EFFECTS OF SEE-THROUGH INTERFACES ON USER ACCEPTANCE OF SMALL-SCREEN INFORMATION SYSTEMS

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Abstract

Small-screen devices such as mobile phones are increasingly pervasive. Reduced screen areas compromise the ease-of-use of such devices, and consequently, a concern for system designers becomes the maximization of available screen space. On large-screen displays, menus can overlap and obscure others, and be displayed simultaneously to the user. This is generally not the case with small screens: where a user selects from an on-screen menu, that menu must 'vacate' the screen before another appears. Menu translucency, where a user can see through an on-screen menu to displayed elements beneath, is a possible solution to small-screen display maximization.

Based on experimental evidence with 70 participants, and using an extended Technology Acceptance Model (TAM) this research examines the effect of on-screen translucent menus on perceptions of ease-of-use, usefulness, and enjoyment for a third generation mobile phone prototype user interface. We offer explanations for our findings and discuss implications for practitioners and researchers.

Keywords: Small-screen displays, translucent interface, ease of use, mobile phone.

INTRODUCTION

This paper presents one of the first empirical studies examining the impact of menu translucency on user acceptance of small screen devices. The paper presents the results of a study measuring the perceived usefulness, enjoyment, and ease-of-use of on-screen translucent menus on a small screen user interface. We provide an implementation of the Technology Acceptance Model (TAM, Davis et al. 1989) in the context of small screens, and illustrate its applicability towards gauging the user acceptance of small-screen information systems by providing new empirical data. The paper poses implications for designers of small-screen information systems, and identifies further avenues for research emanating from the findings of this study.

A common problem associated with information systems is the 'relatively small window through which an information space can be viewed' (Leung and Apperley 1994). This is exacerbated in the case of small screen devices such as Personal Digital Assistants (PDAs). Such devices are restricted in the quantity of data that can be displayed on screen at a given time, and also on the means by which such data can be presented effectively (Kamba et al. 1996). Devices with even smaller screens, such as mobile phones, are even further restricted. The small amounts of display "real estate" available relative to the amount of data to be displayed presents a real challenge in developing useful information systems (Harrison et al. 1995b).

Many types of information systems, which are designed mainly for large screens, try to maximize the available screen space through various techniques: these include overlapping of on-screen objects, enlargement of portions of the screen area when a mouse pointer travels across certain areas on screen, employing various distortive (Kamba et al. 1996) or non-distortive techniques (Leung and Apperley 1994), such as scrolling and clicking of folder icons, and adding three-dimensional appearances to elements displayed on two-dimensional screens. However, one particular solution to the maximisation of available screen space lies in interfaces designed to 'layer' simultaneously displayed on-screen objects that allows the user to both realise that layered objects are present and also that these objects are usable (Genau and Kramer 1995, Kramer 1994). Such layering of on-screen objects may be implemented through user interface *translucency*, where the user can visibly see through displayed objects such as menus and graphics to objects 'beneath' them (Harrison et al. 1995b). Physical 'translucency' of an interface screen object (such as an icon, menu, or displayed text) is the user's ability to visually see through or partially see through that object (Bier et al. 1993, Genau and Kramer 1995). An object at 0% translucency is fully opaque, and visually covers any underlying object(s) that may be present. An object at 100% translucency is fully translucent. Translucency levels for an object that lie between 0% and 100% show some level of translucency, allowing the user to see underlying objects to some extent (Genau and Kramer 1995). Authors such as Bier et al. (1993), Encarnacao et al. (1999), Genau and Kramer (1995), Harrison et al. (1995), Kramer (1994), and Zhai et al. (1994) have successfully used on-screen translucency of objects and menus in large-screen user interfaces to maximize the available display area. For large screen systems the use of translucency has allowed designers to permit certain interface objects to remain on-screen whilst other objects are simultaneously displayed, permitting multiple virtual layers of objects on a two-dimensional area open to direct manipulation by users. In particular the studies by Encarnacao et al. (1999) and by Zhai et al. (1994) illustrated the suitability of translucency to interfaces where visibility of underlying objects and the ability to interact with partially visible objects is desirable and advantageous. Indeed these and other authors (Bier et al. 1993, Kramer 1994) argue that see-through user interfaces on large screen devices can offer many advantages over traditional types of interface. However, the size of small-screen devices necessitates more industrious application of interface design techniques (Leung and Apperley 1994), and with the available display area at a premium, the use of translucency for on-screen display of objects may or may not provide similar advantages. With the

maximization of screen space even more important for such devices, whether translucency is suitable for these interfaces remains a concern from an information system development perspective.

The benefits of translucent menus for large-screen system developers are manifested through their effects on object visibility, manipulability, menu navigability, and simultaneous display of underlying screen components. Such benefits, however, may or may not map directly to small-screen interfaces, and an important question is how the user of small-screen devices will respond to translucent menus in the context of a much reduced screen size. Indeed menu translucency may help to increase users' perceptions of ease-of-use, may be considered a useful addition to small screen interfaces, and may be enjoyable to use. By increasing the usable screen area on small devices, menu translucency may directly affect the user acceptance of small-screen systems.

1 CONCEPTUAL DEVELOPMENT

The Technology Acceptance Model (TAM) is a well-established model to help understand the user acceptance of information systems (Davis 1986, Davis, 1989, Davis et al. 1989, Davis et al. 1992, Venkatesh and Davis 2000, Venkatesh and Morris 2000). The model gauges user acceptance of a particular system by producing measures of attitude and behavioural intent through measures of perceptive criteria. TAM embraces the Theory of Reasoned Action's (Fishbein and Ajzen 1975) causal chain of beliefs where attitudes are formed towards certain objects, which in turn influence behaviour with respect to that object. In particular, a key objective of TAM is 'to provide a basis for tracing the impact of external factors on internal beliefs, attitudes, and intentions' (Davis et al. 1989).

Many authors (Adams et al. 1992, Davis et al. 1989, Hassenzahl and Wessler 2000, Mathieson and Kiel 1998, Subramanian 1994, Van der Heijden 2001, Venkatesh and Davis 2000, Venkatesh and Morris 2000) have empirically confirmed that system use is affected by that system's perceived ease-of-use and perceived usefulness. Perceived Usefulness is defined as 'the degree to which a person believes that using a particular system would enhance his or her performance with respect to usage of that system' (Davis 1989). Perceived Ease-of-Use is defined as 'the degree to which a person believes that using a particular system would be free of effort' (Davis 1989, Venkatesh and Morris 2000). A number of studies using TAM have found perceived ease-of-use as a fundamental component affecting behavioural attitudes towards system usage (Cheung et al. 2000, Hong et al. 2001, Igbaria and Guimaraes 1995, Moon and Kim 2001, Van der Heijden 2001, Venkatesh and Morris 2000). Furthermore, studies using TAM have shown that perceived usefulness is a strong determinant of system acceptance, adoption, and usage behaviour (Davis et al. 1989, Taylor and Todd 1995, Venkatesh and Davis 2000). Recent studies using TAM (Atkinson and Kidd 1997, Igbaria et al. 1996) have also illustrated the effect of perceived enjoyment on system usage and behavioural intent, strengthening earlier findings for this component to the model (Igbaria et al. 1995). Perceived Enjoyment is defined as 'the extent to which the activity of using the system is perceived to be enjoyable in its own right, apart from any performance consequences that may be anticipated' (Davis et al. 1992). Moreover, later studies by Teo et al. (1999) and by Moon and Kim (2001) reinforce the influence of perceived enjoyment on attitude and intent towards system adoption and usage.

Whilst perceptions of ease-of-use, enjoyment, and usefulness have been identified as determinants of system acceptance through adoption and usage, these factors are themselves affected by user-centric external variables such as user characteristics, personal preferences, or user personality traits, together with system-centric variables such as system design characteristics, task details, or other aspects of information system architectures. In this study menu translucency is regarded as one of these external variables, with TAM accommodating these variables as indirect determinants of acceptance and usage

behaviour through direct influence on established predictors such as ease-of-use, usefulness, and enjoyment (Davis et al. 1989). Figure 1 below illustrates the revised TAM model proposed in this study:

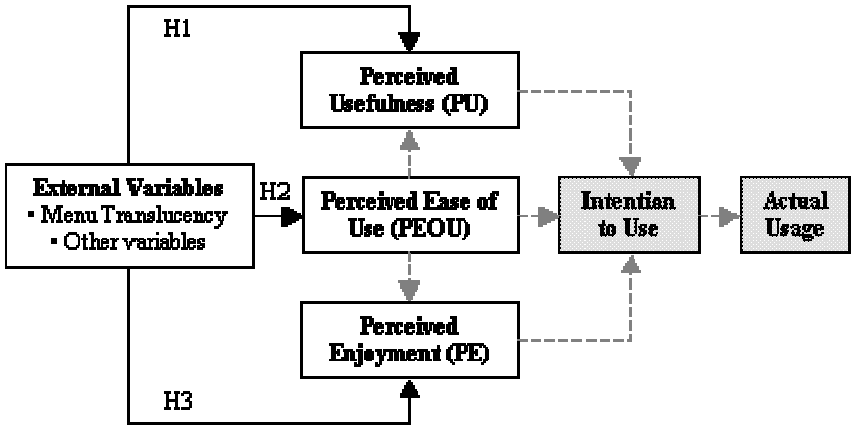

Figure 1. An adaptation of the TAM model to illustrate the potential effect of menu translucency on user acceptance of small screen information systems

The presence of many overlapping translucent objects on screen can lead to a psychological issue of focused and divided attention (Harrison et al. 1995b), where overlapping objects can not only physically interfere with one another and lead to confusion, but where one or more objects can psychologically distract from another, thus reducing the user's focus on a particular object, leading to a negative influence on ease-of-use and enjoyment, and a reduction in the overall usefulness of translucency. For this reason, researchers (Kramer 1994, Leung and Apperley 1994) maintain that users must be able to separate which features belong to the foreground and which belong to the background object(s), if divided attention is to be minimised. Differing translucency levels for objects displayed on-screen in the foreground to those in the background can help minimise divided attention and help focus attention on certain objects (Zhai et al. 1994). Harrison and Vicente (1996), in experiments involving translucency on large screens, found that increased levels of translucency for on-screen objects affected perceived visual interference, and affected usefulness of the feature in terms of measured performance. Harrison et al. (1995b) found that the conflicting effects of divided and focused attention on user performance in a translucent interface consisting of text, colour, and object recognition and significance were optimal where objects were at a 50% degree of translucency. In this study translucent menus were visible on screen to a depth of two layers, that is, only two overlapping menus were present on screen at a given time, providing one foreground image lying over one background image. In addition, overlapping menus were displaced over one another to increase attention and minimize distraction, and 50% translucency was implemented as a measure to increase usefulness (Harrison et al., 1995b). Furthermore, this degree of translucency may provide a useful informational advantage to users in terms of the ability to see underlying menu data, for example an underlying menu showing the status of a background operation such as a file download. We hypothesize that the degree and implementation of menu translucency used in this study will be considered a useful aspect to the user interface.

H1: *Menu Translucency positively influences the Perceived Usefulness of information systems on small screen devices*

Ease-of-use is a major determinant of system acceptability, and small screens are known to compromise ease-of-use. Layering of translucent menus and other objects may somewhat overcome some of the technological and psychological display constraints of small screens (Harrison et al. 1995). In

experiments using a small screen device, Kamba et al. (1996) found that distraction is reduced and attention maintained when interaction with underlying objects is excluded where a translucent foreground object is present. However, the authors also found that the users expected to be able to interact with visible on-screen objects, and so the absence of obvious interactive functionality with background objects led to some degree of frustration, unless users were aware of how such interaction could be achieved (for example, by 'closing' the foreground object, thus making the background object active, or by maintaining a mouse-down action on the foreground object for longer than a specified time, to 'transfer' the mouse action to the object beneath). In this study, where two menus are simultaneously present on screen, only the foreground menu is active for input. Regression to a background menu is enabled through backwards navigation through the menu system, and user interaction only with the foreground menu is possible. This design aims to minimize confusion and distraction due to a potential interactive capability with multiple menus, which could hinder ease-of-use, by removing the possibility altogether. The visibility of a previously visited menu on screen could ease navigability through the system, and lead to a higher sense of ease-of-use. We hypothesize, therefore, that menu translucency leads to a greater sense of system ease-of-use.

H2: *Menu Translucency positively influences Perceived Ease-of-Use of information systems on small screen devices*

Subjective feelings of enjoyment when using an information system have been found to be a predictor of system usage and an important component of user acceptance (Atkinson and Kidd 1997, Igbaria et al. 1996). Furthermore, aspects that increase the aesthetics of that interface can directly lead to an increased perception of ease-of-use (Tractinsky et al. 2000). Translucent menus may increase the aesthetic nature of user interfaces on small-screen devices, which in turn may result in more usable interfaces that are regarded as more enjoyable (Tractinsky et al. 2000). Additionally, previous TAM studies have shown that attitudes towards enjoyment can be positively affected by perceptions of ease-of-use (Igbaria et al. 1996, Van der Heijden 2001). Notwithstanding the indirect effects on enjoyment possible through ease-of-use attitudes, we hypothesize that translucent menus on small-screen user interfaces can directly affect perceptions of enjoyment.

H3: *Menu Translucency positively influences Perceived Enjoyment of information systems on small screen devices*

2 METHOD

We studied the effects of menu translucency on user acceptance with a laboratory experiment in which users were exposed to a prototype of a small screen user interface: this prototype comprised a graphical user interface for a third generation mobile phone containing an on-screen translucent menu system. 50% translucency was implemented two menus deep, so that at any given time only two overlapping menus were visible on screen, with the topmost translucent menu partially displaced over a non-translucent underlying menu. The prototype was created in parallel with a control version lacking translucency, using Macromedia's Flash software with Actionscript as the underlying code. The experimental design was single factor between subjects with the presence of menu translucency as treatment.

2.1 Participants

70 undergraduate students from an Irish university (39 male, 31 female, mean age = 18.64, SD = 1.33) volunteered to participate. All owned a second-generation mobile phone, and had a high level of familiarity with software-based menu navigational mechanisms on large screen personal computers and on

their mobile phones. Participants were randomly assigned to the control or treatment groups, resulting in 32 participants for the control group and 38 participants for the treatment (translucent) group.

2.2 Treatment

Figure 2 illustrates the visual differences due to translucency. These screenshots illustrate the possible informational advantage to end-users downloading a particular song from a web site, insofar as the title of the song being downloaded remains visible in the translucent system, and not visible in the non-translucent system. Selections on each on-screen menu were made using the prototype phone's navigational and number buttons, as would be the case under normal usage conditions.

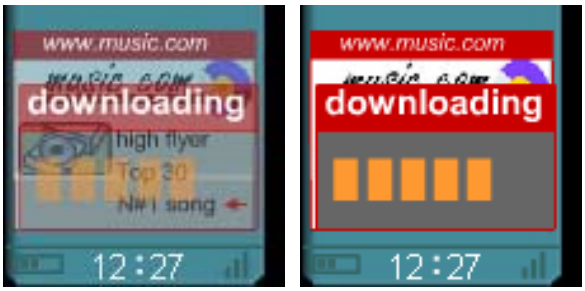

Figure 2. Translucent and Non-translucent Interfaces

2.3 Procedure

Participants conducted the following seven tasks, which were identified through an exploratory survey questionnaire administered to a superset of 179 participants: sending and receiving text messages, making a voice call over the Internet using voice-over Internet Protocol, changing the clock time on the device's interface, downloading a music file onto the device from a web site, using the device to execute a banking transaction, and using the phone's address book to look up a phone number. Separately for each participant, tasks were provided in random order to minimise any learning effect as that participant progressed from one task to the next. Participants then completed a post-test questionnaire (based on TAM) to assess the effect of menu translucency. Perceived usefulness, ease of use, and perceived enjoyment were assessed using Likert scales similar to a previous study by Van der Heijden (2003). Each construct was measured using four attitude scales with 5 categorical responses ranging from Wholly Disagree to Wholly Agree.

3 RESULTS

To ensure the convergent and discriminant validity of the measures, we conducted an exploratory factor analysis with varimax rotation. The sample met the necessary thresholds for conducting a factor analysis (KMO Measure of Sampling Adequacy = .79, Bartlett's Test of Sphericity is 334.48, $df = 66$, $p = .000$). The factor loadings and common variance are provided in the following table.

	Factor loading			
Item	1	2	3	h^2

1	PU1	.68			.55
2	PU2	.81			.69
3	PU3	.78			.67
4	PU4	.79			.70
5	PE1		.84		.75
6	PE2		.72		.68
7	PE3		.60	.54	.66
8	PE4		.81		.71
9	PEOU1			.76	.59
10	PEOU2			.74	.61
11	PEOU3			.83	.71
12	PEOU4			.81	.70

Table 1. *Items and Factor Loadings for Varimax Orthogonal Three Factor Solution for Perceived Usefulness, Perceived Enjoyment, and Perceived Ease of Use (*N *= 70)*

Note: *PU1-4 = Items for Perceived Usefulness, PE1-4 = Items for Perceived Enjoyment, PEOU1-4 = Items for Perceived Ease of Use. Factor loadings below .4 are not shown.* h^2 *= communality.*

The factor loadings demonstrate convergent and discriminant validity of the three measures, with the exception of item PE3. This measurement item does not appear to discriminate sufficiently between the concepts of enjoyment and ease of use. Consequently, we dropped this item in further analysis.

Cronbach Alphas for perceived usefulness, perceived enjoyment, and perceived ease of use were .79, .78, and .82 respectively. We deemed these alphas sufficient to conclude that the measures were reliable. Composite scores were then computed by averaging the individual item scores. The following table presents the univariate descriptives.

	Non-translucent user interface (*n* = 32)		Translucent user interface (*n* = 38)	
	M	*SD*	*M*	*SD*
Perceived Usefulness	3.70	.70	3.89	.61
Perceived Enjoyment	3.90	.62	3.85	.67
Perceived Ease-of-Use	4.04	.59	3.97	.69

Table 2 *Differences in perceived usefulness, perceived enjoyment, and perceived ease of use between individuals who used a non-translucent user interface and those who use a translucent interface*

A visual inspection of the univariate statistics reveals that the mean differences were very small. The mean differences for perceived usefulness, enjoyment, and ease of use were .19, -.05, and -.07 respectively. The correlations between the measures are depicted in the following table.

	Perceived enjoyment	Perceived ease of use
Perceived usefulness	.29*	.19
Perceived enjoyment	-	.43**
Perceived ease of use	-	-

Table 3 *Correlation coefficients for relations among perceived usefulness, perceived enjoyment, and perceived ease of use. Note: * $p < .05$, ** $p < .01$*

The presence of these correlations is consistent with prior TAM research. A MANOVA was carried out using the General Linear Model function in SPSS 10.1.0. The results are displayed in the following table. Box M was insignificant at 3.12 ($F_{6, 30890} = .49$, $p = .81$). This implies that the covariance matrices of the dependent variables were equal across the two groups, and that we could proceed with the analysis.

	SS	*MS*	*F* (1, 68)	η^2
Perceived usefulness	.60	.60	1.39	.02
Perceived enjoyment	.01	.01	.03	.00
Perceived ease of use	.09	.09	.21	.00

Table 4 *Summary of multivariate analysis of variance for perceived usefulness, perceived enjoyment, and perceived ease of use. Note: η^2 = effect size*

Phillai's trace is .67 ($p = .57$), which implies that there were no multivariate differences across the two groups. In addition, the *F*-tests for the three dependent variables were not significant at $p = .05$. This implies that no significant difference could be detected in each of the three dependent variables. Therefore, none of the hypotheses are supported.

The partial η^2 reveals a potentially small effect on perceived usefulness (.02), and a negligible effect on perceived enjoyment and perceived ease of use. Should these potential effects represent true differences in the two populations, it is likely that our sample size would not have been large enough to detect them. Indeed, the power levels that were computed for these effects are 21.3%, 5.9%, and 7.4%.

4 DISCUSSION

This study did not detect significant relationships between the presence of menu translucency and perceptions of ease-of-use, enjoyment, and usefulness. A translucent menu system was not regarded as more or less easy to use. Translucency did not lead to a higher or lower sense of enjoyment, and was not considered to be more or less useful than a non-translucent menu system. As such, translucency does not appear to impact user acceptance.

Such lack of influence may be due to methodological weaknesses. First, the sample size (70) may have been too low to identify very small effects. Yet, at more than 30 participants in both groups, the experiment is sufficiently sensitive to detect small to medium effects. Additionally, one can wonder whether such very small differences would have practical significance, even if they were detected using a much larger sample. Second, perhaps the measures of Ease-of-Use, Enjoyment, and Usefulness used in the study were incomplete or invalid in some way: however usage of these measures was replicated from previous studies using TAM, and in particular from van der Heijden (2003) where the measures were validated. Additionally, this study revalidated the measures through Cronbach Alpha determination and exploratory factor analysis.

Furthermore, the statistical lack of differences between participants using the translucent and non-translucent interfaces may stem from the definition, structure, and type of tasks carried out. However, these tasks were defined and structured based on survey data on the most common tasks currently executed by the participants. Additionally, each task was designed to involve navigation through numerous menus, to be capable of completion using either version of the interface, and take some time to complete. In usage terms, participants using the treatment interface were exposed to an equivalent number and type of displayed menu sequences as those in the control group, resulting in comparable experiential exposure to the interface in each case. Moreover, the perceptive attitudes of ease-of-use, usefulness, and enjoyment were measured by questionnaire separately from, and after, the completion of tasks.

A final alternative explanation as to why translucency failed to impact the perceptions examined in the study is the degree of translucency implemented in the design of the interface. Menu translucency was implemented at 50%, as a measure to maximize the visible screen area in accordance with Harrison et al. (1995b). A similar experiment at higher or lower 'doses' of translucency may generate different findings: indeed perhaps 75% translucency may lead to lower levels of acceptance through a decreased sense of usefulness, ease-of-use, or enjoyment. Alternatively, different levels of translucency may be lead to an interface that is regarded as easier to use, more useful, or more enjoyable to use than non-translucent equivalents.

These alternative explanations notwithstanding, there was no statistically significant effect on user acceptance at the translucency levels used in this study. This has implications for information system designers considering mechanisms to maximize screen space on small devices. Whilst previous studies have illustrated the benefits of translucency as a means of increasing the visible screen area on large screen information systems (Harrison et al. 1995, Harrison and Vicente 1996), its applicability may not translate to small interfaces such as those on mobile phones. Designers may decide to include translucent components to small-screen user interfaces for a number of reasons, but they should be aware that such inclusion is not likely to influence perceptive determinants of user acceptance.

This paper introduced a new domain to study technology acceptance, that of applications with very small screens, instantiated here using a third generation mobile phone user interface. The study highlighted one major challenge of these applications in contrast with traditional large-screen information systems, namely the increased importance of maximization of the available screen area. The research demonstrated the effectiveness of a new way to address this challenge through translucency of on-screen menu systems. Additionally, the study provides new theoretical work in this area by applying generic TAM constructs in the context of small screen user interfaces and acceptability of small-screen systems. Furthermore, using TAM, the research provides new empirical evidence in the context of small screens, which strengthens the theoretical model and expands its applicability.

This study provides a starting point for further research on measuring the user acceptance of small-screen information systems: subsequent research is needed to address some of the questions raised by this paper. Further research is required to assess the effects, if any, of interface translucency using different translucency levels, or indeed with translucency applied to other on-screen objects other than selectable menus. Whilst 50% translucency had no effect on the perceptive attitudes examined in this study, it remains to be seen whether higher or lower translucency levels can be shown to affect such attitudes in a linear or non-linear fashion. Also, further research is needed to study the effects of varying some of the properties held constant in this instance, in particular the dimensions of the screen. The study could be replicated to PDAs, larger screen mobile phones than that used here, or ultra small-screen devices such as wristwatches.

References

Adams, D. A., Nelson, R. R. and Todd, P. A. (1992) Perceived Usefulness, Ease Of Use, And Usage Of Information Technology: A Replication, MIS Quarterly, 16 (2), pp. 227-248.

Atkinson, M. A. and Kydd, C. (1997) Individual Characteristics Associated With World Wide Web Use: An Empirical Study Of Playfulness And Motivation, Database for advances in information systems, 28 (2), pp. 53-62.

Bier, E. A., Stone, M. C., Pier, K., Buxton, W. and DeRose, T. D. (1993) Toolglass And Magic Lenses: The See-Through Interface, Proceedings of the 20th annual conference on Computer graphics, August 2 - 6, 1993, Anaheim, CA USA, August 2 - 6, 1993, Anaheim, CA USA, pp. 73-80.

Cheung, W., Chang, M. K. and Lai, V. S. (2000) Prediction of Internet and World Wide Web usage at work: a test of an extended Triandis model, Decision Support Systems, 30 (1), pp. 83-100.

Davis, F. D. (1986) A Technology Acceptance Model for Empirically Testing New End-User Information Systems: Theory and Results, Unpublished Doctoral dissertation, Sloan School of Management, Massachusetts Institute of Technology.

Davis, F. D. (1989) Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology, MIS Quarterly, September, pp. 318-340.

Davis, F. D., Bagozzi, R. P. and Warshaw, P. R. (1989) User Acceptance Of Computer Technology: A Comparison Of Two Theoretical Models, Management Science, 35 (8), pp. 982-1003.

Davis, F. D., Bagozzi, R. P. and Warshaw, P. R. (1992) Extrinsic And Intrinsic Motivation To Use Computers In The Workplace, Journal of Applied Social Psychology, 22 (14), pp. 1111-1132.

Encarnacão, L. M., Bimber, O., Schmalstieg, D. and Chandler, S. D. (1999) A Translucent Sketchpad for the Virtual Table Exploring Motion-based Gesture Recognition, Computer Graphics Forum, 18 (3), pp. 277-287.

Fishbein, M. and Ajzen, I. (1975) Belief, Attitude, Intention, and Behaviour: An Introduction to Theory and Research, Addison-Wesley, Reading.

Genau, A. and Kramer, A. (1995) Translucent History, Conference Companion On Human Factors In Computing Systems, ACM Press, Denver, Colorado, United States, pp. 250-251.

Harrison, B. L., Ishii, H., Vicente, K. J. and Buxton, W. A. S. (1995b) Transparent Layered User Interfaces: An Evaluation Of A Display Design To Enhance Focused And Divided Attention, Conference proceedings on Human factors in computing systems, ACM Press, Denver, Colorado, United States, pp. 317-324.

Harrison, B. L., Kurtenbach, G. and Vicente, K. J. (1995) An Experimental Evaluation Of Transparent User Interface Tools And Information Content, Proceedings of the 8th ACM symposium on User interface and software technology, November 15 - 17, 1995, Pittsburgh, PA USA.

Harrison, B. L. and Vicente, K. J. (1996) An experimental evaluation of transparent menu usage, Conference proceedings on Human factors in computing systemsACM Press, Vancouver, British Columbia, Canada, pp. 391-398.

Hassenzahl, M. and Wessler, R. (2000) Capturing Design Space From A User Perspective: The Repertory Grid Technique Revisited, International Journal of Human-Computer Interaction, 12 (3-4), pp. 441-459.

Hong, W., Thong, J. Y. L., Wong, W.-M. and Tam, K.-Y. (2001) Determinants of User Acceptance of Digital Libraries: An Empirical Examination of Individual Differences and System Characteristics, Journal of Management Information Systems, 18 (3), pp. 97-125.

Igbaria, M. and Guimaraes, T. (1995) Testing The Determinants Of Microcomputer Usage Via A Structural Equation Model, Journal of Management Information Systems, 11 (4), pp. 87-115.

Igbaria, M., IIvari, J. and Maragahh, H. (1995b) Why Do Individuals Use Computer Technology? A Finnish Case Study, Information and Management, 29 227-238.

Igbaria, M., Parasuraman, S. and Baroudi, J.J. (1996) A motivational model of microcomputer usage, Journal of Management Information Systems, 13 (1), pp. 127-143.
Kamba, T., Elson, S. A., Harpold, T., Stamper, T. and Sukaviriya, P. N. (1996) Using Small Screen Space More Efficiently, Conference proceedings on Human factors in computing systemsACM Press, Vancouver, Canada, pp. 383-390.
Kramer, A. (1994) Translucent Patches—Dissolving Windows, Proceedings of the 7th annual ACM symposium on User interface software and technology, ACM Press, Marina del Rey, California, United States, pp. 121-130.
Leung, Y. K. and Apperley, M. D. (1994) A Review And Taxonomy Of Distortion-Oriented Presentation Techniques, ACM Transactions on Computer-Human Interaction, 1 (2), pp. 126-160.
Mathieson, K. and Keil, M. (1998) Beyond The Interface: Ease Of Use And Task/Technology Fit, Information & Management, 34 (4), pp. 221-230.
Moon, J.-W. and Kim, Y.-G. (2001) Extending the TAM for a World-Wide-Web context, Information & Management, 38 (4), pp. 217-230.
Subramanian, G. H. (1994) A replication of perceived usefulness and perceived ease of use measurement, Decision Sciences, 25 (5/6), pp. 863-874.
Taylor, S. and Todd, P. A. (1995) Assessing IT usage: The role of prior experience, MIS Quarterly, 19 (4), pp. 561-661.
Teo, T., Lim, V. and Lai, R., (1999) Intrinsic and extrinsic motivation in Internet usage, International Journal of Management Science (27), pp. 25-37.
Tractinsky, N., Katz, A. and Ikar, D. (2000) What Is Beautiful Is Usable, Interacting with Computers, 13 (2), pp. 127-145.
Van der Heijden, H., Factors influencing the usage of websites: the case of a generic portal in The Netherlands, Information & Management, (2003) vol 40, Issue 6, pp. 541 - 549
Venkatesh, V. and Davis, F. D. (2000) A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies, Management Science, 46 (2), pp. 186-205.
Venkatesh, V. and Morris, M. (2000) Why Don't Men Ever Stop To Ask For Directions? Gender, Social Influence, And Their Role In Technology Acceptance And Usage Behavior, MIS Quarterly, 24 (1), pp. 115-140.
Zhai, S., Buxton, W. and Milgram, P. (1994) The “Silk Cursor”: Investigating Transparency For 3D Target Acquisition, Conference proceedings on Human factors in computing systems: “celebrating interdependence”, ACM Press, Boston, Massachusetts, United States, pp. 459-464.