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Combining Digital and Physical User Interfaces. Concept of a Self-Service System for Exhibitions

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ABSTRACT

Digitization is finding its way into many different areas and applications, including exhibitions and museums. While until a few decades ago the information presented was purely restricted to physical elements, self-service systems are now increasingly applied in exhibitions. They allow the visitors to enhance their experience by obtaining additional digital information. Usually, these self-service systems are implemented using standard computers, equipped either with a keyboard or a touchscreen. Nevertheless, the added value of interacting with physical elements in our environment is undeniable. This article presents work in progress and describes the concept and prototype of a novel system that cleverly combines digital information with the interaction through physical elements using innovative technology. The aim is to design an interactive exhibition for museums that combines the traditional, physical user interface with the digital version and thus creates a mixture of both worlds. Using the example of a physical city map, the system offers visitors the opportunity to interact by touch and wooden cubes equipped with NFC tags. The article concludes with an outlook for an evaluation of the prototype and recommendations for further research.

Keywords: User experience design, Consumer experience, Interface, Ubiquitous computing

INTRODUCTION

Today - more than ever - digitization is penetrating almost all parts of social and economic interaction. New technologies, innovative business models, intensely competitive markets, well-informed customers, and growing cost pressure are major challenges that business organizations must face today. In recent years, technological developments have led to fundamental changes in the way we communicate, collaborate, obtain information, make decisions, and consume. In today's competitive marketing environment, many products and services have become mass-produced and can no longer be used to differentiate companies or brands as part of a customer's purchasing decision, as they usually only have small differences in quality. The markets are largely saturated, so that the pure presentation of information and facts in the product presentation offers no advantage over other products (Esch, 2003). In addition, from a sociological and economic perspective, society has undergone a change in attitude from a materialistic to a post-materialistic culture.

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This means that experiences are now given a higher priority than consumer goods (Hassenzahl, 2010; Van de Sand, 2017).

The change from a consumer to an experience society means that consumers today have much more comprehensive needs and demands for consumer goods that go far beyond the pure functionality or performance of a product or service. They desire holistic and long-lasting personal experiences that combine memories, sensations, and symbolism (Hosany and Witham, 2010). These developments require that business institutions upgrade their offerings and provide their customers with memorable and satisfying experiences that appeal to them on an emotional, physical, intellectual, and spiritual level (Pine and Gilmore, 1998). Such experiences have become a critical means of shaping a brand's consumer perception, driving consumer advocacy, and ultimately creating a sustainable competitive advantage (Shaw and Ivens, 2002; Tynan and McKechnie, 2009).

However, not only companies are confronted with these developments, but also the entire tourism, leisure, and cultural sector, including museums. These not only compete amongst each other, but also with other leisure and cultural facilities as well as with home entertainment. Museums today need to focus on customer satisfaction because only satisfied customers are repeating customers. Customer satisfaction is a result of all experiences throughout the entire customer journey of a museum visit, from the moment the customers want to park their car, navigating through the exhibition rooms, the impressions of the exhibits on display, to the moment when the customers leaves the museum. In their traditional role, museums are preservers and transmitters of culture, sources of information and research institutions at the same time. However, since consumers are increasingly asking for products and services that provide emotions, focusing on learning, being and doing instead of just physically being there (Mehmetoglu and Engen, 2011). Hence, museums seem to be under the same pressure as other economic institutions and their offer, which is currently primarily limited to collecting, researching, and exhibiting exhibits. This means that they now must include additional offers in order to expand into holistic experiences. "Consumption has begun to be seen as involving a steady flow of fantasies, feelings and fun encompassed by that we call the 'experiential view"' (Holbrook and Hirschman, 1982). Museums should therefore offer their visitors experiences in the sense of an experience economy (Pine and Gilmore, 1998). Previous research was able to prove that innovative technology in the area of ubiquitous computing and human-computer interaction is able to not only enhance existing experiences, but to create completely new systems that fascinate users (Zagel, 2016).

DEVELOPING A HYBRID INTERACTION SYSTEM FOR MUSEUMS

Humans are characterized by the fact that they use their hands to carry out their daily work, with which even complex tasks are possible. Although the hand as a tool represents the most intuitive form of interaction, keyboards and mice have always been used to operate computers.

New developments in the field of computer technology nowadays more than ever involve new forms of human-computer interaction. Intuitive

operation using fingertips or gestures on a touchscreen display has gained popularity, especially since the introduction of Apple's iPhone. Large-area touch-sensitive displays are also finding their way into modern workplaces and are gradually replacing conventional display devices. As the example of the Microsoft Surface Table from 2007 shows, the integration of the display surface into a table also offers a wide range of applications, especially at the point of sale. Since the release of Windows 7 in October 2009, as the first operating system with native multi-touch support, a broad platform for the development and use of touch-sensitive applications has been available for the first time. Due to the simultaneous evaluation of several touch points, this technology is not only suitable for recognizing more complex gestures with several fingers, but also for use in multi-user environments (Forlines and Lilien, 2008).

For a long time, the research field of human-computer interaction has not only included the physical elements of a system, but also theoretical and psychological aspects of operation (Dix, Finlay, Abword and Beale, 2004). The aim is to optimize the system by selecting the best possible selection of the interaction medium in such a way that a positive user experience is created. Studies have shown that systems with a positive user experience are given a higher value due to improved user satisfaction (Hassenzahl, Eckholdt, and Thielsch, 2009).

One approach in Human-Computer Interaction research is using physical objects to access and manipulate digital information: so called "tangible user interfaces (TUIs)" (Ishii and Ullmer, 1997). As a concept of ubiquitous computing, they make use of the user's real-life skills, pushing the computer into the background by making elements of the system invisible (Diekmann, 2007). However, research focusing on the affective effects of ubiquitous computing are relatively new (Tan et al., 2013).

The system at hand has the goal to educate museum visitors regarding the history and chronicle of geographical places, such as cities, countries, or continents. The basis is a three-dimensional topographical map that was milled into a wooden panel with a CNC milling machine (Fig. 1, A). This panel is mounted in a metal frame that houses an infrared touch frame (Fig. 1, B). Both elements are mounted on a table roughly one meter high (Fig. 1, C). To bridge the gap between physical environment and virtual content as well as to ease the process of navigation, we integrated NFC readers into the table (Fig. 1, D). These readers enable the users to trigger actions by using NFC enabled cards, wooden disks, or other physical elements like boxes or figures, comparable to the system developed by Zagel et al. (2016). All interactions activated by placing the NFC-enabled item next to the reader result in a new historic scenario visualized through a high-resolution projector mounted above the table (Fig. 1, E). This setup allows browsing through history and historic scenes like ages, wars, or political developments.

The right part of Figure 2 shows an example of a medieval scenario that is being projected on the three-dimensional geographic surface (left part of the image), when placing the according NFC token on the reader. This shows how many different scenarios can be illustrated. In this way, not only the settlement that predominates at the relevant time, but also forest cover, the change

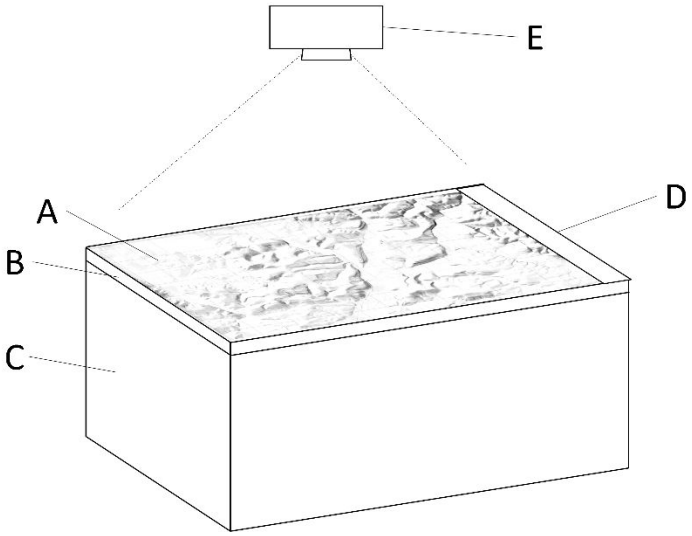

Figure 1: Physical setup.

Figure 2: Original (left) and projected (right) scenario.

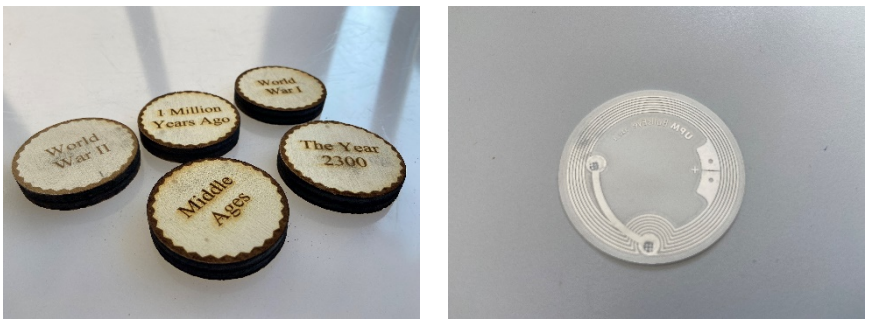

Figure 3: Interaction tokens (left), embedded NFC tag (right).

in river courses or animations for the temporal change in the relief structures can be displayed on the respective piece of land. As we use digital data even visions of the future (e.g., "The year 2100") as well as moving pictures (e.g., visualizing the attacks during World War II) are possible. As a data source we use the platform of the Bavarian "Agency for Digitization, High-Speed Internet and Surveying" which not only offers access to geographic data, but also to historic maps, aerial views, and many more.

For the prototype we use NFC tags (Figure 3, right) embedded into wooden disks (Figure 3, left).

CONCLUSION

In this paper we presented the concept of a novel system for interactive exhibitions in a museum context. The system uses tangible objects to manipulate digital information, hence, offering the visitors the possibility to experience the presented knowledge in a novel way. As a result, it offers the possibility of natural human interaction while experiencing a value add. Currently, the concept is being realized as a physical system. It will be evaluated in a real-life context within an exhibition at an event held in Kronach, Germany, using the User Experience Questionnaire provided by Schrepp et al. (2014). Future applications of the underlying idea include the use of comparable systems in retail stores, in entertainment as well as in home environments.

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