

Massive flux design for an interactive water installation: WATER GAMES *

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ABSTRACT

This paper identifies and contextualizes the limitations and problems found in interactive installations that require a massive flux of users. It then presents a set of solutions for these practical problems and shows how they have been applied to a real life installation with exceptionally good results. The application is an interactive water installation for children and their families for the international event called "Universal Forum of Cultures, Barcelona 2004".

Categories and Subject Descriptors

H.5.2 [Information Interfaces and Presentation]: User Interfaces—*Ergonomics, Evaluation/methodology, Interaction styles*

General Terms

Performance, Design, Reliability, Experimentation, Human Factors

Keywords

Interactive attractions, interaction-driven design, real time interaction, throughput

1. INTRODUCTION

The promise of interactive technologies becoming an important element in large scale edutainment and leisure installations has been flying in the air for the last ten to fifteen years

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without really becoming a reality. Only small and medium location based entertainment (LBE) has managed to work reasonably well, through video game type applications in coin op formats and with relatively standard interfaces. But when we turn to medium and large capacity attractions (in amusement or water parks), interaction presents a series of important limitations that have made it become more of a headache than an advantage for managers and designers alike.

We will now analyze briefly the current state of the art in interactive installations and attractions to see their handicaps and advantages. With this we will then be able to define a list of general issues that must always be dealt with. Finally we will then describe the design process of an interactive water installation and how it has tackled possible solutions to the previously defined problems.

2. INTERACTIVE INSTALLATIONS

There are some partly successful examples of interactive installations in medium and large scale LBE. Most of large scale interactive attractions such "Buzz Lightyear's Space Ranger Spin" [3] and "Men in Black" [6] have obtained a huge level of visitors per hour by using large capacity transport systems within the attraction (see table 1), mainly designed by Disney in the 60's [5]. However, their interaction is poor and can be considered as merely shoot up galleries or arcades in motion. Their robustness is compromised by the necessity of providing the users with special guns with which to shoot appearing enemies. Although in both attractions the experience of a few (2 or 6) users occurs simultaneously in time and space, it is basically an individual experience.

In the case of medium sized interactive attractions we can basically count those in DisneyQuest [7], like "Aladdin's Magic Carpet Ride" and "Pirates of the Caribbean: Battle for Buccaneer Gold". The idea of a transport system is not used in this experiences; in the first one a head-mounted display (HMD) is used, while in the second users must wear active 3D glasses. These changes introduce a long preparation phase of the user and a long learning curve of the navigation interface and of the navigation itself within the experience. Some robustness issues also appear because of the physical interfaces and devices. Although the cabins are multiplied as many times as the available space allows for, both present an extremely low throughput (see Table 1). In

the "Pirates", the experience allows 4 users to share the action, which is a good improvement with respect to Aladdin (single user), but interaction is also mainly a shoot up game.

There aren't too many other interactive attractions that deserve to be mentioned here, except for the Mandala LBE experiences by Vivid Group [2]. These are medium/small attractions with single user experiences and extremely low throughput (see Table 1). They are quite natural in use and the interface is completely non-invasive because they are based on an artificial vision system, although the set up needs important restrictions such as a chroma background, constant lighting, and user isolation.

3. ISSUES RELATED TO INTERACTIVE INSTALLATIONS

With the above referents in mind, let us now sum up and describe the general problems we have identified for interactive attractions.

Preparation or Approach Phase: Many of the installations that use invasive sensors and/or devices, HMDs and/or 3D glasses require an important preparation time for each user to be ready before actually starting the experience.

Learning Curve: This is divided into two parts: first, the time that a user needs to become acquainted with the manipulation elements of the interface (joysticks, guns, etc.), and second, the time spent learning how to interact with the experience.

Naturalness: This refers to the fact that the activity that the user is asked to do is often not ergonomically and/or culturally easy or obvious for her.

Invasiveness: This refers to how many sensors, visualization aids, etc., must the user wear that may hinder her interaction.

Robustness: This refers to how easily can the physical interfaces break down or need maintenance due to normal use.

Isolated experience: It is generally more fun to be able to share the interactive experience with other people, but many interactive installations are designed for a single user because they are generally speaking easier to design and control.

Non participative: Even when an installation allows multiple users in at the same time, very often the experience is individual and can isolate the users.

Throughput: This is the issue all designers are after to achieve the affordability of the installation and to avoid queues that bore users. But the real challenge is to get a good flux of users without compromising the richness of interaction nor obtaining poor results in the rest of the above issues.

Of course all these issues have some interdependence, but by identifying and separating them, we can better attack each in the design process of new interactive installations.

4. WATER GAMES INITIAL REQUESTS

Water Games was defined as an open air interactive installation for the international cultural event Universal Forum of Cultures, Barcelona 2004. The organization of the Forum fixed some initial requests for us to meet. Namely, the installation had to be specially conceived for children, although it would be good if all visitors could enjoy it. It had to be based on water because the Forum event would be going on during the hot summer season in Barcelona (from May to September); i.e. water as a refreshing and fun element had to be the central focus of the installation. Finally, the installation had to be interactive and had to have a very good throughput of visitors/users.

Our team decided that it would be interesting to thematically link the experience to the three main axes of the Forum of Cultures, namely: *respect towards cultural and ethnical diversity, conditions for peace and sustainability*

Additional demands were that the installation should be able to work from 11am until 01am (14 hours of continuous operation) during the 141 days that the Forum would last for and had to be adapted and integrated to a specific piece of land within the event site (approximately 1200m²).

5. MASSIVE FLUX INTERACTION DESIGN

Interaction design in Water Games has tried to avoid the problems found in interactive installations, as listed above, and has centered its attention in obtaining the highest possible flux of users.

Installation for children: Because of the international dimension of the event, the first challenge was to achieve a deep study of the different ways in which children play with each other. Hence, the most universal game structures and playing behaviors had to be analyzed to determine which to use as the groundwork for the installation to be accessible to children from as many cultures as possible.

Finally, it was decided to base the interaction on the game of forming rings because it is an extremely well known game to all cultures. Moreover a natural interaction would be obtained, because children would be asked to do something they already knew. This should influence the naturalness of interaction and minimize the learning curve enhancing throughput of users.

The role of water: As the initial goal was to design a water installation, we thought that the formation and spinning of the ring should be the interaction mechanism that would activate a set of water games. So we decided that the rings would have to be formed and spun around water fountains, providing water with a prominent position in the game and letting the children be splashed and refreshed in a fun experience. Because of this interactive activity the activation of the water fountain was designed to occur while and only as long as, the ring remained completely closed and in motion.

Robust, safe, natural & easy: Of course, in Water Games, the technology to be chosen for the interaction with water had to be safe, robust, natural and ensure a short approach time & learning curve. The solution found was to develop an ad hoc artificial vision system that would detect the for-

mation of the rings and whether they were in motion or not. This artificial vision system should not require any markers on the users and had to work under all natural lighting conditions. If this could be accomplished, then we would obtain a system that would be 100% non-invasive; provide a null preparation time of the users and no learning curve; give best naturalness in approach and during game play; and provide 100% robustness and safety because there are no physical interfaces to be manipulated.

Thematic adequacy: An added achievement is the richness of the experience and adequacy of the installation to the three main axes of the Forum of Cultures. In this experience users actively learn the meaning of their actions. Forming a ring is an act of socialization and because it is a non-hierarchical structure all users have the same status; *respect to diversity*. To spin around users must agree on direction: allegory of *working for peace*. The ring protects water showing it is an important natural resource: *sustainability*.

Interaction-driven design for massive flux interaction: The described analysis and design of interaction follow the design strategy known as Interaction-driven design [4]. This strategy bases its design analysis and procedure on the definition of the actual activities that the users will be asked to do during interaction. The flexibility of this approach makes it possible to attack a specific issue such as the flux of users.

6. WATER GAMES: FINAL INSTALLATION

Water Games finally became an installation with a footprint of approximately 1200m² placed next to the Universal Forum of Cultures central plaza. It offered a refreshing and fun area for children from 3 to 8 years of age and their parents, although its games were attractive to all ages [1].

It was composed of a set of 9 circular plazas that were connected by short paths, see Figure 1, providing a discovery site as a free roaming promenade. Each plaza was 6 meters in diameter and had a water fountain in its center as an interaction element, see Figure 2a, proposing a different water game.



Figure 1: Water Games installation aerial view

At the end of the promenade a large fountain generated a cloud of water that created a refreshing ambience. Music from around the world flooded the installation with sound, providing the perfect set up for a game based on forming spinning rings. The rings around the fountains could be formed by four or more users, but in all cases they had to be closed structures and in motion to activate the water games and sounds of children laughing, see Figure 2b.



Figure 2: a) A circular plaza, with the fountain and the tubular tripod for the artificial vision system. b) Visitors interacting

Above each plaza, a metal box with a glass bottom, held in place by a tubular metal tripod 5m high, contained an intelligent video camera inside, see Figure 2a. Therefore the camera was placed vertically over the water fountain so that it captured the images of the rings as seen from above. These cameras not only captured the images of what was occurring in the plaza, but also had a specialized microprocessor in them that allowed image processing operations to be made in real time. This way, all ring shapes and spinning recognition was done within the cameras and no other computer was needed. These were very robust cameras usually used in verification of industrial manufacturing processes and could work under very stressful conditions. If the camera detected a ring-like structure around the fountain, it then sent an activation message to a central control, via TCP/IP, where a PLC managed the hydraulics of the activated fountain.

7. RESULTS

Water Games was accessible at the Forum of Cultures for 141 consecutive days, with a final operating schedule from 11am to 11pm. During this time, over 317000 users experienced it. Water Games provided a proven throughput of over 2100 users per hour, making it an attraction with a massive flux of visitors. Moreover it was a multi-user experience that allowed over 100 simultaneous users making it an exceptionally participative experience. Table 1 compares Water Games with the rest of attractions and installations (interactive or non-interactive) that have been mentioned in this paper. As it can be seen, the flux of users of Water Games are well above most of the rest of interactive installations. It is only topped or equaled by those interactive installations that are based on very powerful transportation systems (and of course by the non interactive attractions that also use these transportation systems). Therefore, we may say the design criteria applied and the analysis made during the design has been extremely successful.

During the last two weeks of the event 400 users of different ages were surveyed to know their opinion and collect their experiences in Water Games. From the questions related to possible difficulties in learning and initial approach to the interaction of the installation, it was found that more than 83% thought it was very easy to learn how to interact (71% of the participants considered that learning was immediate). This is an excellent result showing that the interaction structures and interfaces were adequately chosen to enhance naturalness and ease and they have indeed shortened the learning curve. Also 71% of the users thought that the sense of control of the interaction was very good. This

Table 1: Throughput comparison of several installations or attractions (data obtained either from specialized web sites or by approximate calculation from direct measurements on site)

Installation/Attraction name	Throughput (users per hour)	Interactive (Yes/No)
Pirates of the Caribbean (Disneyland)	3400	N
Haunted Mansion (Disneyland)	2600	N
Men in Black (Universal Studios)	2200	Y
Buzz Lightyear's Space Ranger Spin (Walt Disney World)	2200	Y
Water Games	2100	Y
Aladdin's Magic Carpet Ride (DisneyQuest)	200	Y
Pirates of the Caribbean: Battle for Buccaneer Gold (DisneyQuest)	200	Y
Virtual Hoops (Vivid Group)	20	Y

also shows that naturalness was well attained, but also that the final development of the artificial vision system worked very well under any lighting condition and without incorporating annoying lags. These statistical results also come to show the success of the solution found for each of the defined problems in interactive installations:

Robustness: The artificial vision system specially developed, achieved an interaction without elements to be manipulated maximizing robustness. There were no technical problems with interaction during the 141 days that the installation was open.

Naturalness: Achieved by analyzing the best structure for the interactive activity together with the artificial vision system, following the interaction-driven design strategy. Users could approach the installation and start interaction right away as they would do in any other ring-a-ring roses game.

Short learning curve: Because forming rings is such a well known and popular action, users did not need to learn how to form a ring.

Non-Invasive: The artificial vision system also provided Water Games with a non-invasive interaction system where users need not wear any sensors, cables or markers, making the installation extremely accessible to all sorts of public.

Multiuser: the chosen interaction structure is inherently multiuser and has therefore allowed for more than 100 users to play simultaneously.

Participative: by asking the users to interact with each other, making them find enough partners to form a ring, making them agree to spin and play, we achieved the goal of making them naturally involved in a social participative event where they could comment their experience in real time.

Excellent flux: Water Games, apart from having a huge multi-user instantaneous capacity, also provided a proven flux of 2100+ users per hour, making it an attraction with a massive flux of users.

8. CONCLUSIONS

Water Games has successfully reached most goals related to interactivity in an installation that had important initial constraints such as being an open air attraction, having to cope with large fluxes of visitors, having to interact with a

physical medium as water and having to provide a meaningful experience. The importance of this success lies in the interaction design process. This process has followed a strict analysis of the tasks that the users would be asked to do in the experience. This is what we call interaction-driven design. The proposed framework must be further applied to new interactive installations to be consolidated as a good approach for designing such installations, but it already sets a powerful and encouraging method to design successful interactive experiences for entertainment.

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