Interactive Exhibition Design in the Post-2020 World

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Introduction

Interactive design is the interaction between users and objects with the goal of enabling "the user to achieve their objectives in the best way possible" (Siang, para. 2). Museums are an integral part of modern society. They are educational but also serve as sources of leisure and entertainment. Museums must provide entertaining, informative, and educational exhibits (Haywood & Cairns, 2006). This is where interactive exhibit design come in. Interactive exhibits allow for interaction in a form other than just visual perception (Haywood & Cairns, 2006). Interactive exhibition design is important because it engages the users is creative and innovative. The keys to interactive exhibit design are mental immersion through constructivism, bodily immersion through stimulation theory, and environmental immersion through environmental psychology.

Constructivism is a teaching pedagogy that is useful inside and outside the classroom (Allen 2004; Juvova et al., 2015). Independence, interaction, and critical thinking are the main parts of constructivism and lead to mental immersion (Juvova et al., 2015). Siebert states the three important constructivist components are viability, which is the usefulness of teaching, permanence or stability, which are environmental concepts, and an enlightened sense, which is directly related to bodily immersion (as cited in Juvova et al., 2015). Constructivism is a positive education theory that promotes activity and motivation, problem solving, consistency, communication, action learning, synergy and teamwork, and allows learners to work at their own cognitive level (Juvova et al., 2015).

Stimulation theory allows for bodily immersion. Stimulation theory is the idea that our environment is "a source of sensory information derived from sight, sound, touch, taste, and smell" (Kopec, 2018, p. 32). Part of stimulation theory is arousal which is when "the environment itself causes automatic physiological responses" (Kopec, 2018, p. 33). This connects to environment immersion. "Sparking" interest or curiosity comes from this theory, which is connected to mental immersion. Our senses can be over or under stimulated depending on our environment. Mental and psychological health problems can occur from under stimulation; keeping the senses stimulated helps people stay healthy (Kopec, 2018).

Environmental psychology is "the study of transaction between individuals and their physical

setting" on all scales to improve the quality of life (Moore et al., 1985; Gifford, 2002 as cited in Mahmoud 2018, p. 2). This can mean examining the psychological attributes of spaces including lighting, size, color, acoustics, wall and floor coverings, and specialty equipment (Kopec, 2018). To create environmental immersion, all these things must work together to create one cohesive space that promotes stimulation and constructivism.

As everyone is aware, 2020 was hit with a virus, called COVID-19, that brought the world to a halt. Places like museums and exhibits were closed mid-March and remained closed through the summer and some are still closed (Vankin, 2020). Now, as the world starts to reemerge, there will be many changes, and not just to our physical health. Interactive design must adapt to post 2020 order with new philosophies of social interaction and health standards that affect immersion in exhibitions. How can interactive design in exhibits remain mentally, physically, and environmentally immersive in the post 2020 world when contaminants and the spread of viruses are major social and health issues?

Theoretical Framework

In the late 20th century, museum visitors started becoming more focused on experience and personal meaning rather than passively taking in content from exhibits. Bodnár (2019) claims "meaning-making is the key [to] modern museums". To create these meaningful experiences, museum guests must become immersed in the exhibit they are visiting. Immersion defined in this paper means a total release of themselves and unconscious captivation on the event at hand (Bodnár, 2019). Three types of immersion are explored below; they are layered and build on top of each other starting with mental immersion, then bodily immersion, and finally, environmental immersion.

Mental Immersion

Mental immersion is total cognitive engrossment with the activity at hand. Mental immersion is built on concepts of constructivism and includes engagement in the exhibit and information processing. The coronavirus affects mental immersion in the areas of fear, disgust, screen time, and mental health.

Engagement

The three themes under the umbrella of engagement are edutainment, interest, and curiosity.

Edutainment, or education and entertainment, is a term originally coined by Bodnár (2019) to define the educational experience. This experience must engage the learner so that they become an active participant. While wanting to learn would be positive in this situation, it is not required; the learner just must be open towards new information. The knowledge and skills often absorb in the person whether they intend it or not (Bodnár, 2019). Edutainment is a useful tool in interactive exhibit design because the visitors come willingly which typically indicates a desire to acquire new information, and it happens in an entertaining and engaging way. A central issue for museums and exhibition design is how to create links between interests of visitors' everyday life and the knowledge presented in the museums (Dindler et al., 2010). Dindler et al. (2010) state that to create this link, interactive exhibit designers must "plac[e] the everyday engagement of their audiences at the center of their work" (p. 73). This theory of sparking engagement through the familiar combined with Bodnár's (2019) idea of edutainment creates a process of developing fun and interesting interactions.

Allen (2004) created an inquiry cycle using curiosity as the driving force. The four steps are surprising phenomenon, exploration, explanation, and relevance. The visitor observes a surprising phenomenon, attempts to manipulate it, looks for an explanation, and then makes a connection to an everyday experience. The observer of this phenomenon must be curios to progress to the next stage. Allen's (2004) inquiry cycle was first developed for science museum, which is why it has the steps of explanation and relevance. Not all interactive exhibits are scientific and may not need to be explained or applied to a real world application. For example, Bilda et al. (2008) state intended results of the exhibit can be left ambiguous to the user. This ambiguity can lead the user to become frustrated or it can lead to them becoming curios and encourage exploration, which is when the user achieves creative engagement (Bilda, 2008). Allen's (2004) stages of surprising phenomenon and exploration directly tie to Bilda et al.'s (2008) creative engagement concept and can shift the user into a state of enjoying the moment.

Information Processing

The second essential concept of mental immersion is information processing. Information processing includes technologies, perception, narration, and reflection and recall. Information and

communication technologies (ICT) work to achieve the demand of experience from visitors (Bodnár, 2019). These ICT devices include multimedia installation, mobile application, augmented reality, and virtual reconstruction just to name a few. There are so many technology choices available now that the question is not whether to use them, but which ones to use to create the deepest, richest understanding and reinforce involvement within the exhibit design (Bodnár, 2019).

Perception is how one views the information being processed in the brain and is greatly influenced by aesthetics, which is part of environmental immersion. Bilda et al. (2008) define perception as an active and constructive process to develop meaning through interaction. Norman (2004, as cited in Bilda, 2008) describes three perception levels- the visceral, the behavioral, and reflective. The visceral level is basic perception, or immediate judgements, categorized as good or bad, safe or dangerous. The behavioral level is driven by the perception of control, and the reflective level is the result of intellectual information processing. While this model of perception is a useful tool to understanding information processing, it leaves out the perception of entertaining, which drives engagement as discussed earlier. Narration is an important element in learning that makes presented information more personal, allows connections to be formed, and promotes fantasy, discussed under bodily immersion (Haywood & Cairns, 2006). Decentering is also evident when narration is present. Haywood and Cairns describe decentering as the process of considering events and actions from various perspectives, which in turn promotes mental immersion.

Davis et al. (2017, as cited in Long et al., 2019) state individuals alternate between clamped cognition, which is fluid creative expression, and unclamped cognition, which is a period of reflection. Long et al. (2019) suggest that designers should create opportunities of reflection and mental-model revision to promote in depth opportunities for learning. Allen supports this and adds that physical interaction, a component of bodily immersion can increase recall of information, rather than just interacting through observation. Willingness to recall and discuss information learned from an interactive exhibit indicates personal learning (Gammon, 2003, as cited in Haywood & Cairns, 2006).

Changes from COVID-19

COVID-19 is changing the current world as it is known, in every area of life. COVD-19 has also

affected the mental states of many people around the world (Fitzpatrick et al., 2020), therefore it will also change the way mental immersion happens within an interactive exhibit and the way designers plan the interactive exhibits. Hoog et al. (2008, as cited in Pakpour & Griffiths, 2020) defines fear as "an unpleasant emotional state that is triggered by the perception of threatening stimuli (p. 2). Fitzpatrick et al. (2020) conducted a study of United States adults to measure who was fearful and how fearful they were of the coronavirus. They discovered people from all over the country were fearful, but fear was elevated in densely populated cities, cities with a higher number of cases, and urban locations. The average score was a seven on a scale from one to ten. Fitzpatrick et al. (2020) often link fear to uncertainty and stress. Questions on the study assessed levels of worry, stress, anxiety, and depression caused by the coronavirus, which is an assessment of mental health. The mean of results of depression levels was in the clinical caseness territory. Depression has also been associated with screen time, which is time spent looking at technology screens, has greatly increased around the world, and has also been associated with many different mental health comes such as depression, anxiety, and poor mental wellbeing (Smith et al., 2020; Sultana et al., 2020). Another response to COVID-19 has been disgust. Disgust is a processing system to prevent us from encountering things that appear to contain diseases, and it also greatly influences decision-making in the brain (Olivera-La Rosa et al., 2020). Interest and perception are highly influenced by brain function and can be negatively impacted by fear, depression, and levels of disgust. The impact of the coronavirus is felt immediately, and the consequences will be long-lasting (Fitzpatrick et al., 2020). This emphasizes the importance of curiosity and edutainment because these are positive ways to be mentally immersed.

Bodily Immersion

Bodily immersion is complete physical engagement in an activity. Bodily immersion is built on concepts of stimulation theory and includes sensory experience, participation, fantasy. COVID-19 affects bodily immersion in the areas of screen time and myopia, need for movement, ventilation and spreaders, and surfaces.

Sensory Experience

Engaging senses using hands-on objects, sounds, scents, and roleplay have an impact on interactive

exhibit design and visitor experience (Harvey et al., 1998, as cited in Bodnár, 2019). This multisensory design enriches the exhibit and ensures memorability of visitors (Bodnár, 2019). Every person has different preferences on senses, especially touch (Agardi, 2019, as cited in Bodnár, 2019). Stimulating different senses enriches the exhibit experience and allows for disabled people to interact with it because of the wide range of ways to experience the space (Bodnár, 2019). A multisensory experience indicates bodily immersion has begun and a person is approaching an escapist experience (Bodnár, 2019). Escapism, according to Pine and Gilmore (1998, as cited in Bodnár, 2019), means escaping from the real world through an experience. Great examples of escapism include 4D movies and going to a casino. Using all the bodily senses is one of the greatest keys to creating an immersive interactive exhibit.

Participation and Fantasy

To fully engage in escapism, visitors must participate. Participation is a conscious, active process that leads to engaged learning (Goulding, 2000, as cited in Bodnár, 2019). Participation leads to fantasy, which is physical activity rooted in imagination and allows children to create actions that reinforce what was learned in the exhibit (Haywood & Cairns, 2006). Fantasy is associated with enjoyment, and if encouraged early on in an interactive exhibit, it can encourage the use of fantasy throughout the exhibit (Haywood & Cairns, 2006). Fantasy is supported with the use of narrative, a mental immersion tool, and promotes the creation of cognitive structures (Vygotsky, 1978, as cited in Haywood & Cairns, 2006). Participation and fantasy are positive tools to use for bodily immersion.

Changes from COVID-19

When it comes to bodily immersion, COVID-19 impacts physical ailments from screen time, the need for movement, ventilation, and cleaning processes. According to Sultana et al. (2020), screen time can be associated with obesity, hypertension, type 2 diabetes, myopia, sleep disorders, and other non-infectious diseases. A study from the United Kingdom found that participants spent around 7.2 hours on screens (Smith et al., 2020, as cited in Sultana et al., 2020). Another study indicated every hour spent viewing a television increased the risk of hypertension and type 2 diabetes by 6% and 8% respectively (Guo et al., 2020, as cited in Sultana et al., 2020). Many of these diseases come from substantial amounts of sitting, and

Xiang et al. (2020) implores people to start moving. These sedentary patterns can have a lasting impact in people's lives (Xiang et al., 2020). Sultana et al. (2020) speculate that the sudden change in screen time required of many people from work and school could impose the burden of many non-infectious diseases. These physical ailments could decrease participation and fantasy in museum visitors.

Ventilation is one of the biggest topics discussed in conjunction with COVID-19 because it is one of the main ways the coronavirus can spread in an interior space (Morawska et al., 2020). Small airborne droplets produced when talking spread through ventilation (Morawska et al., 2020). The spread of coronavirus droplets increases the chance a person will catch the COVID-19 virus, which ultimately effects our bodily functions. To have bodily immersion, visitors' bodies must be working properly. To reduce the risk of infection, ventilation needs to be readdressed (Morawska et al., 2020). Past ventilation standards have been more to promote efficiency, save energy, and have a low cost. This was largely due to the oil crisis in 1973 which increased concern over greenhouse gas emissions and climate change (Bhagat et al., 2020). Bhagat et al. (2020) agree with Morawska et al. (2020) that ventilation should be readdressed because one of the primary ventilation methods, mixing ventilation, distributes air from inside the building into other parts of the building and creates no potential clean zones. Instead Bhagat (2020) advocates for displacement ventilation which pushes polluted warm air to the ceiling and clean air to human height level.

Surfaces are a huge breeding ground for several diseases, including COVID-19, which can last on different surfaces for hours or even days (Fathizadeh et al., 2020). Disinfectants are currently being used to treat surfaces. The most effective are disinfectants with 62-71% ethanol or .1% sodium hypochlorite if exposed to the surface for one minute (Fathizadeh et al., 2020). While Sun and Ostrikov (2020) also claim these disinfectants work, he argues that the disinfectants are labor intensive, consume many materials, are difficult to apply to all areas, and need repetition. These chemicals could also be harmful to the human body which would ultimately decrease bodily immersion. Megahed and Ghoneim (2020) advocate for touchless technologies. 80% of infectious diseases are transmitted through touch (Megahed & Ghoneim, 2020). Touchless technology could remove the requirement to infect people's hands.

Environmental Immersion

Environmental Immersion is unrestricted focus and attention on the immediate surroundings of a person. It is built on theories of design including spatial exploration and interaction. COVID-19 influences environmental immersion through social distance, finishes and furnishings, and ultraviolet lighting.

Spatial Exploration

Allen (2004) describes a well-designed interactive exhibit space as one that goes unnoticed because this reduces the cognitive load of visitors which frees them to focus on the exhibit. Some solutions explored by Allen (2004) are different lighting options, more seating, using acoustic baffling, having orientation maps for visitors, and using wayfinding throughout the space. Learning has been documented to be enhanced in quieter, smaller, better defined spaces (Maxwell & Evans, 2002, as cited in Allen, 2004). The use of partitions, noted from a controlled study that added simple partitions around related exhibits, helped visitors identify common themes in the exhibit and ultimately helped further their cognition, which is essential to mental immersion (Allen, 2003, as cited in Allen, 2004). Allen (2004) suggests that the layout and orientation of interactive exhibits should be considered to fully create an immersive space. Another element of spatial exploration is the importance of free choice (Allen, 2004). When visitors can move through an exhibit in their own way, they are be more engaged because they go towards areas that interest them; this links directly to mental immersion (Ciolfi & Bannon, 2002). Spaces designed as such form "the essential backdrop which makes such exhilarating foreground experiences possible" (Allen, 2004, p. 24).

Interaction

Interactions are arguably the most essential aspect of interactive exhibit design; it is even in the name. There are several interaction types including roleplay, search and discover, create and build, demonstrate a principle, and test your abilities (Fontaine, 2014). Hornecker and Stifter (2006) state that true interactivity leads to the creation of personal content through open-ended activity of users. Active prolonged engagement (APE) is defined by visitor led interactions for an extended period where they practice open-ended activity (Allen, 2004; Long et al., 2019). APE exhibits engage users at the environmental, physical, and intellectual level (Long et al., 2019). This means APE is one interaction type that fully encompasses mental, bodily, and environmental immersion.

Socialization is very important in the interaction process (Dindler et al., 2010). Dindler et al. (2010) describe an experiment where they had high school students design interactive exhibits. Nearly every group of students emphasized socialization and collaboration in their projects and labeled it as an essential part of interactive design. However, Haywood and Cairns (2006) argue that collaboration is not as important as co-presence. Co-presence means that other people are present in the physical surroundings of an interactive exhibit, but the people are not working together to achieve a common goal. Co-presence is associated with visitors' desire to talk to someone about their experiences within an exhibit, which is directly linked to recall and reflection, two mental immersion qualities (Haywood & Cairns, 2006). Haywood and Cairns (2006) also state that co-presence was found to be motivating and increased self-awareness, which are both linked to engagement.

Co-creation is the joint experience of two people within an exhibit (Bodnár, 2019). It can be physical or mental and plays a large role in fantasy, which is a bodily immersion topic. Co-creation has an impact on the perceived value of an experience and therefore customer satisfaction (Bodnár, 2019). Dindler et al. (2010) describe co-creation as a display to the world expressing who an individual is, which shows the importance of leaving marks in a space. This personalization can "create or intensify bonds of attachment" and gives visitors "a sense of control and competence" (Brown, 1987, pp. 519-520). In Dindler et al.'s (2010) experiment, several of the student groups added an outlet to leave traces of visitors' selves behind. Adding an outlet for place attachment is a positive way for exhibits to connect with the visitors.

Changes from COVID-19

COVID-19 impacts environmental immersion in the areas of finishes and furnishings, ultraviolet lighting, and social distance. Sun and Ostrikov (2020) discuss the need for long-term durability and low toxicity levels of sanitation agents used on finishes and furnishings. Sun and Ostrikov (2020) suggests using antiviral surfaces and coatings instead of using high chemical disinfectant sprays. There are three categories of antiviral coatings- natural, artificial, and bio-mimetic. Natural coatings are found in nature. Many natural herbs already work as immunity enhancers and can improve respiratory health. Some man-made metal nanoparticles can also be used as coatings that work to break down viruses when they come in contact. Bio-

mimetic options are inspired from natural structure like lotus leaves, gecko setae, fly eyes, etc (Sun & Ostrikov, 2020). While this seems like a great idea, these technologies are often expensive and may not eliminate the need to use disinfectant. Ultraviolet light has also been suggested to kill germs in a space. While UVGI (ultraviolet germicidal irradiation) has not been proved to irradicate COVID-19, it has been effective to use against other coronaviruses, vaccinia, and even influenza (Morawska et al., 2020). According to Noakes et al. (2015, as cited in Morawska et al., 2020), UVGI "may reduce risk of infection by an amount equivalent to doubling the ventilation rate" (p. 4). This practice is already in use in hospitals to fight the spread of infection (Megahed & Ghoneim, 2020). UVGI could be a more practical and quicker method to use in interactive exhibits.

Social distancing is another hot topic that has come from the coronavirus pandemic. The distance that is socially acceptable is six feet because that is how far droplets of the virus can fall depending upon some environmental factors; however, when a person is coughing or sneezing, the droplets can travel up to 23-27 feet away (Sun & Zhai, 2020). Part of effective social distancing is reducing the number of people using a shared space at the same time (Morawska et al., 2020). Megahed and Ghoneim (2020) propose the idea of decentralization to help with social distancing. A decentralization could encourage horizontal expansion of entire cities (Megahed & Ghoneim, 2020). While it could be possible to see some areas expand in this way, it does not seem probable in high populated areas.

In the pre-2020 era, standards of interactive design described above were able to create spaces that were immersive mentally, bodily, and environmentally. However, in the post-2020 era, many new standards of health and wellbeing will influence how visitors interact with interactive exhibits mentally, bodily, and environmentally and therefore should affect the way designers create interactive exhibits.

Discussion

When it comes to mental immersion, it is possible that many areas of cognition will be different moving forward. During quarantine, screen time drastically increased, and people were stuck in their homes. Boredom was a real issue. This boredom could cause a shift in what people find entertaining and designers will need to be aware of that so techniques used to grab visitor's attention can remain effective.

There was also a debate in mental immersion if ambiguity was positive or negative. It is likely that the mental state of museum visitors will not be as healthy as it once was, and ambiguity could more often be a hinderance rather than something interesting. Designers should be aware of this and create clarity and a sense of safety in their exhibits. Engagement will look different as well. One area to explore in the future would be the effect of high levels of screen time and attention span. Technology will also shift to be more integrated into the space rather than just being a screen because of the large levels of screen fatigue being experienced. The largest area affected by COVID-19 on mental immersion will be perception of good verses bad and safe verses dangerous. People are now much more cautious and will keep their distance if they feel their health could be compromised.

Bodily immersion and physical engagement will also change post-2020. Many interactive exhibit designers are aware of the role of the senses in engagement processes, but often only one or two senses are engaged at a time. The two most common are sight and touch. It is safe to assume touch will be greatly decreased in the future from fear or catching a disease and the need to preserve self-health. Now is the time to incorporate the use of all the human senses into interactive exhibits. When many senses are engaged at once, true immersion starts to emerge. One museum that uses sound well is the Oklahoma City National Memorial and Museum. After visiting the first room full of artifacts and interesting information, visitors are ushered into a second room set up as a small court room. Then, a tape is played from a recording that took place during the bombing. This is an example of narrative and evokes an incredible emotional response from the users. Taste has been implemented in the Color Factory. At one point in the experience, you are given a macaroon that coordinates to a color experience had in another room. Participation will be heavily impacted from COVID-19 as well. One way to potentially keep visitors participating is to create larger open areas where they can spread out but still be part of an activity. Fantasy will become even more important post-2020. If interactive exhibits can engage fantasy early on, there is a higher likelihood they will stay engaged throughout the exhibit. A possible short and long term effect of the coronavirus will be weaker immune systems and lower physical capabilities. Movement will become even more important and should be a focus in interactive exhibits not only to promote health, but movement and kinesthetics can also help

with memory and retention which leads to recall, a mental immersion component.

Interactive exhibit designers will need to have environmental transparency to help visitors feel at ease in the space. This will help the visitors have peace in mind and remove cognitive stress which will allow for greater levels of unhindered mental immersion. APE exhibits should be moved out of common travel paths so that visitors can spend the necessary time in the exhibit without feeling exposed and without exposing others. Space planning will be a major part of future exhibit design. It is important to keep people moving through the space to reduce the amount of people in a space at one time, but it is also important to have the time to engage with the exhibit. This is a time of experimentation to create strategies that will keep visitors moving from one spot of interaction to the next so everyone can get a chance to engage in the interactive exhibits. Social interaction is still essential to have a truly environmentally immersive interactive exhibit. People have shown that they can create new ways of socialization even from six feet apart. Interactive exhibit designers should learn from those existing methods and discover how to implement them into interactive design. There is also a need to leave bits of one's self in interactive design. This may look different in the future because of germ spread but must still exist.

Finally, cleaning standards and health standards will change in the many years to come. There are many existing cleaning technologies, but not all of them may be safe for human contact. Antibacterial materials will become the standard in all commercial spaces. Ventilation practices will be improved. The outdoors should continue to be integrated into interior space through atriums or through the presence of biophilic design. Cleaning routines will also be improved. An interactive museum already doing this well is the Color Factory. They have UV lights in their HVAC system and use antimicrobial vapor systems that disperse food-grade disinfectant, so it is safe to ingest. Self-cleaning films have been put on top of all high touch areas, hand sanitizing stations have increased, and their edible treats are prepackaged. They have a disinfectant crew to follow all CDC guidelines and good practice standards (What are we doing, 2020). Through a personal survey executed by the Color Factory, they reported 100% of their guests felt safe while inside the Houston exhibit (Color Factory Exhibit, n.d.). Some of these changes are temporary, but a lot will be permanent. This is a great example on how to move forward and remain a truly immersive and

interactive exhibition.

Conclusion

Interactive exhibit design is complete mental, bodily, and environmental immersion. The three types of immersion are layered and build on top of each other starting with mental immersion, then bodily immersion, and finally, environmental immersion. Each type of immersion has necessary components that have been affected by the changes brought about from COVID-19. However, this means new strategies and creativity must be used to keep interactive design immersive and engaging. Interactive designers can start by answering three questions: Where are interactions happening? What are the potential risks or opportunities from those interactions? How can we overcome these or integrate them into other design areas, respectively? Future research should be implementing some broad and specific changes into interactive exhibits and testing the outcomes both quantitatively and qualitatively.

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