, as it represents a demand-side that only appears to know what it wants when it sees it. For instance, PC users in the early 1982 did not demand a graphical user interface, a mouse, and draggable windows. In fact, PC users appeared rather content (an assumption based on the tremendous growth in sales of the PC in the early 1980s) to simply have a backspace features instead of using white-out and a typewriter. Yet, when Apple introduced the MacIntosh with said usability enhancements, it became clear to PC users (and manufacturers) that this was a new usability expectation that would need to be met. Soon, every PC had these usability features built-in.

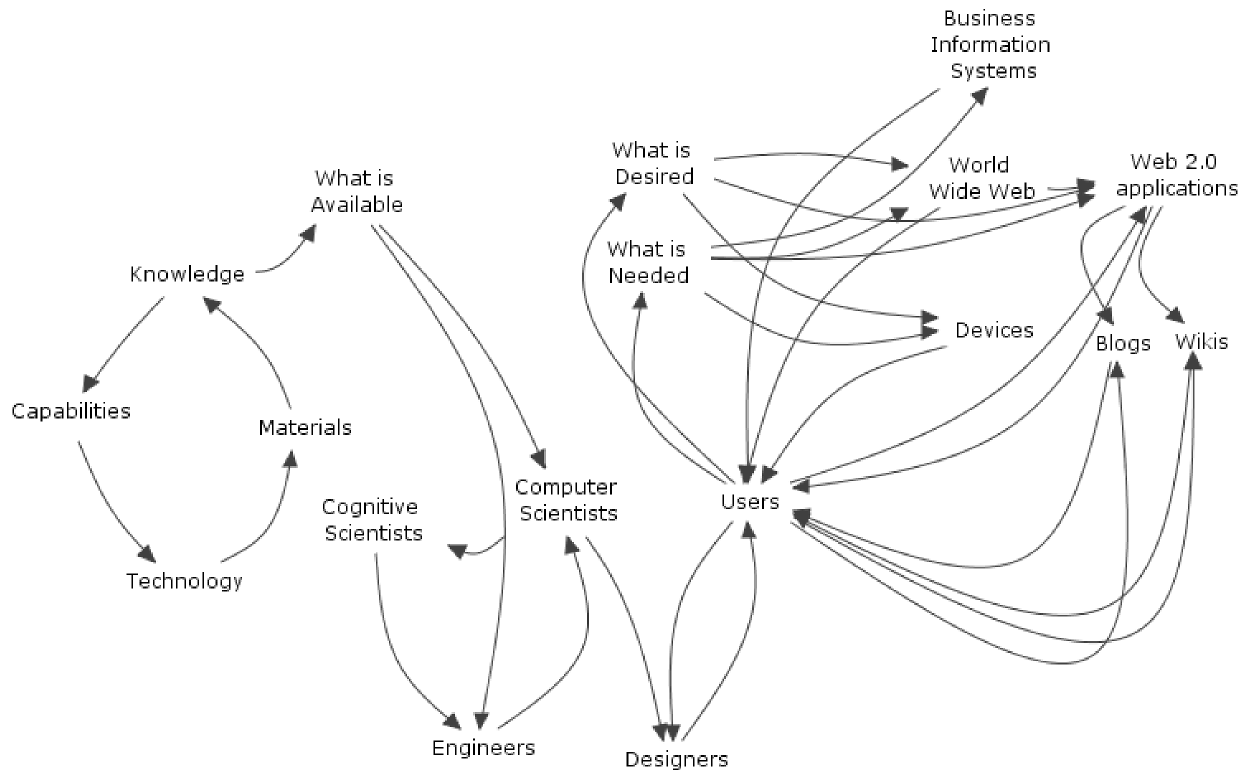
CHAPTER 6

INTERRELATIONAL MODEL FOR HI-TECH USABILITY

Several examples and cases of hi-tech outpacing usability have been documented in the prior chapters, yet there are countless other examples that most of us has experienced. If this is a growing concern, the question must be asked: why are there increasing challenges around the usability of high technology, and why hasn't someone solved this problem? I argue that there is a complex, interrelated set of issues governing this gap between technological capability and what is actually needed or desired.

Figure 10 presents a system dynamics description of the various interrelated elements and relationships that embody the process of hi-tech design.

Figure 10. Hi-Tech Design System Dynamics Graph



System dynamics graphs are useful as they graphically depict non-linear relationships that might not be obvious in a linear model. In this case, graphing the many interrelated elements of hi-tech design helps present some of the potential reasons behind the lack of design in many hi-tech solutions, as well as present how relationships can affect outcomes. System dynamics graphs also give us an ability to develop "what if" scenarios by allowing us to manipulate relationships, relationship weights, and add/remove nodes in order to affect outcomes. For the purposes of this thesis, I will provide an interpretation in an effort to expose some rationale of the current state. I will leave it to further research to investigate possible changes to the system to positively affect outcomes.

Based on the premise of the definition of “design gap” stated in Chapter 1, the fundamental elements in this model are “What is Available” as well as “What is Needed” and, similarly, “What is Desired.” As presented, there is no direct connection between the two states (where “What is Needed or Desired” together can be considered a single state in the model), which aligns with the design gap principle -- that a usability design stage is required between the two states. Beyond this fundamental interrelationship, I offer the following: First, scientists and engineers are the primary stakeholders who have access to the knowledge, capabilities, materials and raw technology that embodies “What is Available.” Second, users are at the center of the system activity, which indicates that they should be in a strong position to influence the outcome of the process. Third, designers exist between the technical stakeholders and the users, which indicates that designers need to rely on both technical/scientific interpretations of “What is Available” and interpreting what users claim they are looking for. Fourth, there is more system activity between users and Web 2.0 applications than there is between users and devices and users and business information systems. And, finally, Business Information Systems are only fed by “What is Needed,” not “What is Desired.”

If we hold that Web 2.0 applications are inherently more usable than devices and/or business information systems (argued in Chapter 5), it can be explained by the stronger bi-directional system linkages between Web 2.0 applications and users. This more intermingled relationship could represent a greater, more rapid response dynamic

– enabling the purveyors of Web 2.0 applications more meaningful information about user needs than other types of high technology.

Another observation might explain why many hi-tech devices and business information systems might traditionally not be as usable as Web 2.0 applications – the systems dynamics figure illustrates that devices and information systems generally are not exposed to direct user feedback. User feedback gets fed back through user research, but not by the end products/solutions themselves. This response dynamic is indirect, and might result in a slower reaction time to user input.

This figure also provides a perspective that while users are the center of most of the activity, further inspection shows that the user is generally not exposed to “What is Available” directly. This dynamic could help explain why users generally do not know what they should expect from hi-tech solutions. How can users set expectations for an outcome if they are not aware of the context of “What is Available?”

These observations may have an effect on the outcomes of hi-tech design, but further research will be needed to quantify and qualify any relation between this system dynamics graph and actual outcomes.

CHAPTER 7

THE ORGANIZATIONAL ALIGNMENT OF HI-TECH DESIGN

The organizational alignment of resources is a focus in business schools and leadership studies for good reason: organization alignment affects outcomes (Powell, 1992). Based on this premise, the organizational alignment of usability and hi-tech design resources is a factor in the efficacy of the outputs of these resources. I argue that the current organizational alignment of hi-tech design resources is a factor in today's usability challenges with hi-tech solutions, and that a restructuring and strategic shift is required to address many of the technology design issues we face today in hi-tech.

Computer-Human Interaction Currently a Technical Discipline

Usability and user-centered design come out of the technical fields of study. In fact, the computer/human interaction special interest group (CHI SIG) is a subsidiary of ACM (Association for Computing Machinery). The ACM website provides a review of the CHI SIG:

> The ACM Special Interest Group on Computer-Human Interaction is the world's largest association of professionals who work in the research and practice of computer-human interaction. We are an interdisciplinary group of computer scientists, software engineers, psychologists, interaction designers, graphic designers, sociologists, and anthropologists, just to name some of the domains whose special expertise come to bear in this area. What brings us together is a shared understanding that designing useful and usable technology is an interdisciplinary process, and when done properly it has the power to transform persons' lives.

This description and position is not necessarily bad or misguided – clearly the interdisciplinary areas of study within CHI are aligned with the goal of user-centered design. However, like any organizational culture, the alignment of resources can affect outcomes. In the case of CHI, the alignment of computer/human interaction design within the computer machinery domain could have an impact on the value and emphasis placed on how technology design is implemented and measured. As a member of the Philadelphia chapter of CHI, I agree that the majority of the members are indeed technical, and have a predominantly technical viewpoint into interaction design (i.e., an anchoring bias). The organizational alignment of CHI as an outgrowth of ACM indicates that there is a technology fundamentalism, which helps enable inertia around technology and science driving the usability solution – not the human.

I argue that because technology design generally lies within the technical realm (as CHI lies within ACM), there are two outcomes that work against the success of usability in technology design: First, usability is considered to be foremost a technical discipline. Usability design originates from technological/scientific sphere, which generally ensures that this discipline resides in the IT area of the business when developing new technology solutions. This can lead two at least two important organizational dynamics implications: First, technical departments in organizations tend to engender a culture of “knowns” – IT departments prefer the measurable, definable, operational, and explicit. As a result, the intangibles do not generally get as much “air time” (or, in my professional experience, respect) due to the technical/scientific nature of the culture. Second, usability is seen as a quantitative practice. Due to the scientific/technical foundation of usability, a quantitative approach is naturally taken in implementation of the discipline. This organizational alignment status quo (generalized here to make a point – additional research would be required to demonstrate that this is representative of the preponderance of situations) helps shape how usability is practiced in organizations where, due to the lineage of the discipline, it tends to preside.

Neither of these two outcomes is, by themselves, problematic. However, it is the exclusivity of the organizational alignment in the technical realm that, in my estimation, relegates usability design as a purely technical component of technology solutions and tools, similar to the disciplines of testing and quality assurance.

Human Factors Engineers are not Qualitative

Human factors and user experiences are a domain that should consist of both quantitative and qualitative research and design, yet the predominant approach in the field is quantitative and is aligned with a technical domain. It is true that done properly, the art and science and technical discipline of usability can greatly and positively impact the user interface of most any technology.

But what of the qualitative components of the user experience? Due to the quantitative and systems nature of the discipline, software companies and IT organizations do not appear to pay much heed to the more qualitative, “desirable” axis of usability. How many software systems or technologies bring a smile to the face of the user? How many business systems are a delight and a pleasure to interact with? This is where companies like Apple have been leading in technology design: technology devices like the iPhone as well as software like Mac OSX, iLife, and their other software packages regularly demonstrate that technology and software can be designed around the human experience – that human emotions like delight and enjoyment do not have to be cast aside when interacting with technology. Apple is not the only vendor who puts a premium on technology design, but they are known for it, and make for an effective archetype of user-centric technology design and usability.

CHAPTER 8

USABILITY AND HUMAN AND INDIVIDUAL CAPTIAL

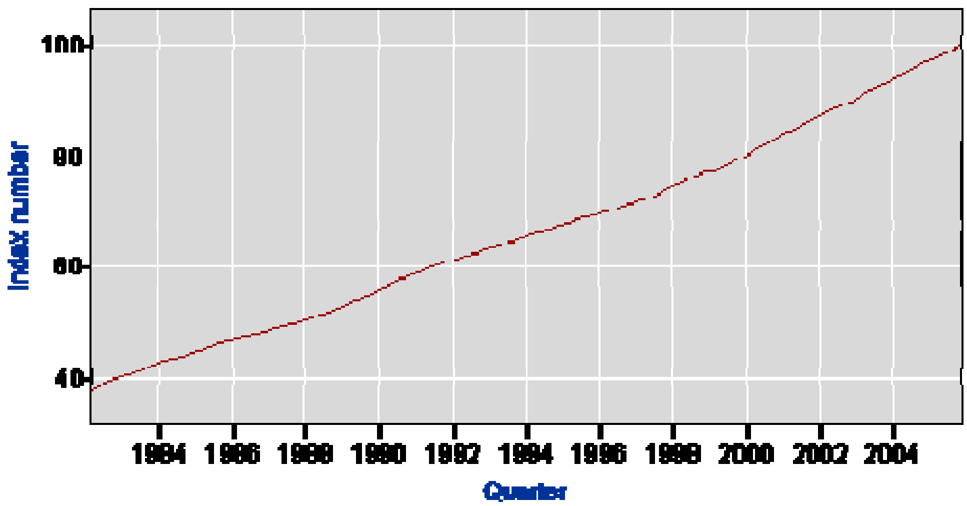
The goal of this thesis is to highlight the importance of technology design and usability, specifically in the areas where technology interacts directly with people. Human capital, the receiving end of the usability equation, bares the brunt of inefficiencies and constraints brought about by poor design, and conversely is the beneficiary of effectively-design technology. In a business context, the term human capital is used to describe the economic value of an employee's skill set. A broader definition of human capital, as originally presented by economist Theodore Schultz, is the reflection of value of our human capacities (1961). This definition was clearly intended to encompass the human as a special type of capital asset, but Schultz also saw the human as an actor that owns this capital and can apply it to any professional or non-professional activity. In this context, human capital includes the value of employees in the workforce, but extends to consumers outside their workplace as they conduct their daily activities to optimize, improve and enjoy their lives.

Optimizing the Investment of Human Capital in Organizations

According to the United States Bureau of Labor Statistics (2006), human capital is one of the fasted growing expenditures for non-manufacturing organizations, which are typically employing white-collar workers (see Figure 11).

Figure 11. White-Collar Employment Cost Index

Series Id: ECS11102I
Seasonally Adjusted
compensation: Total compensation
ownership: Private industry
periodicity: Index number
group: White-collar occupations



Source: U.S. Bureau of Labor Statistics (2006)

White-collar employees are an expensive type of employee to maintain because they are information processors and decision makers – roles that require access to information. To support and optimize the performance of these costly resources, organizations have made large investments in information systems to ensure that these workers have access to the information they need to transform into knowledge and insights. Yet this thesis has asserted that there is a substantial “design gap” between the information residing in these information systems and the interface that optimizes the employee’s interaction with this information. To address this gap, companies that produce these business information systems have attempted to properly invest in usability design processes, yet I have argued they are still mainly governed by the technical discipline and culture, resulting in design that is tested to be optimized for the information, not the employee. There is not enough primary or secondary research to prove causation, but as cleverly characterized by Nobel Laureate and economist Robert Solow, "We see computers everywhere except in the productivity statistics" (King, 2003).

A dichotomy seems to exist between the presumption of the value of high technology and the value of making this technology usable – a situation brought to light in my research for studies that linked usability to productivity. The research I found was inconclusive when assessing the direct impact of productivity on high technologies (Brynjolfsson, 1993). And, when researching the reasons behind the lack of productivity, I have found a surprising lack of technical journals that include usability as part of the study of technology and productivity. Table 3 presents an example from the Business Computing section of Communications of the ACM (Brynjolfsson, 1993) where the author provides an analysis of why business computing has not reaped the expected productivity gains.

Table 3. Why Computers Haven't Measurably Improved Productivity

1. Measurement Error: Outputs (and inputs) of information-using industries are not being properly measured by conventional approaches.
2. Lags: Time lags in the payoffs to IT make analysis of current costs vs. current benefits misleading.
3. Redistribution: It is especially likely that IT is used in redistributive activities among firms, making it privately beneficial without adding to total output.
4. Mismanagement: The lack of explicit measures of the value of information makes it particularly vulnerable to misallocation and overconsumption by managers.

Source: The Productivity Paradox of Information Technology (Brynjolfsson, 1993)

This productivity analysis illustrates a bias within the business technology sphere where the lens around productivity does not include the critical interface between user and machine. Conversely, there are scores of studies dedicated specifically to usability and user-centered design. Based on this, my assessment is that usability and the user interface are not considered in the same domain as more traditional productivity factors. It appears from the research that the business domain tracks productivity, process and quality, and yet excludes design. This narrow focus of business analysis could be a symptom of the overarching problem where design is simply not under the same level of scrutiny as other core business activities. If design is not monitored, assessed and invested in like other core business metrics, it is easy to understand how its importance would be reduced or even ignored. This dynamic could have a measurable effect on the efficacy of technology design and usability within organizations.

Optimizing the Investment of Individual Capital

While the term "human capital" can include the value of the individual as an independent actor, it is generally used to refer to the value and effectiveness of a human resource to an organization. To help clarify the contrast, I define "individual capital" as a subset of "human capital" to describe a person's potential value as an individual, where an individual's value can be represented in social and/or creative terms. This is important because the value of usability in technology design is no longer limited to that of an employee's ability to use business technology systems. Hi-tech devices and information systems have permeated the individual lives of billions of people – ranging from mobile phones and personal computers to access to the World Wide Web and e-mail. Hi-tech devices and information systems give individuals the ability to communicate, collaborate, participate and contribute in ways previously unthinkable. Yet as higher-order technologies (devices or software) become available, they tend to depart from the baseline mechanical-electronic model the original technology was based upon, creating a new interaction model that requires learning, which in term requires an investment of time and energy. The question should be asked: is this the only way forward? Or, are there more innovative ways of modeling these higher-order technologies against existing interaction models? When considering interaction models that are quite underdeveloped – such as vocal (using one's voice) and kinetic (using bodily movements) interfaces – it would appear that a series of idealized design (Ackoff, Magidson & Addison, 2006) may be a useful methodology to help plan the future for personal device and information systems vendors.

An interesting dynamic is emerging, however, that should be explored further: the World Wide Web (and particularly Web 2.0 applications and services) appears to be on a trajectory towards high levels of usability. Yet I have not found any conclusive evidence to explain why the World Wide Web (specifically accessed via a personal computer) has emerged as a generally usable platform in comparison to other applications and devices. Nevertheless, the fact that web-based services and applications have recently begun to show an ability to replace other, less usable applications is a very positive sign that we might have stumbled upon an effective and standard model for hi-tech interaction for the next generation of information services. This is an opportunity for other purveyors of hi-tech solutions to leverage the user interaction models being established and standardized in the Web 2.0 space. Hi-tech gadgets that might not have a mechanical-electric model to base the interaction model on might benefit from lifting some concepts being cemented in the Web 2.0 space to allow some natural transfer of existing models onto new devices.

Bottom-Up or Top-Down Change?

Much of this thesis has been oriented toward a top-down model; in other words, identifying issues on the supply-side, and putting the onus on vendors to improve high technology design, which would, in turn, improve employee productivity and enhance individual's lives. From this vantage point, my assessment is that the current state is severely lacking: While the majority of hi-tech vendors still struggle with optimizing the user experience, design-focused companies like Apple have shown that the nexus of people and technology need not require intense training, a computer science degree, or time wasted in trial and error in order to interface with hi-tech devices and software. Yet, the number of hi-tech companies that put a premium on design is, in this author's opinion, far too limited. Apple serves less than 7% of the personal computer market (Gartner, 2008), and .6% of the cellular phone market (Strategy Analytics, 2008). For the vast majority of hi-tech vendors, user-centered design takes many quantitative steps in bridging the existing design gap between technology and people, but more can be done. Qualitative views into usability and technology design should be given more credence in organizations creating and designing new technologies. This means opening up to disciplines beyond the measurable and into the intangibles such as happiness and delight, which are addressed by researchers in positive psychology (Seligman, 2002). This also means looking outside technology for usability expertise. Case in point: Apple hired a bathroom designer to design their new line of iMac computers in 1998, which ushered in a new era of sustained growth, profits and shareholder value for Apple that persists to this date (AAPL share price prior to the launch of the bathroom-designed iMac was 4.54 on Jan 5, 1998, and the value of APPL is 119.46 per share on April 25, 2008).

But what if I swap the perspective and put the onus on the user? What if the individual – acting as an employee or otherwise – was accountable for seeding the market with feedback that hi-tech usability is lacking? This might help bring about the changes and improvements in usability through free market processes – create a demand, and the free market will supply what is demanded if it is profitable. But, why does this not happen? It could be that the cost of good design is prohibitive, putting the profits in jeopardy. Or, it could be that the suppliers have not identified the demand because they are not looking for that type of feedback. Or, it could be what I have experienced first-hand as an individual and as an executive in web communications for a decade: that users do not feel empowered to provide feedback on usability. Users tend to feel that there are inherent limitations on what can be achieved with technology, and whatever is provided must be the state-of-the-art, and make do with what they are given or provided. If what I have observed is indeed the dominant dynamic in this process, then vendors will not find the demand because it does not currently exist. This intercepts the feedback loop that otherwise drives innovation and new value in a free market system.

Users of hi-tech are stakeholders in the technologies they interact with, and these users need to start believing that technology can and should be designed around their needs, their biology, their sensibilities, as well as their abilities and limitations. It is the responsibility of end-users not be victims of technology, and instead be advocates for their needs and desires, and to demand better. In a free market economy, innovation in the domain of user-centered design must be demand-driven. Until this process dynamic changes, however, only the vendors like Apple who proactively put a premium on technology design will continue to see higher profit margins, and as a result, better shareholder returns.

CHAPTER 9

SUMMARY AND RECOMMENDATIONS

In my personal life, as well as in my career, I have found that the state of design of hi-tech devices, software and information systems is lacking, and I have observed the resulting effects on employee productivity and organizational effectiveness, as well as personal productivity and pleasure. Further, I have found that my current professional role as the intermediary between purveyors and end-users of hi-tech solutions has given me a unique perspective on the “design gap” between the base technology that enables new solutions and the actual needs and usage behaviors. The confluence of these two perspectives led me to further explore the reasons, rationales and dynamics of this situation in an effort bring a greater focus to the problem as I have observed it. Through research, insights, and proposed models, new ways of diagnosing and analyzing the problem of hi-tech design have been introduced. Based on this, the following summary and recommendations are offered to the key stakeholders in the sphere of hi-tech design.

For purveyors and manufacturers of high technology, a fresh look at the process of design itself is needed on two fronts. First, I argue that the very role of design requires more qualitative and empirical methods, and should not solely reside within the technology domain of an organization. The role of design has too many hooks into the “analog” world – where people live – to be confined explicitly to an analytical, scientific, research-driven and technical domain. Design in other industries, such as the fashion industry, benefits from "gurus" who have proven their ability to gauge what will be "hot" and drive trends through a non-technical analysis of what people are looking for in fashion design. In the high technology field, only a select few vendors (Apple being one example) employ this design strategy to their technology products. Second, I have introduced a new comparative model for hi-tech usability: mechanical-electric devices. While more research and analysis should be conducted to advance this hypothesis, the basic research compiled in this thesis makes a case for looking at existing user interaction models in the mechanical-electrical sphere as a basis for hi-tech design models. Don Norman, the author of The Design of Everyday Things (1990) as well as former executive at Apple, asserts that there are two principles in designing for people: provide a good conceptual model, and make things visible. Norman's conceptual model philosophy links into my mechanical-electric usability transference model.

For designers, usability engineers, and user interface developers, an exploration of fictional hi-tech tools provided a unique perspective by viewing the devices in Star Trek from a usability perspective. Identified was the usability and design of these devices that appeared to consist of a hybrid of mechanical-electric principles combined with physical world context sensitivity. It is from this analysis that the notion was advanced that today's hi-tech devices tend to focus on virtual world context sensitivity at the expense of physical world context sensitivity. While this is an understandable trajectory, I argue that it has limited the focus of design to virtual context optimization at the expense of physical world usability and design. This is arguably due to the notion that engineers and technologists are likely to exert "system empathy" instead of "user empathy" as a function of their closeness to the systems that they are fully invested in designing. Based on this analysis, my recommendation to designers of hi-tech solutions would be two-fold: First, try to ground design models based on mechanical-electric principles, and second, work hard to innovate in interfaces to the physical world in conjunction with the existing virtual world optimization that is already at the fore. In addition to the Star Trek analysis, a usability analysis of the World Wide Web was conducted, and a notion was presented that the next generation of intuitive hi-tech design may be reflective of the highly usable web browser interaction model. The history of web usability was explored, and rationales for a convergence of usability around this web-based user experience were offered.

For end-users (including employees and general consumers) of hi-tech solutions, a series of case studies and examples were outlined in an effort to pull away the curtain behind the systems and processes to help explain why hi-tech usability is not optimized for us, the users. The history behind centralized IT was described, as well as how that organizational dynamic might affect current information system usability problems. Also explored was how consumer devices have exerted a "device-centric" design that optimizes the technology for the device itself, and as a result, the user is expected to learn how to use it. This "usability epidemic" in hi-tech devices is now, surprisingly, spreading to the ubiquitous television. I introduced the notion that people do not feel empowered to affect usability improvements because of the two-fold nature of hi-tech: the market value of the base technology outstripping the investments required to learn the technology, and the ignorance and resulting sense of victimization in the mind of the end-user. In addition, due to the rapid expansion of what technology can do for organizations and individuals, there is a sense that users expect these technologies to be difficult, and do not feel compelled or empowered to send a message back to the purveyors– thereby breaking the free market supply/demand feedback loop innate to modern capitalist models. Further research is required to better understand why people are not as demanding with hi-tech design as they could be.

Conclusion

In the field of hi-tech solutions and tools, there does not appear to be any indication of a slow-down in the rapid pace of innovation and change.   Yet for each interactive innovation and new product development underway, a critical component of the technology will be at the user interface. Since the advent of hi-tech in the 1980s, usability has, in general, begun to fall behind the capabilities of the base technology, reducing the overall value proposition of these new technologies. If it were not for the tremendous increase in fundamental value of these new technologies, it is unlikely that these solutions would have succeeded in the free market. However, the base technologies are so compelling that design can lag and yet still succeed in the free market. Despite this reality, I have made a case in this thesis that vendors that put the proper amount of focus and investment in hi-tech design are able to increase their market value and improve their brand image. But the value of hi-tech design goes beyond shareholder value, brand equity and growth strategies – improving technology design holds the potential to make organizations more efficient, to alleviate stress and frustrations in people, and, ideally, help enrich people's lives.

REFERENCES

Ackoff, R., Magidson, J., & Addison, H. (2006). *Idealized Design.* Philadelphia: Wharton School Publishing.

Anonymous. (2008). Web 2.0 (Part 2). *Strategic Finance* , 57-58.

Brynjolfsson, E. (1993). The productivity paradox of information technology. *Communications of the ACM* , 66-77.

The United States Central Intelligence Agency. *World Fact Book.* https://www.cia.gov/library/publications/the-world-factbook/geos/xx.html#Comm

Computer Industry Almanac, Inc. *Worldwide Cumulative PC Sales Exceed 1 billion.* http://www.c-i-a.com/pr0907.htm.

Crowston, H. C. (1997). *Comparative Diffusion of the Telephone and the World Wide Web: An Analysis of Rates of Adoption.* Syracuse: Syracuse University.

Consumer Electronics Association (2005). *New Data Shows Analog Broadcasting Cut-Off Will Imact Few U.S. TV Sets and Homes* http://www.ce.org/Press/CurrentNews/press_release_detail.asp?id=10764

Deutsch, J. (2007). *The Design Gap.* Unpublished Mansucript. Organizationl Dynamics.

Gartner.com. (2008, April 16). *Gartner Says Worldwide PC Market Grew 12 Percent in First Quarter of 2008.* http://www.gartner.com/it/page.jsp?id=648619

Hall, John. (2006). *ATM Fact Sheet.* New York: American Bankers Association.

Hernandez-Campos, F., Jeffay, K., & Smith, F. (2003). Tracking the evolution of Web traffic: 1995-2003. *IEEE/ACM International Symposium* (pp. pp. 16-25, 12-15). Modeling, Analysis and Simulation of Computer Telecommunications Systems.

internet.com. (1997, June 17). *HTML Unleashed: SGML and the HTML DTD.* Retrieved April 14, 2008, from Webreference.com: http://www.webreference.com/dlab/books/html/3-2.html

Jonssen, P. (2006). Bradford: 2000. *International Journal of Operations & Production* Management , Vol. 20, Iss. 12; p. 1446.

Kahneman D., Tversky A., & Slovic P. (1982). *Judgment under Uncertainty: Heuristics and Biases.* Cambridge University Press, p. 16, p. 423

Kendrick, D. (2001, July). *Money Talks: An Overview of Access to Automated Teller Machines.* Retrieved April 5, 2007, from Access World: http://www.afb.org/AFBPress/pub.asp?DocID=aw020404

King, J.L. (2003, September). IT Responsible For Most Productivity Gains. Computing Research News. Vol 15, No. 4. pp. 1, 6.

Norman, D. A. (1990). The Design of Everyday Things. New York: Doubleday Books.

OneStat. (2006, August 14). *Microsoft's Windows dominates the OS market on the web according to OneStat.com*. http://www.onestat.com/html/aboutus_pressbox46-operating-systems-market-share.html

Powell, T.C. (1992). Organizational Alignment as Competitive Advantage. *Strategic Management Journal*, Vol. 13, No. 2. pp. 119-134

Schaller, R. (1997). Moore's law: past, present and future. *Spectrum, IEEE* , vol.34, no.6, pp.52-59.

Schneier, R. (1997). People value added the new performance measure. *Strategy & Leadership* , 14-19.

Schultz, T. (1961). Investment in Human Capital. *The American Economic Review*. Volume 51, Iss. 1; p. 2

Seligman, M. (2002). *Authentic Happiness: Using the New Positive Psychology to Realize Your Potential for Lasting Fulfillment*. Simon and Schuster.

Strategy Analytics. (2008, April 28). *Motorola, Sony Ericsson and Apple Lose Global Handset Marketshare in Q1 2008.* http://www.strategyanalytics.net/default.aspx?mod=ReportAbstractViewer&a0=3918

Tredinnick, L. (2006). *Web 2.0 and Business: A pointer to the intranets of the future?* London, Thousand Oaks, New Delhi: Business Information Review.

U.S. Bureau of Labor Statistics. (2001). *Report on the American Workforce.* Washington DC: U.S. Department of Labor.

van Welie, M. (2006). *Task-Based User Interface Design.* Amsterdam: SIKS Dutch Graduate School for Information and Knowledge Systems.

World Wide Web Consortium. (1995). *A Little History of the World Wide Web*. Retrieved April 15, 2008, from World Wide Web Consortium: http://www.w3.org/History.html