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Yu "Andy" Wu  
ywu@bus.ucf.edu

Craig Van Slyke

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# INTERFACE COMPLEXITY AND ELDERLY USERS: REVISITED

**Yu “Andy” Wu**  
University of Central Florida  
ywu@bus.ucf.edu

**Craig Van Slyke**  
University of Central Florida  
cvanslyke@bus.ucf.edu

## Abstract

*The ever-increasing functionality of today’s software applications comes in tandem with added complexity, which may hinder elderly citizens’ full participation in the digital world. Building upon Van Slyke et al’s (2004) extension to TAM, the authors explicate the relationships between software functionality/complexity and users’ perceived usefulness and ease-of-use of software. The influence of age difference on these relationships is also examined.*

**Keywords:** Technology adoption, software functionality, software complexity, perceived usefulness, perceived ease-of-use, senior citizens.

## 1. Introduction

Recent advancements in information technologies have created a vast ocean of new opportunities for the society. These technologies, however, may exacerbate the digital divide problem if certain properties of technologies are too challenging for elderly citizens. Software applications tend to increase in complexity over time, cluttering the application interface. This heavily taxes information processing capacity of the elderly people. As information technologies enter the entire gamut of modern life, usability of technologies becomes critical to governments’ online initiatives and citizens’ equal participation in society (Van Slyke, Belanger, & Haynes, 2004).

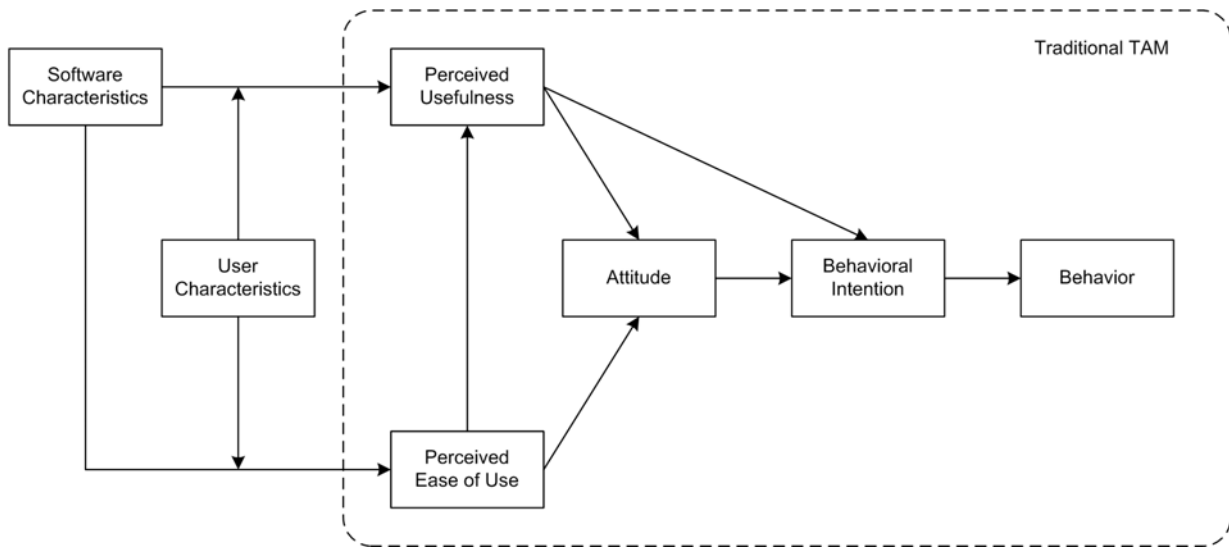
To attain the “universal usability” that older technologies such as telephones and television have achieved, software designers should consider technology variety, user diversity, and gaps in user knowledge. User diversity includes age and physical ability differences (Shneiderman, 2000; Shneiderman & Hochheiser, 2001). While design changes originally may be aimed at a certain group of users, e.g., the elderly, often they also benefit more or even all users (Chadwick-Dias, McNulty, & Tullis, 2003; Shneiderman, 2000).

Terms like “feature creep,” “feature leapfrogging,” and “bloatware” reflect a fact of current practices in software design. Gearing their products primarily toward younger users and knowledge workers, software vendors have the urge to cram ever more “new features” into every turnout of an application. Yet without breakthroughs in interface design it has become increasingly difficult to achieve the dilemmatic task of adding functionality while preserving usability at the same time. Perhaps software vendors should ruminate about their stance on the functionality/usability trade-off. As Shneiderman (2000) puts it, “Reaching a broad audience is more than a democratic ideal; it makes good business sense” (p. 88).

A widely used model for studying technology adoption is the Technology Acceptance Model (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989; Venkatesh, Morris, David, & Davis, 2003). TAM is a parsimonious model that has enjoyed substantial empirical support. As speculated by TAM and depicted in the right section of Figure 1, perceived usefulness (PU) and perceived ease of use (PEOU) determine users’ attitude toward and adoption of the software. PEOU is particularly influential in that it affects attitude both directly and indirectly via its impact on PU.

Van Slyke et al (2004) propose an extension to TAM. They suggest that software characteristics such as functionality and complexity affect users’ PU and PEOU of software. These perceptions, in addition, are subject to the influence of users’ characteristics, e.g. age and experience. Further questions remain to be answered, however – What is the exact relationship between software characteristics and PU or PEOU? How does this relationship differ across different age groups or groups with different experiences?

**Figure 1. An extension of the technology acceptance model (Van Slyke et al 2004)**



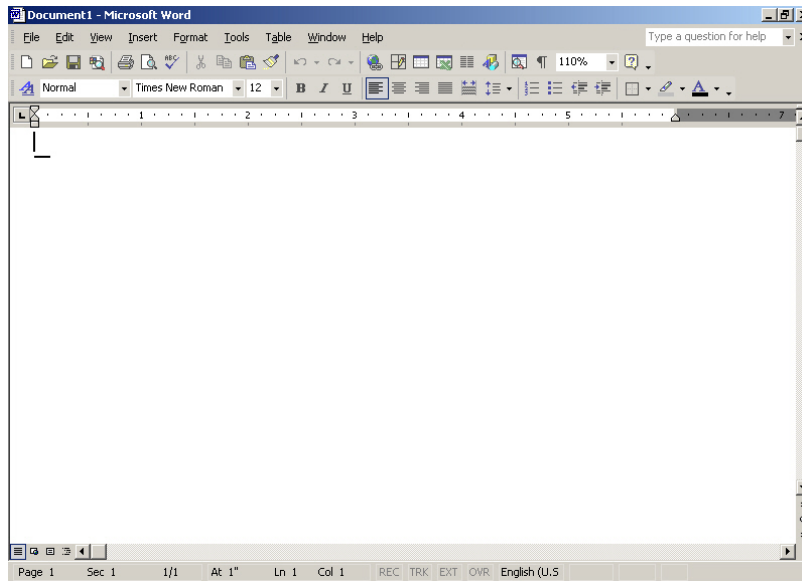
This paper, therefore, builds upon this extension to TAM and tries to provide a more in-depth treatment to the above questions. Particularly, we zero in on two important and related software characteristics – functionality and complexity. As for user characteristics, we focus on their age difference. We attempt to explicate these relationships in a formal fashion, including a set of formulas to portrait the relationships mathematically. Although, as it is with most social science phenomena, the formulas should not be viewed as an exact science, they do help to generate the illustrative figures in this text. Due to limited space they are not provided here. Details on derivation of the formulas, however, are available upon request.

## 2. Functionality, Complexity, User Characteristics, and Perceived Usefulness

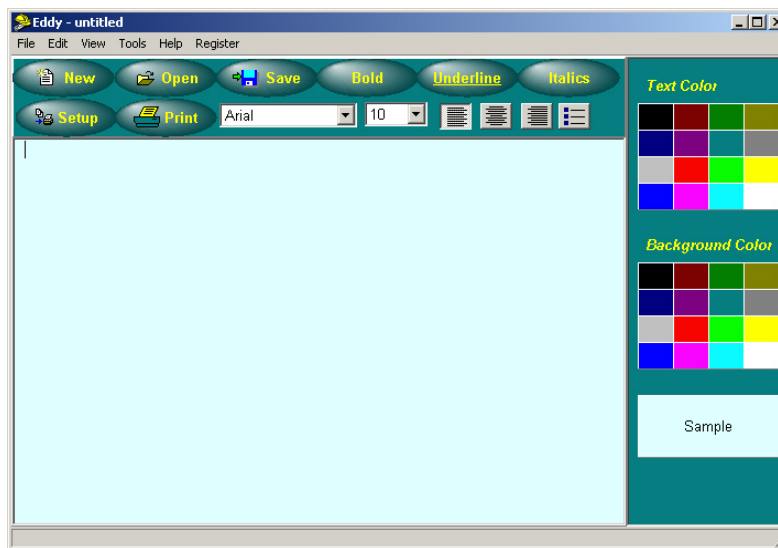
Van Slyke et al. (2004) posit that additional functionality often increases interface complexity and that, so far, designers’ attempts at taming complexity have been largely unsuccessful. The familiar WIMP (Windows, Icon, Menu, and Pointer) GUI hides some of the clutters however may not necessarily reduce complexity.

For illustration, compare the interfaces of two word processor applications – the omnipresent Word and the very simple Eddy (software by TestedOK, 2000). Figure 2 is the standard interface of Word and Figure 3, Eddy.

**Figure 2. Standard Interface of Microsoft Word**



**Figure 3. Standard Interface of Eddy**



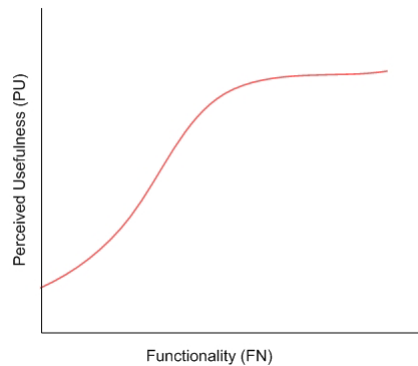
Word undoubtedly has much more functionality than Eddy. Nevertheless, the Word interface also features a much more complex system of icons and menus. While all available icons in Eddy are in view simultaneously, the toolbar in Word's standard lineup is a "smart" one that shows only those most frequently used icons and hides the less popular ones, which can be "turned on" by clicking the chevron (») or arrow (▼) at the end of each icon group or the View → Toolbars menu. Correspondingly, the icon size is much smaller in Word than in Eddy. In addition, Word has more dropdown menus and each of them contains far more items than its counterpart in Eddy. To add to complexity, default installation of some programs, e.g., Acrobat Professional and EndNote, automatically puts new macros, icons, and/or dropdown menus into this hodgepodge of menus and icons.

All the functionality that gives rise to the complexity, however, may not be that important to some users. It can even be irrelevant. Many elderly, novice, or casual users may be perfectly content with the limited functionality Eddy provides. Anything more offers little for performing their tasks at hand hence little added PU. Nevertheless, the rationale behind the software industry's incessant pursuit for added functionality probably is that more functionality means more value perceived by the user. In other words, a linear relationship is assumed to exist between functionality and users' perceived usefulness. At a closer look, however, the truth may be much more complicated. The marginal value the user places on additional functionality is not constant, thus nullifying a linear relationship.

First, users' individual differences aside, the PU may vary along the software's life cycle. Earlier versions of an application usually constitute a maturing stage during which the "core" of the application is formed. For each added feature within the portion of functionality adding up to the "core," the user will perceive higher incremental usefulness. That is, the increase in

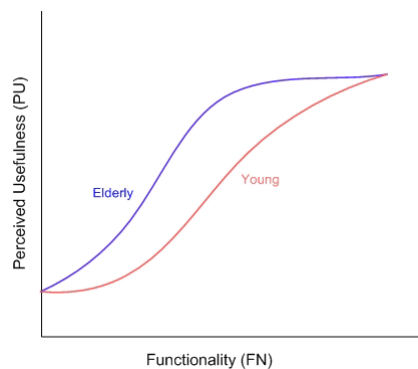
PU starts at a steeper rate. However, sooner or later this fast growth in PU will come to an end. After a certain amount of functionality, i.e., the core functionality which the user considers indispensable for the software, has been built, the growth rate slows down. A curvilinear relationship (Figure 4) may be a more accurate representation of the relationship between PU and functionality.

**Figure 4. Cumulative Effect of Functionality (FN) on Perceived Usefulness (PU)**



Second, this curve may take on different shapes for users with different characteristics. One such difference this paper is concerned about is age. Due to their early exposure to computer technologies and higher expectations of novelty in general, younger users may include more features as “must-haves” than older people. Their curve may differ from that of the elderly, flattening out after a higher magnitude of functionality has been built into the software. The younger group’s inflection point will appear later than the elderly group (Figure 5).

**Figure 5. Comparison of Cumulative Effect of Functionality on PU for Different Age Groups**



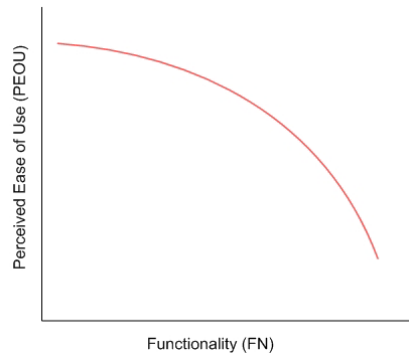
### 3. Functionality, Complexity, User Characteristics, and Perceived Ease of Use

Generally, complexity penalizes users’ perception of ease of use of the interface. This is largely due to the natural limit on human’s information processing capacity. To tackle a higher degree of complexity, more attention is demanded of the user, whereas the user’s attention is not inexhaustible. The attentional resource theories in psychology maintain that a person has a fixed amount of attention and it has to be divided among multiple tasks. Allocating attention to one task simultaneously divert attention away from other competing tasks (Sternberg, 1995). Therefore, there is a limit to the number of tasks across which attention can be spread. Miller (1956) reckons that human can process at most  $7\pm 2$  chunks of information at any one time.

Interleaving multiple tasks is one of the reasons that make the limitations on human attention pronounced (Horvitz, Kadie, Paek, & Hovel, 2003). Some researchers consider a task as consisting of three stages: perception of stimulus, response choice, and response production. Human cannot produce the response-choice stages of two tasks at once (Gray, 1994). In their study of how decision makers process information, Lerch and Harter (2001) posit that decision making involves both monitoring and control. Monitoring refers to the activities to keep track of key system variables. Control is the actual generation, evaluation, and selection of alternative actions, which are what decisions are really about. In real-time decision making, these two types of “situational awareness” activities compete for the decision maker’s attention, placing a significant demand on human’s working memory, to such an extent that it becomes one of the factors hampering successful cognitive support for decision making.

In the same vein, when using a software application, the user has to engage in two types of similar activities. One is to handle the software environment, which is basically the interface. The other is the actual task the user is trying to accomplish with the application. A more complex interface will demand more attention from the user and thus take away some attention that the user could have spent on the task itself. This will cause the user to perceive the software as less easy to use, hence an inverse relationship between complexity and PEOU. Since complexity is positively related to functionality, an inverse relationship between functionality and PEOU exists, as illustrated in Figure 6.

**Figure 6. Cumulative Effect of Functionality (FN) on Perceived Ease of Use (PEOU)**



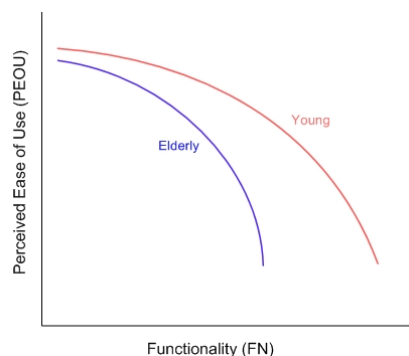
This relationship is not linear. At higher degree of functionality hence higher level of complexity, users are likely to feel that they have too much a handful to deal with already. Thus they will be more easily “overloaded” and put a more severe penalty on PEOU at the sight of new “features” to learn. That is, the marginal PEOU drops at a more accelerating rate at higher levels of functionality.

Also, as in the case of PU, different age groups may have a different curve for the relationship between functionality and PEOU. The elderly users are more adversely impacted by the complexity of the interface, particularly the icons. Two specific physical changes occurring with age are vision impairments and reduced dexterity, leading to difficulties in performing the basic pointing and selection tasks, which are essential to the icon-based WIMP interfaces (Hanson, 2001). Low vision reduces senior users’ ability to adjust to small font sizes and small objects like icons (Hanson, 2001; Jacko et al., 2000; Worden, Walker, Bharat, & Hudson, 1997), whereas a common practice given today’s technology is to use small icons to fit a lot of information into limited display (Worden et al., 1997). Thus vision loss significantly alters elderly users’ interaction style (Jacko et al., 2000). Because of reduced dexterity, such as the decreased ability to make small movements (Worden et al., 1997), senior users encounter problems in using mouse and keyboard. Clicking on an icon becomes difficult (Hanson, 2001) and their mouse clicking speed is much slower than that of younger people (Chadwick-Dias et al., 2003). Chadwick-Dias et al. (2003) conclude that limited usability is most likely a problem for the elderly.

Cognitive problems also contribute to the reduced PEOU. Seniors may have difficulty learning an unfamiliar domain while their previously learned skills may become more interference than assistance (Hanson, 2001). Their old frame of reference may generate misunderstanding (Van Slyke et al., 2004). The interface can easily overwhelm a senior. Hanson (Hanson, 2001) suggests that visual clutter and irrelevant information are difficult for seniors to comprehend. “Bells and whistles” such as animations can in fact create distractions.

For a given level of complexity, therefore, the seniors will tend to have less perceived ease of use than the younger people. Figure 7 illustrates this difference.

**Figure 7. Comparison of Cumulative Effect of Functionality on PEOU for Different Age Groups**



## 4. Conclusion

Without breakthroughs in technology, added functionality invariably adds to complexity. The relationship between functionality and PU is more likely to be curvilinear than linear. The slope of the curve may be different in different phases of the product's life cycle. Moreover, user characteristics influence this relationship. Different age groups may have different curves. The relationship between functionality and PEOU, similarly, is more likely to be a downward sloping curve. Older users' curve drops much faster than younger users', as software functionality (hence complexity) increases.

Design innovations accounting for these differences can enhance usability (Chadwick-Dias et al., 2003; Worden et al., 1997). Nonetheless, we might ask the more philosophical question, "Are all these many functions necessary?" Simplifying the interface by limiting functionality should not be overlooked or dismissed. For many senior, casual, and novice users, basic functions may well suffice for their daily routines. For these users, the benefit of enhanced functionality is not worth the associated added complexity and reduction in ease of use.

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