ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL OF SCIENCE
INDUSTRIAL PRODUCT DESIGN

THE EXPLORATION OF INTERACTIVE INTERFACES & PRODUCTS IN EDUTAINMENT: THE ISTANBUL AQUARIUM

M.Sc. THESIS

Mehmet Sinan Yum

Department of Industrial Product Design

Industrial Product Design Programme

MAY 2015

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İSTANBUL TEKNİK ÜNİVERSİTESİ ★ FEN BİLİMLERİ ENSTİTÜSÜ

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Endüstri Ürünleri Tasarımı Anabilim Dalı

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Mehmet Sinan Yum, a **M.Sc./a Ph.D.** student of ITU **Institute of School of Architecture** student ID 502971006, successfully defended the **thesis** entitled "**THE EXPLORATION OF INTERACTIVE INTERFACES & PRODUCTS IN EDUTAINMENT: THE ISTANBUL AQUARIUM**", which he prepared after fulfilling the requirements specified in the associated legislations, before the jury whose signatures are below.

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To my dear wife & family,

FOREWORD

I remain immensely grateful to the mentor and friend who guided me through the process of conceptualizing, researching, organizing, polishing, submitting, and publishing my thesis, Associated Prof. Dr. Gülname TURAN. To the jury, Fred and Cem, my family and friends, Bukra, Iffet, Kıvılcım, Ozan and Associated Prof. Dr. Faruk Kural on behalf of myself, my colleagues, and my past, present, and future students: Thank you!

'Remember; the darkest hour of night is just before dawn!'

May 2015

M. Sinan YUM
(Industrial Product Designer)

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ABBREVIATIONS

Gr	**:** Gesture Recognition
Vr	**:** Virtual Reality
Hci	**:** Human Computer Interaction
Edu	**:** Edutainment
Api	**:** Application Programming Interfaces
Ar	**:** Augmented Reality
Data Viz	**:** Data Visualization
FCL	**:** Free-Choice Learning
ID	**:** Industrial Design
AI	**:** Artificial Intelligence
UCD	**:** User Centered Design
LCD	**:** Learner Centered Design
UXD	**:** User Experience Design
ID	**:** Industrial Design
PD	**:** Product Design

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THE EXPLORATION OF INTERACTIVE INTERFACES & PRODUCTS IN EDUTAINMENT: THE ISTANBUL AQUARIUM

SUMMARY

Information is one of the most important values of the digital world of today and technology is an indispensable part of the infrastructure of the living environment. Electronic technology is being smartly integrated in various products to enhance their performance, resulting that these products possess the properties of both physical and computing entities. The changing nature of products has expanded the realm of industrial design to direct its course toward the design of interaction design. Furthermore, it has reshaped the product development process and coordination of teamwork. While the digital revolution is still progressing, this study aims to propose an innovative learning oriented product-development process suitable for the post-pc era. The study focuses on the edutainment implementations in Istanbul Aquarium concentrating on the education and entertainment providing products. Similar projects have been mentioned through a design perspective which creates product interaction in public spaces such as museums and aquariums. The edutainment implementations are a journey for the guests carrying them from the entrance to the exit with sparks of informative and educative content. The study mentions the design development assets of Istanbul Aquarium edutainment products observing and analyzing the tools and the products used in the project augmenting communication as well as education through a tailor made framework. The aquarium consists of all possible design techniques and interactive products of today. One can find samples of product, graphic, interaction and motion design in the aquarium distributed according to the edutainment project. The guests venture towards education and entertainment visiting different areas with spectacular separate concepts representing the seas of the world.

The study observes the relevance of the interactive products in the aquarium in relation to the literature compiled in accordance with the principles of learning and knowledge creation. The document also provides global examples of similar projects and leading companies in the market.

The thesis is devised in such a way that it presents the information step by step. The sequence in which the content is organized begins with the presentation of the terms in order to associate the reader with the terms and and overview of the structure. The venue in which the project has been carried out is one of the leading projects worldwide with various design implementations from an architectural, design and social point of view. As it is situated in a strategic location 10 km from the airport, it has a touristic attraction value housing a mall, restaurants and other structures for public entertainment and leisure purposes. Many visitor flood to the aquarium on a daily tour basis for sightseeing and shopping, some even while waiting for their flights to different corners of the world. The study explores the potential of using touch-screen interfaces and interactive products to open new opportunities for interactive experiences in the aquarium.

The study pinpoints the approach in design by mentioning relevant academic and social studies made in the field centralizing of the factors which affect the design development process and the social factors related to the learning assets in edutainment. It continues off with the presentation of the research that has been made on terms such as edutainment, interaction and learning, aiming to create a direct contact with the literature. The literature observes and analysis previous studies as well as publications suggested by the study clarifying the connection among different portions of the thesis. Blending the information about the interactive implementations that enhance the knowledge creation and the communication goal of interactive products with the literature is the real challenge the study proposes. The description and the explanation of the design products mentioned in the study all have a precise essentiality in the context of edutainment as the thesis pinpoints.

It is hoped that, through integrating the new approach of learning into public spaces design curricula in order to increase its application within the industries, this research may inspire the designers to keep comprehensive perspectives as they embark on a new project. In addition, this research intends to encourage a new thinking in edutainment design process and methodology, as well as in product development. The latter part of the study provides examples of global projects which hold a similar value in the context of edutainment presenting products in the projects and the companies involved in the creation process. The literature review in relation to the interactive products in the aquarium suggests that edutainment related technologies can provide a prominent and viable solution to the need for knowledge enhancing and entertaining informative systems. Through design, interaction, entertainment and knowledge related literature and methods, this study contributes to theory of exhibit design for visitor engagement and learning.

İSTANBUL AKVARYUMU'NDAKİ ETKİLEŞİMLİ ARAYÜZLERİN VE ÜRÜNLERİN EĞİTLENCE TASARIMINDAKİ YERLERİNİN KEŞFİ ÜZERİNE BİR ARAŞTIRMA

ÖZET

Bilgi günümüz elektronik çağının en önemli değerlerinden biri olmakla beraber, yaşadığımız çevrenin ayrılmaz bir bütünüdür.

Çağın gereksinimlerine ayak uydurmak, teknoloji ve bilgi açısından cevap verebilmek ve akılcı bir biçimde ürünlerin performanslarını arttırmak adına, ürünler dijital teknolojiye uygun bir biçimde şekillendirilmektedirler. Dijital teknoloji birçok ürüne entegre edilmektedir ve bu durum sonuç olarak bahsi geçen ürünlerin fiziksel hesap yapma yani yapay zeka yetisine sahip varlıklar olmasına sebep olmuştur.

Ürünlerin değişmekte olan doğası, endüstri ürünleri tasarımı disiplininin rotasını etkileşim tasarımına doğru kırmasına sebep olmuştur. Bu; tasarımda yeni bir dönemin başlangıcı olmuştur. İlaveten bu gelişmeler, tasarım gelişim sürecinin ve takım çalışmasına yönelik koordinasyonun yeniden şekillenmesine neden olmaktadır. Dijital devrim halen gelişmekte iken bu çalışma, pc sonrası dönem için, daha yenilikçi öğrenme odaklı ürün geliştirme sürecine uygun düşecek şekilde önerilerde bulunmayı hedeflemektedir.

Topluma açık alanlarda mekanların konseptlerine uygun düşecek şekilde yaratılan içeriklerin daha etkili bir şekilde iletilebilmesi için ve geleneksel bilgi oluşturma şekillerini teknolojinin desteği ile iletmek adına tasarımda bazı adımlar atılmıştır. Eski metodlarla harmanlanan yeni teknolojilerin oluşturduğu modern metodlar kullanıcıların, bu mekanlarda daha çok eğlenirken daha çok öğrenmesini hedeflemektedir. Dolaylı olarak etkin öğrenme süreci, farkında olmadan kullanıcıları etki altına alarak öğrenmenin daha efektif olmasını sağlamaktadır. Bu amaca uzanan yolda, geliştirilen ürünler vasıtasıyla hem mekanlar daha kompleks bir atmosfere bürünmüş olup hem de hedeflenen amaca ulaşmak adına daha emin bir adım atmaktadır.

Bu tez, İstanbul Akvaryumu'nda eğitim ve eğlence sağlayan eğitlence odaklı uygulama ürünlerine odaklanmaktadır. Eğitlence uygulamaları, misafirlerin bu mecralardaki yolculuklarının başından sonuna kadar bilgilendirici ve eğitici bir içerik sağlamaktadır. Ürünlerin kendi içindeki uyum sayesinde bilgi, misafirlere farklı porsiyonlarda ve mekanın eğitlence düzenine uygun olarak sunulmaktadır. Böylelikle misafirler günümüzde çok sık rastlandığı üzere fazla bilgi yüklemesine maruz kalmazlar.

Bu çalışma, eğitlence ürünlerinin tasarım alanındaki gelişim niteliklerinden bahsetmektedir. Tasarım araçlarını incelemekte ve analiz etmektedir. Projenin iletişimini arttıran özel üretilmiş bir sistem yazılımı üzerinden, iletişim ve eğitimi destekleyen ürünleri incelemeye alan tasarım geliştirme niteliklerini konu edinir.

İstanbul Akvaryumu, bugün mevcut olan bütün mümkün tasarım tekniklerini ve interaktif ürünleri içinde barındırmaktadır. Gün geçtikçe her ne kadar yeni teknolojiler

geliştirilmekte ve eğitlence tasarımına uygulanmakta olsa da bu akvaryumun, barındırdığı teknolojilerle halen güncel olduğu rahatlıkla söylenebilir. Ürün tasarımı, grafik, interaksiyon ve video tasarımı gibi alanlara ait barındırdığı birçok uygulama üzerinden akvaryum, tümüyle eğitlence projesine özgü niteliklere sahip donanımdadır.

Misafirler eğitime ve eğlenceye doğru yaptıkları bu yolculuklarında, dünya denizlerini temsil eden farklı bölgelerin değişik sualtı konseptlerine, özgün ve gözalıcı özelliklerine tanıklık etmektedirler.

Bu araştırma, projenin barındırdığı interaktif ürünlerin, toplanan litearatüre göre öğrenme ve bilgi oluşturma prensiplerine uygunluklarını, eğitlence konusuna bağlı olarak incelemektedir. Aynı zamanda, benzer projelerin evrensel örneklerini sunmakta ve pazarın önde gelen firmalarıyla ilgili bilgi sağlamaktadır. Çalışmaya dahil edilen benzer projeleri ve firmaları belirleme aşamasında en önemli kriter, geliştirilen projelerin eğitlence prensiplerine uygunluğu ve İstanbul Akvaryumu'ndaki tasarım süreçlerine benzer süreçlere uygunluğudur.

Çalışma, bilgiyi adım adım sunacak şekilde bölümlere ayrılmıştır. İçeriğin organize edilme sırası, okuyucuyu terimler ve çalışmanın genel hatlarıyla ilişkilendirmek için, terminoloji sunumlarıyla başlamaktadır.

Projenin hayata geçirildiği mekan, uluslararası standartlara uygun projelerden biri olmakla beraber mimari, tasarımsal ve sosyal anlamlarda çok önemli bir yer işgal etmektedir. Havaalanına 10 km. uzaklıkta son derece stratejik bir lokasyonda bulunmaktadır. Barındırdığı bir alışveriş merkezi ve restoranlarıyla halkın eğlenme ve boş vakit değerlendirmesine olanak sağlamaktadır. Seyir ve alışveriş amaçlı günübirlik turlarla birçok yerli ve yabancı turistin akın ettiği akvaryum turistik bir değere sahiptir. Hatta bazı misafirler bu turlarını, dünyanın birçok ayrı köşesine yapacakları uçuşlarının aktarmalarını beklerken yapmaktadırlar.

Tez, tasarım gelişim sürecini ve eğitlencedeki öğrenme nitelikleriyle alakalı sosyal faktörleri merkezine taşımaktadır. İlgili akademik ve sosyal çalışmalardan bahsedip öğrenmeye dair tasarım metodlarını odağına almaktadır. Literatüre bakıldığında eğitlence tasarımının temel taşlarından olan Piaget ve Papert'in öğrenme ile ilgili kaynakları referans alınmıştır.

Çalışma eğitlence, interaksiyon ve öğrenmeyi hedefleyen literatürle ilişkili araştırmanın sunumuyla başlar. Literatür, tezin farklı bölümlerinde olan birbiriyle olan bağlantıları açığa çıkarmak için daha önceki yayınları inceleyip analiz etmeye çalışmaktadır. Bilgi birikimini arttırmak için tasarlanmış, iletişimsel hedefleri olan interaktif ürünleri, literatür vasıtasıyla harmanlanması; çalışmanın asıl amacıdır. Bu çalışmada bahsedilen interaktif ürünlerin tanım ve açıklamalarının, eğitlence literatürüyle örtüşmesine gereksinim duyulmasından dolayı tez, buna göre kurgulanmıştır.

Bu araştırma, sosyal alanlarda tasarım literatürünün endüstri dahilinde üretilecek olan uygulamalarına bu yeni yaklaşımı entegre ederek, tasarımcılara yeni bir projeye doğru yol alırlarken perspektiflerini daha geniş tutmaları konusunda ilham vermeyi ummaktadır. Buna ek olarak tasarım eğitimi, eğitlence tasarım süreci ve metodolojisinde yeni düşünce sistemlerine yönelik tasarımcıları motive etmeyi

arzulamaktadır. Akvaryumdaki ürünlerle ilişki üzerinden toparlanan literatüre göre bu araştırma; eğitlence teknolojisi, bilgi gelişimi ve eğlendirici-bilgilendirici sistemlerle alakalı belirgin ve geçerli çözümler sunmaya çalışmaktadır.

Çalışmanın ilerleyen kısımları, benzer değer taşıyan evrensel proje örnekleri sunarken aynı zamanda tasarım ve yaratma sürecine dahil olan firmalarla ilgili bilgiler de vermektedir. Gün geçtikçe eğitlence, uluslararası alanda bulunan toplumsal merkezlerde daha da yaygınlaşmasına rağmen bir çok ülkeye göre ülkemizde daha başlangıç noktasındadır. Ülkemizde benzer nitelikler taşıyan konularda çalışmalar yapılmış olsa da toplumsal bir alanda eğitlence ürünlerinin varlığı üzerine çok fazla kaynak bulunmamaktadır.

Bu çalışma eğitlence odaklı interaktif yerel ürün literatüre etki etmeyi hedeflemesinin yanı sıra tasarım, interaksiyon, eğlence ve bilgiyle alakalı literatür ve metotlar sayesinde öğrenme ve ilişki kurma konusunda eğitlence sergi tasarımı teorisine katkı sağlamayı amaçlamaktadır.

1. INTRODUCTION

This study focuses on the concept of edutainment and its relation to interaction designed maintained through interactive products. Many features of the literature study is reflected onto an already existing edutainment project, Istanbul Florya Aquarium. Istanbul, bridging two continents with its rich history, has a lot to tell the visitors. The Aquarium is situated in the heart of the city on the vicinity to the primary airport Atatürk Airport. This makes the Aquarium an interesting spot to visit during touristic visits to Istanbul as it also offers numerous services provided in the neighboring mall. Many guests have the possibility to drop by just to take a look at the place while waiting for their flight. With the sea life it presents, the Aquarium is a mixture of different species, colors and textures just like its visitors.

The design approach in Istanbul Aquarium is a hybrid one as it integrates different creative styles bonding them with various products. The interactive and non-interactive products are the synthesis of interior design, product design, graphic design, interaction design and information design.

The aquarium has a vast range of circulation. Amongst the visitors are various groups such as tourists and students that are brought to the location on a daily basis as site seeing tour. The plan of the Aquarium enables an easy navigation creating different spaces to present the content to the guests. The plan has been made accordingly so as the crowds visiting do not accumulate in the same areas of the structure that would prevent the newcomers advancement.

The mass effect of the project is enables the multi-functional space to execute various tasks simultaneously such as placement of information providing products, themed areas, gift shop, food court etc. The space itself is distinctive with the visual implementations, tanks, fish, lighting and its storytelling.

The edutainment aspect of the project has been realized by Boid Contemporary Communications after Manila Ocean Park in the Philippines. There are cutting edge technological applications that are used for edutainment purposes such as augmented

reality, gesture recognition systems, touch systems, hologram kiosks, ring screens which carry the purpose of presenting the content to the visitors in an effective way. Educational entertainment is any entertainment content that is designed to educate as well as to entertain. In the study "edutainment" is referred as any content with a high degree of both educational and entertainment value. Edutainment systems within the Aquarium consists of audio and video implementations integrated with mostly touch and gesture recognition technologies. This follows the same pattern of edutainment throughout the world. The way learning, working and playing takes place is being changed by new technologies. Technical knowledge and understanding alone are inadequate to deal effectively with many of the implications of new technology. This raises questions concerning both what technology can do and what technology should do. It is fundamental to understand what they are, what they do and how to use the products, systems, and services create with new technology. Fully grasping the essence of their existence increases its value.

As stated by Budd & Wakkary (2005), one of the keys in addressing the complexity of interaction is a balanced understanding of both the technical (utilitarian and performance) issues and human (social and cultural) considerations. To ensure the solutions to these complex problems do in fact meet design expectations, it will be critical to integrate an active prototype testing and validation process into the design development cycle. This carries an important role as a part of the education process. In the past public spaces meant religious structures, hospitals, cinemas. Ever since the construction of Crystal Palace in 1851 by Sir Joseph Paxton, the way people do shopping and spent time in malls has changed. The cast iron and plate glass building was the first example of a public space solely for leisure purposes providing protection from the elements but giving the feeling of being outside at the same time. It was constructed by the use of latest advancements in technology. Today public spaces refer to museums, theaters, aquariums, concert halls, and so on. They all have a different mission that introduces something interesting. The role of the museums in society has changed in the last few decades. According to Wagner et al. (2004), unlike early museums — called Wundekammer or "room of wonders"— holding collections of items destined to enchant the viewer, museums today have become institutions that promote diffusion of culture and education (Falk & Dierking, 1992). For today's museum curators the focus has shifted from collecting items to defining their

communication strategies and storytelling styles. Curators need to address difficult issues such as how to communicate with people from different age groups and which have different education or cultural backgrounds. As mentioned by Wagner et al. (2004), together with the exhibit designers, curators need to find an arrangement of space, objects, sign, images, and labels that can convey effectively the exhibit's message (Hodge & D'Souza, 1999). Museums have become narrative spaces, able to compete with other popular entertainment places, such as cinemas or theaters, to attract and entertain their visitors.

Audio tours are the first step towards improving the museum communication strategies. Yet when they are button activated, as opposed to having a location identification system that triggers them, they can be distracting for the visitor. People are cognitively busy identifying numbers on the museum walls and punching them into the interface, rather than relaxing and enjoying the visual work. The information conveyed is also limited by the medium; mostly audio. It is not possible to compare the visual work describimg the production stage of the artist, nor show other relevant images. Interactive kiosks are more frequently found today in museum galleries. Yet they are usually physically distant from the work they describe thus not supporting the opportunity for the visitor to see, compare, and verify the information received against the actual object. When extensive web sites are made available through interactive kiosks placed along the museum galleries, these may absorb lengthy amount of time from the visit, thereby detracting from, rather than attracting to, the objects on display.

While these can certainly provide additional information and description of the objects, they can sometimes also be cumbersome and boring. When the additional material offered by the handhelds is presented on the small screen of the device as small text accompanied by icon-size images, this adds an additional burden on the visitor who has to read small items on a small screen and push buttons to learn more about things. Adapting web authoring techniques to handheld devices, which have much smaller screens than the desktop computers monitors that typically show web content, is not an effective communication technique. A storytelling oriented approach needs to be undertaken to make the narrative more compelling for the public.

Today's museums can take advantage of the new most recent technologies to create a sense of wonder not solely through the objects on display but, all the more so, through the tools used to display them. Paradoxically, for the sophisticated 21st century

audience already heavily bombarded by information, what sparks greater interest, emotion, surprise is the new means of communication, which in turn predisposes it for the playful learning experience at hand.

Istanbul Aquarium uses a wide range of state-of-the-art technologies to convey most effectively to the audience the content of the interactive products. The new technologies turn the aquarium into a body-driven interactive multimedia narrative space. Synchronized projections on entrance walls and interactive systems, audiovisual video content and 3D animation of various exhibition materials all join with the playful spirit of exploration made possible by interactive technologies to spark in the visitor a sense of wonder, curiosity and genuine interest in the aquarium.

1.1 Purpose And The Motivation Of The Study

The study presents the factors that affect edutainment, in order to design and produce effective edutainment products and the integration of disciplines in design. The study focuses on education and entertainment qualities of edutainment as well as knowledge creation methods and learning. The purpose of the study can be listed as :

1) The presentation of edutainment and terms related to edutainment.
2) The classification of global edutainment aquarium projects.
3) The classification of the edutainment products in Istanbul Aquarium.
4) The evaluation of the products according to the literature.

The study focuses on the educational and entertainment aspects of the edutainment providing interactive devices in museums specifically in Istanbul Aquarium and explores the potential of using touch-screen interfaces and interactive products related to edutainment. Edutainment implementations have direct effect on the perception of a recreational center. Centers with edutainment products which blend in with the environment and function effectively with the right type of content enhances the positive perception of a center. Multimodal design focused edutainment approach produces the desired effect as enhanced user experience in such centers. The collaboration of related disciplines of design presents itself as edutainment. There have always been many design approaches and product development methods in individual disciplines of design whereas multimodal design has managed to bridge the gap among

the disciplines leading to the creation of the ultimate products. Almost all forms of design can be observed in edutainment. Edutainment provides many projects for the public on location and also has the ability to function in integration with online virtual systems, enabling visitors to have an enjoyable time. In context of education, even though a child may tend to lose interest in school, the systems in an edutainment ambient with content similar to the education software has the possibility to further the education progress. Compared to sitting in class and listening to the teacher, edutainment systems enable the children to choose the content they are interested in. It is possible to track technologies related to edutainment over the web, continuing progress at home. The system also provides performance information as log files so that the parents or teachers have the possibility to evaluate the child. The study mentions all related disciplines and hints on how to bridge the gap through examples of edutainment products. It also provides global examples of an aquarium to demonstrate that the systems in Istanbul Aquarium are technologically up to date. Istanbul Aquarium is the biggest edutainment oriented aquarium in the world and the study highlights the coherence behind the creation and design of edutainment elements. The study pinpoints the major design differences and similarities of the products in edutainment providing information about the experience, learning and desing values of the products. The outcome of the study shows the progress in designing an edutainment center through multimodal design and the uniqueness of the project. The significance of the study lies in relating a contemporary edutainment project with a modern and classical literature. This signifies that edutainment is a product of true evolution.

1.2 Structure Of The Study

The study consists of the presentation of the importance, purpose, range, research questions, method and the structure. The second chapter of the study presents the notion of edutainment, providing introductory information about the term. Global examples of similar aquarium projects follows the literature review. In the literature review, all the terms, keywords and literature related content are presented by providing reference from collected data. The third chapter of the study focuses on the research process and method. The method has been defined and explained providing information on the research process and materials. The forth chapter focuses of the

edutainment products in Istanbul Aquarium. The products' relation with the literature is explained and relevant information has been presented. The fifth chapter of the study presents the literature review, results, conclusions and the appendix providing suggestions for future studies.

The study aims to present the edutainment design, products and implementations in Istanbul Aquarium. The focus on method of design in edutainment products has been explained and all the terms related to the content has been defined in the study. A list of some of the significant global aquarium edutainment projects has been inserted to present the similarities with the case study. Literature references on knowledge creation and learning regarding edutainment linked to the products have been presented.

2. BACKGROUND AND LITERATURE REVIEW

Earlier edutainment software running offline was designed to provide a primitive kind of feedback about the user advance information. In some cases, it offered tools for constructing new knowledge instead of giving illustrative information or practicing specific skills providing repetitive data. The predominant trend in modern educational software are products with wide content range and multiple ways for the users to practice skills. This refers to the fact that the content is designed to present the subject area holistically, crossing the traditional borders between school subjects, and to support the idea of learning by practice. The modern edutainment software is designed for a long time span allowing the users to easily advance at their own pace. The decision making stage enhances the learning process enabling the user to define his own path.

Walldén & Soronen (2004), asserts that teaching can be defined in numerous different ways, for example, as "an intentional interaction obeying the educational goals whose aim is to cause learning" or as "intentional tutoring of studying and learning". Eduainment is a word created by combining education and entertainment, in which the union between learning and entertainment defines the motivation factor. Edutainment can only be applied in a flawless way if certain elements contribute to the design process. It is critical to present the current state of edutainment oriented implementations in different environments. Edutainment is used in education as well as entertainment. Edutainment applications and research projects can be mentioned as modern implementations of edutainment. Various projects in museums and in public facilities correspond to the state-of-the-art edutainment implementations. Edutainment extends to fields such as entertainment, medicine, industry, emergency response, sports, games and military. Many fields regard edutainment as a new frontier to explore with possibilities to offer. These fields can be summarized as examples of using edutainment oriented products according to the scope of use.

According to Brandejsky & Kilzer (2006), the fields that are concerned with edutainment, are :

1) In Medical Training, edutainment is used in Training and Education, Surgical Planning, Image Guidance, Tele-Surgery.
2) In Emergency Response, disaster tracking systems to decrease fatalities, for detection control and treatment.
3) Military Training, Air Combat Simulator, Virtual Intel Agents.
4) Industrial Purposes, Industry oriented Training, Airplane Inspection,
5) Sports Training.
6) Museum and Exhibitions.
7) Internet and Technology.
8) Entertainment and Theme Parks.

Edutainment has many practical uses well integrated to different industries. The study specifically focuses on the education and entertainment aspects of edutainment. Edutainment implementations carry cutting edge product qualities as mentioned in the study by providing examples in comparison to similar projects.

2.1 Edutainment

Edutainment is not a new concept. Some in forms of stories and fables, some as legends leading to social changes, edutainment has been existing for more than a millennia. In order to use entertainment to attract an audience, edutainment utilizes television productions, exhibits, and computer software transmitting educational content or messages. Edutainment has been used to transfer knowledge on health and social issues such as substance abuse, immunization, teenage pregnancy, HIV and cancer since the 1970s. In Turkey, there are similar initiatives run by non governmental organisations such as LÖSEV, Kidzania, Toy Museum of Istanbul, Beşiktaş Science Center and several exhibitions organized can also be cited as examples.

Educational centers are constantly looking for new and innovative ways to reach the surrounding public to get people interested in areas such as the fine arts, science, literature, history and social issues. Field trip visits to these educational centers provide

interactional stimulus to those involved in learning. These places are very popular for learning in an entertaining way outside of a conventional classroom or didactive environments.

In the first instance, edutainment can be thought as similar to infotainment which was one of the first genres that came up with the revolution caused by interactive multimedia in the late 1980s along with edutainment. Infotainment material often resembles edutainment. Various kinds of quizzes and talk shows can be cited as examples of infotainment. However, infotainment and edutainment strongly differ from each other from a pedagogical point of view. The context of infotainment is not teaching, although it might cause informal learning. It is required that in order to be accepted as edutainment, for example a TV program, needs to be produced for educational purposes. Edutainment often employs a narrative approach which is one of the primary differences with infotainment.

There is also a major difference between "edutainment" and "technotainment". The concept of technotainment is not as commonly used as edutainment and infotainment, but it describes very well a certain sort of educational material which is also said to be entertaining. In technotainment entertaining refers to multimedia tricks, such as animations and sounds. Technotainment uses tricks that do not correspond to the real world phenomena. This is against educational principles of real world simulating situation. As a result, the educational goals and methods in which the content is created, sets the boundaries between the terms edutainment and technotainment.

As mentioned in "Creative Evolution" by Bergson (1907), nature and intelligence are considered through examining of mechanisms of thought and illusion presenting a criticism of philosophical systems from those of the ancients to those of the 19th century contemporaries. Bergson (1907), mentions the biology of time presenting his ideas on duration releasing himself from the old patters of mechanisms which demostrates intuitive abilities. Bergson’s thoughts on "Consciousness" lead into questioning the classical methods used in the regulation of many social aspects and the conception of intelligence. According to Bergson (1907), the importance of entropy changes during evolution of species and development of perception, memory, cognition and intuition. While intelligence treats everything mechanically, instinct proceeds organically.

The search for more effective methods has always been what mankind strives for. In this search by the aid of technology and research, the combination of multimodal design approaches produces products for edutainment. Edutainment firstly refers to an atmosphere design beginning with architectural implementations to tailor made production, content or products in order to enhance "educational and entertainment goals" of the project concept for a better visitor experience. Lighting, projection systems, information kiosks with user centered interface design and similar interactive products all support the content to create an entertaining and educative environment. The edutainment design process is a tailor made product development sequence of varying from concept studies to interface design. The tailor made productions are made according to multiple factors such as financial, social, economical and design-based elements.

Since interactive features in edutainment projects function under constant monitoring of a "framework", they entail additional systems to gather data and produce optimization which means high investment. Accordingly, questioning and trying to understand the special and characteristic communication it provides in terms of teaching are essential since the main goal of edutainment is to transfer knowledge.

2.1.1 Basic terms related to edutainment

Edutainment : Any content that is designed and structured to educate whilst entertaining is called "Edutainment" (Rapeepisarn et al., 2006). The ratio between entertainment and education differs according to the medium. There exists a content that is primarily educational but contains incidental entertainment value. There is also a content that is mostly entertaining but has some educational value.

Edutainment in general is the act of learning heavily through various media such as television programs, video games, films, music, multimedia, websites and computer software. Entertainment is the media and education is the content. The development of edutainment environment is also intended to implement technological innovations in education.

Human–Computer Interaction : Human Computer Interaction (HCI) involves the study, planning, design and uses of the interfaces between people (users) and computers. It is often regarded as the intersection of computer science, behavioral sciences, design, media studies, and several other fields of study. The term connotes

that, unlike other tools with only limited uses, computer has many uses and this takes place as an open-ended dialog between the user and the computer (Raymond & Ogbonna, 2014).

Framework : In computer programming, it can be defined as an abstraction in which, software providing generic functionality can be selectively changed by additional user-written code, thus providing application-specific software. A software framework is a universal, reusable software environment that provides particular functionality as part of a larger software platform to facilitate development of software applications, products and solutions. Software frameworks may include support programs, compilers, code libraries, tool sets, and application programming interfaces that bring together all the different components to enable development of a project or solution (Riehle, 2000).

Single Touch : Gesture-enhanced single-touch, also known as "dual control", "gesture touch", and often as "dual-touch", describes the ability of a touchscreen to register certain two-finger gestures, even though the display hardware does not have full dual-touch capabilities. A very common application is the pinch-to-zoom gesture, which allows the user to zoom in or out by moving two fingers farther apart or closer together while touching the display (Lao & Heng, 2009).

Multi Touch : In computing, multi-touch refers to a touch sensing surface's (trackpad or touchscreen) ability to recognize the presence of two or more points of contact with the surface. This plural-point awareness is often used to implement advanced functionality. Lao & Heng (2009), state that in an effort of disambiguation or marketing classification, some companies further break down the various definitions of multi-touch. An example of this is 3M defining multi-touch as a touch-screen's ability to register three or more distinct positions.

Gesture Recognition : Gesture Recognition (GR) is a topic in computer science and language technology with the aim of interpreting human gestures via mathematical algorithms. GR pertains to recognizing meaningful expressions of motion by a human, involving the hands, arms, face, head, and/or body. It is of utmost importance in designing an intelligent and efficient HCI (Chaudhary et al., 2010).

Beta Test : A Beta Test is the external pilot test of a software usually tested by the target group. The Beta Test takes before the commercial launch of a software and aims to remove all defects and flaws. It is also called Alpha Testing.

Multimodal Design : Utilizing divergent modes such as imagery, video or text, in order to recontextualize a cluster of knowledge for a target group. The results of the process as design, reach the learner through online or offline systems and in classroom or at home.

2.1.2 Approaches and types of edutainment

As opposed to physicists' idea of measurable time, life is perceived in human experience as a continuous and immeasurable flow rather than as a succession of marked-off states of consciousness (Bergson, 1889). In designing an edutainment tool, the real challenge is to provide a perception of experience, time and keeping the balance between education and entertainment. In some cases it is very difficult to understand the scope of the task and the goal of design. A desirable aim is to implement an education material that is neither too entertaining nor too laborious. For example, in some edutainment games, game playing and actual learning material can be so separated from each other that a user can go through the game without noticing the represented information contents completely. In such a case, entertainment replaces the aim of learning. Even though entertainment is among the goals, edutainment needs to strive towards education in order to fulfil its defined objectives.

Edutainment can be classified in many ways. The classification organized by Rapeepisarn et al. (2006), shows the divisions of edutainment segments.

1) Location-based edutainment, can be divided into two categories (Rapeepisarn et al., 2006):

a) Interactive & participatory, where children can play and participate in game.

b) Non-interactive & spectator, where children can just be seated and exploring (movie, science show, museums and zoos).

2) Edutainment can also be divided according to target group (Rapeepisarn et al., 2006):

a) Motivation-Oriented : Users who have the same interest regardless of their age, present knowledge level etc.

b) Age-Oriented : Users having similar age groups.

c) Material-oriented : Contents of the material. School TV programs, games, and game tools.

3) Edutainment can be grouped into 3 by type of media content (Rapeepisarn et al., 2006):

a) Edutainment on TV includes comedic drama, historical drama, sketch comedy, skills and travel.

b) Computer edutainment included game types, adventure, quiz, role-play, strategy, simulation, and experimental drama.

c) Edutainment on Internet included, tele-teaching and tele-learning systems, and web-based educational systems; interactive television. This type of edutainment uses the advent of digital television to provide the interactivity via software and hardware and connect with other telecommunication systems.

4) Purpose and content, consists of informal education which is to improve learners' life control, and skills education providing experiences like simulations. Edutainment can be divided according to its purpose and content according to Rapeepisarn et al. (2006):

a) Edutainment to improve users' life control (informal education). It is presented usually with discussion or narrative forms.

b) Edutainment to give experiences (skills education). It is presented usually with experiences, like simulations (virtual mobility).

2.1.3 Basic design approaches in edutainment design

Television is a very immersive product whose communication and transmission range is larger than any other method. When television edutainment tends approaching the edutainment software, methods of User-Centered Design (UCD) and Learner-Centered Design (LCD) are useful to be involved in the design process. Both approaches commonly involve the target audience from the beginning of the design process. After the definition of the target group or groups, designers enhance their knowledge of the group, identifying their needs, motivations, attitudes, and usual procedures relating to the domain or task. During the process of educational software

design carrying edutainment purposes, there is always a typical problem in learning the subject matter that needs to be taken into account.

According to Draper (1986), UCD design is a multi-disciplinary activity, which incorporates human factors, ergonomics knowledge and techniques with the aim of enhancing effectiveness and productivity. UCD improves human working conditions and counteracts the possible adverse effects of use on human health, safety and performance. Draper (1986), suggests that the iterative activities of UCD are, to plan the human centered process, to understand and specify the context of use, to specify the user and organizational requirements, to produce design solutions and to evaluate design against user requirements. The term UCD is often used in the field of digital products in different, related ways. It is a design philosophy in which the needs, wants, and imitations of end users of a product are given extensive attention at each stage of the design process and from a more practical point of view; it is a set of methods or techniques applied during the design process of a digital tool (Draper, 1986).

Monteiro et al. (2014) characterize UCD by six principles :

1) The understanding of users, tasks and environments defines the design of a digital tool.
2) The design and development of the "product" is made by the involvement of the users.
3) Focusing on user evaluations refines the design.
4) It is an iterative process.
5) User expertience is the goal of design.
6) Multidisciplinary skills and perspectives form the design team.

UCD places the target users of a system at the center of its design and development. To make sure that the system achieves its requirements, users interact at key points. It’s very important that the beta test is made by participants that reflect the actual target user profile. UCD addressing questions to the target users about their tasks and goals converts the information gathered into decisions on development and design. Some of the questions a design should answer are (Monteiro et al., 2014):

1) Who uses the system?

2) What are the tasks and goals of the users?
3) What experience do the users have with a similar system?
4) What functions does the system needs to execute for the users?
5) What data does the users need and in what form?
6) How should the system work according to the users?

In a UCD approach it is typical to follow an iterative process, until the usability goals of the project are reached. UCD occurs when needs and limitations of a target group of a product or service are considered and analyzed thorougly through extensive caution and attention.

Following UCD, a new approach specicied as LCD has been developed and implemented in order to obtain efficiency in transmitting educational material. LCD is an approach that extends UCD techniques and is based on social constructivist theories of learning. As mentioned by Soloway et al. (1998), when the main goal for UCD is to design interactive systems that help users complete their tasks easily and efficiently, LCD focuses on building software that supports learners as they engage in unfamiliar activities and learn about a new subject matter. If the underlying presumption in UCD is that the users are knowledgeable and motivated about their work tasks, in the area of LCD the assumption is that the learners are novices trying to learn about a new domain through software and they aren't often motivated in the same way as experts believe. LCD does not completely depend on experience but is desirable in situations hinting slight experience. When producing interactive edutainment for any medium, LCD is the desirable approach as all product development process is being made depending on the user profile of the target group which does require a previous experience stage.

2.1.4 Target groups in edutainment design

The target group carries an important role in defining the edutainment product. If the target group is not familiar with the intended user interface, it is essential to carefully evaluate if the efforts required in learning this new user interface are clearly worth pursuit compared to using the conventional or familiar interface solutions. Understanding and using the user interface shouldn't be cognitively too difficult along with efforts relating to studying the subject.

The usage of educational material is the most important factor to consider. Subject matter is an exclusive issue in defining target groups. The subject matter decides the path to follow while designing educational contents, the broadness of the content, the medium in question as well as the main target group. Designers consider what aim the content is directed for and how the content fits different learning situations. When designing content related to edutainment, the designers need to think on supporting the amusement of users without disregarding the educative side of the content. Accordingly, edutainment designers need to be aware of what kind of local customs and target group preferences the user has in the area of entertainment consumption. The size of the target group may determine the difficulty of the creative process. It is beneficial to test the appropriateness of entertaining representation style, (verbal and visual) humor, imagery, audiovisual appearance and overall setting with the target group. The deciding stage is always a beta test period to see if the preset goals are according to the target group within the reach and performance tests.

2.1.5 Computer in edutainment

Computers have a wide range of usage in the world of today. Computer or digital, the level of interactive learning increases exponentially with the release of smart phones and tablets. This is due to two main elements; connectivity and natural interface design. Computers are used in educational administration, research, and teaching, playing the roles of both tools and targets. These different roles of computers are named as Computer-Based Education (CBE) or Computer-Based Learning (CBL).

As mentioned by Rapeepisarn et al. (2006), an early stage of using computers in education was related to the so-called programmed learning, which was a behavioristic learning method used in the 1950s. The aim of programmed learning was managing human learning under controlled conditions. In the 1970s, computer terminals were first presented in education. Back then, the focus of the educational programs was transmitting information and controlling learning. In the 1980s, Constructivism in education brought a new approach that moved learning process to the focus. The term "Constructivism" refers to the idea that learners construct knowledge for themselves, each learner individually and socially constructs meaning. In the 1990s, the use of computer education changed soundly. Most of the research relating to the use of computing and information technology in teaching began to concern the possibilities

of technology to improve social interaction between the teacher and the learner and among the learners as communicative teaching was established. The computers were integrated into various forms of learning and there was a high demand for new teaching materials and well trained teachers.

The types of eudational software in computers which carry educational purposes can be classified according to the type of interaction. There are many types of educational softwares with various contents and target groups. They can be classified in general as follows (Walldén & Soronen, 2004):

1) A tutorial teaches new things and tests whether students have learnt them.
2) A drill repeats a fixed set of questions until the learner gives a sufficient number of correct answers.
3) A simulation tries to imitate phenomena such that the learner gets a clear picture of what is happening in the real world. A subcategory of simulation is a demonstration, which does not allow the learner to affect the depicted phenomena but keep her as a passive viewer.

2.1.6 Learning through edutainment

"Learning" necessitates to be classified and segmented in order to obtain a better understanding of the term. Learning can be divided into four forms based on its context and purpose (Walldén & Soronen, 2004):

1) Formal learning : Occurs in education and training institutions, as diplomas obtained from structured educative institutions.
2) Non-formal learning : Occurs through activities of civil society organizations, unions and sport clubs and does not necessarily lead to formalized diplomas or certificates. Non-formal learning activities can also be produced by the learners themselves in work places.
3) Informal learning : Occurs through a lifelong process whereby individuals acquire attitudes, experiences, values, skills and knowledge from daily experience. All contact with others involved in everyday life is a situation to obtain learning including contact with family, neighbors, shopping, and mass media.

4) Accidental learning : Occurs in everyday activities when an individual learns something without intention or expectation.

According to Benjamin Bloom's classification, learning can be divided into cognitive (knowledge), affective (emotions), and psycho-motor (skills)(Walldén & Soronen, 2004).

Bloom's Taxonomy created in 1956 under the leadership of educational psychologist Dr. Benjamin Bloom promoted higher forms of thinking in education, such as analyzing and evaluating concepts, processes, procedures, and principles, rather than just remembering facts. It is still used during designing educational, training, and learning processes.

As the need to create an analysis depending on more than one reference point is scientifically essential, the combination of above mentioned classifications form a unity between each other and give the possibility of thinking on learning in a complex way.

Defining entertainment can be challenging because being entertained is always a personal subjective experience. In context of edutainment, it is fruitful to embrace being entertained in a wider sense. Instead of entertainment, it is more realistic to mention pleasure or a positive experience that a learner gets from using edutainment, in the case of interaction. The pleasure can result not only from the entertaining and interesting content itself. In games, it refers to the social interaction with other learners such as teamwork based applications, from the satisfaction of getting problems solved or progressing in learning. Meaningful, related and motivating material for the learners, gives way to curiosity and pleasure for the learners in their own lives.

2.1.6.1 Piaget and theories of cognitive development

Jean Piaget was arguably among the most influential experts on child development during the 20th century. His work continues to have a significant influence in developmental psychology and educational research. His views on how children learn have affected the field of interaction design. Today, Piaget is known for studying the cognitive development in children. His studies were based on his own three children and their intellectual development and came up with a theory that describes the stages children pass through during development.

Piaget (1964), believed that learning occurs through a process of adaptation, where children adapt to the environment. He perceived adaptation as an active process in which children construct knowledge structures by experiencing the world and interacting with it. The idea that children actively construct their own knowledge through experiences and that this construction is based on each individual's existing knowledge structures is referred to as constructivism. This contrasts with the view that children can simply store knowledge imparted by others and that they all perceive and learn from an experience in the same way.

Piaget (1964), cited four major factors that he thought affected development; maturation, experience, social aspects, and emotions. All four have a direct impact on how technologies for children should be designed. In the case of maturation, being aware of what most children are able to accomplish at a given age can provide interaction designers with useful guidelines. The other three factors are crucial in the design of educational technologies where children should be provided with new experiences where they can interact with others as part of activities of interest.

2.1.6.2 Factors effecting development

According to Piaget (1964), children's physical maturation limits what and how they are able to learn. As children grow up, their potential for learning increases. Piaget thought that while maturation certainly plays a role in learning, it does not guarantee that learning will occur. Rather, it limits what children can do. Hence, children's limited cognitive and motor abilities will limit their ability to interact with technologies. This view on maturation needs to be taken in context of evidence that maturation, and in particular cognitive development, is affected by the environment in which children grow. In other words, while children's maturation limits what they can do, the experiences they go through shape neural development and thus affect children's cognition.

Piaget (1964) viewed experience as a key factor in adaptation. Experiences are required for building knowledge structures. Technologies can provide unique experiences or augment them through virtual environments and simulations. Children can learn about a variety of subjects through digital libraries, as well as explore data and reach conclusions of their own through information visualization technologies. Piaget thought that social interaction played a key role in development by enabling

knowledge to be passed from one generation to the next. One important aspect of social issues in development is that the knowledge that gets passed from one generation to the next is not just information, but strategies. Piaget also highlighted the roles that motivation and emotions play in development. He suggested that children's motivations to learn are in great part due to their drive to grow, love and be loved, and declare themselves.

Papert (1980), makes a distinction between activities that are relevant to children's lives and those that children feel passionate about. He believes the latter will be much better at motivating learning. This view highlights the necessity of flexible and varied learning possibilities that provide each child the chance to discover a connection between the subject matter and their curiosity. This is an area where computers can prove a positive tool due to their flexibility in providing a variety of experiences and learning opportunities. This property manifests itself as customization in the context of computerized skillsets.

More specifically, researchers have taken into account Piaget's views on motivation when providing children with technologies that incorporate learning in entertaining ways (Papert, 1980). Games, also supporting learning, are increasingly used for teaching a variety of subjects, and are particularly popular in commercial mathematics learning software for children. Storytelling is another approach that can make learning more interesting for children.

2.1.6.3 Seymour papert approach

As mentioned by Hourcade (2007), Seymour Papert, a key figure in the genesis of the field of interaction design and children, expanded on Piaget's ideas with his proposal for constructionism. Papert (1980) proposes that Piaget's adaptation works best when children are "consciously engaged in constructing a public entity". Papert (1980) suggests that ideas have a great influence in the work on interaction design and children. This is particularly clear in terms of the emphasis of providing children with technologies with which they get to be authors, rather than experiencing worlds and situations that are pre-scripted, or absorbing facts provided by a computer. It implies that it is essential for the children to use their creativity. It also shows in the recurring emphasis of having children participate in designing the technologies that they use. As mentioned by Hourcade (2007), Papert's interest in computers for learning arises in

great part from the great variety and complexity of entities children can construct using computers, which thus provide better learning opportunities and empower a shift from learning by being told to learning by doing. Papert also sees computers as providing children with a tool that can connect their interests to subjects that children sometimes lack the motivation to learn such as mathematics. Papert sees the key to providing better learning opportunities as connecting children's interests to powerful ideas (Hourcade, 2007).

2.1.6.4 Sscaffolding as a learning process and edutainment

Scaffolding is the process of enhancing a deeper level of learning and understanding. Essentially scaffolding refers to a teacher controlling the elements during the learning process and motivating the subject of a task that may be difficult to overcome. The teacher provides different levels of support, demonstrates the problem solving process and steps back until help is required. The scope of the process is for the students to reach a higher level of comprehension (Podolefsky et al., 2013).

Scaffolding situations stimulates characteristics of a powerful learning (Veenstra et al., 2009). Scaffolding becomes active in different situations in ways such as :

1) Providing clue
2) Suggesting
3) Directing comments
4) Providing feedback and advice on performance
5) Urging reflection

Giving clear directions to reduce confusion of the learner is another characteristic of scaffolding. The learners need to be provided with directions adapt to their individual differences. Two important scaffolding strategies to keep the learner motivated are providing structure or simplifying the task.

In order to maintain the dynamics of the scaffolding situation, there needs to be an overlapping goal that explicitly guides the scaffolding actions, in function of the current level of competence or skill attained by the child (Steenbeek & Van Geert, 2006). The learner's engagement and flow needs to be stimulated in order to achieve a higher learning effect. Edutainment software designed, needs to contain scaffolding characteristics such as variety, diversity and individuality, control, challenge,

imagination, cooperation and prize. Gathering information about a child is critical in understanding the individual tendencies of the child and is critical in self improvement of the child by transmitting an evaluative judgment on progress. The assessment of performances motivates the child in trusting the scaffolding methods and creates an important self-regulation mechanism. The sofware designed for edutainment needs to be supportive, objective, stable and trustworthy. Interface learner interaction (the process of manipulating tools to complete a task by interacting with technology) is positively related to flow experience and to a positive learning effect (Veenstra et al., 2009).

It is possible to achieve powerful learning if edutainment contains a number of individually, age and socioculturally appropriate characteristics that stimulate playful learning, motivation, engagement and flow that enable for the establishment of a scaffolding interaction.

2.1.6.5 Free-choice learning

Free-Choice Learning (FCL) is learning that occurs when the individual has control over what is learned, where it is learned, with whom learning occurs. Rather than having a curriculum dictated to the individual, the learner's agenda drives and motivates the degree of learning. This means that FCL can occur anywhere anytime; art museum, zoo, science center, television or the Internet, almost any place where information is presented and the individual makes the decision to learn could qualify as a FCL environment. With the variety of information and settings, learning occurs all the time, based on the learner's own agenda and goals (Karydis, 2011).

"Non-formal" often covers program-based, group-based, or organization-based learning such as environmental education in summer programs, weekend workshops or after-school activities.

Many museums and science centers describe themselves as "informal" education outlets with their emphasis on interactive exhibits as well as increased presence in programming.

It is the informal learning that takes place in all situations that is through own volition. There are many subjects introduced by the study of Hanshumaker (2011) as referral to FCL, he describes the effects of interactive devices on visitor learning, engagement, and attitudes.

2.1.7 Learning environment and edutainment

The spaces used in contemporary social activities as gathering venues are mainly designed for service purposes such as exhibition halls, malls, concert halls etc. Most of these spaces have multiple functions as content and scope. For instance, a convention center simultaneously may host an exhibition, a fashion show, a charity event and carry other functions. Awareness of purpose needs to be taken into consideration during the design process of creating a powerful learning environment.

The characteristics of a powerful edutainment software that contributes to learning one or more specific skills in an environment with the purpose of learning should have characteristics designed specifically for the hosting area. As the content of an environment is what causes an attraction, the input needs to be configured through the consideration of the targeted audience. In an environment designed especially for an exhibit, the concept and the content of the exhibit define the communicative, spatial and technological aspects of the final setting.

Designing powerful environments is a powerful means of learning (Veenstra et al., 2009). According to Bétrancourt et al. (2003), a powerful learning environment generates high learning gains for its users. Learners in powerful learning environments are encouraged to construct their own knowledge, learn in realistic situations and to learn together with others.

There are various slightly different definitions of powerful learning environments, but the common interpretation is that powerful learning environments promote active and constructive learning and present collaborative activities as defined by De Jong & Pieters (2006).

In powerful learning environments children can make decisions and are allowed to take initiative in learning. They can make choices which can be explored or manipulated (Gillespie, 2004). The instructional design is aimed at integrated sets of learning goals (De Corte et al., 2003). The main goal of powerful learning environments is to learn through practice by improving one or more skills of a child on a particular developmental domain. Instruction needs to be fully aligned with individual differences and human cognitive architecture (e.g. the limited processing capacity of the human mind (De Corte et al., 2003)). And the learners' capacities are enhanced or the learners' cognitive capacities are 'stretched' through specific types of

support which facilitates knowledge acquisition or practice of one or more skills (Linn et al., 2004; Quintana, et al., 2004).

In this context, engagement can be defined as an energetic arrangement as an outcome of a powerful learning environment while flow can be defined as the psychological state of a child that emerges in the same environment. As mentioned by Veenstra et al. (2009), powerful learning environments are based on what is known of child developmental theories; they are age appropriate, individually appropriate; they should take an eclectic view of learning (people learn in different ways) and also be socioculturally appropriate (De Corte et al., 2003; Bredekamp & Copple, 1997). As a conclusion, a powerful learning environment is an environment in which active and constructive learning are promoted and regulated with respective diversities by playful learning.

2.1.8 Game based learning in edutainment

Software designers often emphasize the story in edutainment games. Compared to classical games, development of graphic and audiovisual expression in educational computer games has been slower as edutainment follows a different set of rules in design. This was the tricky part as the role of the player is confined to making a few choices during the story that proceeds independently. Another problem in some edutainment games is the fact that the learner can advance through the game by "trial-and-error" style without any great mental effort. This is the case when players play automatically by guessing and clicking between alternatives without reasoning, without absorbing new information or solving problems. Depending on the level of interaction between the game and the player, the motivation of the player increases or decreases as the player feels only having a superficial effect on the game. The computer games designed for educational purposes generate high level of motivation and intensity based on strong interactivity they create. Education and gaming have common properties as both present content and require user interaction. The interaction methods randomly differ but the gap regarding the relationship of the two terms has been breached by edutainment. Games have a special way of involving the user created concentration and motivation almost automatically. Concentration is the key to success in transmitting the educative content and with the unique attributes of gaming, a whole new concept takes form in education. Edutainment applications being

introduced in the form of a game could be divided into following three types (Walldén & Soronen, 2004):

1) Learning as a result of tasks stimulated by the content of the games. The use of games as a stimulus to associated work was mainly restricted to primary schools. But, for example, games with simulations corresponding to real world phenomena can be a starting point for general discussion. Games could be a better stimulus for learning, if teachers were more aware of the importance of games in pupils' lives, and willing to have children contribute their expertise in these areas to the learning activity.

2) Knowledge developed through the content of the game. Games vary as to the amount of content they contain which is of direct relevance to the school curriculum, but the amount is generally low. Even where the context seems to be relevant to curriculum content, its contribution to the child's learning may be very peripheral. The best game type seemed to be simulations. Problems in using games include lack of time to play a game, and illogical and too concise content.

3) Skills arising as a result of playing the game. This last type of learning can be subdivided into direct and indirect learning. Skills developed by the games were dependent on pupils' age but generally they were supposed to develop personal and social skills, cognitive skills (problem solving, deductive reasoning etc.) and knowledge of the content.

Games are mostly used in informal education rather than formal education. It is possible to divide educational games into several subclasses (Walldén & Soronen, 2004):

1) Maze, level and problem games. Timing is often critical with heavy reliance on motor-skills, memory and planning.
2) Adventure games.
3) Role-playing games (RPG) for example Warcraft.
4) Simulation games, which imitate the real world situations, for example The Sims.
5) Strategy games for example AOE.
6) Shooting/arcade games where usually moving objects are fired and destroyed. These develop fast hand to eye co-ordination for example COD.

7) Traditional games, in which the player usually plays against a computer player, like in chess or solitaire.

Many studies claim that games are proved to improve learners' motivation, concentration and reflexes. Typical problems considered during the design process are usability of the programs, user model, user's workflow, and personalization. In formal education where educational software is used, the teaching factors are controlled and the users are considered similar individuals as representatives of a larger group of users.

In the area of computer edutainment, a significant part of the software is aimed at children. In children's computer edutainment, a general way to implement entertaining content is to use characters that are meant to be fun. In educational software they are usually animated creatures that are comic like assistants of the user or occasional comic characters or even essential characters in the story. A typical way to use characters in children's edutainment is to choose animals that have many human features. The characters can also be used as guides who give feedback about the learner's progression which promotes scaffolding.

In adult learners, the strength of digital edutainment is the power to present many viewpoints and approaches to the same subject. It is difficult to name specific entertainment features that are typical in adults' edutainment software because they depend so much on the educational content in question, the venue and the concept of the location. As a result, the style of audio visual expression is usually more realistic and the narration is based more on audio and text than on visual narration. For instance, if the interface and visual attributes of a software is too simple, the adult learners do not take the content serious thinking that it may be unreliable, so the feeling of an application needs to be well thought of in the design process.

2.1.9 Ludic value and edutainment

The term is defined as showing spontaneous and undirected playfulness as in French word 'ludique' and covers a wide range of creative and exploratory activities. Ludic value does not simply mean playing, but includes mental creation activities like meditation, composing music and writing literature as mentioned by Nam & Kim (2011). Numerous researches and case studies have been conducted on the theories, methods and techniques regarding fun, pleasure and enjoyment in design. They bring

not only functional benefits, but also emotional ones. Pleasure is a deeper form of enjoyment achieved when people are devoted to an object or activity. It happens when people try to make sense of themselves, exploring and nourishing their identities.

Ludic activities have been studied in the area of play, User Experience Design (UXD), culture and content theories (Nam & Kim ,2011). Ludic activities cover a wide range of creative, exploratory, self-motivated actions and seek to obtain enjoyment, fun, or refreshment of one's feelings as mentioned by Gaver et al. (2007). Although ludic activities can be highly related to playfulness, they are differentiated from game play which tends to follow a set of arbitrary rules and has a sense of competitiveness. The ludic value of a product can trigger impulsed activities. Inspired by the concept of ludic activities as suggested by Gaver et al. (2007), two aspects - which are fundamental to increasing the ludic value of a product can be identified; openness and engagement.

Openness is the aspect of the product that enables users' free interpretation and exploration of an object or situation. It allows self motivated interpretation while interacting with a product. According to play theory, people can be satisfied by the mental activity of discharging energy without a specific purpose. Ambiguity is often considered as a means to support the openness aspect of the ludic value as proposed by Gaver et al. (2007).

In contrast to the purpose of optimization for functionality, it allows people to act for the sake of an activity itself rather than a predefined purpose. It is expected that users find ludic value by reinterpreting the meaning and value of an activity related to the use of a product. Ludic value can stimulate a person's curiosity through inspiring a user's imagination about various and exciting possibilities of use.

Engagement is another attribute that is greatly related to ludic value of a product. Humans can reach an enjoyment stage in usage by concentrating and participating in specific situations. Engagement is also related to the state of flow as in the mental state of operation in which the person is fully immersed in what he or she is doing (Csikszentmihalyi, 1998). Energized focus, full involvement, and success in the process of the activity characterize the feeling. From a design point of view, specifically engagement can be obtained from participating actively in a process through interaction with a product.

Ludic value is related to the concept of fun, pleasure and enjoyment. The definition of ludic value is highly related to the concept of ludic engagement suggested by Gaver et al. (2007). Ludic value of a product can trigger creative, explorative, self- motivated experiences and is different from the play in games. Adding features of open interpretation and self motivated engagement in digital products. openness and engagement are the fundamental parameters of ludic value aids in achieving value.

2.1.10 Challenges for edutainment design

Aquariums and museums host exhibitions in order to transmit specific information to their visitors. In the context of the aquarium, this is achieved by combining exhibits and information in a carefully designed systematic order and presentation style. New technologies such as multimedia, GR, 3D graphics and VR can be used to enhance the presentation, offering a more eloquent and enjoyable experience. A number of venues make use of images, interactivity, sounds and video aiming to complement existing presentations and to create a memorable exhibition. During the past years, the public spaces have shifted in communication styles from simple exhibitors of objects to educative and entertaining institutions. Interactive products allow their visitors, usually children, to interact with exhibits and to learn while they play. However, these type of exhibitions, need to be carefully planned to maintain the interest. Visitor's physical presence is the key to success for the interactive exhibits organized by public spaces as home usage of interactive exhibit applications cannot be compared to the one gained at the museum.

According to Vassilakis & Lepouras (2004), there are some factors to consider in designing the exhibits :

1) Exhibit selection, museum curators select the most appropriate exhibits, taking into account the exhibit significance, the message that the museum needs to communicate and the profile of the visitors.

2) Exhibition space design, the exhibition space is usually comprised of halls, foyers and corridors. The exhibition space needs be appropriate for the exhibits selected, while its structure may allow for different levels of movement freedom; linear hall sequences direct visitors through a predetermined path, while foyers with entrances to different wings permit a more flexible choice of route within the museum.

3) Selection of presentation methods, for each exhibit, the most prominent presentation methods are chosen. This may include any combination of 2D photos, 3D photos, audio, video, 3D models, textual descriptions, etc.

4) Interaction design should be chosen depending on the content.

5) Exhibit digitization, once the presentation and interaction requirements for each exhibit have been determined, digital representations for each exhibit are created.

6) Placement of exhibits within the exhibition space, is the phase in which the digital representations of the exhibits are placed in appropriate locations within the exhibition space.

7) Interaction programming is the step of which necessary actions for delivering the specified interaction capabilities are performed. These actions may range from simply defining hotspots or animation sequences to writing complex, custom code, depending on the desired interaction capabilities and the facilities offered by the development environment.

Designing successful edutainment material is a demanding task. Insufficient structuring and incoherence of the content and lack of pedagogical approach may create problems of digital learning material. Based on the study made by Lepouras & Vassilakis (2004), a recent criteria for evaluating digital learning material from pedagogical perspective have been developed. They include eleven factors which are learnability, graphic appearance and layout, technical requirements, intuitive efficiency, suitability for different learners and different situations, ease of use; technical and pedagogical approach, interactivity, objectiveness, sociality, motivation and added value for teaching.

These factors connect and affect each other and often overlap. In reference to goal-orientation of the material, the most central criterias in the pedagogical sense can be seen as motivation, efficiency, and objectiveness. Digital learning material should awaken, direct and keep the interest of learners as motivation is essential in self directed learning. Horila et al. (2002), state that efficiency also relates to the willingness to use material. If the material is felt efficient, the willingness to use the material again is high. Efficiency involves the feedback about the progress of the learner. Both teaching and learning phases need to be done with objectivity.

Objectivity of the designer is an essentiality for the goal orientation of the digital learning material. Especially in edutainment material, the objectives are not often as clearly explicated as in traditional digital learning material.

The usability in the sense of ease-of-use is an interesting question within educational software. The dilemma is that the products should be usable enough not to frustrate learners, but shouldn't be so easy to use that would prevent the completion of tasks without strong engagement.

The usability of the product should be evaluated according to the educational goals of the product. When discussing educational digital games, the discrepancy between the traditional usability criteria and objectives of products become even clearer. The learnability of the user interface is an important matter in providing the necessary experience as an outcome of games. Learning related to playing is the initial process in which children obtained different kinds of knowledge even though edutainment existed in many forms before the usage in public spaces as digital content serving applications. Learning through playing has been around for a much longer timeline. Children have been playing different role playing games even times before the invention of communication. Edutainment teaches the content and entertains the setting off the cognitive properties almost the same way as learn-through-play. As mentioned by Rapeepisarn et al. (2006), both terms have some similarities and can be classified according to the relation of characteristics and similarities as :

1) General Concepts : Amusing activities and learning at the same time, effective teaching strategy, key facilitator for learning, a way of thinking and intuitive of metaphorical mind and dynamic, active, constructive behavior.
2) Activities During Interaction : Explore, imagine, discuss, construct, plan, manipulate, problem-solving, use logic, critical thinking, visualize, discover, create, experiment.
3) Foundation Skills : Memory, self regulation, symbolic perception, coordination, social skills, abstract thinking, imagination.

The unique effectiveness of edutainment can be classified as listed below (Rapeepisarn et al., 2006):

1) Social Behavior : Companionship, self control, cooperative, sharing, negotiate, solve.

2) Cognitive Development : Memory, creativity, divergent thinking, extending math skill reasoning.

3) Intellectual Development : Resolving problems, devising strategies, understand how things work.

2.2 Concepts In Design Related To Edutainment

Edutainment includes and connects many disciplines and methods related to technology. The connectivity that edutainment provides occurs according to the context and content. The combination of multiple disciplines come together in producing edutainment. Edutainment is a creative process as well as a systematic one. While creating an edutainment concept, various design disciplines and technology-based methods need to intersect. As previously mentioned, the outcomes of the design disciplines align to merge and form unison. The same approach is valid regarding the technology-based methods. Even though design disciplines have many in aspects in common, they also tend to have fundamental differences from each other. To bridge this gap, edutainment is the necessary element in order to obtain a common, unique, exclusive outcome. Technology may vary depending on industrial, financial and productional differences. Edutainment unites the different elements essential in producing a unique product, merging them to serve its purpose. By assigning the necessary qualities in techology-driven methods, edutainment produces a design and technology-oriented product. Interaction design is a term long used in literature related to the contact between classical design and computer-based design. The activity of human element in computer sciences has led to the development of HCI. In this chapter, the study focuses on the techonology-driven aspects of edutainment. HCI, interaction design and product related HCI provide the necessary compound for producing the interactive products mentioned in the study. The chapter mentions the effects of the previously mentioned terms in relation to learning and knowledge creation methods and HCI in edutainment.

2.2.1 Human computer interaction in edutainment

In the early 20th century Raymond Lowey, Peter Behrens and others began the Industrial Design (ID) movement. The design and implementation of mechanical

products were thus separated from each other. The role of the industrial designer has historically been one of the form giving, designing a shell for an object to reside within.

John Arnold in 1958 created a program in response to ID called Product Design (PD). PD was an engineering-centered design discipline with foundations in mechanical engineering. Designers are interdisciplinary designers with an expertise devoted to finding mechanical solutions to the needs of people. Just as a computer scientist will find software needs for a computational problem, a product designer uses his or her understanding of physical apparatuses to address observed needs. Industrial designers with programming capabilities work with or as interaction designer to create aesthetics that complement the intended usage of a product.

The interaction designer is not so much concerned with form giving as deciding how the aesthetic of a product affects its perception. A central concern of interaction design is to develop interactive products that are usable. What is usually meant by this is that these products are easy to learn, effective to use, and provide an enjoyable user experience. The products can differ radically in their usability. Especially in aquarium projects that are complicated and time consuming, the stages of design needs to be carefully planned and scheduled.

The progress of the conceptual design and the design management process need to be done in accordance to the UXD as it consists of a mixture of various disciplines of design and the success of this phase defines the final product may it be an edutainment concept or an interactive device. Envis Precisly (2013), an interactive design company has defined the disciplines of UXD as in Figure 2.1.

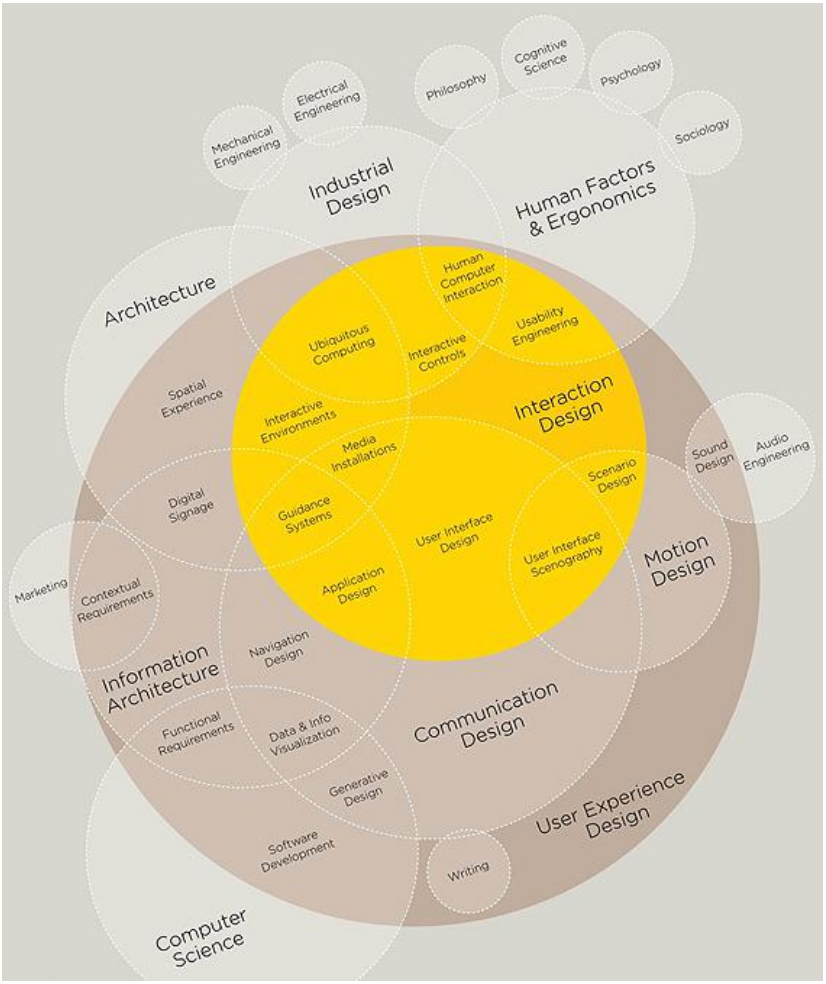

Figure 2.1. Disciplines of UXD (Envis Precisely, 2013)

Interaction design is a multidisciplinary subject bordering to areas like PD, ID, software design and cognitive science. It deals with the design of actions between humans, software and technology, together with all the other materials that build the things that are used. This includes any kind of product containing software, a computer supported tool, interactive products designed for public spaces, a smart phone, the interface between the driver of a car or the complex software that serves as aid. For designing actual products or interfaces, social and cultural aspects needs to be taken into account as the interaction designer is highly concerned with the interaction provided by the product. Interaction designer does not only consider what happens when one user uses the product/interface, but what happens if many users use it; and how this can affect users, society and culture. When comparing the industrial designer and the interaction designer, the latter deals with the interaction with objects that can have some kind of complex interaction behavior, due to their embedded software.

The scope of interaction design can be listed as :

1) To adapt to situations by devising and implementing a designed artifact.
2) To explore all possibilities.
3) Evaluating design.
4) Presenting solutions from a non-engineering perspective.
5) Creating intentional and tangible representations.
6) Incorporating instrumental, technical, ethical and aesthetical aspects.

Usability is one of the most important properties in designing products in ID and interaction design. Both disciplines aim to design products that are fun, entertaining, beautiful, puzzling rather than just usefulness in a strict sense. The interaction designer's goal is to create an interactive object that stimulates the user and the context by use in the intended way.

Hardware is the essential component to run any kind of software and interface components such as sensors and keyboards to interact with human users and present the result of the software data. However, as computational technology becomes embedded in almost everything around and the interface components vary greatly, it is seen essential that the students also familiarize themselves with alternative means of interaction with computational systems. In this sense, it is similar to product or ID, with the major difference that it primarily work with the interactive components (software, algorithms) and their physical extensions (sensors, actuators) and give a physical form to the service it provides through PD.

The designer has a different approach to the world, works with people, materials, products and are perceived as people concerned with form, function and texture. Programming is as a creative activity as drawing and designing. Deriving from experiences from the discipline of interaction design, a hybrid approach to interaction design thinking has led to the birth of new designer profile of which programming has become a part of design. In other words designers have the capability of designing through programming, dealing with computational technology as any other design material and becoming designers in a digital environment. The method proposed by Lundgren et al. (2006) to create an education in applied interaction design lends ideas

from traditional design education, but also incorporates high-fidelity prototyping and multidisciplinary projects carried out by heterogeneous groups.

Human experience design is a combination of the relationship among PD, interaction design and user interface design. The aim is to develop usable products which respond to various needs. The products need to have certain attributes in order to fulfil their reason of existence especially in case of useability. Usability in this context means easy to learn, effective to use and provide an enjoyable experience. In developing any product which is almost always tailor made to a specific place or situation, the design team needs to involve users in the design phases in certain stages of the process to be able to understand the real use of technology from a user perspective. Human interaction design is a union of several design disciplines. This refers to the fact that whoever hopes to create a synthesis needs to master all disciplines at least at a certain degree. Apart from being able to manipulate the disciplines, the designer should also comprehend their behavior in relation to each other adjusting at the right quantity. It is essential to focus on the disciplines at hand from an interaction designer point of view. Compared to UXD, human experience design is a more brief version, focusing on the relation among interior design, architecture, PD, interaction design and user interface design. The Figure 2.2 below shows the relation of the above mentioned disciplines.

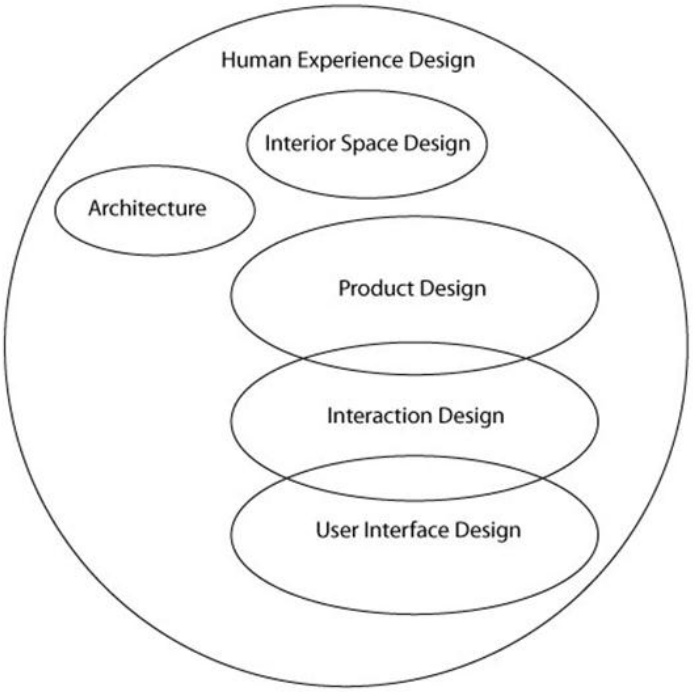

Figure 2.2. Disciplines of Human Experience

2.2.1.1 Elements of design and complexity

According to Hourcade (2007), visual design consists of several elements which form the graphic user interface. The user reaches data by the aid of the interface designed in a way that helps the user in finding, selecting and observing the information introduced. In order to provide more detailed information, one needs to focus on the graphic elements the user interacts through the Piaget point of view. High visual complexity can overwhelm any user, let alone children who cannot process visual information as quickly as adults. One way of dealing with visual complexity is to use multilayer strategies where children are first presented with few actions and objects and as they become proficient with these, they can move on to add other actions and objects to the user interface. Apart from introducing the primary educative content, creating a software that teaches its own usage with hint or help functions can guarantee the efficiency of the system. Graphic design is the mirror in which a software can be perceived by means of interface design aspects of a product. Graphic Design has widespread foundations in print and digital media. It may help to think of Graphic Design as the reflection of ID for software. Graphic design has its history date back much farther than software design. Therefore, the graphic designer will be able to help the user interface designer create an aesthetic for a product's digital component, similar to the way in which an ID would shape the form of a product's physical manifestation. Interaction design, as with most design disciplines, is not entirely self-contained. It overlaps with PD and graphic design in the form of UI design because it deals with the larger issue of human experience design.

The most important consistency is consistency with user expectations. As suggested by Guan & Tay (2007), within an interface, a user needs to be able to quickly identify a logical, rational pattern of relationships between user actions and effects. A pattern refers to the relationship between actions computed by the user and its effects on the system. Design patterns should be consistent within borders of the interface and the system performance. To reinforce the pattern, a user needs to be able to depend on an acceptable level of consistency. Consistency does not refer to monotony, a process always proceeding in the same exact manner. It is doable to design a rational evolution of relationships between user actions and effects throughout the interface experience. The actions and effects may vary in logical ways as the content changes. From visual

form to motion, and the connections of these to content types, a user should find a logical consistency of all aspects of interaction.

Well thought interface design is based on human logic and cognition. Users with average cognitive abilities will recognize the patterns and their meanings when patterns are consistently and rationally connected to actions and content. Internal consistency is important because each interface creates a world that is distinct, though not isolated, from its immediate context. Consistency aids learning and keeps the learning curve short. Comprehensiveness builds a sense of reliability and keeps users from wondering whether different forms, words, situations, and actions mean the same thing.

Icons

Visual means of interacting with user interfaces are crucial to the success of software. Often a user may observe problems with textual interfaces. Just as in the case of icons for adults, icons for children should be designed so they represent actions or objects in a recognizable manner. The icons for children need to be easily distinguishable from each other, can be recognized as interactive and separate from the background, and have no more visual complexity than that required to accomplish the previous requirements. Icons should also be sized so that children can easily click on them. In case of adults the icons should clearly define the function the interaction refers to. A good icon design may aesthetically and functionally enhance the software and the interface.

Text

The use of text should be done according to the target group preferably using larger font size for children and smaller for adults. Text exceptions can be made for software that has reading or writing as a goal. Some adults may have difficulty in reading due to health issues, so the interface should be designed very carefully taking every kind of user in consideration. The fonts transmitting an emotion may it be comfort or casuality, transpires a feeling to the reader instantly which is supported by the content of the text. Headlines, the main body, using italic or bold have a significance in sense of design which is complementary to the interface.

Menus And Direct Manipulation

As discussed by Hourcade (2007), Shneiderman (1998), mentions three ideas behind the concept of direct manipulation : visibility of objects and actions of interest; rapid, reversible, incremental actions; and a replacement of typed commands by pointing actions on objects of interest. Most software for children nowadays attempt to follow the ideas behind direct manipulation.

Children experience menus are sets of choices in softwares. Rapid actions are very important in children's user interfaces because children will often be less patient than adults when using software. Children need quick feedback, and if they do not get it, they are likely to move to another activity. The problems emerge when these choices are not immediately visible, and arranged in pull-down menus or other types of interactive structures. The menus need to be designed enabling the user to interact and receive response without getting lost in navigation.

Reversibility of actions is also quite important for children to encourage the exploration of technologies while keeping the children in control. If deducting a function leads children to lose a drawing they worked on, it will lead to a great deal of frustration and likely will lead the children to quit using the technology unless they can reverse the action. Making actions incremental can also help children by avoiding the need for them to formulate complex instructions. Paired with timely and informative feedback, this can help children accomplish complex tasks.

Use Of Sound

Traditionally, evaluations of technology have focused on instrumental aspects of interactive systems, predominantly the concepts of usefulness and usability (Mahlke & Lindgaard, 2007). Non-instrumental qualities on the other hand can be described as quality aspects that address user needs that go beyond tasks, goals and their efficient achievement. Especially the perception of instrumental qualities was shown to have an impact on the users' emotional reactions (subjective feelings as well as cognitive appraisals). Sound is a parameter which should be placed according to the content. Some products support the use of instrumental qualities in order to enhance the communication of the content the interactive product provides. Sound can be very simple or very complex from a wav file to a mp3 file enriching the perception.

Interactive products supported by the use of sound provide an enhanced experience. The users feel the drama of the content in a stronger manner once sound is involved.

Storytelling

Supporting storytelling has been a popular theme in technologies that support creativity. Storytelling has played an important role for humanity as a way of transferring and retaining information, with oral traditions being an example. It is easier to remember sets of facts if they are put together in a story, than if they are in a list. In this way, storytelling also helps children develop communication skills. Technology can play a positive role in storytelling by allowing for storage, the ability to copy, share, and edit stories. It can also provide the means to create non-traditional forms such as non-linear stories.

Storytelling has been conducted with help from programming environments. Some computer games now allow users to program their own characters, settings, and plots. Children who are involved in storytelling through the construction of games are highly motivated by being able to design their own characters and put together plots which greatly supports scaffolding.

In case of aquariums, traditional storytelling items have been :

1) Signs and text labels, spread across the exhibit space.
2) Exhibit catalogues, typically sold at the aquarium store.
3) Guided tours, offered to groups or individuals.
4) Audio tours, and more recently video or multimedia kiosks with background information on the displayed objects.

Each of these storytelling aids has advantages and disadvantages. Catalogues are usually attractive and well done, yet they often too are cumbersome to carry around during the visit as a means to offer guidance and explanations. Guided tours take away from visitors the choice of what they wish to see and for how long. They can be highly disruptive for the surrounding visitors, and their effectiveness strictly depends on the knowledge, competence, and skills of the guide. Interactive products placed in a public space in order to provide content under the light of edutainment benefits from multimedia methods in transmitting information using a storyline.

Simulations

Computers can provide children with learning opportunities not otherwise available by taking them to places and situations they would otherwise not be able to experience. That is the motivation behind providing children with access to simulations.

As mentioned by Hourcade (2007), VR has been used to create learning environments in which play is used for learning. Moher et al. (1999), used immersive virtual environments to teach third grade children that the Earth is round. They found that children not only needed to find the environments plausible, but activities were required to bridge knowledge gained while experiencing the simulation to the target domain. Moher et al. (1999), then moved his concentration to classroom based simulations that no longer use virtual environments. Instead, a simulation is scaled in time and space to fit within a classroom and its activities. These simulations called embedded phenomena work by providing children with displays to monitor phenomena. The simulations run continuously over weeks or months enabling children to monitor events and conduct scientific inquiries in a convenient setting.

As simulations in the aquarium, virtual habitat is an application which simulates the movement of fish in their habitat. Underwater observatory also houses an interactive product simulating the depths of the sea creatures for the visitors to observe.

2.2.1.2 Products and HCI

The relationship between ID and interaction design has led to an emerging new approach called "Interactive Product Design". ID is a profession that grew up in the 20th century to shape manufactured products. It was a response to the design freedom provided by modern materials and manufacturing processes – especially plastics. With plastic, a product could take on almost any shape, color and pattern. It could mimic metal or wood, looks sleek or substantial or reveals or hides. Interaction design plays an essential role in new product development. As the boundaries of computer, communication, and consumer electronic are blurring, the shift suggests exciting new possibilities but also poses new challenges in design education and practice. The main focus falls on incorporating interaction design into the ID process for improving professional skills of industrial designers and makes way for a new thinking in design education and practice.

Interaction design is a profession that will keep on maturing in the 21st century. According to Verplank (2003), the central concern is how to design for people – for their physical and emotional needs and specifically for their intellect. With computers, it is possible to make products take on almost any behavior. The response to human input can be delayed or repeated (mappings). From moment to moment, products can change how they respond (modes). With networks, the notion of a stand-alone product is obsolete. The effect of actions may be local or remote (Verplank, 2003).

Design is the language which is reshaped by all according to a necessity, idea, creativity or hunch (Verplank, 2003). Technological advancements are changing the appearances of products and the services they provide. The shifting nature of products will in turn fundamentally transform the process of developing products. In other words, the user interface expected to fulfil user anticipations will be designed first, followed by the construction of the core hardware or software used to support the functions. This shift will convert the product development process into an interdisciplinary, concurrent design approach. While the domains of the related disciplines are being redefined, industrial designers need to think about how should the field be defined as it evolves further. Today, ID means something more than simply dealing with the physical properties of objects, just form, color, texture, etc. It needs to go further to take into account the interactive system, the operational logic and path, and new user-interaction possibilities that meet user expectations. The aim is to create a friendly and pleasurable experience for the user by creating recognizable links between the content of the product and the user's comprehension.

2.2.2 Interaction design in edutainment

Cybernetics is the science of purpose which permits the formal modeling and system regulation in intricate situations such as decision making, conversations and computer oriented associations. As mentioned by Ashby (1956), cybernetics is likely to reveal a great number of interesting and suggestive parallelisms between machine, brain and society. Cybernetics can provide the common language by which discoveries in one branch can readily be made use of in the others. Defining the value added by cybernetics as a "Common Language" may be the link of mankind to the future allowing the younger generations to use common terms in communication. The communication referred to is not an oral one but a uniting language in the age of

communication and technology. Children are increasingly using computer technologies and are given the greater exposure to these technologies. It is compulsory that interactive products should be designed taking into account children's abilities, interests, and developmental needs. The content being served by the interactive products contribute toward the goal of enhancing knowledge through the children's cognitive and motor development skills. To understand children's developmental needs, it is important to be aware of the factors that affect children's intellectual development. There are many theories in relevance to development of constructivist, socio-cultural, and other modern theories with respect to the technology oriented design for children. In HCI developing process, examining the significance of research on children's cognitive development in terms of perception, memory, symbolic representation, problem solving and language is essential since interacting with technologies most often involves children as a point of reference in edutaintment. Children's fine motor development including manipulation and reaching movements are skills that are important in aiding children's development. The design process focuses on the effects of technology which can negatively affect children's physical, intellectual, social, emotional, and moral development. According to Hourcade (2007), the focus needs to be on the design methodologies for children's technologies organized based on the roles children play during the design process including a description of cooperative inquiry and informant design methods. The process of design is based on design principles related to visual design such as icons, visual complexity, interaction styles such as menus, and the use of input devices like touch screen interactions or mouse buttons. There also needs to be an emphasis on issues such as supporting creativity and problem solving, supporting collaboration and communication, accessing, gathering and exploring content, learning from simulations, supporting children with special needs, interacting with intelligent characters, supporting healthy lifestyles, learning skills, mobile, tangible, and ubiquitous computing, and designing and evaluating technologies.

2.2.2.1 Interaction design; form vs function

Cybernetics provides the essential models for the transfer of information by regulating the reactions in systems such as mechanical, biological, cognitive and social. It is believed that Plato was the first who mentioned the term. The approach introduced by cybernetics has been used in regulatory systems exploring their structures, constraints,

and possibilities. The invention of computers has been a breakthrough in the science of cybernetics. In the early 1980s, Bill Moggridge began working on technology devices that combined software and hardware systems. The company designed the first laptop, that prompted Bill to search for a name that encapsulated the idea of designing devices that include software and hardware. First referred to as Softface design, Moggridge later came up with the term "Interaction Design".

Currently, interaction designers are employed by Moggridge's new company, IDEO Product Development (after a merger with David Kelley Design), to work on devices such as e-books that download digital books into a physical device for browsing. The interaction designer's role is enigmatic and differs from company to company. A fresh developing field, the role of the interaction designer in a product cycle, still being defined.

Just as difficult as with the designer, the product definions have changed. The process of defining a pro6duct has become more problematic recently as many disciplines started merging. According to an approach by Manzari (1999), form follows function has become a cliché contemporary time, but it will quickly give way to form follows purpose as the function of an object becomes increasingly less tangible. The conjunction of software and hardware creates a blurred distinction between the ID world of form and function and the user interface world of icons and metaphors. The intended role of the designer is to provide solutions to problems by designing products which prodive function beyond form.

2.2.2.2 Sensorial, information and interaction design

Interaction and sensorial design allow the product to be filtered for usability from a lens of multiple design disciplines. To be able to reach an effective content, the integration of interaction, information and sensorial design needs to be developed respectively. According the Figure 2.3, Shedroff (1994), content based design is the combination of three design disciplines.

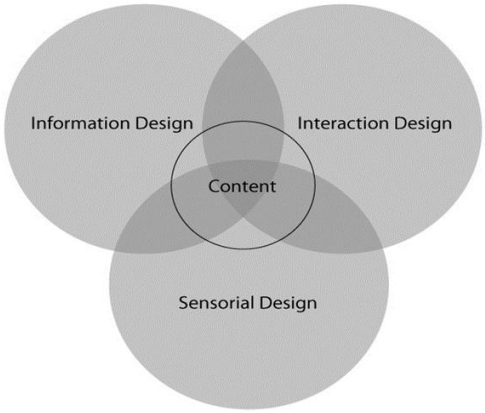

Figure 2.3. Content based design (Shedroff, 1994)

The kinship among the design disciplines enables the designer to create a new generation of products of which are the perfect combination of a whole new approach. This gives the opportunity to think and create what has not been done before as a result of design thinking and technology. The bonding of the disciplines carries an important role in the concept development stage during the classification of the process where the relationship of the terms needs to be defined. Shedroff (1994), has defined all these terms placing them in accordance to their functions, communication and design objectives, stating that ınformation ınteraction design is the intersection of the disciplines of ınformation design, ınteraction design, and sensorial design. Information design's roots are in publishing and graphic design, although few people in these industries intentionally practice them. Information design addresses the organization and presentation of data ; its transformation into valuable, meaningful information. The creation of information has only recently been identified as a discipline with proven processes that can be employed or taught.

Information design does not replace graphic design and other visual disciplines, but is the structure through which these capabilities are expressed.

Interaction design, which is essentially story telling and creating, is at once both an ancient art and a new technology. Media have always effected the telling of stories and the creation of experiences, but currently new media offer capabilities and opportunities not yet addressed in the history of interaction and performance. In particular, the demands of interactivity are often misunderstood by all but the most experienced storytellers and performers. This is new territory that is seeking some new

ideas and logical explanations which is also the most critical component to the success of interactive products.

Sensorial design is the employment of all techniques of communication through senses. After writing, visual design techniques in disciplines such as graphic design, videography, cinematography, typography, illustration, and photography are usually the first to be recognized and employed, but the disciplines that communicate through other senses are just as important. Sound design and engineering and musical and vocal performance are also useful in the appropriate circumstances. In fact, sometimes they are the only appropriate media for communicating a particular message. Tactile, olfactory, and kinesthetic senses are rarely employed (often due to technological or market constraints), but are just as valid and can add enriching detail to an experience.

Sensorial Design involves everything related to perception in terms of the stimuli the world produces and transmits. It is an all-encompassing category over those disciplines involved with the creation and presentation of media. Among other disciplines, sensorial design includes writing, graphic design, iconography, map making, calligraphy, typography, illustration, and graphics; photography, animation, and images; and sound design, singing, and music, sound. Each of these disciplines have deep traditions and detailed procedures, in many ways, they all share some common attributes and concerns. These include the appropriate use of media, style, technique, media literacy, and bandwidth applicable to the technology of the situation, as well as an understanding of the human senses. As shown in Figure 2.4, Shedroff (1994), creates a visual explaining the relation among the senses and their connection in determining the skill sets related to abilities.

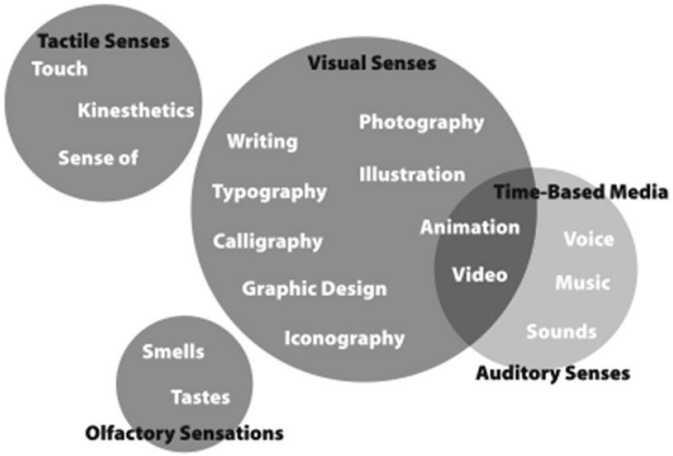

Figure 2.4. Sensorial design & senses (Shedroff, 1994)

2.2.2.3 Interaction design as an experience

The goals of designing interactive products to be fun, enjoyable, pleasurable, aesthetically pleasing are concerned primarily with the user experience. It is important how the interaction with the system feels like to the user. This involves explicating the nature of the user experience in subjective terms. User experience goals differ from the more objective usability goals in that they are concerned with how users experience an interactive product from their perspective, rather than assessing how useful or productive a system is from its own perspective.

Major work that has been done on enjoyment and fun has been carried out in the entertainment and games computer industry, which guarantees the interest in understanding the role of pleasure in considerable detail. Alben & Fellow (1997), mentions aspects that have been described as contributing to pleasure in considerable detail that include attention, pace, play, interactivity, conscious and un conscious control, engagement and style of narrative.

Interaction design is concerned with designing interactive products to support people in their everyday and working lives. Alben & Fellow (1997), posits human experience instead of technology as the core of interactive design referring to the emotional and sentimental values essential while creating an interaction design product. Alben & Fellow (1997), quote "Are their experiences successful and satisfying? By experience, I mean all the aspects of how people interact with something—how well they understand how it works; the way it feels in their hands; how they feel about it while they are using it; how well it serves their purposes; the way it fits into the context in which they are using it; and how well it contributes to the quality of their lives. If these experiences are engaging and productive, then people value them. This is quality of experience."

With developing technology, the expectation regarding the service the interactive products are bound to offer, has increased and brings the experience and usability issues under the spotlight. The realization that new technologies that bring new opportunities for supporting people in their everyday lives has led researchers and practitioners to consider further goals. The emergence of technologies such as VR in a diversity of application areas has brought about much wider set of concerns. Interaction design aims to the creation of systems with the following attributes which

focus primarily on efficiency and productivity that can be listed as satisfying, fun, helpful, aesthetically pleasing, rewarding, enjoyable, entertaining, motivating, supportive of creativity and emotionally fulfilling (Rogers et al., 2002).

Usability goals are fundamental to interaction design and are put to use through specific criteria. Rogers et al. (2002), examines the usability and user experience goals as shown in Figure 2.5. Usability goals can be related to emotions and experience. The inner ring focuses on the usability factors meanwhile the outer ring presents the possible experience goals gained by the user.

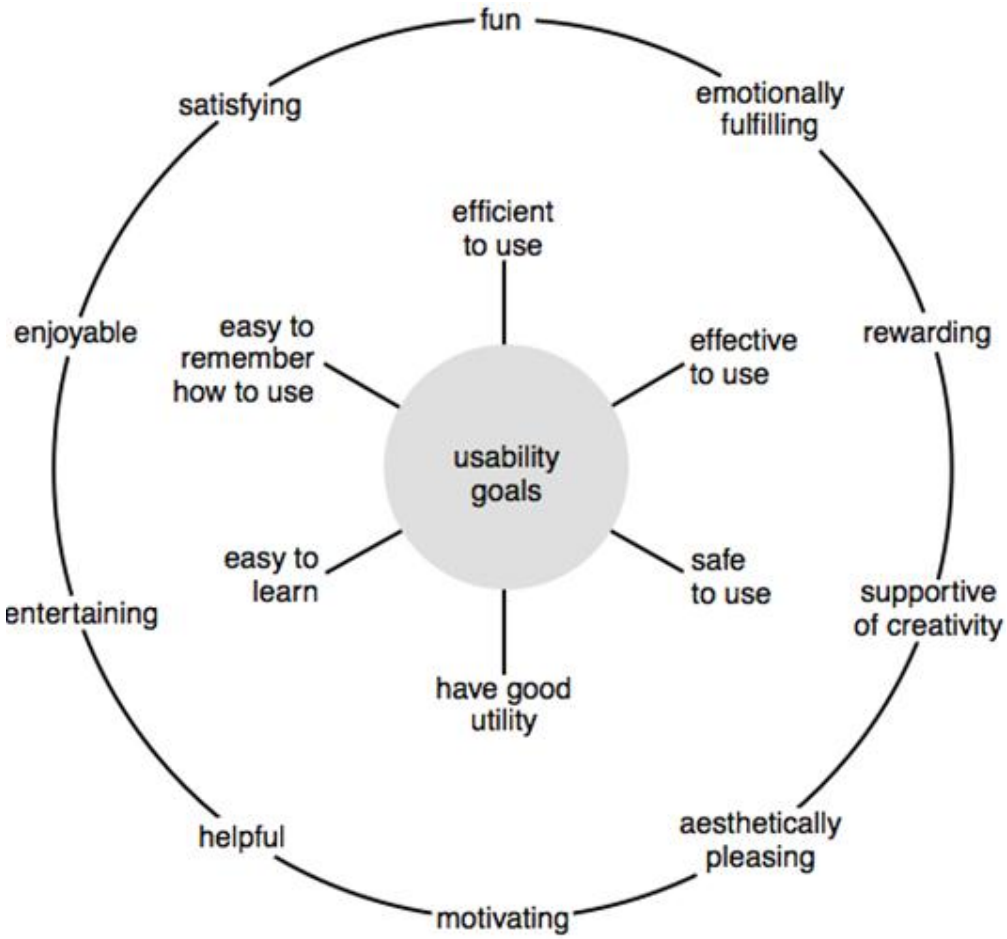

Figure 2.5. Usability goals (Rogers et al., 2002)

According to Sommerville (1986), usability attributes carry an important role in the creation of an interface design based product. The system that functions with minimal errors has the chance of being used by a larger quantity of users. The method in which the data is shown is also crucial. This is called Data Viz which is a graphic based information node. The attributes and their descriptions related to usability in the process of design can be listed as :

1) Learnability : How long does it take a new user to become productive with the system?
2) Robustness : How tolerant is the system of user errors?
3) Recoverability : How good is the system at recovering from user errors?
4) Speed of operation : How well does the system response match the user's work practice?
5) Adaptability : How closely is the system tied to a single model of work?

Data Viz is the output the user is served by the system. There are many methods in which to transfer and visualize data depending on the content and graphic approach. Data Viz is essential as it is concerned with techniques for displaying large amounts of information and can reveal relationships between entities and trends in the data. Some examples of Data Viz are, weather information collected from a number of sources, the state of a telephone network as a linked set of nodes, a model of a molecule displayed in 3D and web pages displayed as a hyperbolic tree. The content cannot be visualized using this method if it is plain imagery, text, video or sound but can be interpreted into a virtual symbolic data if necessary.

UXD is the process of enhancing user satisfaction by improving the usability, accessibility, and pleasure provided in the interaction between the user and the product. UXD is a result of interaction design and empirical experience and is the creation and synchronization of the elements that affect users' experience with a particular software with the intentions of influencing their perceptions and behavior. Empirical comes from the Greek word meaning experience. It refers to creating a combined experience from things that can be touched, heard, smelled, seen and interacted. UXD encompasses traditional HCI design, and extends it by addressing all aspects of a product or service as perceived by users. Smart interaction design is an essential part of the overall software design process. If a software system is to achieve its full potential, it is essential that its user interface should be designed to match the skills, experience and expectations of its anticipated users. Good interaction design is critical for system dependability. Many 'user errors' are caused by the fact that user interfaces do not consider the capabilities of real users and their working environment. A poorly designed user interface means that users will probably be unable to access some of the

system features, will make mistakes and will feel that the system falters rather than helping them in achieving whatever it is used for.

As mentioned by Sommerville (1986), when making interaction design decisions, the physical and mental capabilities of the people who use software should be considered. The user factors to consider are :

1) Everyone makes mistakes, especially when handling too much information under stress. When systems go wrong and issue warning messages and alarms, this often puts more stress on users thus increasing the chances that they will make operational errors.
2) Everone has a diverse range of physical capabilities. Some people see and hear better than others, some people are color blind, some are better than others at physical manipulation. Design should focus on personal capabilities and assume that all users will be able to cope.
3) The interaction should be based on terms and concepts drawn from the experience of the people who will make most use of the system.
4) The interface should be consistent in that, wherever possible, comparable operations should be activated in the same way.
5) Users should never be surprised by the behavior of a system.
6) The interface should include mechanisms to allow users to recover from errors.
7) The interface should provide meaningful feedback when errors occur and provide context-sensitive user help facilities.
8) There should be appropriate interaction facilities for different types of system users.
9) Presenting users with too much information at the same time may create confusion. People have a limited short-term memory.

Everyone has a different interaction preference. Some people like to work with pictures, others with text. Direct manipulation is natural for some people but others prefer a style of interaction that is based on issuing commands to the system.

The principle of user familiarity suggests that users should not be forced to adapt to an interface because it is convenient to implement. The interface should use terms that

are familiar to the user and the objects manipulated by the system should be directly related to the user's working environment.

The principle of user interface consistency means that system commands and menus should have the same format, parameters should be passed to all commands in the same way, and command punctuation should be similar. Consistent interfaces reduce user learning time. It becomes easy to apply knowledge learned in one command to the other parts of the system.

Interface consistency across applications is also consequential. A coherent user interface needs to integrate user interaction and information presentation. This can be hard because the designer has to compromise between the most appropriate styles of interaction and presentation for the application, the background and experience of the system users, and the equipment that is available.

All interactive systems have to provide some style of transmitting information to users. The data presentation may simply be a direct representation of the input information or it may be a graphic information. It is an optimized and efficent design guideline keeping the software required for information presentation separate from the information itself. Splitting the presentation system from the data enables us to change the representation on the user's screen without having to change the underlying computational system which is best done through a framework backend without creating a distress on the user front end. As listed by Sommerville (1986), interaction design related interactive product interface principles and descriptions are :

1) User Familiarity : The interaction should be based on terms and concepts drawn from the experience of the people who will make most system use.
2) Consistency : The interface should be consistent in that wherever possible, comparable operations should be activated the same way.
3) Minimal Surprise : User should never be surprised by the behavior of a system.
4) Recoverability: The interface should include mechanisms to allow users recover from errors.
5) User Guidance : The interface should provide meaningful feedback when errors occur and provide context sensitive user help mechanisms.

6) User Diversity : There should be appropriate interaction facilities for different type of system users.

2.2.2.4 User interface design principles for interaction design

There has always been debate about the connection between icon and interface design. The 1992 version of "Macintosh Human Interface Guidelines" by Apple Computer, has widely been recognized as pioneering in user interface development. This suggested that interface and icon were nearly synonymous and that, logically, the best interfaces would be those with the best icons; and that those without icons would fail. This is clearly not the case, but suggests the extent to which interfaces had become thought occupying in an existing pattern based on icons and a paradigm of interfaces as tools to manage software. According to Blair-Early & Zender (2008), the term is defined as the means by which users interact with content to accomplish some goal. The interaction involves both inputs and outputs. Focusing on content interface, any interface has two basic considerations; users and content. A great deal is made in HCI literature about UCD and user needs. This suggested that, for users, interaction has a purpose or aim even if that aim is merely one of idle amusement. The user interface is the combination of means by which the users interact with a particular machine, device, computer program, or other complex tool. The user interface provides the means of input, allowing the users to control the system and output, allowing the system to inform the users which is the feedback provided by the system.

Graphic User Interface is the communication providing tool between the user and the system. It has the responsibility of interpreting the data transfer transpiring between both parties. As mentioned by Manzari (1999), when the software revolution came in the 1980s, Kapor (1990) was one of the first to call himself a software designer. Recently, with the emergence of highly visually engaging Internet websites, user interface design has been accepted as a crucial part of the development process. The availability of software has taken off so quickly that companies are making great strides to set themselves apart using a strong design and branding strategy investing on how they look and feel through the digital world.

UI designers make decisions about more than simple graphic user interface elements or designing icons. Instead, the UI of a software application should be seen as anything that affects the user experience. Kapor (1990), explains, “the look and feel of a product

is but one part of its design". Understanding the UI of software is more than understanding the way to represent a list of objects in a graphic user interface; it is more than providing appropriate affordances for a draggable object. To UI and interaction designers, the details of a graphic user interface design are what various varnishes are to a furniture maker: an enhancement that can accentuate the product, but cannot alone compensate for poor design. With great expertise in graphic user interface solutions for interaction problems, UI designers play an increasing strong role in the design of interactive products.

The first step is to identify what the project aims to achieve in using HCI standards. Here are some possibilities :

1) Familiar look and feel : Standardizing the look and feel of software enables users to transfer the skills they learn on one piece of software to another.
2) Provide Consistency : Standardization may occur in varying scopes. Examples include the various components of an application, applications that will be used together, and an operating system and all the software that runs on it. The more broadly a standard can be applied, the greater the benefits.
3) Use human factors findings : Standards take advantage of the large body of human factors research and accepted practice.
4) Streamline development : Standards make many design decisions routine. This frees designers to spend time on decisions that are more difficult or critical.
5) Evaluate usability : Standards provide one basis for judging the usability of products. All else being equal, a product that meets an HCI standard should be more usable than one that does not.
6) Comply with requirements : Standards compliance for the software may be required by the buyer.

2.2.3 Product design in edutainment

Design based on product plays an important role in edutainment. Part of the edutainment gadgets and tools are products which have been specifically designed for edutainment purposes. Digital technology is effectively being embedded into various products to enhance their performance, allowing the result products to possess the

properties of both physical and computing entities. The shifting nature of products has expanded the realm of ID to direct its course toward the design of interaction design. Furthermore, it has reshaped the product-development process and coordination of teamwork. Products that are absent of idea and poorly executed can lead to negative experiences while good design provides satisfaction and quality of life. In order to gain a positive experience, the aesthetics, emotions and meaning assigned to a product, work as contributors to the satisfaction of using a product. Everyone has a unique character that shapes their own experience depending on the personality, skills and background of a person with a product where as when it comes to experience, the product properties such as material, texture and color, can also be a defining factor. In the themed area with a chosen idea, the environment transmits numerous messages depending on the concept. In order to reflect the idea more vividly, the environment needs tools, objects, visuals and a setting that would make the visitors feel a part of an abstract environment. As storytelling is the main scope of edutainment, it needs to be supported with physical objects often randomly used out of their context rendering the area more realistically in sense of edutainment. Whatever the main theme may be, the initial goal has to be the representation of the concept in the most realistic sophisticated manner. The products placed in such an area, need to be products especially developed according to theme, providing some sort of enjoyment, content and information. Every object placed in the area should have a meaning in the context of edutainment. Since being objects with a precise reason of existence, they have to be designed in a certain manner. As products are becoming hybrid artefacts, physical design and software design need to be thought of as one and develop simultaneously. PD in the near future will mean to successfully translate meaningful information structures into physical forms and to smoothly install digital products into the physical structures of objects that are to contain them.

2.2.3.1 Interactive features of product design

During the development of a product with interactive properties, the role of the product in daily life should be well thought of. As PD questions the idea and the reason in product development slightly different than ID, the parameters of design are almost as important as the form of a product. According to Kolko (2009), the sequence of the parameters that should be taken into account while designing a product are function,

usability and form. Kolko (2009), suggests that an interactive product should carry the below listed attributes :

1) Encourages a natural dialogue between product and user.
2) Encompasses some form of technological advancement.
3) Becomes cohesive when the user "uses" the product.

When designing a product with interactive capabilities, the path to follow is more or less like designing any industrial product. Even though there always has been debate between the form and the function not being able to decide which is more important than the other, when it comes to interactivity, the integration of software changes the perspective. The function is the most important factor as when looking at the interaction providing products today, such as smart phones, it can be seen that they are mainly made of a flat touch screen and no buttons. Size of the phone is mostly determined by the touch screen size. Software often offers a user friendly interface and many electronic functions and applications. Usability is all about service design when it comes to software. Interaction designer, along with product designer, integrates the software to the main body. Usability is the key factor when choosing a phone as the operating system could generally be the reason a phone is purchased. In addition, form should be attractive and ergonomic offering a comfortable grip and a target oriented look.

According to Davis et al. (2008), design generally entails multiple kinds, or modalities, of representation and reasoning. For example, designers reason with different kinds of representations, including both imagistic such as drawings, sketches and diagrams and propositional such as function, behavior, causality, and structure. This multimodal nature of design representation and reasoning raises several issues for AI research on design. It is logical to question what types of knowledge are captured by various modalities of representation or what kinds of inferences are enabled and constrained by different representation modalities. AI has long been interested in these issues, though not necessarily in the context of design (Davis et al., 2008). The interactive products developed for edutainment are the seeds of a multimodal design approach and requires a new set of criteria that set them apart from everyday objects. They evolve over time depending on the needs of the user, technology and content. The environment modifies the implementations according to its need as even though many

spaces have similar concept based siblings but in reality these spaces all have unique concepts at the eyes of the designer. It is logical to start design process by asking some generalized questions in order to define the products and how they fit into the concept. Vogel (2005), has asked critical questions regarding product and the system, proposes five dimensions :

1) Interaction : Does the system support implicit or explicit interaction? Implicit interaction refers to indirect, naturally occurring input like walking up to a display. Explicit interaction is what is used when manipulating a mouse or using an intentional hand gesture.
2) Input : What input devices are supported or required?
3) Information : Does the system provide general, public information only, or can it also supply personal information for specific individuals or groups of individuals?
4) Multiple Users : Does it support multiple users on a single display and if so, how does it support them? Typically systems use time based queuing or explicit space partitioning to support multiple users on a shared display.
5) Location : What kind of space is the system located? Public or private space?

The responses given to the questions above defines the characteristics and attributes of the interactive products designed in order to provide edutainment.

2.2.3.2 Cognitive effects of interactivity

Affordable consumer hardware, touch screens, and smart phones drive an increasing escalation of public space with interactive applications. Such applications include artistic, playful, and informative content on public displays. The aquarium interactive products have these above mentioned qualities as products developed by the combination of everyday hardware such as GR tools, touch screens and computers. Using tools that users have a tendency to identify eases the product familiariziation stage.

Today, various interaction techniques exist that have a potential influence on recall and recognition. Such techniques include touch, gestures, presence, etc. There are several types of interactive systems that define product interaction. Generally the type of interaction is determined by the technology deployed. Whereas touch-enabled

screens enable direct interaction (i.e., dragging/dropping an object), gesture-based techniques are indirect and require a mapping of the user interaction to the feedback on the screen. Thus, the expressiveness of the interaction can be controlled, for example, by implementing a transfer function that requires the user to move more or less in front of the screen. Examples of all types of interactive products can be seen in the aquarium from gesture-based to touch-enabled solutions. The type of interaction is generally chosen according to the content, the area, the target group and the product. It is essential to define and develop the product with the most effective implementation that serves the interaction.

The purpose of interaction design is establishing an organic relationship between the product and its users through the interaction design of product interface and behavior, which can effectively achieve the user's goal (Jin & Liu, 2014). Interaction driven design is the key in designing user focused interactive products which is the center of the user and the usability goals of a product. In 1984, Bill Moggridge came up with the initial idea which then evolved to the term as is known today, interaction design.

Interface design balances the data exchange between the user and the content. User centered development needs to identify the user and recognize the task the user has at hand. A good interface design positions the user in the center, a lesser user oriented interface design may be inadequate for the user to act upon. Interaction design makes the products easier to use, emphasizing on the user oriented aspects of the products developed. Designing usable interactive products requires considering who the user is and where they are going to be used. Another key concern is understanding the kind of activities people execute while interacting with the products. The appropriateness of different kinds of interfaces and arrangements, regarding edutaiment, of input and output products depend on what kinds of activities need to be supported.

2.3 Global Interactıve Edutainment Projects

Informal educational centers, such as museums and public aquariums, have looked towards interactivity as one way to make their exhibits more attractive and informative. In some institutions, such as aquariums, direct interaction with most of the specimens is impractical. However, touch screen information systems may become an effective way to introduce interactive experiences to visitors. Interactive products improve the entertainment and educational value on aquarium exhibits. Interaction

providing products allow the users to spend more time with perceived educative levels of learning and enjoyment and encourage involvement of children and their parents.

Aquariums being informal education centers, serve as important sources of inspiration and life-long learning for the general community. Museums and aquariums are vast resources that communicate wildlife, culture, history, and identity. Aquaria bring ocean life to the surface and increases public awareness about an important resource on which all depend and help people experience places and environments that impact us all but are beyond the scope of everyday lives. As mentioned by Lin (2007), ever since museums and other informal education centers opened their doors to the public, their roles have expanded to include recreation. Even though many visitors come to museums with the expectation to learn new things, their primary reasons are most often social (Weil, 2002). These reasons may include spending time and having fun with family, friends, and loved ones. In order to reach their full potential as an important community resource, it is vital that museums, aquariums, and other informal education centers be seen as not only educational but also enjoyable places to visit.

One method of addressing this challenge is introducing highly interactive exhibits, which not only help attract visitors but also helps these spaces fulfil their educational mission. Interactive exhibits and their role in museums have become an interesting area of research.

As there are many interaction providing edutainment implemented aquariums, it would be appropriate to provide a number of examples. The examples chosen represent the most reknown companies of the world, capable of making out of the box edutainment projects from aquariums to museums.

2.3.1 Georgia aquarium

Design Company : Merlin Mobility is a cutting-edge software development company founded in the heart of Atlanta's technology community. Merlin has developped a Platform-as-a-Service that enables companies to easily create, deploy and update AR content to iOS and Android mobile devices. The platform aligns with the full lifecycle of the customer's products, systems and services including marketing, training, manufacturing and supply chain and creates dedicated apps for specific business needs

and white-labeled apps that can easily be embedded into the customer's current mobile applications.

Aquarium : Ocean Voyager, the biggest exhibit in the aquarium, features more than 60,000 animals. Families can view the animals in a 100-foot-long tunnel that surrounds visitors with water on three sides and features a floor-to-ceiling window, and for a more focused look, numerous smaller lower-level windows. A touch-screen wall allows kids to press a digital fish as it swims by and to learn fun facts about all of the sea creatures in the exhibit.

Interactive Elements : Touchscreen gaming applications, joy sticks to control a camera that displays close-up shots of animals; and a playground with a rubber floor, crawl tubes, and a whale slide. The Figure 2.6 show the touch screen application.

Figure 2.6. Mouth brooders touchscreen

2.3.2 Monterey bay aquarium

Design Company : InwindowOutdoor founded on 2002 and located in NYC, Inwindow Outdoor is an innovative outdoor advertising company specializing in providing advertisers with high profile messages in storefronts and malls throughout the U.S. The company originated the concept in 2002 and creates cutting edge displays incorporating unique technology and interactive components. Their client list includes

brands such as HBO, HSBC, Sony, Absolut, Converse, Coca-Cola, JetBlue, Disney, BMW and Lexus. www.inwindowoutdoor.com.

Aquarium : The Monterey Bay Aquarium is located on the site of a former sardine cannery on Cannery Row in Monterey, California. Among the aquarium's numerous exhibits are two gigantic tanks. The centerpiece of the Ocean's Edge Wing is a 10 meter high, 1,3 million liter tank for viewing California coastal marine life. The other one is a 4,5 million liter tank in the Outer Bay Wing which features one of the world's largest single-paned windows. Sea life on exhibit includes stingrays, jellyfish, sea otters, and numerous other native marine species, which can be viewed above and below the waterline. Below Figure 2.7 is the fish tank control console.

Figure 2.7. Fish tank control console

2.3.3 Santa monica pier aquarium

Design Company : Mad Systems Orange County, California Provides custom audiovisual design, system integration, and technology solutions for museums and attractions. Since this exhibit is intended to be used by individual kids, grown-ups as well as groups of kids with a docent, a touchscreen was not the best way to provide the interaction with the quiz. Mad Systems installed an electromechanical interface that keeps with the theme of the exhibit and mounted some indestructible optical

sensors inside some heavy-duty valves, which were slightly modified to take the optical sensors.

When a valve is opened, the optical sensor uses an infra-red beam to sense that the valve has been moved, which in turn is used to feed the computer that runs the quiz. To indicate a ‘right’ and a ‘wrong’ answer to the quiz questions, Mad Systems installed a toilet within the exhibit. A flushing toilet indicates an incorrect answer, making for a lighthearted way to allow kids to differentiate between the right and wrong answers to each of the questions. On Figure 2.8, Heal the Bay interactive product can be seen.

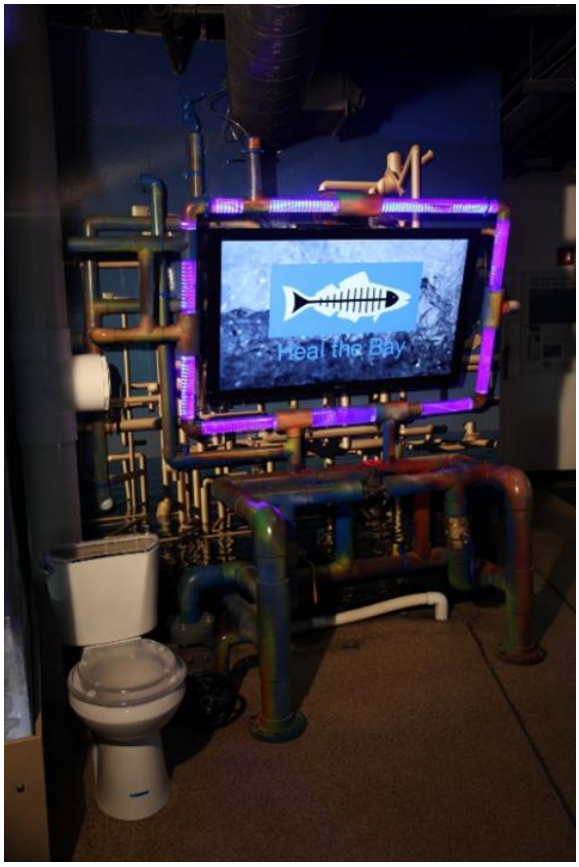

Figure 2.8. Heal the bay interactive

2.3.4 Mystic aquarium

Design Company : Tim Delaney, creator and former Walt Disney Imagineer. Tim Delaney's 34 years at Walt Disney Imagineering included 19 years as a creative director and Vice President of Design. He has been instrumental in all phases of design from initial concept through design development, corporate sponsorship, project production and onsite construction supervision through completion. As a designer, illustrator, painter, creative director, producer and art director, Delaney has lead teams

that have designed and constructed over $1.2 billion of Disney Parks and attractions worldwide, including Anaheim, Orlando, Paris and Hong Kong. Beyond his signature design and production capabilities, Delaney has assembled creative teams, and collaborated with all disciplines, while always maintaining the highest standard of design excellence, with all projects delivered on time and on or under budget.

Aquarium : Mystic Aquarium is an aquarium and oceanography institute in Mystic, Connecticut. It is part of the Sea Research Foundation, a nonprofit organization that also includes JASON Learning and the Ocean Exploration Center. Special exhibits include a ray and shark touch pool, a penguin exhibit, and a jelly gallery.

The Ocean Exploration Center features maps, diagrams, and models from Dr. Robert Ballard's explorations of the Black Sea and of the wreck of the *Titanic*. At the Nautilus Live Theater, presentations tell more of Dr. Ballard's more recent explorations and the ship Nautilus. Audience members have a live link to crew members on the ship at sea and can ask them questions directly. Titanic iceberg is shown in Figure 2.9.

Figure 2.9. Titanic Iceberg Installation

2.3.5 Palma aquarium

Design Company : Aopen is a major electronics manufacturer and one of the world's leading providers of commercial products and applied business solutions. It specializes in two areas; ultra-small form factor computing for both home and business applications, and digital signage, from hardware to software and services. Founded in 1996 in Taipei, Taiwan, AOPEN listed on the Taiwan Stock Exchange in August 2002.

Through its parent company Wistron, AOPEN has access to a worldwide pool of expertise and solutions. AOPEN now operates a growing global business in over 100 countries worldwide. Its clients range from governments and financial institutions to retailers and branding agencies, including major global brands and blue chip Fortune 500 companies.

Aquarium : Palma Aquarium is a commercial aquarium and park that first opened in 2007 in Palma, Mallorca, Spain. The aquarium is the property of Coral World International. The aquarium includes 55 tanks which are home to over 700 different species from the Mediterranean Sea and the Indian, Atlantic and Pacific Oceans. One tank, "Big Blue" is 8.5 m deep, the deepest shark tank in Europe.

The aquarium organizes environmentally focused activities, and takes part in protection and conservation campaigns. The touch screen application is one of the products designed by Aopen for the Palma Aquarium as seen on Figure 2.10.

Figure 2.10. Educative Touch Screen

2.3.6 Manila aquarium

Design Company : Boid was founded in 2007 as a ‘hybrid idea agency and digital production company’, specializing in the creation of unique inhouse software and

engineering solutions. All of their programming and applications are customized for each client, and are optimized for the specific context required (including museums, schools, shopping malls and various advertising media). One of Boid's main areas of expertise is the production of sophisticated human interaction software for public spaces. Boid is responsible for the conception and launch of the globally successful human gesture recognition software Touchbiance. The company also designs and produces interactive single and multi-touch screens, wall and floor applications and projection systems. They also develop a range of other platform-free, upto-date software solutions.

Boid's approach incorporates design, engineering and digital production into various forms of contemporary communication as well as Boid combines different disciplines of creativity such as graphic, product and multimedia design to obtain unique concepts for each client. Boid is one of the world's leading information techologies company of groundbreaking interaction software, and boid solutions are used globally by wide-ranging clients and creative agencies. Boid produce solutions which are original, aesthetic, and utilising cutting-edge technology, yet at highly competitive prices. Still a young company in its current form, boid has deep and broad experience in the fields of interaction, engineering, design, digital production and optimizing use of public spaces.

Aquarium : Manila Ocean Park is the country's first world-class marine theme park and a premiere educational facility. An integrated urban resort with marine life attractions interactives and aqua-themed hotel, the park is geared towards an all-year, all-weather destination for locals and tourists.

The image below show the rinscreen by Boid obtained by blending footage from 6 projectors a 360 degrees video content as seen in Figure 2.11. Apart from the screen, there are kiosks and a virtual habitat application done by Boid.

Figure 2.11. Ring Screen & Interactive Kiosks

2.3.7 Fixelandia virtual aquariums

Design Company : YDreams is a global company that is redefining the concept of interactivity, with a focus on the exciting field of Augmented Reality technologies. Over the last few years they have been developing full-scale interactive environments (from stores to exhibitions), products and intellectual property, combining technology and design. (See Appendix B for Legoworld Interactive Aquarium)

The company researches and develops proprietary/patented technologies in areas such as image processing, augmented reality and gesture-based interfaces, resulting in best of breed solutions that they integrate into projects and products, or license to partners. The Figure 2.12 shows the interactive aquarium by the company.

Figure 2.12. Interactive Aquarium by Ydreams

2.3.8 North carolina aquarium

Megalodon : Diving with North Carolina's Ultimate Predator. The exhibit opened to the public for the first time on July 1. Megalodon was a huge whale-eating shark that ruled the seas from about 20 million to two million years ago. Although the species is now extinct, it virtually comes to life again at the Aquarium, thanks to an engaging suite of interactive creative elements.

The new exhibit includes dynamic 3D animations, interactive video displays, a complete set of realistic Megalodon teeth, and a feast of astounding facts about a long-gone predator of the prehistoric seas. The result; an up-close perspective that highlights Megalodon's awesome size and power. A life-sized Megalodon jaw, bristling with 184 razor-sharp teeth, serves as a gallery centerpiece. Nearby, a 50-foot carpet-inlay, silhouetting the size of a full-grown Megalodon, leads the eye to an alcove housing the exhibit's headline presentation. Here, on a 23-foot curved projection screen, a diver comes to life at the touch of a fingertip, becoming the ringmaster in a Megalodon-themed multimedia program. The Figure 2.13 projects the interactive Megalodon implementation. The production is an inhouse product.

Figure 2.13. Interactive Megalodon Installation

2.3.9 Miami seaquarium

Design Company : Formula-D is a Cape Town based design company. Education systems are challenged in a world of constant change and life-long learning with the collective vision of being one of the world's leading creators and innovators of ground-breaking, creative educational solutions for an ever more dynamic audience.

Aquarium : The Miami Seaquarium is an oceanarium located on the island of Virginia Key in Biscayne Bay, Miami-Dade County, Florida, United States and is located near downtown Miami. Founded in 1955, it is the oldest oceanarium in the United States. In addition to marine mammals, the Miami Seaquarium houses fish, sharks, sea turtles, birds, reptiles, and manatees. The park offers daily presentations and hosts overnight camps, events for boy scouts, and group programs. Over 500,000 people visit the facility annually. The park has around 225 employees.

Project : Michael Wolf, CEO of Formula-D Interactive, discusses the pitch, the win, the thinking and the process behind developing an interactive digital experience at Miami's new 3 story Aquarium, set to open in 2015. A previous project by the company can be seen in Figure 2.14.

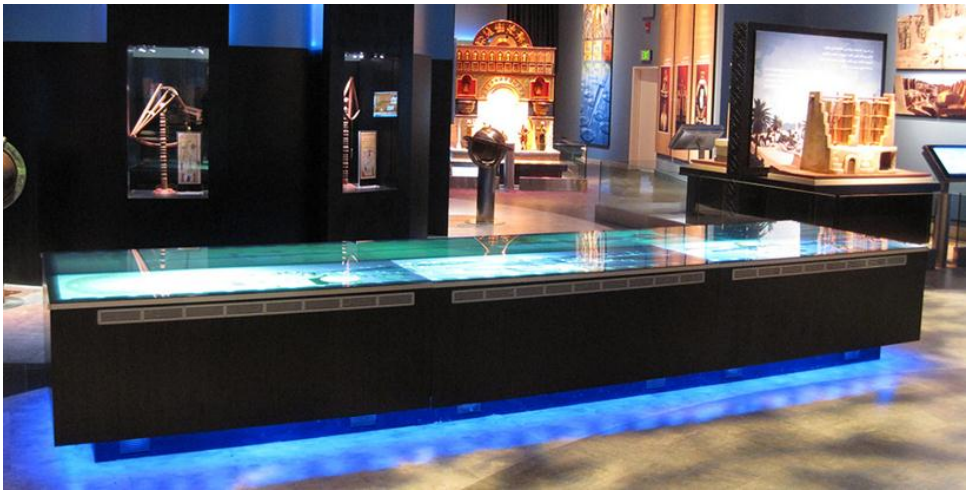

Figure 2.14. Interactive Digital Experience Touch Table

2.3.10 Vancouver aquarium

Design Company : Fourwinds Interactive founded in 2005, FWI has quickly become the industry-leader for enterprise visual communications software. FWI's functionality makes it easy to create a powerful communications tool that solves wayfinding challenges, enhances safety, increase sales, improves experience and much more. FWI is based in Denver, Colorado with additional offices in Dubai, Germany, Hong Kong, Mexico, Miami and the United Kingdom 4WI has placed several interactive products in order to enhance information flow. 30 feet away from the main screen and there are a number of touch panels that use FWi's technology to host Flash video. Some are simple Flash interactive mechanisms, where a button is pushed to start the video, while others are heavily scripted. Despite having widely different applications, they all run

off the same FWi software. One other significant addition to that screen is a live polar bear camera in Churchill, Manitoba, part of a partnership between Vancouver Aquarium and Explore.org. The webcam shows the polar bears waiting to go out onto the ice, providing an unobtrusive look into their natural habitat. Yet, even here, the Vancouver Aquarium was able to take advantage of the flexibility and scheduling functions within FWi. The content management system has been a huge time-saver for Heywood. The Vancouver Aquarium has between 500 and 1,000 items in its library that can be programmed. Any of them can be assigned to any screen simply by dragging and dropping. The items don't have to be associated with a particular screen to be used there, which means Heywood doesn't have to keep multiple copies of different items.

Aquarium : The Vancouver Aquarium is a public aquarium located in Stanley Parkin Vancouver, British Columbia, Canada. In addition to being a major tourist attraction for Vancouver, the aquarium is a center for marine research, conservation and marine animal rehabilitation. The Vancouver Aquarium was one of the first facilities to incorporate professional naturalists into the galleries to interpret animal behaviours. Aquarium research projects extend worldwide, and include marine mammalrescue and rehabilitation. The figure 2.15 shows the drag and drop application used in the aquarium.

Figure 2.15. Drag and drop touch displays

3. RESEARCH DESIGN

The explanation of the stages of research regarding the study has been presented in this chapter. The main topics included in the chapter are :

1) Research question, method and aims of the study.

2) Reviewing the literature.

3) Literature evaluation categories.

4) Data analysis according to evaluation categories gathered through literature review.

The research question, is the main question the study proposes in accordance with the content. All research and data collecting have been made according to this question. The main research question is supported by supporting research questions in order to provide additional insight on research. The second section of the chapter is dedicated to the literature review of the gathered literature data mentioned in the study. The third section consists of the literature evaluation categories which proposes and integrates the literature collected validation standard for the products in the Aquarium. The final section focuses on data analysis according to the evaluation categories gathered through literature review in which the data collected is validated through the research method. The study aims to highlight the answer to the main research question while providing insight on the topic.

3.1 Research Question, Method And Aim Of Study

The section presents the research question, explains the method and the aim of the study. This is one of the most critical parts of the study. The main question is a fundamental deciding element towards the direction of the study. The supporting

questions provide a deeper understanding of the matter at hand and highlight different aspects of the study. The method of the study determines which method to apply during the research and data collection. The method shows how a question is handled, arranged and formulated, how it is answered and what approach is used. The data collected according to the research method is decisive in structuring the study. The goal of following predefined stages of research method renders the study more structured and credible. The aim of the study shows the purpose and range the study focuses on.

Main research question of this research is as follows; What are the main characteristics of interactive interfaces and products that have become an undetachable part of Edutainment? In order to seek for the answer, Istanbul Aquarium was selected as a case study. As the main goal of edutainment can be simplified as teaching, the study observes how the teaching process takes place through the products in an aquarium. The products designed to fulfil the role of transferring information to the guests were designed in order to function as the mediators of knowledge. The products were developed according to the education and entertainment values as mentioned in the literature review.

Supporting Research Questions

1) How does edutainment systems enhance learning?
2) What type of design products does edutainment possess?
3) What type of learning do the systems provide?
4) Are there different systems focusing on age groups?
5) How is it possible to make an aquarium interactive?
6) Which implementations are there in Istanbul Aquarium?

In this study based on qualitative research, the data collected has been processed through literature resources. As a result of the collected data regarding the literature and the aquarium, which is the case of this study, all the information has been filtered and refined in order to present the content into a qualitative analysis. The study is concerned with the qualities of the information collected and with the relation of the data in the context of the literature.

The purpose shows the intention of a study. The method of the study shows the arrangement. The method shows how a question is handled, arranged and formulated, how it is answered and what approach has been used. The credibility of a research is based on the method it provides. A researcher may include numerous data positive and negative into their study only to refine the data and reach a refined result. In this study, the data collected refined is collected according to originality that it promises in a qualitative research. Qualitative research methods was utilised in analyzing the literature review, references and tools. Method refers to research method, tools refer to global examples and references refer to documentation maintaining the raw data collected or prepared by the researcher. Apart from the documentation found online, documentation refers to the collected video footage and photos obtained from multiple Aquarium visits. The process on evaluating the data was handled through the following steps :

1) Literature review.
2) Video and Image data collection.
3) Classification of the data.
4) Istanbul Aquarium case study.

The aim of this study is to investigate the development of an interactive aquarium design motivated by the employment of an innovative technology. In order to achieve the goal, the study presents content directed to the main research question organized according to the literature. The aim is to present a convincing documentation on creation and implementation of an edutainment project that responds to the requirements, is effective, stable and functional for the correct target observed in accordance to the literature. The data collected consists of four groups. These are; outcomes of literature research made on edutainment related terms, outcomes of literature research on knowledge/learning attributes, global examples of similar edutainment projects and the material gathered related to Istanbul Aquarium. The material gathered through the research, supports necessity of the data in a qualitative research.

As introduced previously, the study was based on qualitative research, and the data collected was processed through literature resources in order to recollect information

on edutainment literature. A corresponding research was made on similar global aquarium projects. The research attempts to elicit evidence that suggests the global importance of the edutainment implementation in Istanbul Aquarium, relocate and refine the data collected. As the level objectivity is usually questionable in qualitative research, the relations among the factors that have an effect on a certain situation do not need to be generalized. Every situation has an internal integrity in itself as well as its own meaning. The purpose of the study as a qualitative research can be listed as :

1. The presentation of edutainment and terms related to edutainment.
2. The classification of global edutainment aquarium projects.
3. The classification of the edutainment products in Istanbul Aquarium.
4. The evaluation of the products according to the literature.

As the Istanbul Aquarium is the case of this study, some implementations in similar structures may not fulfil their roles, not being able to adapt to the environment as content, system or a product. Edutainment parameters may be strict when design parameters may promote liberty. Finding the right balance between two factors is essential in designing edutainment. The preset steps to creating edutainment content may not directly apply to all kinds of similar projects. The location, venue, target group and other factors all aid in designing the correct edutainment. The multimodal design allows various disciplines of designers to work in collaboration for a common goal and a unique product. The products within an edutainment system may differ from an environment to a software created for smart phones. The design process of any edutainment product disregarding the scale is mostly the same as the effectiveness of the content. The designer needs to collaborate, emphatize and relate to the users. Design research methodology is an appropriate strategy in the development of an interactive aquarium design in terms of edutainment as it attempts to address a variety of design variables by examining their impacts on interaction and participant outcomes. As visitor behavior can be interpreted by a variety of situational components, it is often difficult to fully control variables in a classic experimental fashion in real learning-oriented centers like aquariums and museums. The availability of interactive devices which is one of the focus of this study may be one of the most important design elements encouraging interactivity at an exhibit.

The features of the design environment that are developed initially carry the role of attracting visitors. Fish species in public aquariums effectively attract the public. Once visitors' attention has been assured, different design strategies can be used to enhance learning. As the visitor enters the aquarium, most of the themed areas are mostly similar as they are basically different portions of the same tank. The real customization takes place in the edutainment features of an area. For the aquarium to be interesting for a longer period of time or to seduce the visitor for multiple visits, the interior decoration and entertaining content is the first thing that comes to mind.

The adaptation of scientific technologies for public use and the elements of design processes are shaped by attempting to achieve different visitor impacts. The ultimate goal for public spaces in whichever method is chosen to be used in order to satisfy the guest, is to obtain visitor engagement within the facility. The interactive aquarium environment also enhances adult learning opportunities as well as children as the interactive products provide content for all target groups. Public aquariums are an important venue for all ages to learn ocean sciences. There are several aquariums worldwide which benefit from the usage of technological products to provide an interactive experience for their visitors that goes beyond simple observations of live fish and mammals in aquarium settings.

3.2 Reviewing The Literature

The study focuses on the edutainment providing product aspects of Istanbul Aquarium. The sequence of literature-oriented data presentation enables the study to present information about the current systems in the Aquarium, provide information about the content and the technology, and give information regarding the target group and relate the presented content with the literature. The literature consists of :

1) Concepts in edutainment
2) Brief information on existing global edutainment centers

Since the success in a research is directly related to the theoretical aspect of the research together with the method, the literature compiled sets the basis of the study. The researchers need to make a vast research on the subject, separating the useless information from the valuable information. Defining and containing the main issue

depends heavily on applying the appropriate method and a model together with the necessary literature review.

During the literature review, numerous sources have been analyzed such as thesis', books, ebooks and articles. As edutainment in aquariums is not a very common topic, especially in terms of academic literature, a limited resource pinpointing on the subject has been found. The main material on the subject was found online from various company, aquarium or individual websites. All the documents found were in English and this justifies the language of the study.

3.3 Literature Evaluation Categories

The parameters of the assessment based on the literature are as follows :

1) Types Of Edutainment; according to Rapeepisarn et al. (2006).
2) Target Group; according to Rapeepisarn et al. (2006).
3) Recognizing Edutainment; according to Rapeepisarn et al. (2006).
4) Edutainment By Type Of Media; according to Rapeepisarn et al. (2006).
5) Types Of Educational Software; according to Rapeepisarn et al. (2006).
6) Learning Types; according to Walldén & Soronen (2004).
7) Learning Typologies; according to Walldén & Soronen (2004).
8) Edutainment Applications For Learning By The Use Of Games; according to Veenstra et al. (2009).
9) Educational Game Types; according to Veenstra et al. (2009).
10) Ludic Value; according to Nam & Kim (2011).
11) Scaffolding; according to Podolefsky et al. (2013).
12) Interaction Types; according to Manzari, (1999).
13) FCL; according to Karydis, (2011).
14) Sound; according to Hourcade, (2007).
15) Piaget; according to Hourcade, (2007).

16) Evaluating Digital Learning From Pedagogical Perspective; according to Lepouras & Vassilakis, (2004).
17) Storytelling; according to Hourcade, (2007).
18) Principles Of Interaction; according to Sommerville, (2009).
19) Interactive Features Of PD; according to Kolko, (2009).
20) 5 Dimensions In An Interactive Product; according to Vogel, (2005).

3.4 Data Collection

Data is described as formatted information that is translated into a form that is easier to process or transfer. Data may consist of images, video, sound files, text documents, numbers or symbols. What makes something data, is the factor that it can be perceived by senses. Data can be classifed as objective data and subjective data. Objective data is the type of data which does not require any kind of validation and is perceived in the same way by everyone. Subjective data can be commented on depending on the way it is perceived. Psychological and sociological factors play roles in data belonging to ideas and thought which is described as judgmental data. This does not refer to the fact that the opinion on a subject belonging to someone needs to be necessarily wrong.

The data comprised in this study are mostly judgmental data. The data represented in the literature review belongs to the owner of the reference. The data collected from the Aquarium based on photos and videos are results of multiple visits to the site. The data collection process is as follows :

1. The specification of the data collection methods.
2. Development of the data collection tools.
3. Collecting the data.
4. Validating the data.
5. Refining the data collected.

The specification of the data collection methods refers to the method used in searching for material and data relevant to the study. There are many resources to collect data from including current desktop resources and school libraries. Development of data collection tools refers to the system of obtaining data offline or online. In the case of

video and photographic data, collecting refers to manual collecting. Apart from the documentation found online, documentation refers to the collected video footage and photos obtained from multiple Aquarium visits. The data collected needs to be sufficient as quantity, quality and needs to respond to certain requirments. After the classification and the editing are made, the data becomes ready for evaluation and analysis.

3.5 Data Analysis According to Evaluation Categories Collected Through Literature Review

In qualitative research, a data needs to carry the essential attributes of being "original" rather than being a "representative". This refers to the fact that in quantitative research being a representative data may be sufficient while in qualitative research the key parameter is the originality. In quantitative research, the representant data may differ in quantity, in qualitative research singularity may refer to originality. In qualitative research, generalization needs to be avoided in order to achieve an optimized result. The data collected consisting of literature and relevant documentation has been collected being targeted as the specific representative of a contemporary subject.

Istanbul Aquarium products have been analyzed in a chart-based structure in relevance to the parameters of literature evaluation. The charts demonstrate various elements of design-oriented aspects, focusing on the literature related qualities of the case study products. During the study, the global edutainment scene has been considered as the general area of analysis. To pinpoint the aquariums, all other recreational centers have been eliminated in the global edutainment examples in order simplify and to avoid confusion. The products used in edutainment aquarium projects have similar quailities with the implementations in Istanbul Aquarium. The simplification of projects and products enable originality to surface. Global edutainment aquarium projects having multiple interactive products permits the study to associate with the field of edutainment providing proof of the validity of the design.

4. CASE STUDY : ISTANBUL AQUARIUM

Istanbul Aquarium is one of the most popular science centers and the major aquarium in the city of Istanbul. The aquarium has a vast range of circulation. Amongst the visitors are various groups such as tourists and students that are brought to the location on a daily basis as site seeing tour. The plan of the Aquarium enables an easy navigation creating different spaces to present the content to the guests. The plan has been made accordingly so as the crowds visiting do not accumulate in the same areas of the structure that would prevent the newcomers advancement.

The mass effect of the project enables the multi-functional space to execute various tasks simultaneously such as placement of information providing products, themed areas, gift shop, food court etc. The space itself is distinctive with the visual implementations, tanks, fish, lighting and its storytelling which also composes the elements of edutainment.

The aquarium is divided into different areas which represent the seas of the world. The visitor route has been made according to the edutainment concept planning of the Aquarium as seen in Figure 4.1.

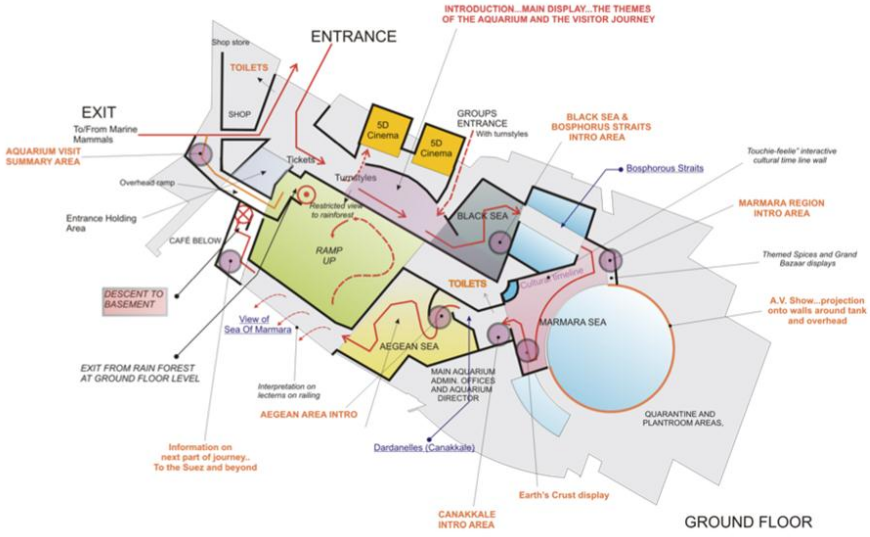

Figure 4.1. The aquarium area plan (Stage File, 2009)

Edutainment software relies heavily on technology, especially computer software (Rapeepisarn et al., 2006). It usually exists in the form of educational electronic games aimed at teaching and learning concepts and processes. The purpose of edutainment is to attract and hold the attention and high motivation of the learners initially by means of a computer monitor now days by gesture recognition, AR and VR technologies for the learning goal to be achieved.

Edutainment is advertised as a meaningful experience for young children, because the aim of edutainment is playful learning of one or multiple skills in a particular developmental domain. Istanbul Aquarium provides this experience. The outcome of edutainment is learning that is based on 'fun'. The edutainment products mentioned in the study have been developed in according to the fun factor. The educative stage during the fun process is centralized between the system and the user. The study observes the implementations in Istanbul Aquarium in relation to the literature presented and explains the scope and the technology in accordance to the project.

4.1 Benefits Of Istanbul Aquarium In Terms Of Edutainment

Edutainment is an innovative form of education that is being successfully used by many education systems around the world. Through edutainment, the children are better able to enjoy their studies seeing that edutainment has the possibility to present interesting and colorful practical applications to overcome the lack of creativity being displayed in classical education softwares. Educational software is designed to serve content and test the knowledge of the learners. When active in order to achieve progress, offers different levels of difficulty and it provides hints for the learners. It provides progress information and some feedback about their advance. Depending on the system, when the preset goals are achieved, it rewards the user. The target group defines the content and the design outcomes in an edutainment software.

The major benefit of a project of this size lies in the location. The project lies in the heart of Istanbul in a strategic point close to the major airport easily reachable. Istanbul Aquarium has a structure belonging only to the recreational center itself and is not attached to any other structure organically. The possibility of being able to witness the existence of numerous species is a unique opportunity for the visitors. Apart from the location, the immense tank and themed areas provide an exciting tour for the guests.

In a project such as Istanbul Aquarium while designing edutainment content, the key issues are a high degree of interactivity, the representation of concepts, the interface (in the sense of manipulating concepts and directing learners' attention), a navigational structure and sequencing of activities, a feedback and rewards system and entertainment elements which are colorful graphics, animation, sound, characters and humor. The engagement of the user with the software needs to be motivating in order to maintain interest and concentration as a necessity of UCD.

According to Spreenberg et al. (1995), the iterative activities of UCD are :

1) To plan the human centered process.
2) To specify the user and organizational requirements.
3) To evaluate design against user requirements.
4) To understand and specify the context of use.
5) To produce design solutions.

The conceptual production sequence in Istanbul Aquarium interactive implementations are :

1) Interface development from a design, content and product point of view. User > Content > Application \ PD
2) The journey of edutainment; transforming the educative phase into a journey.

4.2 Collaboration On Design And Implementation

The edutainment design has been made through a collaboration of three companies.

1) Mike Cox Associates, Istanbul, Turkey. Mechanical Installation Implementation.

Michael Cox Associates is a design company which specializes in the design and realization of museums and visitor attractions.

Formed in 1999, the company offers an innovative but pragmatic approach to design, endeavouring to focus on its clients needs and expectations. The primary objective is to provide quality exhibitions, which stimulate imagination and reflective thought. It strives to provide satisfaction for both client and public and deliver a multi- tiered level of interpretation which is easily accessible, understandable but shows great integrity

and purpose, whilst providing "best value" within the project budget. Mike Cox has acted as the edutainment supervisor and coordinator in the project.

2) Paragon Creative, York, United Kingdom. Edutainment & Mechanical Installation Production.

Paragon Creative is one of Europe's leading design and build companies offering an impressive range of integrated services. Since 1987 the company has a reputation as a cutting edge scenic, theming, model making, interactive and specialist fit-out facility. With over 40,000 sq ft of work space and studios in York and London Paragon provides a broader range of services than most creative design and build company.

Paragon Creative has been involved in over 1000 projects in more than 26 countries around the world. For over 25 years has completed projects for museums, heritage centers, aquariums, design agencies, architects, science centers, theme parks, interpretation centers, stately homes, FECs, nightclubs, bars, corporations, advertising agencies, television and film production companies, theatres, leisure centers, visitor attractions and retail companies.

3) Boid, Istanbul, Turkey. Interactive Programming and Implementation.

Boid was founded in 2007 as a ‘hybrid idea agency and digital production company’, specializing in the creation of unique inhouse software and engineering solutions. All of their programming and applications are customized for each client, and are optimized for the specific context required (including museums, schools, shopping malls and various advertising media). One of Boid’s main areas of expertise is the production of sophisticated human interaction software for public spaces.

4.3 Aquarium Edutainment Concept Art And Generation

The aquarium design process initially began with the definition and description of the areas dedicated to the seas of the world. These areas have been designed to carry and exhibit the major characteristics of the seas beginning with the species information to trade route information. Figure 4.2 and Figure 4.3 shows the conceptual art designed for edutainment purposes. As can be seen clearly the creative approach to the areas has been to reflect the characteristics of the seas by the usage of material, lighting, graphics, interactives and fish tanks in relation to the edutainment theming.

Figure 4.2. Black sea concept art.

Figure 4.3. Underwater observatory concept art.

4.4 Hardware And Content Integration

The interactive products in the aquarium are computerized systems with various technologies applied. The systems have been developed in accordance to the environmental parameters. Graphics, print material, software and video footage form the content. Figure 4.4 shows the content, hardware, software and ecosystem requirements of the implementations.

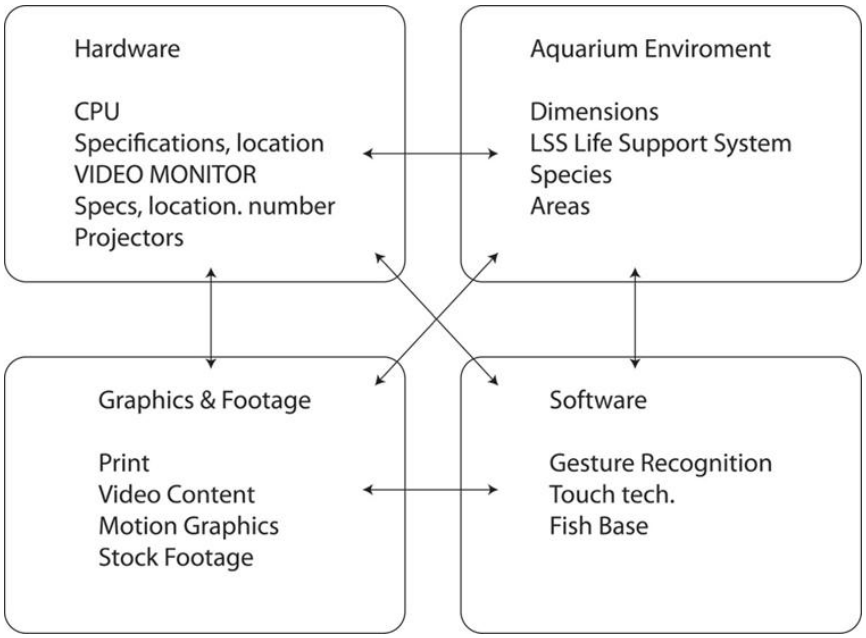

Figure 4.4. Four factors of the aquarium environment

The technology based products according to content, technology and hardware can be listed as :

1) Content & Technology : Gesture recognition, visual content, graphics, interfaces, videos.
2) Hardware : Kiosks, virtual habitat, touch tables.

4.5 Products

The interactive products in the Aquarium use display and interaction techniques such as simple hand gestures and touch screen input for explicit interaction and contextual body orientation and position cues for implicit interaction as methods of interaction.

The preset goals concerning the products in the Aquarium can be listed as :

1) Attract and engage the visitor.
2) Address the individual preferred learning styles of its diverse audience.
3) Be sturdy enough to withstand vandalism and the environmental damages.
4) Transmit the content effectively.
5) Create a unique experience.

The products have been developed according to UCD and LCD methods. The decision making stage of the method applied on the product depends on content, type of interactivity and system. UCD occurs when needs and limitations of a target group of a product or service are considered and analyzed thorougly through extensive caution and attention. When producing interactive edutainment for any medium, LCD is the desirable approach as all product development process is being made depending on the user profile of the target group which does require a previous experience stage. Interactive products and non-interactive products carry attributes belonging to LCD and UCD simultaneously. Through a more detailed look, certain aspects of the products differ in relation to the method applied.

Techniques are presented for subtle notification, self-revealing help, privacy controls, and shared use by multiple users. Apart from the interactive products, numerous mock ups of various objects decorate the aquarium. Seen in Figure 4.5, mock up of an underwater plant.

Figure 4.5. Ecosystem globe.

4.5.1 Kiosks

The kiosks provide information about the fish species living in the related area, downloading information from the offline fish server database. Touch screen technology which performs the function of a keyboard and a mouse allows the users to communicate with the software providing information about the fish species around the globe. The kiosk activates with touch and displays an interactive earth interface.

By default it displays the fish breeding locations depending on the area of the aquarium and it desired, provides information about the other areas as well. The content is synchronized with the fish base server and the system being wired to the internet updates itself on a daily basis. Figure 4.6 shows the breeding spots.

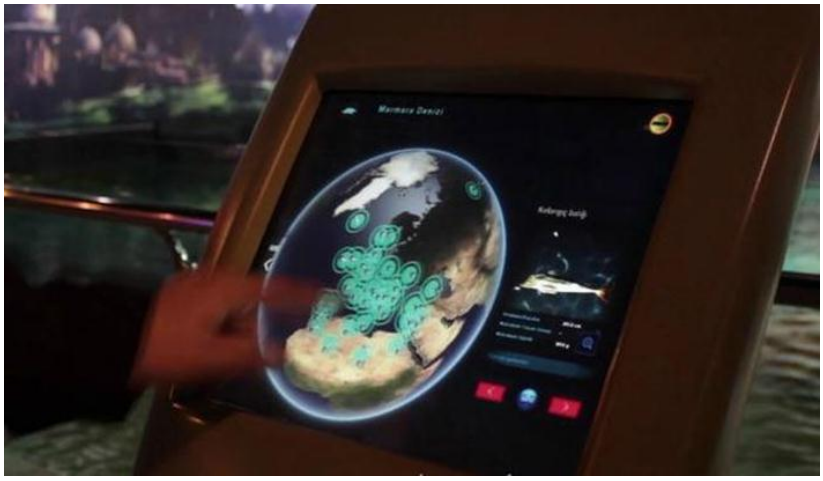

Figure 4.6. Kiosk software touch screen.

The kiosk has been produced by Innova (See Appendix A) complimented with the specified custom hardware configuration and isolated against moisture and air-conditioning circumstances. As seen in Figure 4.7, the ergonomic aspect of the kiosk enables the user to maintain a comfortable posture in the first instance.

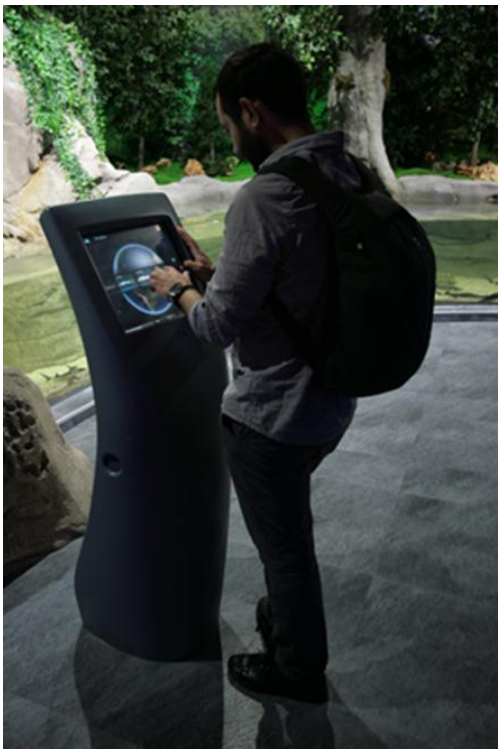

Figure 4.7. Kiosk user experience.

The hardware mainly consists of a 23” Interactive kiosk, single touch screen and a PC. 32 kiosk have been scattered to different areas of the aquarium. Casing has been produced by Innova. The Table 4.1 reviews the interactive product according to the literature.

Table 4.1. Kiosk literature evaluation.

		UCD	LCD
Types Of Edutainment	Edutainment to give experiences presented with experience like simulations. (virtual mobility).		x
Target Group	Motivation oriented; users having same interest regardless of age, present knowledge etc.	x	
Recognizing Edutainment	Location based edutainment sub category participatory and interactive as well as edutainment by purpose and content consisting of informal education which is to give experience like simulations.	x	
Edutainment By Type Of Media	Information oriented simulations, earth animations and fish base.	x	
Types Of Educational Software	Simulation tries to repeat a phenomena.		x
Learning Types	Informal learning for interactive stations.		x
Learning Typologies	Cognitive and psycho motor.	x	
Edutainment Applications For Learning By The Use Of Games	Knowledge developed through the content of the game and interactive product. Indirect learning.		x

Educational Game Types	Simulation games, Memory games, Eye/hand coordination.		x
Carrying Ludic Value And/Or Scaffolding Attributes	Carries both attributes with inviting mechanics.	x	
Interaction Types	Single touch screen kiosk. Active.		x
Free-Choice Learning	FCL as a mode of informal leaning enables the user to navigate through the content as they please creating a unique path for every user.	x	
Use Of Sound	Basic sound effects to enhance interaction.	x	
Cognitive Development Piaget	Maturation, experience, emotions, adaptation.	x	
Evaluating Digital Learning From Pedagogical Perspective	Interaction, product, interface design.	x	
Storytelling	The software is designed to guide the user all through the information transfer process while transmitting a timeline based fishbase. The unique navigation method every user chooses to follow gives the possibility to visualize the content in many different sequential paths.	x	
Principles Of Interaction	Consistent system, consistent interface, user guidance, user diversity, recoverability.		x
Interactive Features Of PD	Encourages dialogue between user and product, becomes cohesive when the user uses the product.		x

5 Dimensions İn An Interactive Product	Location Based Interaction Supporting single user product.		x
Product Quantity	23 scattered in different areas.		

Table 4.1 Kiosk literature evaluation.

4.5.2 Noah's arc

The application shows the salt level related methane gas production on the bottom of the Black Sea having a direct effect on the habitat and the ecosystem. The system is a single touch screen enabling the users to manipulate the salt level in order to achieve a cleaner habitat. The screen has been placed inside the arc which attracts many children being in the Black Sea area at the first hall of the aquarium. The Figure 4.8 shows the area dedicated to the Black Sea in the aquarium. Figure 4.9 displays the inside of the arc with the touch screen.

Figure 4.8. Black Sea Noah's Arc.

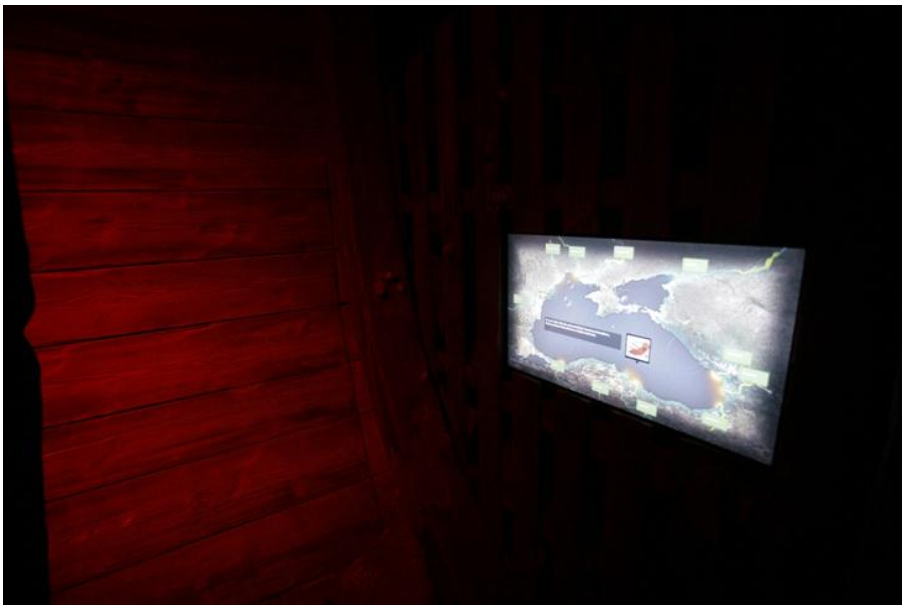

Figure 4.9. The Arc Touch Screen.

The hardware of the interactive inside the arc consists of a 23" Singletouch Screen and a Pc without a casing as the hardware has been embedded inside the wooden console. The Table 4.2 reviews the interactive product according to the literature.

Table 4.2. Arc literature evaluation.

		UCD	LCD
Types Of Edutainment	Edutainment to give experiences presented with experience like simulations. (virtual mobility).		x
Target Group	Motivation oriented; users having same interest regardless of age, present knowledge etc.	x	
Recognizing Edutainment	Location based edutainment sub category participatory and interactive as well as edutainment by purpose and content consisting of informal education which is to give experience like simulations.	x	
Edutainment By Type Of Media	Information oriented simulations, underwater animations and gaming.	x	

Types Of Educational Software	Simulation tries to repeat a phenomena of underwater wildlife.		x
Learning Types	Informal learning for interactive stations.		x
Learning Typologies	Cognitive and psycho motor.	x	
Edutainment Applications For Learning By The Use Of Games	Knowledge developed through the content of the game and interactive product. Indirect learning.		x
Educational Game Types	Simulation games, Memory games, Eye/hand coordination.		x
Carrying Ludic Value And/Or Scaffolding Attributes	Carries both attributes with inviting mechanics.	x	
Interaction Types	Single touch screen kiosk. Active.		x
Free-Choice Learning	FCL as a mode of informal leaning enables the user to navigate through the content as they please creating a unique path for every user.	x	
Use Of Sound	Basic sound effects to enhance interaction.	x	
Cognitive Development Piaget	Maturation, experience, emotions, adaptation.	x	
Evaluating Digital Learning From Pedagogical Perspective	Interaction, product, interface design.	x	

Storytelling	The software is designed to guide the user all through the information transfer process while transmitting a social awareness fact. The unique navigation method every user chooses to follow gives the possibility to visualize the content in many different sequential paths.	x	
Principles Of Interaction	Consistent system, consistent interface, user guidance, user diversity, recoverability.		x
Interactive Features Of PD	Encourages dialogue between user and product, becomes cohesive when the user uses the product.		x
5 Dimensions İn An Interactive Product	Location Based Interaction Supporting single user product.		x
Product Quantity	1 in the Black Sea Region.		

Table 4.2. Arc literature evaluation.

4.5.3 Abbys

Two interactive touch tables have been placed together in the underwater observatory area. The first one is dedicated to angler fish and the second one is a viper fish application. Several light boxes adorned with graphic visualwork surrounds the area giving a stronger feeling of being in an underwater observatory representing fake screens. Physical models of the above mentioned fish also decorate the area adding up to the dimmed light which gives a surreal hue to the space. The console Figure 4.10, consists of light boxes and touch screens mounted on the wall.

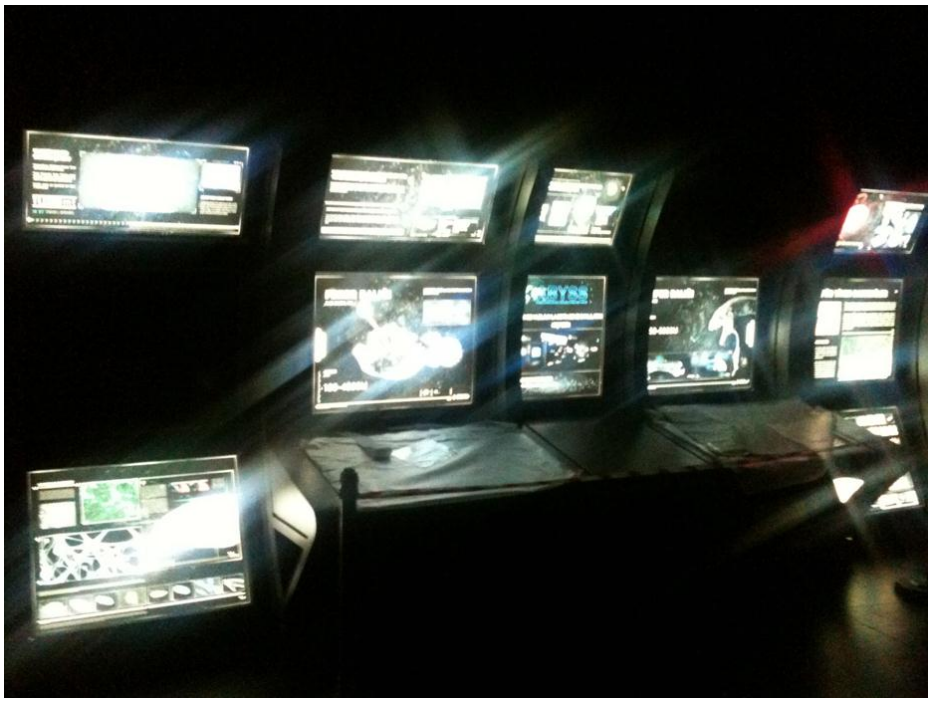

Figure 4.10. Observatory user console.

There are two multitouch tables in which a viperfish and an angler fish content with interactive properties has been placed and react to touch providing information as seen on Figure 4.11.

Figure 4.11. Abbys touchtable.

The hardware configuration of the system is a console with mounted lightboxes and 2 separate 42” Multitouch screen with 2 computers. The casing is a tailor made table with integrated multitouch screens and dashboard surrounded by light boxes according to ergonomic standards. The Table 4.3. reviews the interactive product according to the literature.

Table 4.3. Abbys literature evaluation.

		UCD	LCD
Types Of Edutainment	Edutainment to give experiences presented with experience like simulations. (virtual mobility).		x
Target Group	Motivation oriented; users having same interest regardless of age, present knowledge etc.	x	
Recognizing Edutainment	Location based edutainment sub category participatory and interactive as well as edutainment by purpose and content consisting of informal education which is to give experience like simulations.	x	
Edutainment By Type Of Media	İnformation oriented simulations, earth animations and fish base.	x	
Types Of Educational Software	Simulation tries to repeat a phenomena showing underwater habitat.		x
Learning Types	Informal learning for interactive stations. Gives information about the characteristics of the fish.		x
Learning Typologies	Cognitive and psycho motor	x	
Edutainment Applications For Learning By The Use Of Games	Knowledge developed through the content of the game and interactive product. Indirect learning.		x
Educational Game Types	Simulation games, Memory games, Eye/hand coordination.		x

Carrying Ludic Value And/Or Scaffolding Attributes	Both.	x	
Interaction Types	Multi touch screen kiosk with interactive 40" table. Active.		x
Free-Choice Learning	FCL as a mode of informal leaning enables the user to navigate through the content as they please creating a unique path for every user.	x	
Use Of Sound	Natural sound effects to enhance interaction.	x	
Cognitive Development Piaget	Maturation, experience, emotions, adaptation	x	
Evaluating Digital Learning From Pedagogical Perspective	Ease of use, ergonomics, graphic layout, Interaction, Product, Interface Design.	x	
Storytelling	The software is designed to guide the user all through the information transfer process while transmitting a timeline based ecological story. The unique navigation method every user chooses to follow gives the possibility to visualize the content in many different sequential paths.	x	
Principles Of Interaction	Consistent system, consistent interface, user guidance, user diversity, recoverability.		x
Interactive Features Of PD	Encourages dialogue between user and product, becomes cohesive when the user uses the product.		x

5 Dimensions İn An Interactive Product	Location Based Interaction Supporting Multi user product.		x
Product Quantity	2, underwater observatory.		

Table 4.3. Abbys literature evaluation.

4.5.4 Virtual habitat

The gesture recognition system functions according to the the fish responses based on the movements of the users. If the children move too fast, the fish respond by hiding and if the children slow their movements the fish re-enter the active area defined by the projection. The movement patterns of the fish are random and very realistic. Children are amazed by the natural response the fish give to their movements as seen in Figure 4.12.

Figure 4.12. Habitat children interactive gameplay.

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The 3m x 4m application is in the Atlantic area for the kids to enjoy. The system functions on gesture recognition system through Kinect and a projector. The software consists of an AI manipulating the fish. The Table 4.4 reviews the interactive product according to the literature.

Table 4.4. Virtual habitat literature evaluation.

		UCD	LCD
Types Of Edutainment	Edutainment to give experiences presented with experience like simulations. (virtual mobility).		x
Target Group	Age oriented; users having similar ages.	x	
Recognizing Edutainment	Location based edutainment, sub category participatory and interactive as well as edutainment by target group including age and motivation oriented.	x	
Edutainment By Type Of Media	Information oriented simulations, interactive virtual fish animations with generative rendering capabilities and AI.	x	
Types Of Educational Software	Simulation tries to repeat a phenomena showing a school of fish in a their virtual habitat responding to user interaction.		x
Learning Types	Informal learning. Pre-school and elementary school educational content.		x
Learning Typologies	Cognitive and affective.	x	
Edutainment Applications For Learning By The Use Of Games	Indirect learning. Learning as a result of tasks simulated by the content of the games.		x
Educational Game Types	Simulation games, Shooting, Eye/hand coordination.		x

Carrying Ludic Value And/Or Scaffolding Attributes	Primarily Ludic value enhanced application with a thin layer of scaffolding.	x	
Interaction Types	Floor projection. Active.		x
Free-Choice Learning	FCL is supported by the random scenarios generated by the AI.	x	
Use Of Sound	None.		
Cognitive Development Piaget	Motivation, emotions, adaptation	x	
Evaluating Digital Learning From Pedagogical Perspective	Ease of use, interactivity. Interaction, Sensorial, Graphic Design.	x	
Storytelling	The software simulates fish in their natural environment. The random movement of the fish create a wow factor allowing the users to behave according to the current situation.	x	
Principles Of Interaction	Consistent system user guidance, user diversity, recoverability recoverability.		x
Interactive Features Of PD	Encourages dialogue between user and product, becomes cohesive when the user uses the product.		x
5 Dimensions İn An Interactive Product	Location Based Interaction Supporting Multiple users.		x
Product Quantity	1 in the Atlantic Ridge.		

Table 4.4. Virtual Habitat literature evaluation.

4.5.5 Graphic

Graphic visual work was designed for all the areas of the aquarium serving information about the aforementioned areas supporting the edutainment design. The dimensions of the visual works differ depending on the dimensions of the areas. As all the areas carry different characteristics, the graphics reflect these characteristics in unison. The approach to graphic design is clearly visible as seen in Figure 4.13.

Figure 4.13. Black Sea Wall Graphics.

The work is informative and decorative as well as complementary with the interactive products, lighting and of course, the fish tanks. The figure 4.14 shows the graphics applied to the interior of the structure.

Figure 4.14. Grand bazaar wall graphics.

The graphics are CMYK based prints applied to internal walls. The Table 4.5 reviews the product according to the literature.

Table 4.5. Graphics literature evaluation.

		UCD	LCD
Types Of Edutainment	Edutainment to improve users life control presented in visual narrative forms.	x	
Target Group	Motivation oriented; users having same interest regardless of age, present knowledge etc.	x	
Recognizing Edutainment	Location based edutainment sub category spectator and non interactive. Complementary visuals.		
Edutainment By Type Of Media	Graphic.	x	
Types Of Educational Software	None.		
Learning Types	Formal learning.	x	
Learning Typologies	Cognitive and affective.	x	
Edutainment Applications For Learning By The Use Of Games	None.		
Educational Game Types	None.		

Carrying Ludic Value And/Or Scaffolding Attributes	Primarily Scaffolding, learning process allowing a deeper level of learning.	x	
Interaction Types	Wall visuals. Passive.	x	
Free-Choice Learning	FCL is supported by the content given to the guest allowing them to decide and choose which informative visual to observe.	x	
Use Of Sound	None.		
Cognitive Development / Piaget	Social aspects, emotions.	x	
Evaluating Digital Learning From Pedagogical Perspective	Print media, Sensorial & Graphic Design.	x	
Storytelling	The graphic content of each area is being presented in a chronological order as in a comic strip giving all relevant important information to ease the understanding of the underwater life.	x	
Principles Of Interaction	Consistency, user guidance, user diversity.	x	
Interactive Features Of PD	Encourages dialogue between user and product.	x	
Dimensions İn An Interactive Product	Location based visual ınteraction supporting multi users.	x	
Product Quantity	Multiple, all areas.		

Table 4.5. Graphic literature evaluation.

4.5.6 Video

Video content has been prepared and placed in several areas presenting the major characteristics to the visitors. The videos consists of stock footage, motion graphics, animations and info graphics with the narration of the host and music in certain portions of the videos. The stock footage mainly talks about the local species, feeding and mating patterns, properties of the sea water and underwater plant life. In some cases historical events have been mentioned as well as trade routes. The Figure 4.15 shows the 40” video screens embedded inside the graphics.

Figure 4.15. Aegean Video & Graphics.

The video content has been prepared as HD videos with various time durations displayed on 40" LCD screens played by Usb Players. The table 4.6 reviews the product according to the literature.

Table 4.6. Video literature evaluation.

		UCD	LCD
Types Of Edutainment	Edutainment to improve users life control presented in visual narrative forms.	x	
Target Group	Motivation oriented; users having same interest regardless of age, present knowledge etc.	x	

Recognizing Edutainment	Location based edutainment sub category spectator and non interactive as well as edutainment by purpose and content consisting of informal education which is to give experience like simulations.	x	
Edutainment By Type Of Media	Graphic, Video, Wall Visuals, Motion graphics, Stock footage, Info graphics.	x	
Types Of Educational Software	None.		
Learning Types	Formal learning.	x	
Learning Typologies	Cognitive and affective.	x	
Edutainment Applications For Learning By The Use Of Games	None.		
Educational Game Types	None.		
Carrying Ludic Value And/Or Scaffolding Attributes	Primarily Scaffolding, learning process allowing a deeper level of learning.	x	
Interaction Types	Motion. Passive.	x	
Free-Choice Learning	FCL is supported by the content given to the guest allowing them to decide and choose which informative video to watch.	x	
Use Of Sound	None.		

Cognitive Development / Piaget	Social aspects, emotions.	x	
Evaluating Digital Learning From Pedagogical Perspective	Interaction, visual design, video design.	x	
Storytelling	The video content has been produced according to the storyboards prepared with additional narration and music depending on the characteristics of the host area.	x	
Principles Of Interaction	None.		
Interactive Features Of PD	Encourages dialogue between user and product.	x	
5 Dimensions İn An Interactive Product	Location based visual ınteraction supporting multi users.	x	
Product Quantity	Multiple, all areas.	x	

Table 4.6. Video literature evaluation.

4.5.7 Projection mapping

The entrance area video has been prepared to welcome the guests, making this architectural mapping a unique product giving a hint of what to expect. The content of the mapping is an underwater visualization at the entrance of the aquarium giving the feeling of being at a great depth swimming among whales, dolphins, jelly fish and sharks.

The area greets the visitors with a glimpse of the experience prepared, starting with architectural mappings on the internal halls and continues towards the Black Sea region dedicated zone. The Figure 4.16 shows the concept art of the entrance area.

Figure 4.16. Entrance area architectural projection mapping.

The aspect ratio has been prepared in proportion to the architectural properties of the area and the internal mural curves are achieved by the calculation of the thresholds accordingly. A 5000AL projection with a PC and a wide throw lens has been used to highlight the area giving an underwater feeling to the entrance. The table 4.7 reviews the product according to the literature.

Table 4.7. Projection mapping literature evaluation.

		UCD	LCD
Types Of Edutainment	Edutainment to give experiences presented with experience like simulations. (virtual mobility).	x	
Target Group	Motivation oriented; users having same interest regardless of age, present knowledge etc.	x	
Recognizing Edutainment	Location based edutainment sub category spectator and non interactive.	x	
Edutainment By Type Of Media	Decoration oriented simulations, fish animations, motion.	x	

Types Of Educational Software	Simulation tries to repeat a phenomena.	x	
Learning Types	Accidental learning from video content.	x	
Learning Typologies	Affective.	x	
Edutainment Applications For Learning By The Use Of Games	None.		
Educational Game Types	Simulations.	x	
Carrying Ludic Value And/Or Scaffolding Attributes	Primarily Scaffolding, learning process allowing a deeper level of learning.	x	
Interaction Types	None. Passive.		
Free-Choice Learning	FCL is supported by the content given to the guest allowing them to decide and choose which informative visual to observe.	x	
Use Of Sound	None.		
Cognitive Development / Piaget	Social aspects, emotions.	x	
Evaluating Digital Learning From Pedagogical Perspective	Visual & graphic design.	x	
Storytelling	The digital content has been designed to simulate an underwater scenery.	x	

Principles Of Interaction	Consistency, user diversity.	x	
Interactive Features Of PD	Encourages dialogue between user and product.	x	
5 Dimensions İn An Interactive Product	Location based visual ınteraction supporting multi users.	x	
Product Quantity	Entrance area.	x	

Table 4.7. Projection Mapping literature evaluation.

4.6. Discussion

The type of edutainment and target group parameters are very similar in the products which is either motivation or age oriented target group providing experiences in forms of simulations. When focused on the recognizing edutainment factors of the study, all products are location based interactive products. Obviously mentioning interactivity, it does not only mean touch or gesture technologies but refers to the ability of a product to communicate with the user as an experience and information enhancing product. The products strongly differ from each other when it comes to edutainment by types of media as the development, production and implementation method in which the products are designed are very different from each other some being touch systems, others just carrying a visual content not manipulatable by the public just like the types of educational software differences. Learning typologies depend on the method the products provide, making the user perception the most important parameter as in relation with the above mentioned literature. Edutainment Applications for learning by the use of games considered in the literature review depends on a primary factor, which is defined through the technology of gesture recognition or touch controls. The products which are manipulatable by the user are considered as games and as educational game types these products are simulations which increase hand-eye coordination and memory. All products hint or strongly reflect ludic value and scaffolding parameters depending on the content, technology and communication they serve. The interaction types differ in relation to technology based differences as the hardware aids the content defining the product. For FCL, the user preference is the

ultimate goal through the learning process and every user has a diverse path in reaching and absorbing the content. The sound aspects of the products vary depending on local conditions, area factors and products characteristics. Some products have no sound while some have basic sounds and some very complex sounds simulating a natural environment. The Cognitive development factors mentioned by Piaget (1964) have an important place in the literature review as the unique aspects of each product create a unique method in the creation of knowledge which triggers the learning stage. The most common factors of the technology carrying products are maturation, experience, emotions and adaptation while traditional media products are based on social aspects and emotions. This shows that the method in which the information is served defines the creation of knowledge. Observing the products from a pedagogical perspective in terms of learning, links to interaction design in a relation to design disciplines and various forms of design can be clearly seen. Storytelling is one of the basic factors to consider during the product development process as it creates the the initial storyline of the content depending on the content. The storytelling mechanism should be created in such a way that the products should individually and in unison should enhance learning through edutainment without informative overlapping and competition. The area implemented with diverse products are perceived as a single entity with each providing support to one another. The principles of interaction are mainly similar in all products having some differences based of the interactivity and learning values focusing on user diversity and consistency. Suggesting consistency refers to the consistency of information as well as the consistency of the system. The interactive features of PD is mostly similar among all products as all products being manufactured industrially carry the mission of encouraging the dialogue between the user and the product, which can also be defined as user friendly. As mentioned in the study, the interface, graphic design and typography all support the user in the knowledge acquiring phase.

Finally as for the 5 dimensions of an interactive product, the location based product interaction and visual interaction supporting multi users is the key aspect of the products. The hardware and content variation chart can be seen on Table 4.8.

Table 4.8. Hardware & content variation chart.

Product	Hardware	Interaction	Input	Content Data	Multiple User	Location
Kiosk	Touch Screen Pc	Active, Touch-Enabled	Application	Fish Base	Single	All Areas
Abbys	Touch Screen Pc	Active, Touch-Enabled	Application	3d Models	Multi	Underwater Observatory
Virtual Habitat	Projector Pc	Active, Gesture Recognition	Application	Aı Supported Habitat	Multi	Atlantic Rıdge
Noah's Arc	Touch Screen Pc	Active, Touch-Enabled	Application	2d Scene	Single	Black Sea
Graphics	None	Passive	Print Media	Information	Multi	All Areas
Video	Displays Player	Passive	Stock Footage & Motion	Video	Multi	All Areas

Projection	Projector Pc	Passive	3d Generative	Video	Multi	Entrance

Table 4.8. Hardware & content variation chart.

5. CONCLUSIONS

The interactive products in the Istanbul Aquarium provides an alternative, more efficient educative service enhancing the effect of the learning phase that is one of the most important goals in edutainment. The products implemented support teaching according to Piaget's theories and other parameters pinpointed by the literature research play a key role in the communication the Aquarium provides. The analysis methods used in the study focuses on the education and entertainment factors of an edutainment, providing product oriented atmosphere design.

In order to make use their potential as an important community resource and fulfil their educational mission, informal education centers often look towards interactivity to make their exhibits more attractive to visitors and to prompt more engagement in learning. Some types of centers, however, particularly public aquaria, have a difficult task to introduce interactivity to their exhibits because direct interaction with specimens is usually impractical or inadvisable. Therefore the study proposes the use of interactive products as a means of presenting information as an alternative to static conventional presentation methods. The interactive products have several advantages. They use less space and more information that can be tailored and easily maintained and updated. They also permit interactive activities and games running through the same software distributed to different sections of the structure.

A principal feature of science centers has been the development of interactive exhibits and educational programming connected to the idea that learning is an active venture. Interactive devices need to first attract the participant, and then be intuitive enough for successful self-guided operation. Interactive devices can have more than one learning outcome as open-ended, or didactic, following a stepwise process toward the desired learning outcome. Interactive devices also need to be constructed in a robust manner to resist breakage by an over-enthusiastic public. Aquariums, however, have tended to focus on aesthetic components of visitor experiences and been guided more by

interpretive goals than the development of interactive exhibits. Using a design research approach when conceptualizing aquarium environments provides an opportunity to access the impacts that design components have on visitor attraction and engagement. While maintaining the flexibility to continue changing the environment, revealing which design features are crucial and which may be secondary are sequential steps in edutainment. Visitors need to first be attracted to the aquarium environment before they can be engaged as participants. Live animals act as a natural attraction for many people but sometimes even this isn't sufficient. Visitor fatigue can manifest after repetitive experiences, resulting in disinterest or shortened attention spans. This is especially problematic for aquarium design, as the most obvious differences that might attract visitors are the animals themselves rather than changes in the aquarium environment.

Designing unique aquarium environments can help attract and then engage more visitors. Once visitors are attracted to the aquarium, designers need to create an environment that engages the participants for a sufficient time for learning to occur. Designers' central challenge is prolonging engagement time with a positive experience that connects to the participants' current knowledge or interests. Learning outcomes of the participant, in both the cognitive and behavioral domains, need to be assessed to successfully modify the design. Through ongoing assessment, changes in these components can be evaluated and possibly implemented, leading to a more effective design and, ultimately to a progressively more sophisticated way of how people learn. Interactive products and other edutainment materials, such as graphics and videos all are evidence that higher level of learning is obtained looking at the statistics provided by the systems. Interactives have potential to increase overall education about the exhibit by exposing the information to more users and offering the opportunity to measure and calculate the interaction they create. Given their friendly usability, interactive interfaces can be successful tools for delivering information to users, and have potential to increase the educational value of an aquarium visit.

Further research in the effect of these interfaces on visitor learning and enjoyment in the aquarium should be taken into consideration on the influence of different exhibits and audiences. Methods other than self-report measures should also be employed to see if there are any variations in the results. Future studies can also explore the potential of using similar interfaces in other informal education centers, such as history

and art museums. As a final thought, visitors' general interest in using the interface brings to mind the usage of the system over the Internet may provide promising results on extending the aquarium experience beyond the actual visit. Expanding visitor experiences at informal education centers into day-to-day life can help these institutions develop stronger ties with the general public and increase the opportunities for inspiration and life-long learning.

Visitors who are actively engaged and interested in the exhibit are more likely to understand and remember the content presented. However, introducing interactive experiences is still a challenge for many informal education centers, in particular public aquaria. In the case of aquaria, direct interaction with specimens is limited to designated touch tanks and sometimes larger marine mammals. The other specimens need to be protected from visitors and vice versa. Furthermore, many aquariums use printed, graphical panels to present information on the fish tanks. Although graphical panels are standard ways of communicating information in the aquarium, they have several limitations. First, they are static and offer no interaction. Second, the space and time needed to present information limits the amount that can be provided. Third, identifying specimens can be difficult because the panel is separate from the exhibit and can only show generalized representations of the specimens in the tank. Finally, the information is the same for all visitors and it is difficult to accommodate for differences in visitor interests. For these reasons, the majority of fish and invertebrate tanks still remains a passive viewing experience. The question then becomes how to introduce the benefits of interaction to the aquarium, where direct interaction with specimens is not possible.

In conclusion, it is possible to assume that the above mentioned terms regarding education while entertaining provide a more contemporary path to learning. The edutainment systems placed in strategic locations regulate the mass and serve information regarding the relevant area and the aquarium as a unique point of input, content and information providing structure. The product list within the study in comparison according to the literature can be seen in Appendix A. (Edutainment Products Literature Evaluation, see App. A)

The results show various differences among the products from an edutainment point of view. In summary, on the basic characteristics of services through technology the products offer, the products can be classified as :

1) Touch Technology
2) Gesture recognition
3) Graphic Content
4) Visual Content

Briefly, in order to highlight the basic characteristics that define the products, it is necessary to focus on the roles they play according to the literature provided in the study.

It can be said that the gesture recognition and touch technology based products greatly differ from the graphic and visual/motion content based products in terms of edutainment even though placed altogether form the essence of edutainment. The gesture and touch technology providing products mainly differ in the technology containing aspects of the literature review. Even though the products vary in small or large differences, individual functionality and existence in the aquarium carry an important role in fulfilling their role in the edutainment process collectively.

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APPENDIX A : Innova

Istanbul Aquarium, the world's biggest thematic aquarium, with 6,800 cubic meters of water is home to some 1,500 species land and sea creatures. It offers visitors a special thematised and interactive route which gives a rainforest experience using cutting-edge technology.

This giant aquarium project, spread over 22,000 m2 on two floors, needed kiosks placed in front of the aquarium windows to give information about the species on display. The design needed to match the aquarium's thematic style and in terms of its functions it had to be extremely easy to use by all visitors.

Kiosk Innova's INF 130 model was chosen as it matched all the requirements set out by Istanbul Aquarium and 39 kiosks were manufactured for the project. The decision about which kiosk to use was made after meetings both at the aquarium and in Innova's production facilities. Kiosk Innova also designed a special PC configuration for the project, as the standard configuration was not sufficient. Before completing the project, kiosks were re branded and coloured in order to better fit to the atmosphere of the aquarium.

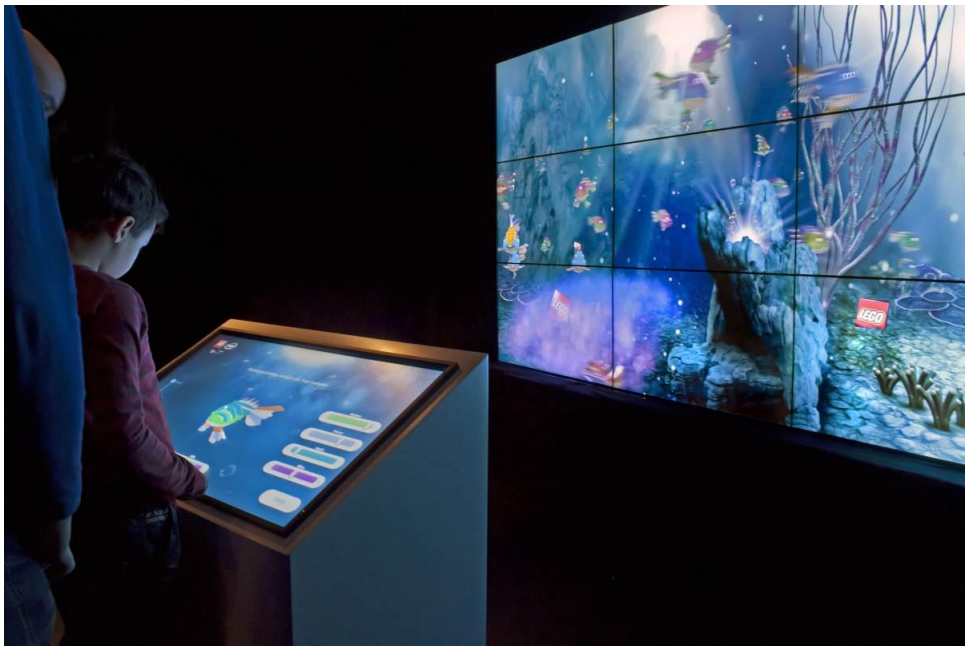
Having started the project in the last quarter of 2010, Kiosk Innova successfully delivered 39 INF 130 model kiosks. With these attractive and practical kiosks that perfectly reflected Istanbul Aquarium's identity, the attraction obtained the high-tech infrastructure it needed to give information about the species it displays to its visitors. Thanks to these kiosks, which have 3D technology capable of bringing an extra level of appeal to the venue and its content, Istanbul Aquarium is now able to offer an interactive experience to its visitors.

Appendix B : Lego World Virtual Aquarium

Intel challenged YDreams to adapt and bring a Lego World version of its Virtual Aquarium to exhibit at the Intel booth in 2012 and again in 2013.
Intel, whose technology is used in Lego Digital Signage as well as other Lego products, has showcased its technology in past editions of Lego World. In 2012 and 2013, Intel invited YDreams to adapt and bring a Lego World version of its Virtual Aquarium (first developed and deployed for shopping center Forum Sintra (Portugal, 2011) and later three MFI Shopping Centers in Germany (2012 & 2013), to exhibit at the Intel booth in 2012 and again in 2013.

The Lego-adapted Virtual Aquarium at the Intel booth enabled Lego executives to test the concept by demonstrating to guests how innovative technologies could be used to promote the classic Lego building brick and simultaneously offer Lego fans new creative and memorable digital experiences.

Lego World 2012 took place in February of that year at Bella Center, Scandinavia's largest exhibition and conference center, located in Copenhagen, Denmark.



Appendix C : Edutainment Products Literature Evaluation.

	Kiosks	Noah's Arc	Abyys	Virtual Habitat	Graphics	Video	Projection	UCD	LCD
Types Of Edutainment	Experience like simulations (virtual mobility).	Experience like simulations (virtual mobility).	Experience like simulations (virtual mobility).	Experience like simulations (virtual mobility).	Edutainment to improve users life control presented in visual narrative forms.	Edutainment to improve users life control presented in visual narrative forms.	Experience like simulations (virtual mobility).		

Target Group	Motivation oriented; same interest regardless of age, present knowledge.	Motivation oriented; same interest regardless of age, present knowledge.	Motivation oriented; same interest regardless of age, present knowledge.	Age oriented; users having similar ages.	Motivation oriented; same interest regardless of age, present knowledge.	Motivation oriented; g same interest regardless of age, present knowledge.	Motivation oriented; same interest regardless of age, present knowledge.		
Recognizing Edutainment	Location based edu participatory and interactive, edu by purpose and content consisting of informal education simulations.	Location based edu participatory and interactive, edu by purpose and content consisting of informal education simulations.	Location based edu participatory and interactive , edu by purpose and content consisting of informal education simulations.	Location based edu participatory and interactive , edu by target group including age and motivation oriented.	Location based edu spectator and non interactive. Complementary visuals.	Location based edut spectator and non interactive, edu by purpose and content consisting of informal education simulations.	Location based edu spectator and non interactive.		
Edutainment By	İnformation oriented	İnformation oriented	İnformation oriented	Information oriented	Graphic.	Graphic, Video, Wall	Decoration oriented simulations		

Type Of Media	simulations, earth animations and fish base.	simulations, underwater animations and gaming.	simulations, earth animations and fish base.	simulations, interactive virtual fish animations with generative rendering capabilities and AI.		Visuals, Motion graphics, Stock footage, Info graphics.	, fish animations. Motion.		
Types Of Educational Software	Simulation tries to repeat a phenomena.	Simulation tries to repeat a phenomena of underwater wildlife.	Simulation tries to repeat a phenomena showing underwater habitat.	Simulation tries to repeat a phenomena simulating a school of fish.	None.	None.	Simulation tries to repeat a phenomena.		
Learning Types	Informal learning for interactive stations.	Informal learning for interactive stations.	Informal learning for interactive stations.	Informal learning.	Formal	Formal learning.	Accidental learning from video content.		

Learning Typologies	Cognitive and psycho motor.	Cognitive and psycho motor.	Cognitive and psycho motor.	Cognitive and affective.	Cognitive and affective.	Cognitive and affective.	Affective.		
Edutainment Applications For Learning By The Use Of Games	Knowledge developed through the content of the game and interactive product. Indirect learning.	Knowledge developed through the content of the game and interactive product. Indirect learning.	Knowledge developed through the content of the game and interactive product. Indirect learning.	Indirect learning. Learning as a result of tasks simulated by the content of the games.	None.	None.	None.		
Educational Game Types	Simulation games, Memory games, Eye/hand coordination.	Simulation games, Memory games, Eye/hand coordination.	Simulation games, Memory games, Eye/hand coordination.	Simulation games, Shooting, Eye/hand coordination.	None.	None.	Simulations.		
Carrying	Carries both	Carries both	Both.	Primarily Ludic	Primarily Scaffoldin	Primarily Scaffoldin	Primarily Scaffolding		

Ludic Value And/Or Scaffolding Attributes	attributes with inviting mechanics.	attributes with inviting mechanics.		value enhanced application with a thin layer of scaffolding.	g, learning process allowing a deeper level of learning.	g, learning process allowing a deeper level of learning.	, learning process allowing a deeper level of learning.		
Interaction Types	Active. Single touch screen kiosk.	Active. Single touch screen kiosk.	Active. Multi touch screen kiosk with interactive 40" table.	Active. Floor projection.	Passive. Wall visuals.	Passive. Motion.	Passive.		
Free-Choice Learning	İnformal leaning enables the user to navigate through the content as they please creating a unique. path for	İnformal leaning enables the user to navigate through the content as they please creating a unique path for	İnformal leaning enables the user to navigate through the content as they please creating a unique	FCL is supported by the random scenarios generated by the AI.	FCL is supported by the content given to the guest allowing them to decide and choose which informativ	FCL is supported by the content given to the guest allowing them to decide and choose which informativ	FCL is supported by the content given to the guest allowing them to decide and choose which informative		

	every user.	every user.	path for every user.		e visual to observe.	e. video to watch.	visual to observe.		
Use Of Sound	Basic sound effects to enhance interaction.	Basic sound effects to enhance interaction.	Natural sound effects to enhance interaction.	None.	None.	None.	None.		
Cognitive Development Piaget	Maturation, experience emotions, adaptation.	Maturation, experience, emotions, adaptation.	Maturation, experience, emotions, adaptation.	Maturation, experience, emotions, adaptation	Social aspects, emotions.	Social aspects, emotions.	Social aspects, emotions.		
Evaluating Digital Learning From Pedagogical Perspective	Interaction, product, interface design.	Interaction, product, interface design.	Ease of use, ergonomics, graphic layout, Interaction, Product, Interface Design.	Ease of use, interactivity. Interaction, Sensorial, Graphic Design.	Print media, Sensorial & Graphic Design.	Interaction, visual design, video design.	Visual & graphic design.		

Storytelling	The software is designed to guide the user all through the information transfer process while transmitting a timeline based fish base.	The software is designed to guide the user all through the information transfer process while transmitting a social awareness fact.	The software is designed to guide the user all through the information transfer process while transmitting a timeline based ecological story.	The software simulates fish in their natural environment. The random movement of the fish create a wow factor allowing the users to behave according to the current situation.	The graphic content of each area is being presented in chronological order giving all relevant important information to ease the understanding of the underwater life.	The video content has been produced according to the storyboards prepared with additional narration and music.	The digital content has been designed to simulate an underwater scenery.		
Principles Of Interaction	Consistent system, consistent interface, user guidance, user	Consistent system, consistent interface, user guidance, user	Consistent system, consiste nt interface , user	Consiste nt system user guidance , user diversity	Consisten cy, user guidance, user diversity.	Consisten cy, user guidance, user diversity.	Consistenc y, user guidance, user diversity.		

	diversity, recoverability.	diversity, recoverability.	guidance, user diversity, recoverability.	, recoverability recoverability.					
Interactive Features Of PD	Encourages dialogue between user and product, becomes cohesive when the user uses the product.	Encourages dialogue between user and product, becomes cohesive when the user uses the product.	Encourages dialogue between user and product, becomes cohesive when the user uses the product.	Encourages dialogue between user and product, becomes cohesive when the user uses the product.	Encourages dialogue between user and product.	Encourages dialogue between user and product.	Encourages dialogue between user and product.		
5 Dimensions İn An Interactive Product	Location Based Interaction Supporting single user product.	Location Based Interaction Supporting single user product.	Location Based Interaction Supporting Multi user product.	Location Based Interaction Supporting Multiple users.	Location based visual ınteractio n supportin g multi users.	Location based visual ınteractio n supportin g multi users.	Location based visual ınteraction supporting multi users.		
Product Quantity	23 scattered in	1 in the Black Sea Region.	2 underwater	1 in the Atlantic Ridge.	Multiple, all areas.	Multiple, all areas.	Entrance area.		

	different areas.		observatory.						
Interaction	Active	Active	Active	Active	Passive	Passive	Passive		

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