Gender and Age Differences in Employee Decisions About New Technology: An Extension to the Theory of Planned Behavior

Michael G. Morris, Viswanath Venkatesh, and Phillip L. Ackerman

***Abstract*—This research extends the theory of planned behavior by incorporating gender and age as moderators of user perceptions and individual adoption and sustained use of technology in the workplace. Individual reactions and technology use behavior were studied over a six-month period among 342 workers being introduced to a new software technology application. While previous studies in the literature have reported gender or age differences separately, the pattern of results from the study reported here indicated that gender effects in individual adoption and use of technology differed based on age. Specifically, gender differences in technology perceptions became more pronounced among older workers, but a unisex pattern of results emerged among younger workers. The theory and empirical results are also discussed in relation to the widely employed technology acceptance model. The results from this study suggest that old stereotypes that portray "technology" as a male-oriented domain may be disappearing—particularly among younger workers. In light of these findings, theoretical implications for researchers and practical suggestions for managers are discussed.**

***Index Terms*—Age differences, gender differences, technology acceptance, theory of planned behavior (TPB).**

I. Introduction

ORGANIZATIONAL investment in new technology continues to rise. The U.S. Department of Commerce, Bureau of Economic Analysis, and the Census Bureau state that as much as 50% of all new capital investment goes into information technology [84]. At the same time, the implementation and use of computer and information technologies in organizations has become so pervasive that it is now considered a routine part of daily operations. As a result, the *adoption* and *use* of technology in organizational settings has become a topic of broad interest to researchers and practitioners in management and psychology. Despite the importance of successful deployment of technology in organizations, highly publicized examples of failed implementation projects continue to accrue in the trade press. Examples such as the IRS' failed \$4B system [37] and the FAA's \$7.6B system [77] indicate the scope of problems that stem from employee rejection of new technologies. Unfortunately, these are not isolated incidents—Landauer [41] estimated that about half of all systems implemented in the U.S. are either underused or not used at all.

Partly as a result of this alarming trend, the development and implementation literature advocates *user-centered design* practices that suggest that analysts must first gain a fundamental understanding of the user—including his or her needs, wants, and expectations about new systems [19], [53], [57]—and that project managers must *prioritize users over designers* [74]. Underscoring the importance of this user-centric approach, the changing nature of today's workforce has significantly broadened the typical user base in organizations and has spawned recent research focusing on the importance of gender (e.g., [1], [36], [75], and [87]) and age effects (e.g., [24]) on technology-related issues in the workplace.

As many have noted, gender and age are among the most fundamental groups to which individuals can belong and membership in such groups is likely to have a profound influence on individual perceptions, attitudes, and performance [54]. Thus, studying the role that membership in these groups plays with respect to attitudes and beliefs about technology in the workplace is especially important today. The importance of such research is further underscored by United Nations' recommendations: "…research institutions should, as appropriate, promote research on the interrelationship between… aging and gender" [76, p. 8]. This is particularly important because the ranks of older workers are increasingly female. For example, between 1990 and 1996, the proportion of working married women ages 55 to 64 increased from 36% to nearly 50% and increasingly greater proportions of women are now employed into their 50s and 60s [83]. From a pragmatic perspective, *if* differences in decision-making processes do exist based on gender and age, designing appropriate interventions is critical. Given the clear importance of this topic combined with the simplicity of collecting gender and age data, research focused on gaining a more fine-grained understanding of the user and their motivation—particularly, if it can be done at a very low cost early in the project management cycle—can serve to significantly reduce implementation risk and will provide a basis for current and future development efforts within the organization.

Of particular interest and relevance for the current research are social psychological theories of individual behavior, such as the theory of planned behavior (TPB); see [2] and [3]), which has been used as a useful lens for looking at user beliefs and behavior (i.e., use). Prior research has successfully

Manuscript received August 1, 2003; revised June 1, 2004. Review of this manuscript was arranged by Department Editor R. Sabherwal.

M. G. Morris is with the McIntire School of Commerce, University of Virginia, Charlottesville, VA 22904 USA.

V. Venkatesh is with the Walton College of Business, University of Arkansas, Fayetteville, AR 72701 USA (e-mail: vvenkatesh@walton.uark.edu).

P. L. Ackerman is with the School of Psychology, Georgia Institute of Technology, Atlanta, GA 30332 USA.

Digital Object Identifier 10.1109/TEM.2004.839967

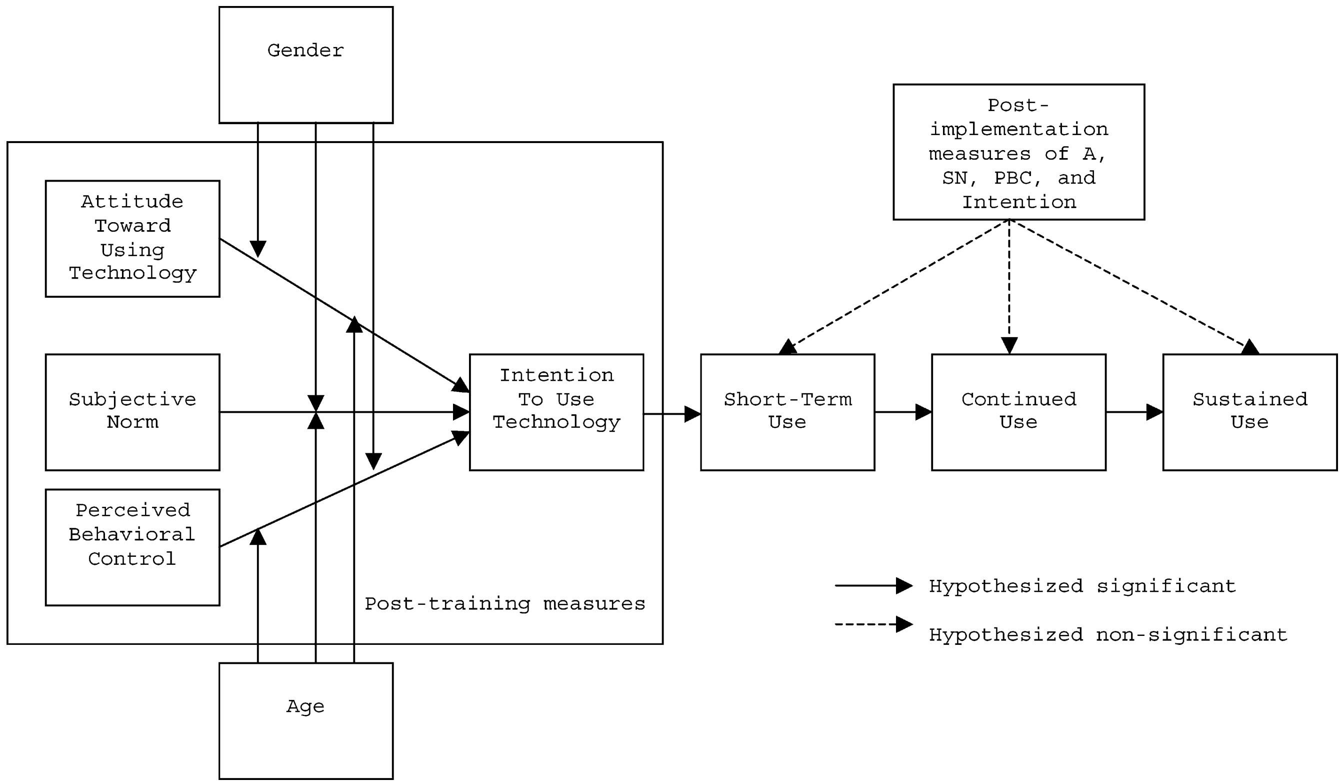

Fig. 1. Research model.

applied TPB to new technology implementation, providing compelling evidence for its efficacy in predicting individual use and adoption of automated tools in the workplace (e.g., [32], [47], and [73]). Another competing model of technology adoption is the widely employed technology acceptance model (TAM, [89], [90]). Although we formally use TPB as the model in the current work, we will draw parallels to TAM and present the case for the applicability of our arguments and empirical evidence to TAM.

Building on this foundation, our previous longitudinal field research has examined moderators that might be incorporated into TPB, including gender [80] and age [52] to provide key insights into how different individuals in organizations may think and make decisions differently when it comes to technology adoption and use. Although our previous studies controlled for the most important potential confounds (see [42]), due to limitations placed on the data gathered by the participating organizations for each study, *neither* study was able to examine the potential effect of gender *and* age simultaneously. In addition, although recent work by Venkatesh *et al.* [81] did examine the simultaneous effects of the two variables, additional confounds were not investigated and their research highlighted the need for a deeper understanding of the theoretical and practical significance of gender and age as key moderators. Specifically, *the current study seeks to build on the our previous work on gender* [80] *and age effects* [52], *respectively, by extending TPB to account for the moderation of the core relationships by both gender and age in the context of technology adoption and use decisions.*

II. Theory

A. Theory of Planned Behavior (TPB)

The theory of planned behavior (TPB) offers a comprehensive yet parsimonious psychological theory that identifies a causal structure for explaining a wide range of human behavior including leisure behavior [4], health care [5], [64], and consumer purchasing behavior [10], [55]. TPB defines relationships between beliefs, attitudes, norms, perceived behavioral control, intentions, and behavior. According to the theory, attitude toward a behavior (A), subjective norm (SN), and perceived behavioral control (PBC) influence an individual's intention to perform a given behavior. Intention, in turn, influences the behavior of interest while fully mediating the influence of A and SN, while PBC typically also has an effect on behavior. Fig. 1 shows TPB and the proposed moderators.

TPB has received extensive empirical support for explaining behavior in both individual and organizational settings. Recent meta-analytic evidence suggests that TPB explains about 41%–50% of the variance in intention, and 28%–34% of the variance in behavior [5], [27]. Despite the impressive predictive power of TPB, a large proportion of the potentially explainable variance remains unaccounted for. Conner *et al.* [17] note that two ways to address this unexplained variance are through the inclusion of *additional variables* and *moderator variables*. The latter approach forms the basis of the current examination of TPB for technology adoption and use decisions in organizations.

Although we chose TPB as the core model for this work, one important consideration is the implications for the TAM. As discussed earlier, while TPB is a general model of behavior developed in psychology and has been applied/adapted to study technology adoption and use, TAM was developed in the IS literature with the specific purpose of studying technology adoption and use. TAM posits that perceived usefulness, i.e., the extent to which using a technology will enhance productivity—and perceived ease of use, i.e., the extent to which using a technology will be free of effort—influence intention to use a technology [90]. Although TAM did not originally include the impact of social influence (subjective norm), recent extensions have included subjective norm in TAM, albeit in certain conditions (see [78] and [79]). This more comprehensive view of TAM is consistent with the recent review and synthesis paper [81] that integrated constructs from eight different technology adoption models into a unified model of technology adoption including performance expectancy, effort expectancy, and subjective norm. The arguments presented in conjunction with TPB will apply quite consistently to the TAM constructs: 1) the arguments for attitude toward using technology will apply to the perceived usefulness construct since instrumentality is at the heart of both constructs in workplace settings; 2) the arguments for perceived behavioral control will apply to the perceived ease of use construct as both constructs are tied to the level of difficulty associated with the use of the technology; and 3) the subjective norm construct is the same across both models. Thus, the overlap is significant.

B. Gender and Age Differences in Employee Adoption and Use of Technology

Driven by changes in the makeup and diversity of the workforce, gender differences are becoming increasingly important in managing the development and implementation of new technology (see [1] and [87]). Within occupational settings, gender differences have manifested themselves in different ways. For example, recent studies in the trade press suggest that women have much higher turnover rates which have been attributed to gender differences in job stress and work-family role conflict (e.g., [49]). In an organizational context, evidence has suggested that women do not exhibit the same sense of personal entitlement that men do (e.g., [7]), and therefore, women may be just as satisfied with their job, despite being paid less than their male counterparts for comparable work [45].

Like gender, age has also proven to be an important demographic variable of interest in organizational settings (e.g., [24] and [65]). This importance is derived from two societal trends: an increasingly older workforce and the rapid introduction of computer technology across virtually all job settings [69]. As a result of these trends, organizations are finding themselves faced with a workforce with dramatically different demographic characteristics than in previous years [83]. Consequently, understanding age differences—especially as they relate to gender—is an important aspect of understanding how to effectively manage tomorrow's workforce [81].

While there have been a number of studies of individual adoption and use of technology using TPB (e.g., [47] and [73]), the vast majority of this research has not examined the potential dynamic influences of user differences. As a result, most studies in this domain implicitly suggest that demographic characteristics are less important than characteristics of the technology itself in determining whether specific technologies will be accepted or rejected by the intended user base. There has been some recent work that has adopted a more *people-centric* position by testing the role of demographic characteristics. Particularly, our two research studies [52], [80] have examined the moderating role of the aforementioned key demographic characteristics—age and gender, respectively, on the TPB relationships using longitudinal data.

In our study on gender differences, we studied differences in the determinants of intention and behavior from a longitudinal viewpoint by pooling the data from various measurements across a five-month period [80]. We found that, as a predictor of intention in the *short-run*, men were more influenced by instrumentality, while women were more strongly influenced by social factors and environmental constraints; however, we found no significant gender differences in the determinants of technology use. In our related research, we used TPB to examine age as moderator of the determinants of technology use [52]. In contrast to Venkatesh *et al.* [80], Morris and Venkatesh [52] does not include intention in the research model and presents a cross-sectional test of the model that includes measurements over a five-month period. We found that older workers were influenced by attitude toward using technology, subjective norm, and perceived behavioral control, while younger workers were only influenced by attitude toward using in making short-term use decisions. However, the influence of subjective norm on older workers became nonsignificant when making long-term use decisions. A summary of the results of our previous two studies is presented in Table I.

In summarizing the existing literature within a technology context, Venkatesh *et al.* [80] and Morris and Venkatesh [52] focused on the moderating roles of gender and age *separately* on the key relationships that influence individual adoption and use of technology in organizational settings. While this research has made an important contribution to our understanding of the moderating effects *individually*, gender and age were not examined *simultaneously* in either study due to restrictions imposed on the data collection by the participating organizations. In considering gender and age together, the potential for cohort differences becomes an important issue (see [14] and [22]). For example, with respect to gender differences in the workplace, one might expect that women born in different decades are likely to have had very different educational and occupational opportunities. As a result, the observed pattern of gender differences could be expected differ based on age [81]. The present work examines the moderation of TPB relationships, specifically focusing on the *concurrent* moderation by gender and age, thus building a more comprehensive understanding of the interplay between these two key demographic variables. Further, the proposed model is tested using longitudinal field data and accounts for other potential confounding demographic variables, i.e., income, education, and occupation levels.

TABLE I
SUMMARY OF MAJOR STUDIES ON GENDER AND AGE DIFFERENCES IN INDIVIDUAL ADOPTION AND USE OF TECHNOLOGY

Gender Differences (Venkatesh et al., 2000)				
Dependent Variable	Independent Variable	Women	Men	Comments
Intention (Post-training)	A SN PBC	Significant Significant Significant	Significant Non-sig. Non-sig.	Gender moderated, all three relationships— A-BI, SN-BI, PBC-BI
Short-term use (1 month post-implementation)	Intention	Significant	Significant	No gender differences. A, SN, and PBC measured post-training and 1 month post-implementation were non-significant.
Continued use (Months 2 and 3 post-implementation)	Short-term use	Significant	Significant	No gender differences. A, SN, and PBC measured post-training, 1 month post-implementation, and 3 months post-implementation were non-significant.
Sustained use (Months 4 and 5 post-implementation)	Continued use	Significant	Significant	No gender differences. A, SN, and PBC measured post-training, 1 month post-implementation, and 3 months post-implementation were non-significant. Short-term use was also non-significant
Age Differences (Morris & Venkatesh, 2000)				
Dependent Variable	Independent Variable	Older	Younger	Comments
Short-term use (1 month post-implementation)	A SN PBC	Significant Significant Significant	Significant Significant Significant	Intention not included in the model; Age moderated all the relationships such that attitude was more important to younger workers while SN and PBC were more important to older workers.
Sustained use (Months 2 through 5 post-implementation)	A SN PBC	Significant Non-sig. Significant	Significant Non-sig. Non-sig.	Intention not included in the model; Short-term use not included in the model; Age moderated two out of three relationships such that attitude was more important to younger workers while PBC was more important to older workers. SN was not significant as a direct effect and an interaction term.

C. Hypothesis Development

Across each of the core TPB relationships, we expect the influence of gender effects to differ based on age. How older and younger individuals develop sex role identities and experience life events and passages obviously vary across cohorts or historical time. For example, Arceneaux *et al.* [8] found evidence supporting age moderation of gender differences based on longitudinal data from WAIS/WAIS-R subtests. More specifically, the observed gender differences were moderated by age for some skills, particularly, those requiring spatial abilities. Similarly, Jones [38] reported gender differences in college students' values; however, he found that these differences varied between "traditionally aged" students and "nontraditionally aged students" (operationalized as > 23 years of age). In sum, this line of research suggests that the definitions, experience, and consequences of being male or female at different life stages varies across generations and, thus, are open to reinterpretation and change throughout the aging process [43]. As Levy explains "…studies of gender and gender-stratification appear static and misleading without reference to the social process of age" [43, p. 485]. This suggests the need to extend existing theory and research in individual adoption and use of technology in order to account for the co-properties of gender and age.

In understanding longitudinal effects, the two main papers that we seek to integrate into a more comprehensive view of TPB as applied to technology adoption and usage contexts have presented two different ways of dealing with the longitudinal data. While Morris and Venkatesh [52] studied long-term use and its determinants, they did not employ short-term use as a predictor since the data were analyzed cross-sectionally. In fact, in Venkatesh *et al.* [80], short-term use was found to be *the key* determinant of long-term use, while intention was the sole predictor of short-term use.[1] Thus, for purposes of developing a full understanding of the phenomenon of individual adoption and use of technology in this research, we find the approach that we took in our earlier study of gender [80] to be the most compelling as it develops a dynamic model of decision-making that incorporates both early perceptions, intentions over time, and prior technology use (see Fig. 1).

D. Attitude Toward Using Technology

TPB defines attitude toward a behavior as "the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question" ([2, p. 188]). In a technology adoption context, the key behavior of interest is use of the system; therefore, attitude toward behavior is an employee's affective evaluation of the costs and benefits of using the new technology. Within TPB, attitude toward a given behavior is determined by behavioral beliefs about the consequences of the behavior and the affective evaluation of the importance of those consequences on the part of the individual. This perspective is consistent with other models of technology acceptance, such as TAM, that conceptualize individual perceptions of usefulness based on instrumentality as being strongly related to attitude toward technology use.

[1]While [80] presented theoretical arguments regarding why one might have expected intention to be moderated by gender, no empirical support was found for such a relationship.

While gender differences research on technology adoption suggested that attitude toward using technology would be more important to men (e.g., [80]), recent psychological theory on implicit attitudes toward male–female stereotypes suggest that gender-based attitudes are more salient for older individuals, but those differences disappear in younger (below age 50) respondents [54]. With respect to gender-based attitudes about technology's role in the workplace, research on age and job-related attitudes has demonstrated that job needs and preferences will, in fact, change with age, further suggesting the potential for a three-way interaction. For example, Porter [60] and Hall and Mansfield [31] found that younger workers placed importance on opportunities for promotion above other job-related factors compared with older workers. However, over time, the importance of promotion opportunities may be supplanted by other factors, especially taking on family responsibilities. Given traditional societal sex-roles, whereby men identify more with work roles, while women identify with family roles (e.g., [9] and [56]), we expect that instrumental factors related to technology's usefulness and its influence on job productivity will be more important to older men than older women, thus resulting in a greater influence for attitude in predicting new technology adoption among older men than older women. In contrast, as suggested in Venkatesh *et al.* [80] and Nosek *et al.* [54], with the ever-expanding presence of women in the professional workforce, traditional gender roles may be in a state of flux and, therefore, we expect few, if any differences in the influence of attitude on technology adoption among younger men and women. Therefore, we hypothesize the following.

H1: Gender and age will moderate the relationship between attitude toward using technology and behavioral intention to use technology, such that gender differences in the importance of attitude will be more pronounced with increasing age.

E. Subjective Norm

Within TPB, subjective norm is defined as "the perceived social pressure to perform or not to perform the behavior" [2, p. 188]. Further, TPB views the role of the normative pressure to be more important when the motivation to comply with that pressure is higher. While the original conceptualization of TAM did not include a social component, more recently, subjective norm has been incorporated into TAM [78], [79]. In the context of technology adoption and use, subjective norm has manifested itself as peer influence and superior influence [47], [73]. In first examining subjective norm from a gender perspective, the literature on gender differences and gender roles suggests that women have higher affiliation needs and are thus more concerned with pleasing others and more likely to conform to majority opinions (e.g., [20] and [50]). However, research has also shown differences based on age in the importance of normative influences. For example, empirical evidence from at least four studies indicates that older workers have a significantly lower need for autonomy (typically, the opposite of affiliation need) than younger workers [6], [18], [21], [30], suggesting that normative influences may be more important to understanding behavior for older workers.

Consistent with this prior work, research on work-related attitudes and behavior has suggested that gender differences may be attenuated for younger workers. For example, task identity and the need for autonomy typically vary by career stage, which is highly correlated with age, and are only important early in one's career [63]. Therefore, while subjective norm may be an important determinant of behavior, due to career staging effects, the differences between men and women are likely to be minimized for a younger population. With the passage of time, however, evidence suggests that older workers place increasing importance on normative influences. For example, Hall and Mansfield [31] reported that the importance of having friendly supervisors and coworkers increased with age. Rhodes' [65] analysis also suggests that needs for affiliation increase with age. This is typically accompanied by preferences for extrinsic rewards, as noted earlier in the paper, and having friendly coworkers and superiors. Thus, while gender role theory suggests that women tend to value and respond to opinions of their social group (e.g., coworkers) more than men, the age differences and career stage literature suggests that these differences will be more apparent with increasing age. Therefore, we hypothesize the following.

H2: Gender and age will moderate the relationship between subjective norm and behavioral intention to use technology, such that gender differences in the importance of subjective norm will be more pronounced with increasing age.

F. Perceived Behavioral Control

Perceived behavioral control is defined as the "… perceived ease or difficulty of performing the behavior" [2, p. 188]. Perceived behavioral control comprises two factors: control beliefs (the availability of skills, resources and opportunities) and perceived facilitation (an individual's assessment of the importance of those resources to the achievement of outcomes). Specifically, control beliefs are defined as the presence or absence of requisite resources and opportunities necessary to perform a behavior [2]. Based on the definition, the ties of perceived behavioral control to perceived ease of use in TAM are strong and have been previously documented [80], [81]. Previous research has shown that situational constraints are more important determinants of intention to use technology for women than they are for men [80] Adding some additional theoretical richness to this view, research further suggests that effect of situational constraints—typically shown to be more important for women [80]—may be differentially experienced by older workers due to age-related changes in cognitive, sensory, and physiological abilities. For example, there is substantial evidence to indicate that behaviors that comprise cognition and the ability to process complex stimuli decline with age [59]. Posner [61] suggests that as these cognitive abilities decline with age, older individuals may believe that the relative benefits that might accrue to learning something new (e.g., new technology) may not be worth the incremental effort required. Thus, for older individuals, one would expect that control beliefs would be particularly important in their decision to use (or not use) new technology.

Lending further support to this notion, Kubeck *et al.* [40] provide meta-analytic evidence that older adults showed less mastery of training material and had a more difficult time completing training tasks. This finding suggests that, for older individuals, the degree to which the new technology is perceived to be easy to use, e.g., requiring little or no formal training—will be more important in their decision to adopt or reject that technology than it will for younger workers (see [80]). Similarly, Welford [82] has found that age-related working memory deficits were more pronounced when the information presented was new, in an unfamiliar cognitive domain, or complex.

As a mechanism for coping with these changes, Hall and Mansfield [31] have reported that older workers attach a great deal more importance to receiving help and assistance on the job. This is consistent with the training findings reported by Kubeck *et al.* [40] and suggests that older adults are cognizant of their lower abilities for learning new facts and procedures and may find personal tutoring the most effective means of acquiring new knowledge or skills. More specifically, for computer-related work, researchers have suggested user interface design strategies such as using windows or particular types of menu structures as especially beneficial for older workers in that they decrease the individual's requirements to maintain information in working memory [69]. The results presented by Morris and Venkatesh [52] also suggest that access to resources and assistance provided by particular user interface design features designed to alleviate the cognitive load associated with complex stimuli (e.g., [71]) are particularly important to older workers. Given these differences in cognitive processing, we believe that previously reported gender differences in the importance of perceived behavioral control will be particularly evident with increasing age and will be less pronounced for younger workers. Therefore, we hypothesize the following.

H3: Gender and age will moderate the relationship between perceived behavioral control and behavioral intention to use technology, such that gender differences in the importance of perceived behavioral control will be more pronounced with increasing age.

G. Technology Use

As suggested earlier, in examining long-term technology use, Venkatesh *et al.* [80] offer compelling arguments for short-term use being the key determinant of long-term use, thus diminishing the role of subsequent perceptual influences on long-term use. Here, all three hypotheses suggest a three-way interaction between gender, age, and each of the determinants of intention (attitude toward behavior, subjective norm, or perceived behavioral control) in the initial stage of individual adoption of technology. However, based on the existing theoretical and empirical evidence from the studies we seek to integrate in extending TPB, we do not expect to find any moderation by gender and/or age in predicting shorter or longer term use of technology. Thus, as noted in Fig. 1 earlier, we expect the relationships that predict intention to be moderated by gender and age, but not the intention-short-term use, short-term use-continued use, and continued use-sustained use relationships.

H4(a): Short-term use will be determined only by behavioral intention to use technology.

H4(b): Continued use will be determined only by short-term use.

H4(c): Sustained use will be determined only by continued use.

H. Ties to TAM

Following up on the earlier ties between TPB and TAM, there are some parallels between our arguments for the roles of gender and age in TPB and their potential role in TAM. In the context of TPB, we have argued that at the root of attitude was the potential influence of productivity factors. Also, TAM research has consistently shown perceived usefulness to be the key driver of attitude (see Davis *et al.* 1989; [47], [73]). Thus, we could expect that the effect of perceived usefulness on intention will be moderated by gender and age similar to the moderation of the attitude-intention relationship. At the heart of the moderation of the perceived behavioral control-intention relationship were arguments related to perceptions of ease of use, thus suggesting that the moderation of the perceived ease of use-intention relationship would follow a pattern similar to the perceived behavioral control-intention relationship. Subjective norm is the same construct across both TPB and TAM. In addition, research has demonstrated that the primary TAM relationships are moderated by gender [79], while the more recent unified model of technology adoption, with constructs similar to the TAM, found a moderation pattern similar to what is being suggested here among the TAM constructs [81].

I. Summary

The model proposed here extends TPB by including gender and age as moderators of key relationships. Specifically, the hypotheses predict that the effects of attitude, subjective norm, and perceived behavioral control on intention will each be moderated by gender and age. Intention in turn will determine short-term use, which in turn will determine continued use, which in turn will determine sustained use; however, these relationships are not expected to be moderated. Finally, in drawing parallels with TAM, the usefulness-intention relationship will be moderated similar to the attitude-intention relationship, the ease of use-intention relationship will be moderated similar to the perceived behavioral control-intention relationship, and the subjective norm construct (when included in TAM) is the identical in both models. The proposed relationships are summarized in Table II.

III. Method

The current research design closely followed the design of our prior work that we seek to integrate in extending TPB (i.e., [52] and [80]). In the next several paragraphs, we discuss the methodological details of the current work.

A. Participants and Setting

Five organizations participated in this study. The organizations included were implementing a new software/technology application in part or all of the organization. Four hundred and forty five individuals agreed to participate in the study, and 342 (156 women—46%) usable responses (about 77% response rate) were received to test TPB in the technology introduction

TABLE II
SUMMARY OF PROPOSED RELATIONSHIPS: GENDER AND AGE DIFFERENCES IN CONCERT

Perception of…	**More important to…**
Attitude toward using technology	Younger; Men
Subjective norm	Older; Women
Perceived behavioral control	Older; Women
Dependent variables	**Proposed relationships**
Intention	Determined by A, SN, and PBC, with the relationships being moderated by gender and age, as outlined in the Figure and earlier in the table
Short-term use	Intention; no moderation by gender/age
Long-term use	Short-term use; no moderation by gender/age

context at all points of measurement.[2] It is important to note that the study reported here has no overlap with the datasets reported in either of the previous two studies [52], [80] that we extend. All the participants had some prior experience with using computers, ranging from 1 to 16 years with an average of 5.5 years. However, none of the participants possessed any knowledge about the software/technology being introduced. The specific software/technology being implemented varied across organizations, but all were enterprise-wide Windows-based systems for data and information retrieval, including accounting information, policies and procedures, and technical data. Use of the system was voluntary in all organizations during the period of the study due to the parallel availability of both old and new systems during the first several months of the new technology implementation.

B. Procedure

At the beginning of the study, all participants received up to a full-day of training on the software/technology. Although the specific length of the training varied across organizations, the allotted training time was beyond the control of the researchers as the research took place in its naturally occurring field setting. After the training was completed, support staff were available to provide help with questions or problems as the systems were implemented. Employee reactions to the technology were measured at three points in time: after the initial training (T1), after one month of experience (T2), and after three months of experience (T3), consistent with Venkatesh *et al.* [80]. While T1 represented initial employee reactions, T2 and T3 represented situations of significant direct experience with the behavior becoming more habituated. Employee reactions gathered at these three points in time were used to predict actual use of the technology, which was gathered using system logs during the entire six-month period of the research.[3] Technology use was divided into three groups based on the times of measurement: Use12 (use between T1 and T2), Use23 (use between T2 and T3), Use34 (use between T3 and the end of the study, i.e., six months).

C. Potential Confounding Factors

As identified in previous research, several demographic variables including income, education, and occupational level, could potentially confound observed gender and/or age differences (see [42]). Specifically, older men are over represented in categories of higher income, higher educational qualifications, and higher organizational positions. Lefkowitz [42] suggests that not controlling for the effect of such covariates "underestimate the complexity of the issue under study and, at worst, are misleading" [42, p. 341]. Thus, in the current research, beyond examining gender and age differences, we examined the potential confounding effects of income, education, and occupation levels (see [12], [28], [67], [68], and [88]).

D. Measurement

The Appendix reports the various scales used in the TPB testing. The scales for attitude toward behavior, subjective norm, perceived behavioral control, and intention to use the technology were measured using extensively validated items from prior TPB research, particularly, those research studies that we seek to extend [52], [80]. Also, in order to examine the generalizability of our arguments in the context of TAM, we included the items for the two constructs that were different from the constructs in TPB: perceived usefulness and perceived ease of use (see [81] for the scales).

Actual use behavior was gathered from network logs and was operationalized as the duration of system use. Principal components analysis with direct oblimin rotation (to allow for correlated factors) confirmed convergent and discriminant validity of the scales at each point of measurement. Reliability analysis (Cronbach alpha) showed that all scales were highly reliable. The results of these analyses at T1 are shown in Table III. The pattern of results were similar at T2 and T3 and are not reported here in the interest of brevity, given the high degree of consistency with T1 and the extensive previous research that has established the reliability and validity of these scales (e.g., [47], [52], [73], and [80]).

[2] 60, 50, 64, 85, and 112 individuals from each of the five sites, respectively, participated in the study.

[3] Both [52] and [80] conducted studies over a five-month period.

TABLE III
PRINCIPAL COMPONENTS ANALYSIS AND RELIABILITY

	A	SN	PBC	BI
Cronbach alpha	.85	.80	.84	.94
Items				
A1	.88	.18	.02	.07
A2	.87	.07	.01	.12
A3	.82	.17	.07	.11
A4	.81	.12	.13	.13
SN1	.12	.82	.02	.08
SN2	.07	.80	.01	.02
PBC1	.08	.08	.88	.01
PBC2	.14	.07	.86	.05
PBC3	.16	.02	.82	.08
PBC4	.12	.01	.81	.02
PBC5	.10	.13	.84	.09
BI1	.21	.12	.02	.92
BI2	.24	.08	.04	.96

Notes:
A = Attitude Toward Using Technology; SN = Subjective Norm; PBC = Perceived Behavioral Control; BI = Behavioral Intention to Use Technology

We also measured the demographic variables of interest: gender, age, income, education, and organizational position. Gender and age were measured using simple items. Income was measured using a scale with alternative ranges (i.e., < 20 000, 20 000–29 999, 30 000–39 999, etc.). Educational level was measured by asking subjects to respond to a question about the highest level of education completed (i.e., some high school or less, graduated high school, some college, etc.), consistent with much prior psychology and sociology research. Information about occupational level was collected by asking participants to choose from a list of various positions in the organizational hierarchy (e.g., top management). The specific scheme used in this research was adapted from Blau and Duncan [11] and modified to be consistent with the scheme used at the different participating organizations in order to ensure accuracy of responses.

E. Analysis Procedure

We used the Chow's test described in Pindyck and Rubenfeld [58, pp. 123–126] to assess whether the data from the different organizations could be pooled. For the data to be pooled, the beta coefficients of the TPB regressions from the different organizations have to be statistically equivalent. In addition, we also examined mean differences in key constructs across the various organizations and found no statistically significant differences, alleviating concerns related to interorganizational differences in systems and training programs and providing further support for pooling the data across organizations.

The categorization with regard to gender was straightforward and a dummy variable was used to represent women/men. Age was treated as a continuous variable consistent with Morris and Venkatesh [52]. Hierarchical regressions were conducted to examine the TPB relationships at T1 (A-BI, SN-BI, and PBC-BI) and the effects of determinants on technology use (USE12, USE23, and USE34). First, we examined gender differences in the importance of A, SN, and PBC as determinants of intention to use the technology (T1). We performed regression analyses by introducing a dummy variable, GENDER ($0 = $ Female; $1 = $ Male), and testing for moderation of the A-BI, SN-BI, and PBC-BI relationships by GENDER. Building on this initial interaction term, we examined three- and four-way interactions with the other demographic variables including age. Specifically, we conducted regression analyses to include three-way interactions (e.g., A $\times$ GENDER $\times$ AGE). If gender effects existed (via significant two-way interactions earlier, but no significant three-way interactions), such results would suggest that the added demographic variable (i.e., age) did not play a role. Next, in order to ensure that the three-way interactions existed as predicted, i.e., only with gender and age, we examined three-way interactions including gender *or* age with the other demographic variables (e.g., A $\times$ GENDER $\times$ INCOME; A $\times$ AGE $\times$ OCCUPATION). Finally, we examined four-way interactions (e.g., A $\times$ GENDER $\times$ AGE $\times$ INCOME) to understand further moderation by the other demographic variables. Interaction terms are very complex to interpret, particularly higher order interaction terms such as the ones reported here. We employed a combination of two techniques to ensure that the effects observed were consistent with the hypotheses here: 1) we plotted the data using two software packages (Systat and Table Curve) to observe patterns of relationships and generate coefficients for various subsets of data (e.g., older men, younger women, etc.) and 2) we split the data into separate subsets, based on a combination of demographic characteristics, e.g., older men, younger women—and analyzed the subsets to determine the beta coefficients among each group. The Chow's test was conducted to examine differences in beta coefficients and confirm that any significant higher order interaction terms were consistent with the hypothesized pattern.

In the longitudinal test to predict technology use (USE12, USE23, and USE34), the data were pooled across measurements, consistent with Venkatesh *et al.* [80]. A hierarchical regression was conducted using perceptions, intentions, and prior use. Interaction terms similar to the earlier regressions (on intention), that used intention as the dependent variable, were in-

TABLE IV
DESCRIPTIVE STATISTICS AND CORRELATIONS

	M	SD	A1	SN1	PBC1	BI1	A2	SN2	PBC2	BI2	A3	SN3	PBC3	BI2	USE12	USE23	USE34
A1	4.7	1.11															
SN1	4.5	0.79	.28**														
PBC1	4.7	0.73	.26**	.20*													
BI1	4.8	0.91	.41***	.37***	.35***												
A2	4.6	1.03	.32***	.17*	.07	.28***											
SN2	4.7	0.83	.18*	.48***	.13	.20*	.20**										
PBC2	4.9	0.82	.19*	.27**	.38***	.19*	.24**	.19*									
BI2	5.0	1.09	.26**	.20*	.19*	.48***	.40***	.24*	.28***								
A3	4.7	1.04	.40***	.18*	.10	.14	.29***	.16	.21*	.28**							
SN3	4.7	0.73	.28***	.29***	.11	.19*	.08	.51***	.17	.14	.19*						
PBC3	5.1	0.81	.21*	.18*	.39***	.20*	.10	.17	.42***	.29***	.22**	.07					
BI3	5.0	1.11	.19**	.22*	.22**	.34***	.14	.19*	.08	.37***	.41***	.14	.29***				
USE12	12.72	3.45	.34**	.29**	.29**	.65***	.33***	.19*	.22*	.46***	.38***	.12	.24**	.39***			
USE23	14.09	3.71	.36***	.20*	.20*	.37***	.28***	.22**	.27**	.49***	.32***	.16	.28***	.45***	.60***		
USE34	14.77	3.91	.38***	.24*	.24*	.35***	.19*	.13	.17*	.40***	.19*	.31***	.31***	.49***	.50***	.62***	

Notes:
1. USE12, USE23, and USE34 are average hours of use per week.
2. * $p < .05$; ** $p < .01$; *** $p < .001$

cluded to examine potential moderation of key relationships by gender, age, and other demographic variables.[4]

IV. RESULTS

A. Preliminary Analysis

The descriptive statistics and correlations from the pooled analysis are shown in Table IV. As indicated in the table, the mean values for each of the perceptual constructs fell slightly above the mid-point of the scale and were stable over time. Standard deviations were also relatively similar for each construct over time. Each of the perceptual variables (A, SN, PBC, and BI) at T1 were correlated with the corresponding measures at subsequent time periods, although perhaps not as strongly as one might expect, ranging from 0.29 to 0.48. Objective behavioral measures (i.e., system use) were more strongly correlated than the perceptual variables across time periods.

B. Tests of Gender and Age as Moderators

The results of the regression analyses performed to examine gender and age differences in the importance of attitude toward using technology, subjective norm, and perceived behavioral control in predicting intention measured at T1 are given in Table V. The results supported hypotheses 1–3. Specifically, the results indicated that gender and age together moderated key TPB relationships such that gender differences were more pronounced with increasing age, with men placing a greater emphasis on attitude toward use compared with women. In contrast, with increasing age, women were strongly influenced by subjective norm while men were not. Also, with increasing age, perceived behavioral control was more significant to women than men. This suggests that with increasing age, men are strongly influenced by attitude toward using technology (and, thus, instrumentality) in their decision-making process, while with increasing age, women are more influenced by all of the determinants, and thus, are more balanced in their evaluation and assessment about whether to adopt or reject new technologies. As noted in Table V, the various alternate/confounding three-way interaction terms added (e.g., A $\times$ GENDER $\times$ INCOME, A $\times$ AGE $\times$ OCCUPATION) were nonsignificant and were, therefore, excluded from the analysis and the results reported in Table V were based on a re-estimated model with nonsignificant terms excluded. Also, all the four-way interaction terms, i.e., those including income, educational level, or occupational level—were nonsignificant and the results reported in Table V were based on a reestimated model with nonsignificant terms excluded.

C. Understanding the Pattern of Moderating Influences

Having established the moderation of TPB relationships by gender and age, the next step was to shift the focus away from a strict evaluation of pure statistical significance and onto a broader interpretation of the practical relevance of the observed pattern of results, especially as it relates to cohort differences. In order to accomplish this, as noted in Section III-E earlier, we first plotted the data to see if the patterns observed fit with the interactions as hypothesized. Using Systat and Table Curve, we grouped subsets of data and generated regression coefficients. Based on these preliminary analyses, we found support for the pattern of results that we had proposed.

In order to further systematically examine the pattern of results and their fit with the proposed interactions, we created subsets of the data based on the demographic characteristics. We classified individuals into *high* and *low* categories according to the various demographic variables. Note that, in the primary analyses described previously, age was coded as a continuous variable in order to retain maximum information. However, to help further dissect the meaning behind the results, age was subsequently coded as a dichotomous variable for clarity in presentation when distinguishing between "older" and "younger" cohorts of workers. Table VI presents a summary of the bases for classification of respondents into the two categories in each of the demographic variables—age, income, education, and occupation—and also presents the number of respondents in each category. We categorized individuals such that individuals who were 39 or under were categorized as "younger," while those 40 or older were placed in the "older" category. This cutoff point for young and old was chosen based on research (see [26] and [69]) that suggests those in their 40s (and over) represent the "older" or "maturing" workforce. To categorize on the basis of

[4]Of course, it should be reiterated here that there were no *a priori* hypotheses regarding moderation and, therefore, the expectation of nonsignificant interaction terms only confirms the null hypothesis and is, thus, a limited test.

TABLE V
PREDICTING INTENTION AT T1

	R^2	ΔR^2	β
GENDER	.16	.16	.27***
AGE			.17**
INCOME			.08
EDUCATION			.02
OCCUPATION			.01
A	.34	.18	.28***
SN			.18*
PBC			.17*
A x GENDER	.52	.18	.13
SN x GENDER			.20*
PBC x GENDER			.12
A x AGE			.22**
SN x AGE			.15*
PBC x AGE			.08
GENDER x AGE			.02
A x GENDER x AGE	.64	.12	.24**
SN x GENDER x AGE			.19*
PBC x GENDER x AGE			.18*

Notes:
1. All constructs were measured at T1.
2. A: Attitude toward using technology; SN: Subjective norm; PBC: Perceived behavioral control.
3. * $p<.05$; ** $p<.01$; *** $p<.001$.
4. All other possible three-way interaction terms—e.g., A x GENDER x INCOME, A x AGE x OCCOUPATION—were included and removed due to their non-significance.
5. All four-way interaction terms, including income, education, and occupation, were included removed due to their non-significance.

income (into low and high), we studied official government reports from the U.S. Bureau of the Census [91], and found the adjusted median income of an average full-time worker for the year of the study was somewhat over $23 000. In order to correspond with this median income, we used "less than $20 000" as the cutoff point for the low and high-income groups, respectively. To categorize educational level, those who graduated college or had some college were classified as "high" in terms of educational level and those with no college education or some vocational/technical school were classified as "low." For occupational level, we categorized executive/top management, middle management, and supervisory positions as "high" and administrative/clerical, technical and other categories as "low" (per [42]).[5]

Regression analyses were conducted within various groups as shown in Table VII. The results indicated that in the older group, there were significant gender differences in the importance of A, SN, and PBC in determining intention. Of course, this is consistent with the regression analyses reported earlier; however, this *post hoc* analysis provides additional detail on the nature of the moderated relationships and, from an applied point of view, helps one better visualize the observed effects. Specifically, older men placed greater emphasis on A, while older women placed greater emphasis on SN and PBC. In this context, it is interesting to note that the mean and standard deviation of subjective norm for older women were 4.7 and 0.8, respectively (at T1). Compared with the other three groups, the mean value of subjective norm for older women was statistically significantly lower, thus indicating that older women were placing greater *emphasis* (evidenced by the higher beta weight) on the normative influence even though the *extent* of normative pressure was not very high (as evidenced by the lower mean). In contrast, a unisex pattern of results was observed in the younger group. Specifically, no significant difference was found between younger women and younger men in terms of importance of A, SN and PBC. As can be observed in Table VII, some three-way interaction effects were also observed in the case of subsets of data broken down by gender and income, gender and educational level, and gender and occupational level. However, in light of the evidence from Table V, it should be noted that none of these effects were significant above and beyond the effects of the three-way interactions with gender and age as moderators.

The next set of regressions examined technology use at various points of measurement as the dependent variables (see Table VIII). As expected, only intention and/or previous use were significant predictors of use and none of these relationships were moderated by the demographic variables. The TPB determinants measured at various points in time were included as direct effects and interaction terms with the various

[5]Nine respondents who chose the *other* category subsequently indicated they were support staff in various capacities and were, therefore, classified as holding low positions.

TABLE VI
DICHOTOMOUS CATEGORIZATION OF PARTICIPANTS BY DEMOGRAPHIC VARIABLES

	Bases for Categorization	Women	Men
Age:			
Low	<39	86	87
High	>=40	70	99
Income:			
Low	<$20,000	89	71
High	>$20,000	67	115
Education:			
Low	Some High School or less	97	76
	Graduated High School		
	Vocational/Technical School		
High	Some College	59	110
	Graduated College		
	Post-Graduate Study		
Occupation:			
Low	Administrative	84	90
	Clerical		
	Technical		
	Other		
High	Executive	72	96
	Top Management		
	Middle Management		
	Supervisory		

demographic variables (two-, three-, and four-way), but did not provide any additional explanatory power beyond the already known determinants of behavior. This pattern supported the predictions presented in H4(a)–(c).

D. Ties to TAM

Although not explicitly the focus of the paper, as noted earlier, we gathered data about the various TAM constructs. As expected, the pattern of results observed in examining the TAM relationships was as follows: 1) the perceived usefulness-intention relationship was moderated by gender and age and the pattern was nearly identical to that observed for the attitude-intention relationships in TPB; 2) the common construct, subjective norm, had a similar impact in the TAM relationships as it did in TPB; and 3) the perceived ease of use-intention relationship was moderated by gender and age, and the pattern and coefficients were quite similar to what was observed in the various perceived behavioral control-intention relationships within TPB.

V. DISCUSSION

The present study extends TPB by incorporating gender and age as moderators of the model's core relationships. In so doing, the present work helps managers understand the details of the impact of gender and age on decisions made by individuals about new technology adoption and use in the workplace. Specifically, the current research shows that the pattern of gender differences in individual technology adoption varies with age such that gender differences were more pronounced with increasing age. With increasing age, the pattern of gender differences appears consistent with all other results reported in Venkatesh *et al.* [80], i.e., attitude was important to men, while attitude, subjective norm, and perceived behavioral control were all important to women. Of most interest, however, is that gender differences decline dramatically among the younger cohort of workers and a more unisex pattern of results emerges.

A. Implications for TPB

Before discussing implications for the context of study, it is important to highlight some of the contributions and implications for TPB and organizational behavior research. In this study, the basic TPB hypothesis that the effect of external variables (e.g., gender) will be completely mediated was not supported, a pattern consistent with some other research (e.g., [72]). This raises a question about situations or circumstances when there is only partial mediation of external variables by TPB constructs. Furthermore, our review of the literature suggested that the role of moderators have been largely overlooked (Albarracin *et al.* [5], Conner *et al.* [17]). Our work suggests that the interplay of gender and age alters the nature of key relationships in TPB. Not only does this serve as a call for a careful examination of moderation by gender and age in other organizational behavior contexts but also, it behooves researchers to examine other potential moderators within TPB when applied in other contexts. TPB is used not only in organizational behavior studies but also in general psychology studies where moderators such as gender, age, income, education, etc., may play an even stronger role. Interestingly, in their TPB meta-analysis, Albarracin *et al.* [5] note that supplemental analyses of TPB relationships indicated that the strength of associations proposed generally varied as a function of gender and age, among other variables [5, p. 154]; however, these results were not the primary focus of that study. Particularly in light of the changing demographics of today's work force,

TABLE VII
GENDER DIFFERENCES IN BETA COEFFICIENTS BY DEMOGRAPHIC VARIABLE CATEGORIES

	Low on Demog. Var.			High on Demog. Var.		
	Women	Men	Significance of Difference	Women	Men	Significance of Difference
Age						
R^2	.59	.57		.55	.43	
A	.43***	.42***	ns	.22*	.65***	***
SN	.18*	.20*	ns	.37***	.04	**
PBC	.24*	.22*	ns	.29**	.07	*
Income						
R^2	.59	.40		.52	.39	
A	.36***	.59***	**	.30***	.56***	**
SN	.27***	.10	**	.28***	.11	**
PBC	.26***	.06	**	.25***	.09	**
Education						
R^2	.62	.39		.56	.41	
A	.31***	.56***	**	.38***	.61***	**
SN	.31***	.10	*	.27**	.14	*
PBC	.30***	.10	*	.25**	.09	*
Occupation						
R^2	.57	.39		.55	.41	
A	.30***	.55***	**	.27**	.58***	***
SN	.28***	.10	**	.29***	.14	*
PBC	.25**	.12	*	.33***	.08	**

Note: Significance of Difference represents the significance of the interaction term (e.g., A X GENDER), and was also confirmed by test of beta differences across independent samples using Chow's test.
*$p < .05$
**$p < .01$
***$p < .001$

the current findings highlight the potential dynamic nature of TPB that can be best understood by including key theoretical moderators when appropriate. In sum, our findings underscore the importance of including gender and age as key extensions to TPB when applied to technology use, and potentially, to more general contexts as well.

B. Implications for Technology Adoption Research

Given that workers over the age of 40 are becoming a larger percentage of the workforce [26], gender differences among older workers have important implications for managers in devising technology implementation and management strategies. However, the more *unisex* pattern observed among younger workers is particularly interesting and encouraging because it emphasizes potential similarities, rather than differences, between women and men (see [20] and [48]). This pattern of findings is different from other recent studies that have suggested that women today are still very different in their reactions to technologies compared with men (for examples, see [16] and [29]). At least with respect to perceptions and decisions about technology, the results here suggest that supposed differences between women and men *must* be interpreted with respect to age. This observation sparks several important questions stemming from plausible explanations for the result. One possible reason for the more unisex pattern among younger workers is that the socialization of women and men in the post-feminist era is more similar compared with socialization patterns of women and men in the past (e.g., less gender typing and increased career focus among women). A second possible reason is that younger workers, both women and men, have received greater exposer to technology compared with older women, thus minimizing gender differences in factors important to younger workers. Both these explanations would suggest that as this younger cohort of workers grows older, there are likely to be more similarities than differences in technology adoption and use decisions. However, a competing explanation is that the similarities observed are related more to age than to socialization patterns and that gender differences will instead begin to surface as this younger cohort matures. Longitudinal research is essential to understand which of the above potential explanations is true. As a first step, this work provides a benchmark for future studies of this phenomenon.

This research and other prior research suggest that instrumentality is a key determinant of attitude toward using

TABLE VIII
PREDICTING TECHNOLOGY USE

	Use12			Use23			Use34		
	R^2	ΔR^2	β	R^2	ΔR^2	β	R^2	ΔR^2	β
USE23			N/A	.37	.37	N/A	.38	.38	.61***
USE12			N/A			.61***			.11
BI3	.41	.41	N/A	.38	.01	N/A	.40	.02	.03
BI2			N/A			.10			.05
BI1			.64***			.07			.11

Notes:
1. BI1: Intention measured at T1; BI2: Intention measured at T2; BI3: Intention measured at T3; USE12: Use measured between T1 and T2; USE23: Use measured between T2 and T3; USE34: Use measured between T3 and T4 (six months post-implementation).
2. * p<.05; ** p<.01; *** p<.001.
3. All demographic variables were entered but were not significant as direct effects. Also, two-way interaction terms (e.g., BI1 X GENDER), three-way interaction terms (e.g., BI1 X GENDER X AGE), and four-way interaction terms (e.g, BI1 X GENDER X AGE X INCOME) were non-significant.
4. A, SN, and PBC measured at T1 were found to be non-significant in predicting USE12, USE23, and USE34.
5. A, SN, and PBC measured at T2 were found to be non-significant in predicting USE23 and USE34.
6. A, SN, and PBC measured at T3 were found to be non-significant in predicting USE34.
7. Two-, three-, and four-way interaction terms related to notes 4 through 6 above were non-significant.

technology. While peer pressure and superiors' influence are key determinants of subjective norm in technology adoption contexts, one crucial direction for future research is the underlying mechanism for the greater importance placed by women on such normative influences. Minton and Schneider [51] and Roberts [66] suggest two potentially competing causal mechanisms—one based on differences in compliance patterns and another based on differential responsiveness to informational input from others. Although both lines of argument suggest similar outcomes, the information processing models proposed are different. It is important to understand these models and circumstances under which each model is operational in order to facilitate design of appropriate organizational interventions for increased buy-in for technologies being introduced.

The findings from the current research have other significant implications for future research. The powerful effects observed in the context of the simple variables of gender and age should be contrasted with constructs rooted in the psychology of individual differences (e.g., conscientiousness and locus of control). Future research should also examine different interventions and their ability to have a favorable impact on different user constituencies. For instance, knowing that women respond to social influences, researchers might examine the most effective methods of creating such a social influence. Other important research questions include examining the impact of technology use on job outcomes such as job satisfaction, organizational commitment, and performance, particularly as they relate to potential moderators such as gender and age. Our research was conducted within the contexts of technology implementations where use was voluntary. The effect of the moderators in the context of situations where use is mandatory should be examined. For example, some researchers have suggested that satisfaction, rather than use, may be the more appropriate dependent variable in such cases (e.g., [13]).

C. Implications for Practice

The results of this research clearly suggest that different constituencies of employees take different factors into account in making technology adoption and use decisions. From a user-centered design perspective, the current results clearly show that individual differences among users are important in understanding how and why users make different choices about technology. The results here imply that user analysis cannot be taken for granted and rather, should become the centerpiece for design, especially at early stages of the systems development and implementation process. Clearly, as noted at the outset, gender and age data and the information about the overall composition of the workforce are typically readily available. This suggests that training and managerial interventions should be appropriately targeted to ensure that the new system is received well by all user constituencies. This is particularly important since, as shown here, early perceptions can have a lasting impression on individual intentions and behavior. Thus, training programs should be tailored to emphasize factors that are important to each group. For example, trainers should be cognizant of the need to emphasize productivity-enhancement factors that are very important to older men. They should also take care to ensure this emphasis does not come at the expense of other factors, e.g., claims by peers or other referents and availability of adequate support—that may be more important to other workers. Similarly, internal and external marketing efforts should capitalize on these findings by designing tailored information for different constituencies, thereby giving each group something to like about new technology products. While the gender differences observed allow for important prescriptions, the exciting finding that individuals born in the post-feminist era—i.e., so-called "Generation Xers"—revealed a more unisex pattern, thus suggesting a new and positive direction that will allow us to focus on similarities between women and men rather than differences.

VI. Conclusion

From a theoretical perspective, our results provide evidence that the relationships posited by the theory of planned behavior can benefit from the inclusion of moderators that are relevant for the behavior in question. The current study indicated that while TPB is useful in explaining technology adoption and use in organizations, extending the theory to include the combined moderating effects of gender and age significantly increases our understanding of the underlying phenomenon. From a practical individual behavior perspective, based on prior research, managers might reasonably wonder whether gender differences matter when implementing new technology in organizations. Our results indicate that the answer to this question is more complex than it may appear and is based on the dynamic interplay between gender and age. For older workers, a clear pattern of differences existed between men and women, and these results were relatively stable over time. However, for younger workers, the picture is less clear, with a unisex pattern emerging, thus suggesting that in the younger generation, men and women were more alike than different. This paints an encouraging picture and suggests that old stereotypes that classify "technology" as a male domain may be disappearing.

Appendix

Gender:	Female Male	
Age:	____________ years	
Education Level:	Some high school or less Graduated high school Vocational/technical school	Some college Graduated college Post-graduate study
Annual Individual Income: *(Before Taxes)*	Less than $20,000 $20,000 - $29,999 $30,000 - $39,999 $40,000 - $49,999 $50,000 - $59,999	$60,000 - $69,999 $70,000 - $79,999 $80,000 - $89,999 $90,000 - $99,999 $100,000 or more
Position:	Executive/Top Management Middle Management Supervisory	Administrative/Clerical Technical Other: ______________ (please specify)

Intention to Use (7-point Likert scale)

Assuming I had access to the system, I intend to use it.

Given that I had access to the system, I predict that I would use it.

Attitude Toward Using (7-point semantic differential scale)

	1	2	3	4	5	6	7
Using the system is a ________ idea.	1 Bad	2	3	4	5	6	7 Good
Using the system is a ________ idea.	1 Foolish	2	3	4	5	6	7 Wise
I ________ the idea of using the system.	1 Dislike	2	3	4	5	6	7 Like
Using the system is ________.	1 Unpleasant	2	3	4	5	6	7 Pleasant

Subjective Norm (7-point Likert scale)

People who influence my behavior think that I should use the system.

People who are important to me think that I should use the system.

Perceived Behavioral Control (7-point Likert scale)

I have control over using the system.

I have the resources necessary to use the system.

I have the knowledge necessary to use the system.

Given the resources, opportunities and knowledge it takes to use the system, it would be easy for me to use the system.

The system is not compatible with other systems I use.

REFERENCES

[1] M. K. Ahuja, "Women in the information technology profession: A literature review, synthesis and research agenda," *Eur. J. Inf. Syst.*, vol. 11, pp. 20–34, 2002.

[2] I. Ajzen, "The theory of planned behavior," *Org. Behav. Human Decision Process.*, vol. 50, pp. 179–211, 1991.

[3] ——, "From intentions to actions: A theory of planned behavior," in *Action Control: From Cognition to Behavior*, J. Kuhl and J. Beckmann, Eds. New York: Springer-Verlag, 1985, pp. 11–39.

[4] I. Ajzen and B. Driver, "Application of the theory of planned behavior to leisure choice," *J. Leisure Res.*, vol. 24, no. 3, pp. 207–224, 1992.

[5] D. Albarracin, B. T. Johnson, M. Fishbein, and P. A. Muellerleile, "Theories of reasoned action and planned behavior as models of condom use: A meta-analysis," *Psych. Bull.*, vol. 127, pp. 142–161, 2001.

[6] R. J. Aldag and A. P. Brief, "Age, work values, and employee reactions," *Ind. Gerontol.*, vol. 4, pp. 192–197, 1977.

[7] E. Apfelbaum, *Women in Leadership Positions*: The British Psychological Society Newsletter, 1988, vol. 17, Henry Tajfel Memorial Lecture, pp. 3–19.

[8] J. M. Arceneaux, G. M. Cheramie, and C. W. Smith, "Gender differences in WAIS-R age-corrected scaled scores," *Perceptual Motor Skills*, vol. 83, no. 3, pp. 1211–1216, 1996.

[9] R. C. Barnett and N. L. Marshall, "The relationship between women's work and family roles and their subjective well-being and psychological distress," in *Women, Work and Health: Stress and Opportunities*, M. Frankenhaeuser, V. Lundberg, and M. A. Chesney, Eds. New York: Plenum, 1991, pp. 111–136.

[10] I. Berger, "A framework for understanding the relationship between environmental attitudes and consumer behavior," in *Marketing Theory Application*, R. Varadarjan and B. Jaworski, Eds. Chicago, IL: Amer. Marketing Assoc., 1993, vol. 4, pp. 157–163.

[11] P. M. Blau and O. D. Duncan, *The American Occupational Structure*. New York: Free, 1967.

[12] O. C. Brenner, A. P. Blazini, and J. H. Greenhaus, "An examination of race and sex differences in managerial work values," *J. Vocational Behav.*, vol. 32, pp. 336–344, 1988.

[13] S. A. Brown, A. P. Massey, M. Montoya-Weiss, and J. Burkman, "Do I really have to: Understanding technology acceptance when use is mandatory," *Eur. J. Inf. Syst.*, vol. 11, no. 4, pp. 283–295, 2002.

[14] D. Butler, "Gender, girls, and computer technology: What's the status now?," *Clearing House*, vol. 73, no. 4, pp. 225–229, 2000.

[15] N. Chodorow, *The Reproduction of Mothering*. Berkeley, CA: Univ. California Press, 1978.

[16] S. Clegg and D. Trayhurn, "Gender and computing: Not the same old problem," *British Educ. Res. J.*, vol. 26, no. 1, pp. 75–89, 2000.

[17] M. Conner, P. Sheeran, P. Norman, and C. J. Armitage, "Temporal stability as a moderator of relationships in the theory of planned behavior," *British J. Soc. Psych.*, vol. 39, pp. 469–493, 2000.

[18] J. Cook and T. Wall, "New work attitude measures of trust, organizational commitment and personal need nonfulfillment," *J. Occupat. Psychol.*, vol. 53, pp. 39–52, 1980.

[19] A. Cooper, *The Inmates are Running the Asylum*. Indianapolis, IN: Sams, 1999.

[20] A. H. Eagly, "Reporting sex differences," *Amer. Psychol.*, vol. 42, pp. 756–757, 1987.

[21] M. Evans, M. Kiggundu, and R. House, "A partial test and extension of the job characteristics model of motivation," *Org. Behav. Human Perform.*, vol. 24, pp. 354–381, 1979.

[22] A. Feingold, "Cognitive gender differences: A developmental perspective," *Sex Roles*, vol. 29, no. 1-2, p. 91, 1993.

[23] L. F. Fitzgerald and N. E. Betz, "Career development in cultural context: The role of gender, race, class, and sexual orientation," in *Convergence in Career Development Theories: Implications for Science and Practice*, M. L. Savickas and R. W. Lent, Eds. Palo Alto, CA: Consulting Psychologists, 1994, pp. 103–117.

[24] F. N. Ford, W. N. Ledbetter, and T. L. Roberts, "The impact of decision support training on computer use: The effect of prior training, age, and gender," *J. End User Comput.*, vol. 8, pp. 15–23, 1996.

[25] J. E. Foss, "Is there a natural sexual inequality of intellect?," *Reply to Kimura, Hypatia*, vol. 11, no. 3, p. 24, 1996.

[26] J. Ginn and S. Arber, "Gender, age and attitudes to retirement in midlife," *Ageing Society*, vol. 16, pp. 27–55, 1996.

[27] G. Godin and G. Kok, "The pattern of influence of perceived behavioral control upon exercising behavior: An application of Ajzen's theory of planned behavior," *J. Behav. Med.*, vol. 16, pp. 81–102, 1996.

[28] S. Gould and J. Werbel, "Work involvement: A comparison of dual wage earner and single wage earner families," *J. Appl. Psychol.*, vol. 68, pp. 313–319, 1983.

[29] M. Y. Green, "Why aren't girls more tech savvy?," *NEA Today*, vol. 19, no. 3, p. 31, 2000.

[30] J. Hackman and G. Oldham, "Motivation through the design of work: Text of a theory," *Org. Behav. Human Perform.*, vol. 16, pp. 250–279, 1976.

[31] D. Hall and R. Mansfield, "Relationships of age and seniority with career variables of engineers and scientists," *J. Appl. Psychol.*, vol. 60, pp. 201–210, 1975.

[32] D. A. Harrison, P. P. Mykytyn, and C. K. Riemenschneider, "Executive decisions about adoption of information technology in small business: Theory and empirical tests," *Inf. Syst. Res.*, vol. 8, pp. 171–195, 1997.

[33] M. Hiscock, "Gonadal hormones and human cognitive development," in *Brain Lateralization in Children*, D. Molfese and S. J. Segalowitz, Eds. New York: Guilford, 1988, pp. 85–169.

[34] J. L. Holland, *Making Vocational Choices: A Theory of Careers*. Englewood Cliffs, NJ: Prentice-Hall, 1973.

[35] J. L. Holland and G. D. Gottfredson, "Predictive value and psychological meaning of vocational aspirations," *J. Vocational Behav.*, vol. 6, pp. 349–363, 1975.

[36] J. A. Hoxmeier, N. Niew, and G. T. Purvis, "The impact of gender and experience on user confidence in electronic mail," *J. End User Comput.*, vol. 12, pp. 11–20, 2000.

[37] D. C. Johnston, "Computers clogged, IRS seeks to hire outside processors," *New York Times*, vol. A1, no. A18, Jan. 1997.

[38] R. W. Jones, "Gender-specific differences in the perceived antecedents of academic stress," *Psycholog. Rep.*, vol. 72, pp. 739–743, 1993.

[39] D. Kimura, "Sex differences in the brain," *Sci. Amer. Presents*, vol. 10, pp. 26–31, 1999.

[40] J. E. Kubeck, N. D. Delp, T. K. Haslett, and M. A. McDaniel, "Does job-related training performance decline with age?," *Psychol. Aging*, vol. 11, pp. 92–107, 1996.

[41] T. K. Landauer, *The Trouble with Computers: Usefulness, Usability, and Productivity*. Cambridge, MA: MIT Press, 1995.

[42] J. Lefkowitz, "Sex-related differences in job attitudes and dispositional variables: Now you see them…," *Acad. Manage. J.*, vol. 37, no. 2, pp. 323–349, 1994.

[43] J. A. Levy, "Intersections of gender and aging," *Sociol. Quart.*, vol. 29, no. 4, pp. 479–486, 1988.

[44] S. M. Lipset, *Political Man*. New York: Heineman, 1960.

[45] B. Major and K. Deaux, "Individual differences in justice behavior," in *Equity and Justice in Social Behavior*, S. Greenberg and L. Cohen, Eds. New York: Academic, 1982.

[46] A. Maslow, *Motivation and Personality*. New York: Harper & Row, 1954.

[47] K. Mathieson, "Predicting user intentions: Comparing the technology acceptance model with the theory of planned behavior," *Inf. Syst. Res.*, vol. 2, pp. 173–191, 1991.

[48] M. D. McHugh, R. D. Koeske, and I. H. Frieze, "Issues to consider conducting nonsexist psychological research: A guide for researchers," *Amer. Psychol.*, vol. 41, pp. 879–890, 1986.

[49] K. Melymuka, "Stressed-out IT women tempted to quit, survey finds," *Computerworld* , March 2001.

[50] J. B. Miller, *Toward a New Psychology of Women*. Boston, MA: Beacon, 1986.

[51] H. L. Minton and F. W. Schneider, *Differential Psychology*. Prospect Heights, IL: Waveland, 1980.

[52] M. G. Morris and V. Venkatesh, "Age differences in technology adoption decisions: Implications for a changing work force," *Pers. Psychol.*, vol. 53, pp. 375–403, 2000.

[53] D. A. Norman and S. W. Draper, *User Centered System Design: New Perspectives on Human-Computer Interaction*. Hillsdale, NJ: Lawrence Erlbaum, 1986.

[54] B. A. Nosek, M. R. Banaji, and A. G. Greenwald, "Havesting implicit group attitudes and beliefs from a demonstration website," *Group Dynamics: Theory, Research, Practice*, vol. 6, pp. 101–115, 2002.

[55] A. S. Notani, "Perceptions of affordability: Their role in predicting purchase intent and purchase," *J. Econ. Psychol.*, vol. 18, pp. 525–546, 1997.

[56] J. M. O'Neil, "Gender-role conflict and strain in men's lives: Implications for psychiatrists, psychologists, and other human-service providers," in *Men in Transition: Theory and Therapy*, K. Solomon and N. B. Levy, Eds. New York: Plenum, 1982, pp. 5–40.

[57] C. O'Rourke, N. Fishman, and W. Selkow, *Enterprise Architecture using the Zachman Framework*. Boston, MA: Course Technology, 2003.

[58] R. S. Pindyck and D. L. Rubenfeld, *Econometric Models and Economic Forecasts*. New York: McGraw-Hill, 1981.

[59] D. Plude and W. Hoyer, "Attention and performance: Identifying and localizing age deficits," in *Aging and Human Performance*, N. Charness, Ed. New York: Wiley, 1985, pp. 47–99.

[60] L. Porter, “Job attitudes in management: Perceived importance of needs as a function of job level,” *J. Appl. Psychol.*, vol. 47, pp. 141–148, 1963.

[61] R. A. Posner, *Aging and Old Age*. Chicago, IL: Univ. of Chicago Press, 1996.

[62] D. J. Prediger and G. R. Hanson, “Holland’s theory of careers applied to women and men: Analysis of implicit assumptions,” *J. Vocational Behav.*, vol. 8, pp. 167–184, 1976.

[63] S. Rabinowitz and D. Hall, “Changing correlates of job involvement in three career stages,” *J. Vocational Behav.*, vol. 18, pp. 138–144, 1981.

[64] D. Randall and A. Gibson, “Ethical decision making in the medical profession: An application of the theory of planned behavior,” *J. Bus. Ethics*, vol. 10, no. 2, pp. 111–122, 1991.

[65] S. R. Rhodes, “Age-related differences in work attitudes and behavior: A review and conceptual analysis,” *Psychol. Bull.*, vol. 93, pp. 328–367, 1983.

[66] T. Roberts, “Gender and the influence of evaluations in self-assessments in achievement settings,” *Psychol. Bull.*, vol. 109, pp. 297–308, 1991.

[67] W. Sauser and C. York, “Sex differences in job satisfaction: A reexamination,” *Pers. Psychol.*, vol. 31, pp. 537–547, 1978.

[68] R. Schuler, “Sex, organizational level, and outcome importance: Where the differences are,” *Pers. Psychol.*, vol. 28, pp. 365–375, 1975.

[69] J. Sharit and S. J. Czaja, “Ageing, computer-based task performance, and stress: Issues and challenges,” *Ergonomics*, vol. 37, pp. 559–577, 1994.

[70] J. Sidanius, B. J. Cling, and F. Pratto, “Ranking and linking as a function of sex and gender role attitudes,” *J. Social Issues*, vol. 47, pp. 131–149, 1991.

[71] C. Speier and M. Morris, “The influence of query interface design on decision-making performance,” *MIS Quart.*, vol. 27, pp. 425–478, 2003.

[72] A. Tashakkori and V. D. Thompson, “Race differences in self-perception and locus of control during adolescence and early adulthood: Methodological implications,” *Genetic, Social, Gen. Psychol. Monographs*, vol. 117, pp. 133–152, 1991.

[73] S. Taylor and P. A. Todd, “Understanding information technology usage: A test of competing models,” *Inf. Syst. Res.*, vol. 6, pp. 144–176, 1995.

[74] B. D. Tempkin, “Web Sites Continue to Fail the Usability Test,”, Forrester Res. Rep. 17 226, 2003.

[75] E. M. Trauth, “Odd girl out: An individual differences perspective on women in the IT profession,” *Inf. Technol. People*, vol. 15, pp. 98–118, 2002.

[76] “Gender and Ageing: Problems, Perceptions, and Policies,” United Nations Economic and Social Council, New York, E/CN.6/1999.3, 1999.

[77] “Information Management and Technology,” United States General Accounting Office, Washington, D.C., GAO/HR-97-9, 1997.

[78] V. Venkatesh and F. D. Davis, “A theoretical extension of the technology acceptance model: Four longitudinal field studies,” *Manage. Sci.*, vol. 46, pp. 186–204, 2000.

[79] V. Venkatesh and M. G. Morris, “Why don’t men ever stop to ask for directions? Gender, social influence, and their role in technology acceptance and usage behavior,” *MIS Quart.*, vol. 24, pp. 115–139, 2000.

[80] V. Venkatesh, M. G. Morris, and P. L. Ackerman, “A longitudinal field investigation of gender differences in individual technology adoption decision-making processes,” *Org. Behav. Human Decision Process.*, vol. 83, pp. 33–60, 2000.

[81] V. Venkatesh, M. G. Morris, G. B. Davis, and F. D. Davis, “User acceptance of information technology: Toward a unified view,” *MIS Quart.*, vol. 26, pp. 425–478, 2003.

[82] A. Welford, “Sensory, perceptual, and motor processes in older adults,” in *Handbook of Mental Health and Aging*, J. E. Birren and R. Sloane, Eds. Englewood Cliffs, NJ, 1980, pp. 192–213.

[83] “The Windfall of Longevity, Research Report,” Wellseley Centers for Women, Spring, 1999.

[84] J. C. Westland and T. Clark, *Global Electronic Commerce: Theory and Case Studies*. Boston, MA: MIT Press, 2000.

[85] J. E. Williams and D. L. Best, *Measuring Sex Stereotypes: A Thirty-Nation Study*. Beverly Hills, CA: Sage, 1982.

[86] S. F. Witelson, “Neurobiological aspects of language in children,” *Child Develop.*, vol. 58, pp. 653–688, 1987.

[87] R. Woodfield, “Women and information systems development: Not just a pretty (inter)face,” *Inf. Technol. People*, vol. 15, pp. 119–138, 2002.

[88] F. J. Yammarino and A. J. Dubinsky, “Employee responses: Gender- or job-related differences?,” *J. Vocational Behav.*, vol. 32, pp. 366–383, 1988.

[89] F. D. Davis, “Perceived usefulness, perceived ease of use, and user acceptance of information technology,” *MIS Quart.*, vol. 13, no. 3, pp. 319–339, 1989.

[90] F. D. Davis, R. P. Bagozzi, and P. R. Warshaw, “User acceptance of computer technology: A comparison of two theoretical models,” *Manage. Sci.*, vol. 35, pp. 982–1002, 1989.

[91] J. C. Day, “Projections of the number of households and families in the United States: 1995 to 2010,” Current Population Rep. U.S. Bureau of the Census (P25-1129), Govt. Printing Office, Washington, DC, 1996.

Michael G. Morris received the Ph.D. degree in management information systems from Indiana University, Bloomington, in 1996.

He is an Associate Professor of Commerce within the Information Technology area at the McIntire School of Commerce, University of Virginia, Charlottesville. Prior to joining the faculty at the McIntire School of Commerce, he spent 15 years as an officer in the United States Air Force, including five years on the faculty at the Air Force Institute of Technology. His research has been published in *MIS Quarterly*, *Organizational Behavior and Human Decision Processes*, *Personnel Psychology*, *Decision Sciences*, and *IEEE Software*, among others. His research interests can broadly be classified as socio-cognitive aspects of human response to information technology, including user acceptance of information technology, usability engineering, and decision-making.

Viswanath Venkatesh received the Ph.D. degree in management information systems from the University of Minnesota, Minneapolis, in 1998.

He is a Professor and the George and Boyce Billingsley Chair in Information Systems at the Walton College of Business, University of Arkansas, Fayetteville. Prior to joining the faculty at the Walton College of Business, he was a Tyser Fellow and Associate Professor of Decision and Information Technologies, Robert H. Smith School of Business, University of Maryland, College Park. He is currently an Associate Editor at *Information Systems Research*, and his research has been published in *Management Science*, *MIS Quarterly*, *Information Systems Research*, *Communications of the ACM*, *Organizational Behavior and Human Decision Processes*, the *Journal of Marketing*, *Personnel Psychology*, *Decision Sciences*, and the IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT, among others. His research interests focus on the implementation and use of technologies in organizations and homes.

Dr. Venkatesh received the *MIS Quarterly’s* Reviewer of the Year Award in 1999 and served on the Editorial Board from 2000 to 2003.

Phillip L. Ackerman received the Ph.D. degree from the University of Illinois, Urbana–Champaign, in 1984.

He is a Professor of Psychology at the Georgia Institute of Technology, Atlanta. He has conducted research on cognitive and information processing psychology, individual differences, human abilities, research methodology, and engineering psychology. He has also written extensively on the nature of adult learning, skill acquisition, selection, training, abilities, personality, and motivation. His recent empirical and theoretical contributions address the ability, motivation, personality, and self-concept determinants of skilled performance, training success, and the development of intellectual competence in adulthood. He is the Editor of the *Journal of Experimental Psychology: Applied* and has published his research in the *Journal of Applied Psychology*, the *Journal of Personality and Social Psychology*, *Psychological Bulletin*, *Organizational Behavior and Human Decision Processes*, and *Psychology and Aging*, among others.

Dr. Ackerman was the recipient of the American Psychological Association’s Distinguished Scientific Award for Early Career Contribution to Psychology for work on the cognitive determinants of individual differences in complex skill acquisition in 1992.