The Usage of Augmented Reality Smartglasses: The Role of Perceived Substitutability

Full Paper

Claus-Peter H. Ernst
Frankfurt University of Applied Sciences
cernst@fb3.fra-uas.de

Bastian Stock
Frankfurt University of Applied Sciences
bstock@fb3.fra-uas.de

Tiago Patrick dos Santos Ferreira
Frankfurt University of Applied Sciences
tferreira@fb3.fra-uas.de

Abstract

Augmented reality smartglasses (ARSG) allow users to place virtual 3D representations of real objects, i.e., holograms, into a user's physical surroundings. For example, users can choose to place a virtual clock on their wall instead of the real physical object. We argue that being able to have fewer physical devices and products by replacing these objects with holograms offers multiple utilitarian and hedonic benefits. More specifically, we postulate that Perceived Substitutability, the extent to which a person believes that ARSG are able to substitute his/her real-life objects with virtual ones, is a positive influence factor of both Perceived Usefulness and Perceived Enjoyment, thus indirectly influencing ARSG usage. After collecting 109 questionnaires about Microsoft HoloLens and applying a SEM approach, our research model is confirmed, suggesting that manufacturers need to emphasize the utilitarian and hedonic benefits of their ARSG as well as promote their device's capability of substituting physical objects.

Keywords

Augmented Reality Smartglasses, Substitutability, Usefulness, Enjoyment.

Introduction

After notebooks, smartphones and tablets, wearable devices — i.e., "electronic technologies or computers that are incorporated into items of clothing and accessories which can comfortably be worn on the body" (Tehrani and Andrew 2014) — have gained momentum in the past few years, with revenues expected to exceed 9 billion Euros in 2018 in Europe alone (Statista 2014).

However, some companies seem to have problems with successfully bringing their wearable devices to market. In particular, augmented reality smartglasses (ARSG), which enhance the real world with virtual functions, seem to suffer from a lack of acceptance by a majority of people. Indeed, Google ended their explorer program for their Google Glass in the beginning of 2015 (Lardinois 2015). As a result, ARSG manufacturers have a strong interest in knowing the factors that drive ARSG usage.

The literature provides multiple insights into technology usage in general. More specifically, the most commonly accepted drivers of technology usage are Perceived Usefulness and Perceived Enjoyment (e.g., Davis 1989; Davis et al. 1989; Davis et al. 1992; van der Heijden 2004). However, the general influence of Perceived Usefulness and Perceived Enjoyment on technology usage behavior does not provide ARSG manufacturers with specific guidance, since they still do not know what factors actually drive the perception that ARSG are useful and fun. Indeed, little is known about the specific antecedents of Perceived Usefulness and Perceived Enjoyment in the context of ARSG usage.

ARSG enable users to complement their physical surroundings with virtual objects. More specifically, users can integrate virtual 3D representations of real objects, i.e., holograms, into their physical surroundings. As a result, ARSG enable users to substitute a broad range of physical objects through holograms. For example, instead of mounting a physical TV to their wall, users can put ARSG on and then place a fully functional virtual holographic TV on their wall instead. We argue that being able to have fewer physical devices and products (without sacrificing functionality) by using ARSG offers multiple utilitarian and hedonic benefits. Consistently with this, we postulate that Perceived Substitutability — which we describe as the extent to which a person believes that ARSG are able to substitute his/her real-life objects with virtual ones — is an important positive influence factor of both the Perceived Usefulness and Perceived Enjoyment of ARSG.

After collecting 109 completed online questionnaires about one specific pair of ARSG, Microsoft HoloLens, and applying a structural equation modeling approach, our findings indicate that ARSG are both utilitarian and hedonic technologies whose usage is influenced by Perceived Usefulness and Perceived Enjoyment. Perceived Substitutability was found to be a positive antecedent of both these constructs, thus indirectly influencing ARSG usage through Perceived Usefulness and Perceived Enjoyment. These findings suggest that ARSG manufacturers need to emphasize the utilitarian and hedonic benefits of their devices as well as promote their device's capability of substituting real physical objects with virtual devices and products.

In the next section, we will present background information on smartglasses, introduce Perceived Usefulness and Perceived Enjoyment as influence factors of technologies that provide utilitarian and hedonic benefits, and also present the theoretical foundations of the Perceived Substitutability construct. Following this, we will present our research model and research design. We will then reveal and discuss our results before summarizing our findings, presenting their theoretical as well as practical implications, and providing an outlook on further research.

Theoretical Background

Smartglasses

Smartglasses, in general, are head-mounted displays "that are worn like regular glasses" (Rauschnabel et al. 2015b, p. 6). They can be divided into two categories: virtual reality smartglasses (VRSG) and augmented reality smartglasses (ARSG) (Amorim et al. 2013; Due 2014; Milgram et al. 1994; Nilsson and Johansson 2007). VRSG such as Oculus Rift place the user in an artificial environment. The user cannot interact with the real world — rather, he/she is completely immersed in the virtual world. In contrast, ARSG such as Google Glass (Google 2015) and Microsoft HoloLens (Microsoft 2015) allow users to interact with the real world since they "merge virtual information with physical information in a user's view field" (Rauschnabel et al. 2015b, p. 6; Azuma 1997; Nilsson and Johansson 2007).

In order to accomplish this, ARSG add "an augmented-reality overlay to whatever … [users are] looking at, automatically bringing up relevant information …" (Engadget 2015), or give users the impression that his/her physical surroundings are complemented with virtual objects, also called holograms[1]. Imagine a user wearing ARSG on top of the Empire State Building: While looking around, the names of each building he/she sees can be added to his/her visual panorama, right next to the buildings in question. Or imagine a user wearing ARSG at home: It gives him/her the ability to place virtual objects such as clocks onto specific spots in his/her home so that each time he/she looks at these spots he/she sees a virtual 3D representation of the real object.

Multiple utilitarian benefits of ARSG have been discussed in the literature. For example, one study evaluated the use of these devices by people with Parkinson's disease and found that they might be useful in helping them carry out everyday tasks (McNaney et al. 2014). In addition, ARSG might prove useful for insurance companies by providing a direct connection to a crash scene and the ensuing damage through integrated cameras, which insurance specialists can then analyze (Kim et al. 2013). Overall, ARSG are

[1] "A hologram is a 3 dimensional recreation of … a physical object which can be placed in a theatrical stage space or installation space" (Chin and Kim 2015, p. 498).

expected to improve productivity, offer new ways to visualize problems and solutions, and enhance collaboration (Nguyen 2013), making them at least partly utilitarian technologies (cf. Ernst et al. 2013).

Additionally, ARSG can also be used for hedonic purposes such as video games (e.g., Microsoft 2015). For example, ARSG can enable players to navigate their game avatar right through their own living room. As a result, ARSG are also partly hedonic technologies.

To the best of our knowledge, we are only aware of two studies that have empirically evaluated the factors that drive people's ARSG usage. Rauschnabel et al. (2015a) studied the influence of personality traits on ARSG usage. Their findings suggested that "[c]onsumers who perceive the potential for high functional benefits and social conformity of smart glasses are more likely to … [use them and t]he strength of these effects is moderated by consumers' … levels of openness to experience, extraversion and neuroticism" (Rauschnabel et al. 2015a, p. 635). Rauschnabel and Ro (2016) confirmed functional benefits, ease of use, individual technology innovativeness, brand attitudes, and social norms to be important drivers of ARSG adoption.

The Role of Perceived Usefulness and Perceived Enjoyment on ARSG Usage

As described above, ARSG are both utilitarian and hedonic technologies. Generally, utilitarian technologies "aim to provide instrumental value to the user" (Van der Heijden 2004, p. 696). Perceived Usefulness — "the degree to which a person believes that using a particular system would enhance his or her job [and task] performance" (Davis 1989, p. 320) — centers on the motivations and benefits that are external to the system-user interaction itself, referred to as extrinsic motivations (Brief and Aldag 1977; Van der Heijden 2004). For example, the external benefits/extrinsic motivations of a text-processing program can be to foster a good writing performance in terms of a well-structured and orthographically error-free text (Davis et al. 1989).

Hedonic technologies "aim to provide self-fulfilling value to the user, … [which] is a function of the degree to which the user experiences fun when using the system" (Van der Heijden 2004, p. 696). Perceived Enjoyment — "the extent to which the activity of using a specific system is perceived to be enjoyable in its own right, aside from any performance consequences resulting from system use" (Venkatesh 2000, p. 351) — reflects a hedonic system's intrinsic motivations, such as fun, enjoyment, and other positive experiences, which stem directly from the system-user interaction (Brief and Aldag 1977; Van der Heijden 2004; Venkatesh et al. 2012). For example, the internal benefits/intrinsic motivations of playing a video game will usually be to experience fun, excitement, etc.

Various studies in a variety of contexts have consistently confirmed that Perceived Usefulness and Perceived Enjoyment are central antecedents of technology usage (e.g., Davis 1989; Davis et al. 1989; Davis et al. 1992; van der Heijden 2004). By applying these findings to the context of ARSG, a person can be expected to use ARSG if he/she believes that they fulfill his/her expectations with regards to their instrumental benefits, that is, to their Perceived Usefulness, and with regards to their hedonic benefits, that is, to their Perceived Enjoyment.

Perceived Substitutability

When new products are introduced, users regularly face the question as to whether the new products provide new functionalities and help with prior insufficiently-addressed problems, or whether they do things better than previous products. More specifically, studies suggest that a new product can only substitute an old one, as long as the new product is similar or superior to the old one in terms of functionality and benefits (e.g., Cha and Chan-Olmsted 2012). In line with this, two products are called substitutive when their functions are similar and the user can fulfill the same need with the new product or device (cf. Cha and Chan-Olmsted 2012). We believe that substitutability itself can be a source of both utilitarian and hedonic benefits in the context of ARSG.

Indeed, as described earlier, ARSG can enable users to complement their physical surroundings with virtual objects. More specifically, users can integrate virtual 3D representation of real objects, i.e. holograms, into their physical surroundings. For example, users could place a virtual TV into their home instead of a physical one; or they could place a virtual bookshelf containing their eBook collection, rather than a wooden bookshelf with real books, into their living room; or they could place a virtual painting on

their wall instead of putting up a frame. In summary, ARSG enable users to substitute a broad range of devices and physical products with holograms.

Being able to have fewer physical devices and products without sacrificing functionality offers multiple utilitarian benefits. For example, digital products such as eBooks are regularly less expensive than their physical counterparts due to their simple reproducibility (e.g., Choi et al. 1997) and hence, provide users with the instrumental benefit of having to spend less money. Likewise, virtual TVs and bookshelves will usually cost less than physical ones and may also be obtained easier than real ones, which require transporting the physical objects to one's apartment or house. Moreover, having to clean around a TV or dust a bookshelf with its books is a time-consuming task. In contrast, holographic objects require no cleaning. Similarly, the less physical objects one has, the less effort is required when moving to a new house or apartment. In summary, being able to substitute multiple physical devices and products with virtual ones provides users with multiple utilitarian benefits.

Additionally, substituting physical objects with holograms using ARSG can also provide hedonic benefits to their users. For example, ARSG and their created holograms are new and futuristic and, hence, can be expected to add exciting new experiences to many users' daily lives. The simple process of checking the time through a clock on the wall becomes an exciting and fun occurrence. Consumers cherish experiences more than material possessions (e.g., Van Boven and Gilovich 2003). More specifically, instead of owning many things, people like to experience exciting, pleasant and fun experiences. In other words, experiences make people happier than material possessions. Moreover, research also suggests that having many possessions is negatively associated with positive feelings such as happiness, fun, and enjoyment (cf. Dittmar et al. 2014). Hence, having virtual possessions instead of physical ones might also positively contribute to people's intrinsic well-being. In summary, being able to substitute multiple physical devices and products with virtual ones could provide users with multiple hedonic benefits.

In line with this argumentation, we believe that Perceived Substitutability — which we describe as the extent to which a person believes that ARSG are able to substitute his/her real-life objects with virtual ones — can be a source of multiple utilitarian and hedonic benefits, or in other words, will be an important positive influence factor of both the Perceived Usefulness and Perceived Enjoyment of ARSG.

Research Model

In the following section, we will present our research model in Figure 1 and then outline our corresponding hypotheses.

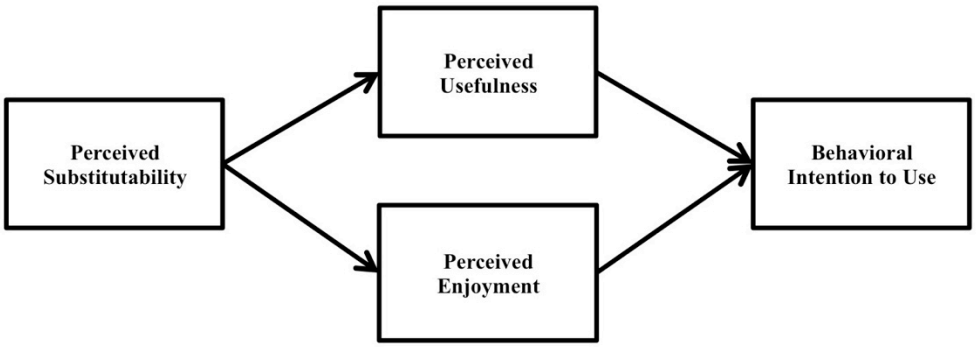

Figure 1. Research Model

As described above, ARSG are useful in a variety of fields: for example, they can enhance collaboration and offer new ways of visualizing problems and solutions (Nguyen 2013). Therefore, ARSG are partly utilitarian technologies (cf. Ernst et al. 2013) that provide users with benefits that are external to the system-user interaction itself. Perceived Usefulness is commonly accepted to be an important antecedent of utilitarian technologies' usage (e.g., Davis et al. 1989). We hypothesize that:

*There is a positive influence of Perceived Usefulness on the Behavioral Intention to Use[2] ARSG (**H1**).*

In addition to their utilitarian benefits, ARSG can also be used for hedonic purposes such as video games. Therefore, ARSG are also partly hedonic technologies (cf. Van der Heijden 2004) that provide positive experiences and feelings such as enjoyment, fun, and excitement. Perceived Enjoyment has been shown to be an important antecedent of hedonic technology usage (e.g., Ernst et al. 2013; Van der Heijden 2004). We hypothesize that:

*There is a positive influence of Perceived Enjoyment on the Behavioral Intention to Use ARSG (**H2**).*

As described above, substitutability itself can be the source of both utilitarian and hedonic benefits in the context of ARSG. More specifically, being able to have fewer devices and physical products (without sacrificing functionality) by replacing the physical objects with holograms offers multiple extrinsic and intrinsic benefits. These benefits include having to spend less money on digital versions of physical products (cf. Choi et al. 1997) and adding exciting new experiences to users' daily lives (cf. Van Boven and Gilovich 2003). As a result, Perceived Substitutability can be expected to exert a positive influence on users' perception of ARSG in terms of their utilitarian and hedonic benefits, that is, their Perceived Usefulness and Perceived Enjoyment. We hypothesize that:

*There is a positive influence of Perceived Substitutability on the Perceived Usefulness of ARSG (**H3**).*

*There is a positive influence of Perceived Substitutability on the Perceived Enjoyment of ARSG (**H4**).*

Research Design

Data Collection

To empirically evaluate our research model, we collected 109 completed German-language online questionnaires about one specific pair of ARSG, Microsoft HoloLens. At the beginning of the questionnaire, we provided a short description of Microsoft HoloLens, including official images and an explanation of its general functionalities. Microsoft HoloLens, which was not yet available at the time of the survey (June 2015), promises users to see "high-definition holograms … seamlessly integrating with … physical places, spaces, and things" (Microsoft 2015).

56 of our respondents were male (51.38 percent) and 53 were female (48.62 percent). The average age was 27.58 years (standard deviation: 7.33). 1 respondent was unemployed (.9 percent), 3 were apprentices (2.6 percent), 5 were pupils (4.6 percent), 26 were currently employed (23.85 percent), 12 were self-employed (11.0 percent), 61 were students (56.0 percent), and 1 selected "other" as a description of themselves (.9 percent).

Measurement

We adapted existing reflective scales to our context in order to measure Behavioral Intention to Use, Perceived Enjoyment, and Perceived Usefulness. For Perceived Substitutability, we developed three of our own reflective items based on the literature (e.g., Pillai and Bindroo 2013) and consulted several researchers from our department throughout the development process. Table 1 presents the resulting reflective items with their corresponding sources. All items were measured using a seven-point Likert-type scale ranging from "strongly agree" to "strongly disagree".

[2] Since at the time of the survey (June 2015), the ARSG under study, Microsoft HoloLens, were not yet available to the general public, we only included Behavioral Intention to Use, and not Actual System Use, into our research model. Behavioral Intention to Use is a commonly accepted mediator between people's beliefs and their actual behavior. It "capture[s] the motivational factors that influence a [person's] behavior; they are indications of how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behavior" (Ajzen 1991, p. 181).

Construct	Items	Adapted from
Behavioral Intention to Use	I intend to use a HoloLens in the next 6 months (BI1)	Hu et al. (2011) Venkatesh et al. (2003)
	I predict that I will use a HoloLens in the coming 6 months (BI2)	
	In the future, I am very likely to use a Hololens (BI3)	
Perceived Enjoyment	Using HoloLens seems to be fun (PE1)	Davis et al., (1992)
	Using HoloLens would be enjoyable (PE2)	
	Using HoloLens would be exciting (PE3)	
Perceived Substitutability	HoloLens is able to replace several of my physical belongings (e.g., TVs, paintings, bookshelves) with holograms (PS1)	created by ourselves
	HoloLens can provide digital substitutes for several of my physical objects (PS2)	
	Multiple physical objects can be replaced by HoloLens through digital ones (PS3)	
Perceived Usefulness	Using HoloLens would enhance my effectiveness (PU1)	Davis (1989)
	Using HoloLens would increase my productivity (PU2)	
	Using HoloLens would enable me to accomplish tasks more quickly (PU3)	

Table 1. Items of our Measurement Model

Results

Since our data was not distributed joint multivariate normal (cf. Hair et al. 2011), we used the Partial-Least-Squares approach via SmartPLS 3.2.0 (Ringle et al. 2015). With 109 datasets, we met the suggested minimum sample size threshold of "ten times the largest number of structural paths directed at a particular latent construct in the structural model" (Hair et al. 2011, p. 144). To test for significance, we used the integrated Bootstrap routine with 5,000 samples (Hair et al. 2011).

In the following section, we will evaluate our measurement model. Indeed, we will examine the indicator reliability, the construct reliability, and the discriminant validity of our reflective constructs. Finally, we will present the results of our structural model.

Measurement Model

Tables 2 and 3 present the correlations between constructs along with the Average Variance Extracted (AVE) and Composite Reliability (CR), and our reflective items' factor loadings, respectively: All items loaded high (.871 or more) and significant (p<.001) on their parent factor and, hence, met the suggested threshold of indicator reliability of .70 (Hair et al. 2011); AVE and CR were higher than .78 and .91, respectively, meeting the suggested construct reliability thresholds of .50/.70 (Hair et al. 2009). The loadings from our reflective indicators were highest for each parent factor and the square root of the AVE of each construct was larger than the absolute value of the construct's correlations with its counterparts, thus indicating discriminant validity (Fornell and Larcker 1981; Hair et al. 2011).

	BI	PE	PS	PU
Behavioral Intention to Use (BI)	.901 (.965)			
Perceived Enjoyment (PE)	.566	.784 (.916)		
Perceived Substitutability (PS)	.582	.658	.847 (.943)	
Perceived Usefulness (PU)	.578	.800	.713	.896 (.963)

Table 2. Correlations between Constructs [AVE (CR) on the Diagonal]

Structural Model

Figure 2 presents the path coefficients of the previously hypothesized relationships as well as the R^2s of both endogenous variables (* = p<.05; ** = p<.01; *** = p<.001). Perceived Usefulness (β=.348, p<.01) and Perceived Enjoyment (β=.287, p<.05) were found to have a significant positive influence on Behavioral Intention to Use, confirming hypothesis 1 and 2, respectively. Furthermore, Perceived Substitutability was found to have a significant positive influence on Perceived Usefulness (β=.713, p<.001) and Perceived Enjoyment (β=.658, p<.001), confirming hypothesis 3 and 4, respectively.

	BI	PE	PS	PU
BI1	.930 (38.151)	.530	.516	.493
BI2	.966 (149.839)	.569	.582	.596
BI3	.951 (80.585)	.509	.556	.551
PE1	.494	.889 (35.476)	.538	.667
PE2	.547	.871 (31.723)	.628	.715
PE3	.455	.896 (33.546)	.574	.740
PS1	.477	.597	.914 (44.520)	.636
PS2	.588	.641	.932 (46.574)	.711
PS3	.537	.575	.914 (42.908)	.617
PU1	.569	.760	.714	.948 (88.430)
PU2	.541	.788	.656	.951 (70.266)
PU3	.530	.724	.654	.941 (64.447)

Table 3. Reflective Items' Loadings (T-Values)

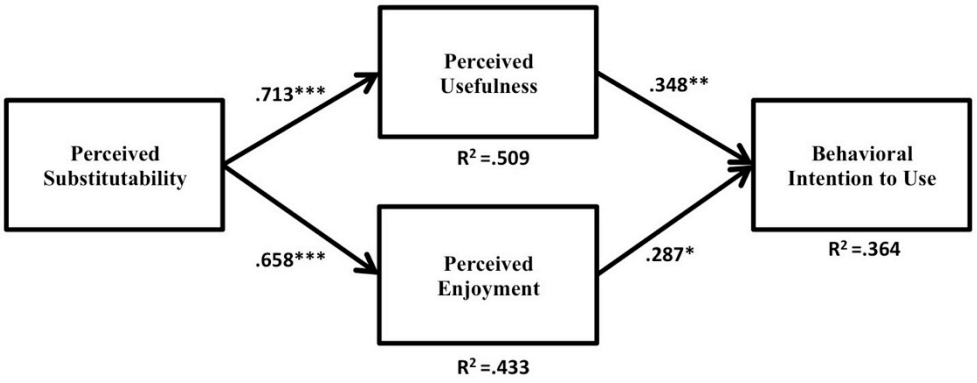

Figure 2. Findings

Our research model included two predecessors of Behavioral Intention to Use (Perceived Enjoyment and Perceived Usefulness), and one predecessor of Perceived Enjoyment and Perceived Usefulness (Perceived Substitutability). By taking this into account, the explanatory power of our structural model is good, since it explains 36.4 percent of the variances of Behavioral Intention to Use, 50.9 percent of the variances of Perceived Usefulness, and 43.3 percent of the variances of Perceived Enjoyment.

Conclusions

In this article, we evaluated the potential influence of Perceived Substitutability on the usage of ARSG. After collecting 109 completed online questionnaires about one specific pair of ARSG, Microsoft HoloLens, and applying a structural equation modeling approach, our findings indicate that ARSG are both utilitarian and hedonic technologies whose usage is positively influenced by Perceived Usefulness and Perceived Enjoyment. Perceived Substitutability was found to be a positive antecedent of both these constructs, thus indirectly influencing ARSG usage through Perceived Usefulness and Perceived Enjoyment.

Our findings have important practical implications. Indeed, they suggest that ARSG manufacturers need to emphasize the utilitarian and hedonic benefits of their devices as well as promote their devices' capability for replacing other devices and physical products with virtual versions of these objects. For example, manufacturers could use advertisements based on specific physical objects that could be digitally substituted with holograms in order to raise the awareness of potential customers. Moreover, manufacturers could establish their own virtual objects store following the popular app store approach used for mobile phones and tablets, and open their devices to third party developers, encouraging them to provide digital objects to the store. Also manufacturers could collaborate with well-known artists in order to provide virtual artifacts such as paintings and sculptures.

Our study has some limitations. First, our empirical findings are based on only one specific pair of ARSG: Microsoft HoloLens. Hence, the results found for these particular ARSG might be very different in studies that use other smartglasses. In addition, Microsoft HoloLens is a product that is not yet available to the general public. Hence, our respondents did not have any hands-on experience with the device and could only state their guesses based on our product description as well as on information they might have gathered on their own. Moreover, since we only surveyed German-speaking people, our results might not hold true for non-German speakers. Finally, our sample individuals were relatively young (mean: 27.58 years; standard deviation: 7.33). Hence, differences might be found for other age groups.

As a next step, we plan to expand our research and address its limitations. More specifically, we want to rollout our survey to a number of other countries around the world, in order to evaluate for potential differences between countries and devices. In addition, we plan to identify and empirically evaluate a number of additional influence factors of ARSG usage.

References

Ajzen, I. 1991. "The Theory of Planned Behavior," *Organizational Behavior and Human Decision Processes* (50:2), pp. 179-211.

Amorim, J. A., Matos, C., Cuperschmid, A. R. M., Gustavsson, P. M., and Pozzer, C. T. 2013. "Augmented Reality and Mixed Reality Technologies: Enhancing Training and Mission Preparation with Simulations," *STO Modelling and Simulation Group Conference 2013 Proceedings*, Paper 111.

Azuma, R. T. 1997. "A Survey of Augmented Reality," *Presence: Teleoperators and Virtual Environments* (6:4), pp. 355-385.

Brief, A. P., and Aldag, R. J. 1977. "The Intrinsic-Extrinsic Dichotomy: Toward Conceptual Clarity," *Academy of Management Review* (2:3), pp. 496-500.

Cha, J., and Chan-Olmsted, S. M. 2012. "Substitutability Between Online Video Platforms and Television," *Journalism & Mass Communication Quarterly* (89:2), pp. 261-278.

Chin, H., and Kim, J. Y. 2015. "An Analysis of Digital Media Holograms Usage Intentions: An Extension of the Technology Acceptance Model," *Indian Journal of Science and Technology* (8:1), pp, 497-503.

Choi, S. Y., Stahl, D. O., and Whinston, A. B. 1997. *The Economics of Electronic Commerce*, Indianapolis, IN: Pearson.

Davis, F. D. 1989. "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly* (13:3), pp. 319-340.

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.

Dittmar, H., Bond, R., Hurst, M., and Kasser, T. 2014. "The Relationship Between Materialism and Personal Well-Being: A Meta-Analysis," *Journal of Personality and Social Psychology* (107:5), pp. 879-924.

Due, B. L. 2014. "The Future of Smart Glasses: An Essay About Challenges and Possibilities with Smart Glasses," *University of Copenhagen: Working papers on interaction and communication* (1:2), pp. 1-21.

Engadget 2015. "Google Glass Review," Retrieved 07-22, 2015, from http://www.engadget.com/products/google/glass.

Ernst, C.-P. H., Pfeiffer, J., and Rothlauf, F. 2013. "Hedonic and Utilitarian Motivations of Social Network Site Adoption," *Johannes Gutenberg University Mainz, Working Paper*.

Fornell, C., and Larcker, D. F. 1981. "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error," *Journal of Marketing Research* (18:1), pp. 39-50.

Google 2015. "Glass," Retrieved 09-29, 2015, from http://developers.google.com/glass.

Hair, J. F., Black, W. C., Babin, B.J., and Anderson, R.E. 2009. *Multivariate Data Analysis*, 7th ed., Upper Saddle River, NJ: Prentice Hall.

Hair, J. F., Ringle, C. M., and Sarstedt, M. 2011. "PLS-SEM: Indeed a Silver Bullet," *Journal of Marketing Theory and Practice* (19:2), pp. 139-151.

Hu, T., Poston, R. S., and Kettinger, W. J. 2011. "Nonadopters of Online Social Network Services: Is It Easy to Have Fun Yet?" *Communications of the Association for Information Systems* (29:1), pp. 441-458.

Kim, M., Francis, A., Gupta, R., and Kumar, M. 2013. "Google Glass: Insurance's Next Killer App," *Cognizant White Paper*.

Lardinois, F. 2015. "Google Glass Explorer Program Shuts Down, Team Now Reports to Tony Fadell," Retrieved 96-29, 2015, from http://techcrunch.com/2015/01/15/google-glass-exits-x-labs-as-explorer-program-shuts-down-team-now-reports-to-tony-fadell.

McNaney, R., Vines, J., Roggen, D., Balaam, M., Zhang P., Poliakov, I., and Olivier, P. 2014. "Exploring the Acceptability of Google Glass as an Everyday Assistive Device for People with Parkinson's," *CHI 2014 Proceedings*, pp. 2551-2554.

Microsoft 2015. "Holographic Computing Is Here," Retrieved 07-22, 2015, from http://www.microsoft.com/microsoft-hololens.

Milgram, P., Takemura, H., Utsumi, A., and Kishino, F. 1994. "Augmented Reality: A Class of Displays on the Reality-Virtuality Continuum," *Telemanipulator and Telepresence Technologies 1994 Proceedings*, pp. 282-292.

Nguyen, T. H. 2013. "Innovation Insight: Augmented Reality Will Become an Important Workplace Tool," Retrieved 06-16, 2015, from http://www.gartner.com/doc/2640230/innovation-insight-augmented-reality-important.

Nilsson, S., and Johansson, B. 2007. "Fun and Usable: Augmented Reality Instructions in a Hospital Setting," *Australasian conference on Computer-Human Interaction 2007 Proceedings*, pp. 123-130.

Pillai, R. G., and Bindroo, V. 2013. "The Moderating Roles of Perceived Complementarity and Substitutability on the Perceived Manufacturing Difficulty-Extension Attitude Relationship," *Journal of Business Research* (67:7), pp. 1353-1359.

Rauschnabel, P. A., Brem, A., and Ivens, B. S. 2015a. "Who Will Buy Smart Glasses? Empirical Results of Two Pre-Market-Entry Studies on the Role of Personality in Individual Awareness and Intended Adoption of Google Glass Wearables," *Computers in Human Behavior* (49), pp. 635-647.

Rauschnabel, P. A., Brem, A, and Ro, Y. 2015b. "Augmented Reality Smart Glasses: Definition, Conceptual Insights, and Managerial Importance," *University of Michigan-Dearborn, Working Paper*.

Rauschnabel, P. A., and Ro, Y. K. 2016. "Augmented Reality Smart Glasses: An Investigation of Technology Acceptance Drivers," International Journal of Technology Marketing (11:2), pp. 123-148.

Ringle, C. M., Wende, S., and Becker, J.-M. 2015. "SmartPLS 3," http://www.smartpls.com.

Statista 2014. "Shipments of Smart Glasses Worldwide From 2013 to 2015," Retrieved 06-16, 2015, from http://www.statista.com/statistics/302717/smart-glasses-shipments-worldwide.

Tehrani, K., and Andrew, M. 2014. "Wearable Technology and Wearable Devices: Everything You Need to Know," Retrieved 06-29, 2015, from http://www.wearabledevices.com/what-is-a-wearable-device.

Van Boven, L., and Gilovich, T. 2003. "To Do or to Have? That Is the Question," *Journal of Personality and Social Psychology* (85:6), pp. 1193-1202.

Van der Heijden, H. 2004. "User Acceptance of Hedonic Information Systems," *MIS Quarterly* (28:4), pp. 695-704.

Venkatesh, V. 2000. "Determinants of Perceived Ease of Use: Integrating Control, Intrinsic Motivation, and Emotion into the Technology Acceptance Model," *Information Systems Research* (11:4), pp. 342-365

Venkatesh, V., Morris, M. G., Davis, G. B., and Davis, F. D. 2003. "User Acceptance of Information Technology: Toward a Unified View," *MIS Quarterly* (27:3), pp. 425-478.

Venkatesh, V., Thong, J. Y. L., and Xu, X. 2012. "Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology," *MIS Quarterly* (36:1), pp. 157-178.

Watjatrakul, B. 2013. "Intention to Use a Free Voluntary Service. The Effects of Social Influence, Knowledge and Perceptions," *Journal of Systems and Information Technology* (15:2), pp. 202-220.