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CAN A MIXED REALITY TOOLKIT ENHANCE CONSUMER VALUE OF THE MASS CUSTOMIZATION EXPERIENCE?

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Abstract: *In the realm of the web, the mass customization (MC) toolkit is the major enabler of relational value for consumers [1]. Not a new concept, but nascent in the context of the MC co-design experience, mixed reality (MR) is "a class of experiences occurring in an ecosystem" [2] where real and virtual worlds merge via "physical and digital objects [that] co-exist and interact in real time" [3]. While the literature extols the significance of the MR components - augmented and virtual reality - in manufacturing, IT, education and, to a limited extent, retail, few if any studies address its relevance to MC and the consumer's perceived value of the co-design experience. Is a mixed reality configurator viable as the enabler of relational benefit in the consumer co-design experience? With visual and feedback features critical to the structure of successful web-based configurators, what characteristics must a MR toolkit possess to deliver optimal experiential value to the MC consumer? What is the nature of the MR toolkit and its bearing upon perceived complexity, control and enjoyment of the co-design process? Are these perceptions the most relevant to consider in designing a MC toolkit utilizing MR technology? This paper contributes to the field by expanding the literature on the consumer's perception of value of the MC co-design experience in the context of mixed reality.*

Key Words: ***mass customization, mixed reality, augmented reality, virtual reality, co-design experience, toolkit, configurator, relational value, loyalty, consumer experience, perceived value***

1. INTRODUCTION

Technological advances continue to enable consumers and firms to interact with one another in a variety of ways for a range of purposes via an assortment of platforms. As technology has paved the way for customization and personalization of offerings, it generates more individualized options, omnichannel interfaces and social connectedness that have yielded unprecedented growth in the importance of unique, experiential offerings beyond just products themselves [4] [5] [6]. "Markets of one" which also comprise many markets in one [7], open innovation [8] and the "hiring" of offerings by consumers to "do jobs" [9] have prompted even faster progressions of the evolution of consumer value.

Today, realities formerly dreamed of to experience are becoming commercially viable. Not a new concept, but nascent in the context of the mass customization (MC) co-design experience, mixed reality (MR) is where real and virtual worlds merge via "physical and digital objects [that] co-exist and interact in real time" [3]. Industry values the AR sector alone at revenues of ranging, if not exceeding, $60-$120 billion by 2020 in the consumer realm [10] [11], indicating the importance of understanding its impact on the consumer's MC experience. Scholars extol the significance of the MR components - augmented and virtual reality - in manufacturing, IT, education and training, tourism, medical and retail. Predicting future retail shopping centers as "morphing" into consumer engagement spaces (CES), Brown & Lubelczyk [12] describe them as "rich experience hubs" or "physical spaces inside CESs using immersive technologies … VR, AR and MR to create unique environments that provide customers sophisticated multisensory experiences … to touch and feel co-created product and rich, deep content." Few studies in the MC field address MR's relevance to the consumer's perceived value of the MC co-design experience. This conceptual paper begins to explore how a mixed reality toolkit might impact individual experiential value in mass customization.

Considering the extant literature on the elements integral to successful MC by both provider and consumer [13] [14] [15], several questions arise relative to our exploration. Is a mixed reality configurator viable as and a key enabler of relational benefit in the consumer co-design experience as MC scholars have established the MC toolkit's importance to date? What characteristics must a MR toolkit possess to deliver optimal experiential value to the MC consumer? What is the nature of the MR toolkit and its bearing upon perceived complexity, control and enjoyment of the co-design process? Are these perceptions the most relevant to consider in designing a MC toolkit utilizing MR technology? Following, we attempt to address these questions. First, we contemplate the nature of the co-design experience in MC and the nature of the consumer's MR experience.

Second, we consider the consumer's perception of value in MC and MR. Third, we discuss design elements of MC toolkits and what might be significant for a MR toolkit in the context of MC. Then, we consider some technologies that could afford the consumer the opportunity to engage in MC and how she might do so via MR. Last, we reflect upon implications of our conceptual exploration, posing ideas for research on what the future might hold regarding the consumer's value of the MC co-design experience in the context of MR.

2. THE NATURE OF THE MC CO-DESIGN EXPERIENCE

The nature of a successful MC experience for the consumer is the interaction between the consumer and the "configurator", or the "co-design toolkit", while she engages in the customization of an offering [16] [17]. Collaboration between the consumer and firm via the co-design experience develops this partnership, but the consumer's use of the toolkit is what creates experiential value for her. Franke & Piller [1] described the MC toolkit as the major enabler of relational value. Well-designed toolkits, or configurators, are effective at benefitting the consumer by rendering a positive co-design experience, and engendering satisfaction and loyalty. The consumer-firm relationship can be understood through exploration of the consumer's perceived experiential value which informs appropriate design of MC toolkits that provide rich individual experiences. Turner & Merle [18] empirically demonstrated the consumer's perceptions of complexity, control, and enjoyment of the co-design experience enhance the relationship between satisfaction with and loyalty intentions toward the online MC program. A litany of work on satisfaction and loyalty in MC, e-loyalty, retailing/e-retailing, and value co-creation emphasize the importance of relational objectives and outcomes resulting from the interaction between the consumer and MC firm. Behavioral intentions, including attitude and affective temperament, influence consumer evaluations to revisit a provider, and result from successive positive collaborative interactions and experiences beyond just repeated transactions (see Turner [19] for a compilation of extant literature). Complementing MC scholars' work on factors that comprise successful toolkit design [13] [14] [20] [21], Turner, Merle, & Fatien [22] described scope of customization, feedback features and comparative elements as three categories MC toolkits should possess to enhance the consumer's perceived experiential value of the co-design process.

3. THE NATURE OF THE MIXED REALITY EXPERIENCE

Hardly new concepts, augmented, virtual and mixed realities have their commercial origins in aerospace in the 1990s [10]. We proceed to distinguish among each of the three concepts.

The simplest description of AR is the merging of the virtual and real worlds [23] or the overlaying of digital images onto the physical world. An early definition of AR describes it as "integrat[ing] computer-generated objects with the real environment … allow[ing] real-time interactions" [24] [25]. In Sholtz & Smith [26], AR "is the practice of displaying digital information over people's real-time view of objects, people, or spaces in the physical world". In all cases, the user should still be able to perceive and feel her surrounding physical environment while viewing digital images superimposed in front of her vision via an AR device. Javornik [10] combines several scholar's descriptions resulting in a description of AR as "[o]verall … the augmentation of the real with the virtual layer [via] computer-generated information [in] combination with interactivity." In the consumer space, AR is used in retail and promotional contexts to visualize and try-on products, promote offers and interact with providers, engage in gaming, and access more detailed information on offerings. Consumer selection of digital images of items such as glasses, apparel and shoes are superimposed onto a user's body. Of the more oft-used and vivid examples of this integration of both augmented and virtual reality are the hugely popular 2016 Pokémon Go game and IKEA's enabling of consumers to superimpose images of selected pieces of furniture in rooms in their homes to see how items look juxtaposed in a particular manner.

In virtual reality, the individual creates an alternate world or sense of being in an environment as if it was the physical world. Steuer [27] conceives VR in terms of presence and telepresence or "the sense of being in an environment, generated by natural or mediated means". One's surroundings are "temporally or spatially distant", like 3D or "an animated … non-existent … world synthesized by a computer" as in video games. The virtual world is "populated by computer-generated objects which appear and behave as real" [28]. Generally, the VR user is completely cut off from reality with no incorporation of the real surrounding environment, any "experience … in which the user is effectively immersed in a responsive virtual world …[where] the user [exercises] dynamic control of [the] viewpoint" [29]. The user is in a created setting as exemplified in Linden Labs' VR offering, Second Life. Applications for VR include consumer video games and online shopping experiences where consumers try on apparel or accessories using a virtual try-on (VTO) mechanism. Further, VR is used in the development of "serious games" [30], applications and simulations used in education, healthcare, the military and corporate training incorporating entertainment, haptic and other human-centered concepts and designs to increase the sense of realness and immersion improving the effectiveness of achieving organizational goals. Ultimately, a "virtual reality system initiates desired real world actions in response to defined events occurring within a virtual environment" [31].

Milgram [32] defines mixed reality as an "environment in which real and virtual world objects are presented together within a single display" generating an experience that allows users to simultaneously interact with objects from the real world and the virtual world. MR is a range of "purely virtual environments to purely real environments" on opposite ends a spectrum from augmented reality to virtual reality, described as the

"Reality-Virtuality (RV) continuum" [3]. Barba, MacIntyre & Mynatt [2] describe MR as "a class of experiences occurring in a … socio-technical ecosystem" of perception beyond simple vision, places beyond space, and capabilities enabled by a variety of technologies. This broad conceptualization is based on Mackay [33] who underscores MR is behaviorally relevant to a specific individual in a given context at a given time. Interestingly, this conceptualization complements the basic tenet of MC, that the consumer gets exactly what she wants when she wants it [34].

4. THE VALUE OF THE MC CO-DESIGN EXPERIENCE

The consumer values the MC co-design experience via the perceived cost of complexity, and the perceived benefits of control and enjoyment. Perceived complexity, the cognitive effort involved in how the consumer makes decisions [35] [14] [36], is a powerful price the consumer pays for engaging in the collaborative design process. MC scholars predicted mixed influences on perceived value, one that can exert negative, positive or no effect depending on the outcome tested [14] [36] [18].

Human beings desire for control over one's environment is potent force. The ability of the MC consumer to master the subject at hand empowers control over the co-design experience [16]. Perceived control is "the extent to which consumers believe they are able to determine the outcome of the MC process" [14]. The user's perception of complexity erodes the sense of control over the co-design experience, but the use of the MC toolkit "enables the ability to focus on what's relevant" and the degree of the individual's control during use of the toolkit dampens perceived complexity [14], yielding a positive impact on intent to use MC.

Perceived enjoyment is another benefit of the MC experience. It is a key factor in both brick-and-mortar and online shopping [37] [38]. MC co-design generates entertainment value [16]; and realizing how enjoyment generates consumer value can help a provider build an effective MC toolkit [14]. Perceived enjoyment is "pleasure associated with the experience of using" MC and "excitement" comes from the individual's ability "to compose [her] ideal product" [14]. Franke & Schreier [36] use the term "process enjoyment … a positive affective reaction elicited by the process of self-designing the product." The design process itself fosters enjoyment and an emotional effect on the MC consumer as she collaborates actively in the co-design experience. Further, perceived enjoyment has a positive impact on intentions to use MC [14].

5. THE VALUE OF THE MR EXPERIENCE

As noted, while the literature has several studies on a variety of aspects of VR, AR and MR, little research appears to exist examining and encompassing the combination of mass customization, MR and the co-design experience. Among those that do, Luh, Wang, Chang, J., Chang, S., & Chu [39] detail mass customization for children's shoe design enabled by AR. Merle, Senecal, & St.-Onge [40] present findings on virtual try-on platforms (VTO) in image interactivity technologies (IIT) and their effect on consumer response. McDonald & Golub [6] introduce the ELSE Corporation, a startup company in Italy offering mass customization in a "Cloud SaaS API platform … aimed at providing an extraordinary new customer shopping experience in 3D (… web and mobile apps, virtual reality, augmented reality and mixed reality environments) … for the consumer goods, apparel and footwear industry". This is not to say that there are few explorations of the characteristics that describe the nature of the three "realities" and their impact on the consumer or individual. As referenced before, Second Life, Pokémon Go, IKEA and many other companies use aspects of these realities either in consumer facing or industry applications for shopping, enriched product and service information, and a variety of consumer promotions [39], many extending the reach to and interaction with customers on individual and social bases [25] [24].

Scholars cite several costs and benefits for consumers using augmented and virtual reality. From the consumer perspective, several are related to those studied in literature on technology acceptance and the theory of planned behavior [42] [43], and explore concepts like telepresence, flow, immersion and consumer innovativeness. Many are in the realms of shopping and apparel retailing, marketing promotions, product information and gaming. Themes include self-efficacy, cognitive and affective effects, and attitude toward adoption. As stated earlier, of interest to this study are the experiential variables of perceived complexity, control, and enjoyment and their relationship to the relational value of the MC consumer's co-design experience [18].

As in the MC literature, the AR experience involves the consumer's perception of complexity. AR provides more information on offerings making search mode easier which heightens the feeling of ease of use [10]. On the other hand, this "information laden enriched" data on offerings in AR might be too much for the consumer and result in greater cognitive load [44] [24]. Complexity is managed by the enjoyment brought by the experience, though for others the process is not perceived as difficult by users who enjoy thinking [43]. In addition, Merle et al., [40], "VTO does not automatically lead to increases in … cognitive responses".

Another MC experiential value is perceived control. In AR, it is related to the responsiveness of the medium enabling an MR experience and the reduction of risk [10]. The order in which content is presented, and to an extent, ease of use impacts the consumer's sense of control [43]. As AR enabling technology can be mobile, if we use mobile shopping experience as a proxy, Yang [42] found a consumer's confidence increases with use which heightens perception of control; and the higher the user's innovativeness, the greater she perceives control. Indeed, Dacko [41] writes that mobile augmented reality (MAR) "apps are seen as changing consumer behavior and are associated with increasingly high user valuations".

Like the MC co-design experience, AR offers enjoyment to the consumer. AR offers an entertaining experience [10] [25] by visual and 3D renderings that contribute to enjoyment and heightens such in this realm

than in the real, physical world [43] [10]. The AR environment is a "multisensory" [18] experience that is also playful and related to the perception of aesthetics [18] [41]. In addition, consumers who like to think enjoy doing so in AR [18]. The environment is an "engaging, stimulating, pleasant" experience that generates enjoyment particularly when gamified [24]. Further, new technology and innovative features inherent in mobile AR provide enjoyment that encourages further use of mobile devices [41] with enjoyment increased for those with more mobile shopping experience [42]. However, those with "indirect" or lower mobile shopping experience enjoyed the AR process less, and VTO does not necessarily increase affective reactions [42] [40].

6. MC TOOLKIT FEATURES THAT ENHANCE THE CO-DESIGN EXPERIENCE

Turner et al. [22] suggest three categories of toolkit design features that enhance the consumer's co-design experience with a provider: scope of customization, feedback mechanisms, and comparative elements [35] [36] [45] [47] [14].

Scope of customization is the breadth and depth of design options and tools that the MC toolkit offers to create unique design experiences utilizing a number of modules, range of options for each module and the degree of design freedom within and across the modules and options. Large and structured to afford more selection, guided choices, flexibility and individual freedom, a well-designed scope of customization in a MC toolkit engenders ease of use to manage complexity and the cognitive cost of burden of choice [35] [45] [14] [13]. The ability to choose from a plethora of well-managed choices not only increases perceived control of the MC process, but also enhances perceived enjoyment [14]. The MC toolkit "creates [the] entertainment process with larger solution spaces" spurring "joy of performing a creative or artistic act" [44]. Visualization mechanisms, variety and number of colors, designs, styles, ability to upload images, few design constraints, and autonomy to modify creations lead to a greater perceived control [14] [47]. The ability to adapt products in a less restricted, freer context further reduces consumer uncertainty associated with "virtual" transactions, while the interactivity yielded by the MC toolkit makes the act of adapting the MC offering more enjoyable [14].

The second toolkit design aspect is feedback [22]. MC toolkits must afford the consumer interactive feedback "to visualize and experience customized products … learn[ing] from the experience of others" [48]. The design should allow feedback and positive reinforcement to the co-designer during toolkit use in the forms of embedded and interpersonal feedback. The former is comprised of visual [14] and trial-and-error feedback integrated into the toolkit [46] [47] [13]. Both serve to decrease complexity while heightening control and enjoyment. Visual feedback helps the MC consumer get as close as possible to being able to examine her design even though she is unable to observe the offering physically [14]; and the feature must be present throughout the entire MC experience to produce perceived value for the user. The stage by stage visualization lowers uncertainty about next steps via "vivid mental images" [14]. Also, it shows progress through the co-design experience that prompts the sense of control. These vivid, visual cues enrich and immerse the consumer creating an enjoyable co-design experience. Further, features for trial-and-error are dynamic in that they help mitigate uncertainty through repeated experimentation while the user navigates, discovers and compares possible solutions. This experience allows her to satisfy needs and wants as she customizes her unique offering from among a variety of options [46] [13]. Fürstner, Anišić, & Takács' [49] empirical study further underscored the value of MC toolkits designed to adapt to the knowledge and expertise levels of customers, further enhancing the individuality of the co-design experience.

Interpersonal feedback features include those that foster requested assistance or counsel via the involvement others. Today, the growth and ubiquity of digital interactions via social media underlies the significance of interpersonal feedback. Blažek et al. [54] note increases in social features in configurator designs. The social aspects inherent in user communities, input of peers and assistance from company representatives [14] [47] enhance the MC consumer's perception of control and enjoyment while decreasing complexity. The ability to see what others have co-designed helps the consumer bring her choices to reality, increases user-friendliness and lowers complexity [13]. In addition, the process provides a shared experience from seeing what others have accomplished during their own co-design experiences [56]. The opportunity to incorporate others' designs or use them as reference points and comparisons, as well as obtain peer input decreases the MC consumer's perceived complexity by provoking "systematic … favorable problem-solving behavior" [56]. The MC consumer's enjoyment of the co-design experience was enhanced by positive peer and user contributions. Further, the means to get feedback from and "interact with trained customer representatives" contributed to the consumer's understanding of the toolkit and her creative options. This helps her to get closer to what she needs or prefers [22]. If interaction with a company representative is direct, "meaningful" and results in immediate clarification of potential difficulties" perceived complexity declines [14]. This form of collaboration empowers and improves the individual's ability to create her co-design solution, increasing her control over the process. From a social perspective, if the interaction remains "cooperative in nature [14] throughout the MC experience, enhanced enjoyment is the result.

The third component of the MC co-design toolkit is comparative elements [22]. These allow the consumer to evaluate, compare and select combinations of options during the co-design experience. The presentation of packaged alternatives alongside a la carte offerings affords the MC consumer opportunities to select from simpler consideration sets, resulting in reduced cognitive effort and perceived complexity [35]. The same holds true for offering package and a la carte pricing. MC toolkits allowing the consumer the ability to compare her design to a standard or default version lowered

complexity as well, particularly when the co-designed result came close to her idea of the perfect offering.

7. MR FEATURES THAT ENHANCE THE MR EXPERIENCE

Literature on users' reactions to any virtual or augmented technology techniques studied produced positive results. Behavioral studies of AR technology in a variety of use cases yielded improved or similar performance relative to controls and include educational applications used by children, rehabilitation games designed for physical therapy purposes, industrial uses for training manufacturing employees and lowering error rates or increasing successful, first attempt, task completion, and hand-eye coordination in surgical training [50] [51] [15] [52]. MR experiences provide several perceived benefits to the consumer. Huang & Liao [43] offer augmented reality interactive technology (ARIT) enables creativity as users "manipulate" offerings or environments, but a variety of aspects of ARIT must accompany the interaction to promote more stimulating experiences to derive greater perceived value. Merle et al. [40] notes that VTO's, a category of or image interactivity technology (IIT), do not in and of themselves prompt increased affective or cognitive responses from consumers. In addition, we assume that using mobile mechanisms in MR may yield value to what Yang [42] described as innovative users whose interaction with mobile shopping promoted repeated use of shopping on such technologies.

Interactivity is the key characteristic of a mixed reality interface [44] [42] [43] [10] [24]. Synonymous with collaboration and cooperation, the underlying meaning of interactivity is exchange with someone or something, integration with and between others [10] [25]. The easier it is to collaborate the more important is seamlessness between how mechanisms or people connect. The physical world delivers reality instantaneously and the realness of interactivity is integral to the MR experience. Speed and seamlessness of response are part of good, interactive technology which promote "smart interactions" that yield "accuracy" for the user [42] [25]. The quality of interactivity is important to providing an experience that submerges or immerses the consumer in what she is doing at the time. Providers must "think about active and passive ingredients" that form the essence of this immersive characteristic, features where the consumer interacts with digitally-imbued objects and that which are in the background [25].

Visualization is another common element of MR/AR/VR highlighted by scholars and relevant to our comparison of the MC and MR consumer co-design experiences. Gervautz & Schmalstieg [44] describe AR technology as "deliver[ing] integrated visual experiences directly related to … [something] … the user views without any delay." This is a key characteristic of interactive consumer technology which "enrich[es] information in a dynamic way" [25]. With rendering 3D visuals in real time and space, visualization and interactive features are tailor-made for enabling a vivid, value rich co-design experience in MR [25].

Virtuality, or virtualization, is another feature of the MR experience [53]. It denotes the "presence of elements of virtual reality" [10]. By its nature, VR's computer-produced images, graphics and interface create the unreal but perceptively immersive environments that thoroughly engage [25] the consumer during use. The interaction with the computer, machine or hardware generates telepresence, a feeling that what one sees and how one moves parallels head and limb movements creating "A sense of being at the distant place … with the body of the machine 'becoming' the body of the human" [35]. As VR and AR are intertwined, the nature of a co-design toolkit in MR must incorporate immersive techniques. Customization is inherent in the avatars, objects, locations, other beings, characterizations, behaviors, time, location, events and all other elements that make up a real world can be at the command of the user in the virtual world. As Dalrymple et al. [31] suggested, many things that trigger the virtual world's goings-on reside in the consumer's ability to "modify behaviors [triggering] the virtual reality system [to] change [other] behaviors based on changing conditions, such as time of day or the whereabouts of a particular user." This non-real, virtual environment and its goings-on can evoke presence, i.e., "acting and feeling that we are in the world created by computer displays" [35], prompting very real affective and cognitive reactions that make structuring a MR co-design toolkit and experience a compelling task. While Merle et al. [40] found VTOs don't necessarily evoke such for apparel websites, their study identified factors related to the consumer's very real body and self-image which a provider must incorporate into the try-on experience in order for the virtual reality to provoke real reactions.

Mobility and location characteristics are addressed in extant studies on the experience in AR [33] [10] [44] [25]. Location is a broader concept beyond specificity of place: the idea that place no longer defines where one is when interacting digitally [33]. For example, one could be in an office, at home, or on the beach when preparing or responding to an email. Therefore, the concept of place is what one wants when and where one wants. This poses an interesting element to the design of a MR toolkit. While location is associated with several technical aspects including physical whereabouts related to mapping, signals and location-based suggestion and offerings to consumers, mobility is important from the design standpoint, not only because enabling mechanisms determine the type and nature of interaction with a toolkit, but MR hardware itself may need to allow free use of consumers' hands and limbs to utilize and interact with the physical process associated with a MR customized offering. In addition, the trigger and viewing of the augmented environment is confined to a limited area or landscape where - with current technology - going outside of these areas results in subjects disappearing from view. On the other hand, restrictions on mobility in the design area could hamper one's sense of movement and flexibility, which is relatively unrestrained when the MC consumer uses a mouse, wireless or wired, or employs touch, unaided or via styli.

The social element of MR is important to the consumer experience. MR's interactive nature offers

both consumers and providers the opportunity to build relationships with one another, and to do so with other users and with bystanders or those on the periphery in during AR activities. Sholtz & Smith [26] describe this as the "socio-physical" or "sociability" aspect of MR. As noted earlier, user communities and peer input are important feedback elements of the MC co-design toolkit. The nature of these elements is social and given the prominence of social media today, such features are integral to well-designed MC toolkits. MC scholars underscore the importance of incorporating robust social and sharing mechanisms in co-design toolkits [54] [55]. The ELSE Corporation's cloud-based MC platform not only incorporates social interaction allowing the consumer to connect to a friend in real-time, conversing with each other and sharing feedback while the user customizes her shoes and selects a matching purse [6]. Incorporating the elements of social media and networking is a necessity [44] given its foundation and ubiquity today.

8. CONCLUSIONS

It would seem that MR is a natural enabler and extender of the next step in the MC co-design experience. Most MC co-design toolkits are enabled by PC or mobile device web interfaces. There are several aspects to consider in toolkit design in MR environments. In a VR co-design situation, the user must take the form of an avatar, whether human-like or not, as the VR experience is of an isolating nature because users are supposed to forget about their surrounding environment and be fully immersed in their virtual worlds. Compared to VR, AR may be best suited for toolkit design due to its grounding in the physical world. In addition, developing MR techniques usually revolve around producing extremely realistic augmented images or visualizations with quick rendering times. In AR, the augmented view is limited to a finite area which when outside of the AR mechanism's view, the experience stops. Haptic aspects may be necessary to enhance the MC co-design experience in MR given one is operating, seeing and responding in real time: beyond rich visualization, a value-laden co-design experience in MR may require further development of sensory inputs to make manipulation of an item more real, e.g. simulating touch or that new-from-the-store scent. In addition, there are a variety of enabling mechanisms which render the MR experience. Mobile devices (smartphones, tablets) goggles, glasses, video screens, sensory gloves, motion-sensing apparel, cameras and hardware, magic mirror, head-mounted displays, and others are utilized in MR. Depending upon the enabling hardware or platform, any of these mechanisms for broad consumer use and adoption is a current constraint likely to be overcome in the near future by technological advances.

Our exploratory analysis contributes to the theoretical conversation on future design and development of MC co-design toolkits in mixed reality. From the managerial perspective, this work offers providers topics to consider in building future co-design experiences that create and capture relational value for consumers via advanced digital and technological offerings.

Though directions for future research are many, we suggest a few that may be integral in delivering value-laden benefits to MC co-design offerings in MR. We considered the consumer experiential values of complexity, control and enjoyment, but further exploration is necessary to ascertain whether these perceptions are the most relevant to consider in designing a mass customization, mixed reality toolkit. Though intentions to use and return are among values cited in the extant literature on MR, aspects of the relational values of satisfaction and loyalty are not addressed in depth. Such may be necessary to determine the extent to which a mixed reality configurator is viable as an enabler of relational benefit in the consumer co-design experience. Also, several scholars note the importance of social connectivity and interaction with other users in MR mechanisms, and the literature could benefit from further examination of the value associated with such relationships.

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