TRANSFORMING AUDIENCE EXPERIENCE

TO DESIGN ENJOYABLE EXHIBITION

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Thesis submitted to the University of Nottingham

for the degree of Doctor of Philosophy

January 2018

Abstract

Exhibition is a natural and intrinsic human behaviour for communication; with the coming of the information society and the experience economy, exhibition design has been considered as an effective tool to achieve the target of cultural engagement and economic benefit. This thesis aims to investigate the relationship among exhibition design factors (EDFs), audience experience factors (AEFs) and behaviour data (BD). It uses mixed method to obtain and analyze multi-data, finding and establishing a framework of designing an enjoyable exhibition (FDEE) (Chapter 5).

The thesis discusses human-exhibition interaction (HEI) as an integrated conceptual framework for designing exhibitions, with a systematic literature review based on grounded theory (Chapter 2). There have been 59 EDFs, 18 AEFs, and 14 BD that were explored (Chapter 3). It moves the attention from the interaction among three stakeholders (clients, designers, and audiences) and exhibitions, to the embedded data with EDFs, AEFs, and BD. Quantitative analysis method and exploratory study were refined using analytic software such as NVivo-11, EndNote X8, and a total of 1467 documents are extracted from EDFs while 270 focusing on the AEFs, and these established an interactive and dynamic relationship among EDFs, AEFs, and BD. The results show only few concerns for the study of designing exhibitions in academic publications, and a trend toward human-exhibition interaction (HEI) in the field of exhibition design can be seen, at the both concept and application level.

Experiment 1a and 1b were conducted to identify the EDFs and AEFs perceived by audiences, through a 16 days' field study with an invitation letter from Expo Milano 2015. Over 500 participants from 10 national pavilions took part in the survey. Then it investigated the EDFs and AEFs used by exhibition designers and perceived by clients like governments and enterprises (Chapter 4) with semi-structured interview.

To explore behaviour data, this thesis conducted a field study by using the timing and tracking approach including eye-tracking system, wearable device, and questionnaire, which confirms the interactive relationship among EDFs, AEFs, BD, and EE supported with the quantitative analysis (Chapter 6). The behavioural data were collected and analyzed by using the software ErgoLAB v.2.2, Tobii Pro Lab Analyzer Edition v.1.49, and IBM SPSS Statistics v.22.

This thesis discusses the relationship among EDFs, AEFs and BD, primarily a performance way of transforming audience experience by designing an enjoyable exhibition based on the framework of HEI, and thus improving exhibition designers' and/or clients' better design decision-making (Chapter 7). In conclusion (Chapter 7), contributions to knowledge and future directions of research are highlighted.

Acknowledgement

I would like to express my deep and sincere appreciation to my thesis supervisor, Dr. Liang Xia, for his profound knowledge, limitless support and encouragement throughout my doctoral research.

I would also like to acknowledge my examiners, Dr. Chunlei Chai and Dr. Jun Lu, for their supportive viva opportunity and positive feedback on my thesis. Furthermore, I would like to thank my co-supervisors for their guidance opportunity, Dr. Xu Sun, Dr. Glyn Lawson, and Dr. Patrick Pradel.

I am sincerely grateful for the experiment and study opportunity given by China Corporate United Pavilion (CCUP) that assisted the conduction of the research project in Milano Expo 2015. Acknowledgements go to the College of Science & Technology Ningbo University that I am working there through nine years' teachings and project experience in the field of exhibition design, which assisted me to focus on my PhD education with full-time.

My infinite gratitude goes to my family for their love and continuing supports during the last three years: Zongchen Wang, Shoufen Zhang; I am grateful for all the friends for their efforts in helping me archive this research goal.

And to over 500 exhibition audiences, and other participants, I thank their contribution to this study, as same as a lot of clients, officials, co-students, co-workers and cooperators who have entered and vitalized my PhD research work.

Finally, this PhD thesis presents the research work that I have done at the University of Nottingham, with partial fundings received from Travel Prize in Graduate School, and DC Award (Doctoral Consortium) of CHI 2015.

Contents

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List of Abbreviations

EDFs Exhibition Design Factors

AEFs Audience Experience Factors

BD Behaviour Data

AE Audience Experience

AB Audience Behaviour

EE Enjoyment Emotion

HEI Human-exhibition Interaction

FDEE Framework of Designing Enjoyable Exhibition

GT Grounded Theory

1 Introduction

1.1 Chapter overview

An introduction to this thesis is described in this chapter, which involves its native work started and conducted at the University of Nottingham. It also presents the objective of the study to investigate the relationship among exhibition design factors (EDFs), audience experience factors (AEFs), and behaviour data (BD). Toward this aim, this doctoral research work includes the progress and approaches which were developed based on a mixed method, to capture multi-data for the application of exhibition designers, clients and audiences. Presented is an overview of the concrete studies and development that served as the structure of this thesis.

1.2 The need for exhibition design research

The necessity of this research in designing exhibition is indicated in terms of its related studies, audience experience, China context, information society, experience economy, and design discipline.

***Related research*.** Exhibition design was first discussed as a new discipline in the view of psychology of advertising by Bayer, a designer and researcher from Bauhaus (Bayer 1939, Bayer 1961). In addition, exhibition design has been further investigated with regard to communication (Chen and Ho 2003, Chuan, Kun et al. 2006, Berger, Lorenc et al. 2007). Detailed studies of exhibition design are shown in Chapter 2. The application of exhibition design has been studied in various scenarios from commercial exhibition (Locker 2011) such as shopping center (Joy, Wang et al. 2014) and world fair (Taylor 1963), to cultural exhibition, e.g. museum (Kelly 2012, Schwarz 2016), gallery (Bourdeau and Chebat 2003), aquarium (Nesbitt and Maldonado 2016), and zoo exhibition (Bitgood, Patterson et al. 1988), etc.. These studies gave the evidence of the importance of exhibition design that focuses largely on analyzing design factors in designing exhibitions. Furthermore, studies have entered into audience experience (Falk and Dierking 2012, Roppola 2013) and behaviour study (Solomon 2014, Yoshimura, Sobolevsky et al. 2014) especially in museum context, and few researches tend to provide guidance to exhibition designers and curators based on the design process of exhibition (Lin 2002, Hou 2015). There is a lack of empirical study focused on the commercial exhibition with the characteristics of limited time and field, little theoretical framework presented the systematic meaning and effective tool for exhibition stakeholders including clients, exhibition designers and audiences, lack of direct support based on data analysis for designers with design decision-making, audiences with enhancing experience and clients with evaluating the performance.

Thus, for the emerging design discipline of exhibition design, investigating the relationship among EDFs, AEFs, and BD could in fact be a new researching field.

Audience experience. Prior studies have shown that audience experience, one of the core reasons audiences entering and staying in exhibitions, needing to be enhanced through more effective exhibition design (Dernie 2006, Berger, Lorenc et al. 2007, Falk and Dierking 2012, Roppola 2013, Nesbitt and Maldonado 2016). Different phases of audience experience have different impacts both on audience's memory, decision and behaviour (Falk and Dierking 2012); however, capturing and measuring audience experience accurately is difficult, since it exists in audience's interior and implicit personal context. Exhibition design addresses these issues through developing either physical or digital space for enhancing audience experience, which can be realized through applying EDFs by exhibition designers. Although there are research work processed investigation of capturing audience experience with a visual way for the museum (Forrest 2015), how to seek a measurable way that could provide quantitative and accurate analysis supported by data collaboration tends to be a possible approach. This is the main part of this PhD research work.

China context. UFI[1] indicated that China accounted for the world's largest increased indoor exhibition space (46% of the global) and Chinese audiences to new venues (69%) (UFI 2014). To promote and accelerate the cultural development, China government hosted the Shanghai World Expo 2010 with a total investment of 45 billion US dollars (Balis 2010), and in 2016 the G20 summit in Hangzhou was held to stimulate economic development in China and world (Guoping 2016). Also, a brilliant project of One Belt, One Road (OBOR) was developed by Chinese paramount leader Xi Jinping in March 2015. OBOR focuses on connectivity and cooperation among two large economies in both Europe and East Asia, which emphasize on the pushing and constructing function of exhibition, exposition, conference, festival event, etc. (Lim, Chan et al. 2016). Studies have shown that reasonable exhibition design used in the project can bring about a better enhancement of audience experience, helping to achieve the cultural communications and economic benefits under the China context, which can be traced to hundred thousand years ago (Wu 1958, Pan 1993).

Information society. Exhibition design involves information (Carliner 2003, Li 2005). Information Society defines information in today's world have become core characteristic coving the global business and culture (Webster 2014). It has multi-layers and various components, and is mentioned in the Information Society as Post-industrial Society (Masuda 1980) that there are changing features including

[1] UFI, the Global Association of the Exhibition Industry, which focuses on organizing the world class tradeshow as one of the international exhibition associations.

human behaviour, communication, technology, economic and social structure. Based on the essence of exhibition design, as an effective tool of communicating information and messages, information society can extend its functions in economic and social development through applying exhibition design.

Experience economy. After industry and service economy, Pine and Gilmore (2011) proposed that experience economy, as a new fourth economic offering, has come to the world economy, which can be verified by numerous successful business case such as Walt Disney and Apple. They suggested that '*in the experience economy every business is a stage, and therefore work is theatre*' (p.19). Also named Theatrical Economy, there are four key concepts: Drama, script, theatre, and performance, that focusing on staging an engaging experience to customers in business-to-business (B2B) settings. Companies creating enjoyable experiences '*not only earn a place in the hearts of consumers but also capture their hard-earned dollars and harder-earned time*' (Pine and Gilmore, 2011, p.37), therefore, experience economic is also defined as memorable events which have a lot in common with exhibition (detail presented in Chapter 3). From this point, designing exhibitions should make most events of experience economy more effective by helping companies to reach their targets.

Design discipline. Among the vast subject system with a long history, design is an emerging discipline (Cross and Roy 1989). Design discipline is involved into science, e.g. in February 2016, MIT Media Lab launched the *Journal of Design and Science (JoDS)* aiming to '*open new connection between science and design*'. Compared with other sub-disciplines of traditional design, exhibition design has different objectives (Locker 2011, Bogle 2013, Schwarz 2016). The former centers on satisfying personal needs regarding user/customer, product/system or environment/space, but the latter focuses on the effectiveness of information communication as a central target, which is one main task of studies on exhibition design. Furthermore, the call for exhibition design is along with the appearance of information society and experience economic, and in addition to connect with advanced technology related to exhibition application such as wearable devices, sensor system, intelligent manufacturing technology, virtual and mixed reality, face-recognition and interior positioning system, etc., which is another major research content of designing exhibitions. Thus, exhibition design tends to play an increasingly important role in design discipline by concentrating on both cultural and economic goals.

1.3 Research aims

This research aims to investigate the relationship among EDFs, AEFs, and BD. Throughout the research, guideline and evaluation method were discussed for exhibition design, for example, establishing a framework of designing enjoyable exhibition, based on the data collaboration and effectiveness evaluation. The objectives are shown as follows:

- to identify and analyze EDFs in exhibitions;
- to identify and analyze AEFs in exhibitions;
- to identify the relationship among EDFs, AEFs and BD;
- to provide applied knowledge for supporting:
  - exhibition designers in designing more enjoyable exhibitions;
  - companies in selecting, evaluating and planning their exhibition strategies;
  - governments and public bodies in evaluating and planning exhibition design polices;
  - audiences in interacting with enjoying exhibitions.
- to define a framework of designing enjoyable exhibitions.

1.4 Research questions

The following three research questions are based on literature review (Chapter 2) and personal narrative (nine years' experiences of projects and teachings in exhibitions design) to address the initial research problem '***What is the relationship among exhibition design factors (EDFs), audience experience factors (AEFs) and behaviour data (BD)?***' The first question studies the EDFs and AEFs in exhibitions:

> **RQ1:** What are the EDFs and AEFs perceived by audiences and used by exhibition designers/clients in exhibitions?
>
> - What are the EDFs and AEFs perceived by audiences in exhibitions?
> - What are the EDFs and AEFs used by designers/clients in exhibitions?

The question group investigates the basic story in exhibition design, and audience experience in exhibitions by using literature review and survey method. This provides a solid theoretical foundation for further data collection and analysis. The research process is based on grounded theory (GT) that allows coding various materials including academic literature, project documents and actual projects etc., for exploring related essential factors and relationships. The second question narrows down. It enters into real world application with a theoretical framework HEI

(human-exhibition interaction) to establish an enjoyable exhibition design framework:

RQ2: How can an exhibition be designed to create enjoyment?

- How are enjoyable exhibitions designed by using EDFs and AEFs?
- How can the exhibition design framework be applied to design exhibitions that create enjoyment?

The second question is based on data collaboration and evaluation performance, aiming at providing guidelines and methods to exhibition designers, governments and companies. It is also aimed at studying the framework (FDEE) that allows exhibitions to transform audience experience within the context of an exhibition, following the framework of HEI. The third question then moves on to the stage of the experiment, enabling it to apply wearable devices for collecting behaviour data:

RQ3: How can behavioural data be used to get more reliable and valid data of enjoyment in exhibitions?

- What are the methods, approaches and tools to get reliable and valid quantitative data about enjoyment emotion in exhibitions?
- How can behavioural data be used to understand the impact of EDFs in enjoyment emotion in exhibitions?

This question group investigates the interactive relationship among EDFs, AEFs, and BD in exhibition design. It focuses on collaboration data as a way both for analyzing the relationship among EDFs, AEFs, and BD, and for extending the possibilities of data collection such as wearable devices and eye-tracking facility.

1.5 Novel contribution

As illustrated in Chapter 2 of the literature review, the gap between the existing exhibition design research and practical world is that three stakeholders including clients, designers and audiences, cannot make an appropriate communication in the context of designing exhibition. It is due to three matters: (1) Complicated state that exhibition design is connected with at least three implicit aspects of audience experience, emotion and behaviour; (2) New emerging field that is short of certain theoretical support for guiding exhibition design; (3) Money- and market-oriented that require the more theoretical and practical value of research work in general.

Chapter 2 reveals that the close connection within the context of exhibition design through a systematic and scientific analysis. This helps to bridge the gap between what the essential factors perceived and used by the key three stakeholders are and what the necessity relationship in an exhibition context is, and therefore offers one of the main novel contributions to the research.

To address those questions discussed in Section 1.4, mixed method is used to progress this thesis. The methodology and research methods for collecting dada are illustrated in Chapter 3 (grounded theory and systematic literature review), and developed in Chapter 4 (survey with questionnaire and interview), and Chapter 6 (field study with timing and tracking). Approaches tend to be extended for exhibition design research in previous studies. Nonetheless, mixed method with data collaboration, by using joint technological devices e.g. eye-tracking system, and wearable device has never been applied to explore the relationship among EDFs, AEFs, and BD in exhibition design. This provides a further novel contribution.

Previous studies show that these are no experiment conducted to explore the dynamic relationship among EDFs, AEFs and BD, while researchers in the different fields have carried out investigations focusing on one aspect, in particular the relationship among EDFs and AEFs, or EDFs and BD. It lacks of the whole and systematic investigation on exhibition design and its evaluation, which are discussed in Chapter 7 is another novel contribution.

During interview (Section 4.3), a reality is found that little guidance in exhibition design activities when trying to design better exhibitions based on more effective and objective evaluation. Therefore, this novel contribution connected with research aims is demonstrated in Chapter 5 and 7, which based on an enjoyable exhibition design framework (FDEE, shown in Chapter 5) and developing guidelines for exhibition designers, clients and audiences when selecting an assessable and systematic approach.

Chapter 7 discusses the whole of research work in terms of the novel contribution to knowledge in the field of exhibition design, to help close the loop among three stakeholders to accomplish the goal of transforming audience experience through designing an enjoyable exhibition.

1.6 Phases, methods and methodologies

The PhD study is developed on three main stages illustrated in several sub-phases: 1) Background; 2) Analysis; and 3) Experimentation. The first phase is aimed at providing the background within which a theoretical framework is established and identifying the EDFs and AEFs by grounded theory, stystematic literature review, questionnaire, and interview. The analysis stage then defines a framework of designing enjoyable exhibition through GT. Based on a systematic review (Chapter 2), theoretical summary (Chapter 3), the experimental stage designs the experiment including survey with questionnaire and semi-structured interview (Chapter 4), a framework of designing enjoyable exhibitions (Chapter 5), and field experiment (Chapter 6) through wearable devices, eye-tracking system,

questionnaire, collecting behavioural data and analyzing the relationship among EDFs, AEFs, and BD during audiences' visiting exhibition. Finally, it completes the analysis, modelling and discussion in Chapter 7.

Mixed method is used to investigate the research questions, which includes different methods involved into two aspects, qualitative and quantitative research in general, e.g.: grounded theory, semi-structured interview, questionnaire, and timing and tracking. Creswell (2013) described mixed method research is that '*the combination of qualitative and quantitative approaches provides a more complete understanding of a research problem than either approach alone*' (p.41). The use of mixed method is motivated by the need of internal research questions and the complex nature of exhibition design itself. Specifically, behaviour data measures used in this thesis are summarized in Table 1.1.

Table 1.1. Behaviour data measures.

BEHAVIOUR DATA MEASURE		TYPE	APPROACH	
			Wearable device	Collection and analysis
Postures	Eye-tracking	Tobii Glasses2	•	Tobii Pro Lab Analyzer version 1.49
	Others	Canon Mark II	-	-
Physiological index	HRV	ErgoLAB sensor	•	ErgoLAB version 2.2
	EDA	ErgoLAB sensor	•	ErgoLAB version 2.2
	EMG	ErgoLAB sensor	•	ErgoLAB version 2.2
	SKT	ErgoLAB sensor	•	ErgoLAB version 2.2

Methodologies can help to further study the academic topics systematically (Kothari 2004). A variety of methodologies from a range of disciplines, such as design (including ergonomics), social science (psychology and ethnography) and HCI (human-computer interaction), have been developed in the exhibition design research. In addition, the paper *Enhancing User Experience to Design Enjoyable Exhibition Events* discussed the methodologies of studying exhibition design based on the view of different disciplines (Wang 2015), which published in the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI)[2].

In general, a bottom-up approach is used to explore a theoretical framework, and a top-to-bottom approach is applied to address issues in this thesis (Figure 1.1). A bottom-up approach means that through investigating various amounts of materials and coding with constant comparing, a theory can be developed when it is saturated based on systematic research process (grounded theory). Moreover,

[2] The publication has been rewarded by the Doctoral Consortium Scholarship of CHI 2015, and supported by the Travel Prize of the Graduate School at the University of Nottingham.

the side, a top-to-bottom approach needs to test the variables and hypotheses by empirical data.

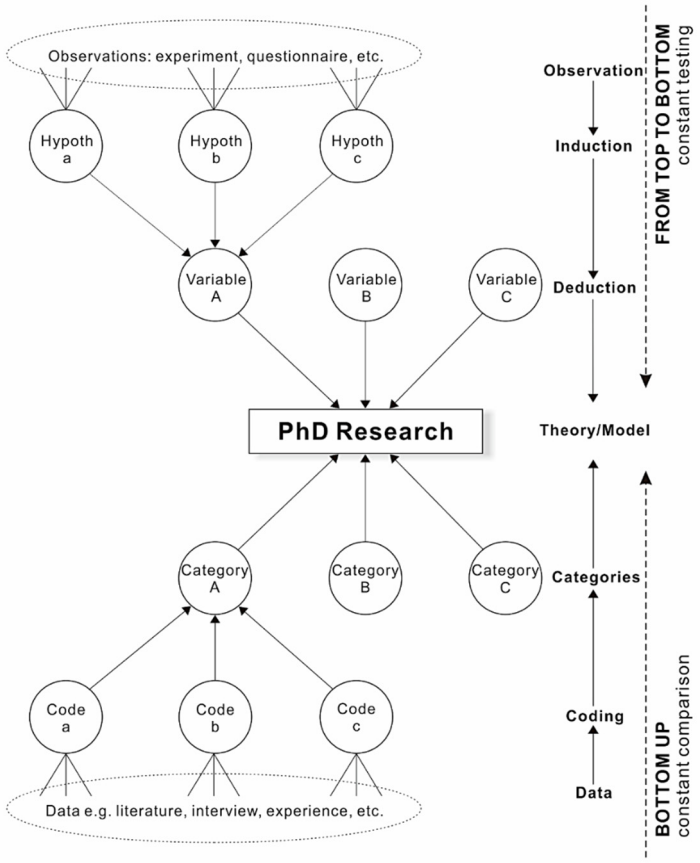


Figure 1.1. General approaches used in thesis.

1.7 Thesis overview

The thesis structure starts from an *Introduction* that includes research aims, research questions and novel contributions. Then it moves to *Literature Review*, which reviews two main research themes including the rules and functions of exhibition and exhibition design. Given the nature of the topic, Chapter 3 conducts a theoretical summary referring to all key academic themes involved in this research, identifying factors and presenting the framework of HEI (human-exhibition interaction). After this, three chapters describe the corresponding research activities. Hereafter, conclusion chapter presents the remaining areas of the thesis. Figure 1.2 below further shows each chapter in detail.

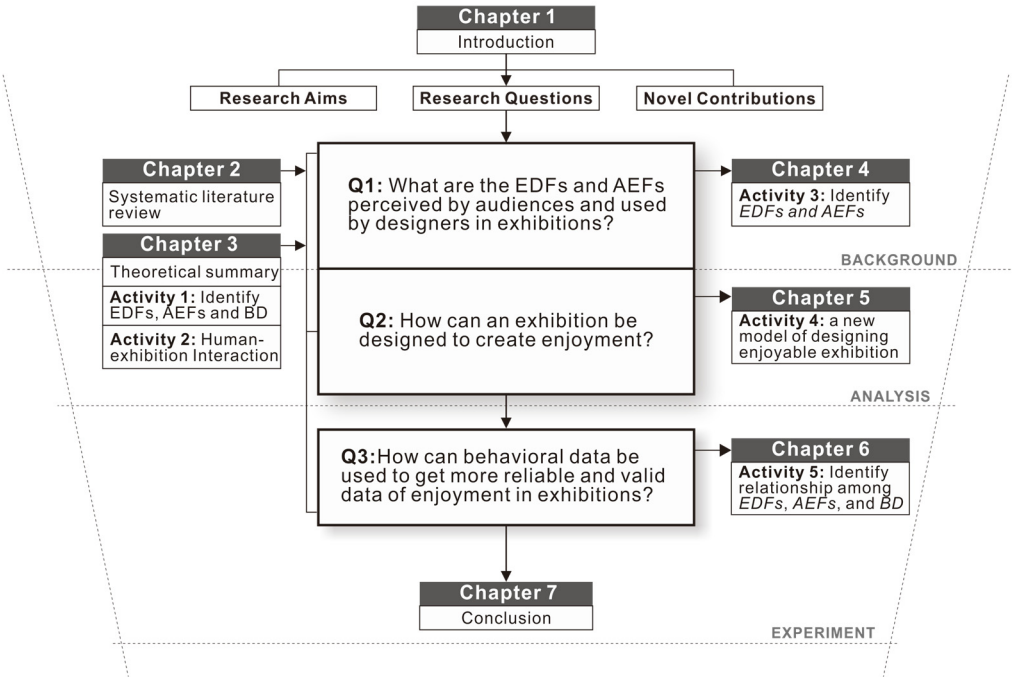


Figure 1.2. Thesis structure.

Chapter 2. Literature review and identifying EDFs and AEFs

Chapter 2 reviews the two main concepts in the field of exhibition design: 2.3 the rules and functions of exhibition, and 2.4 exhibition design. It first provides a review of the concepts related to exhibition design, which is based on a systematic review approach (Section 2.2). In particular, it indicates an academic map to exhibition and exhibition design, the cornerstone of this study, based on a review of previous research such defining exhibition, as communication, categorization, developing exhibition, structure and dimensions of exhibition and mapping, models and theories of exhibition design.

Chapter 3. Theoretical summary – identifying EDFs, AEFs and BD, and HEI

Chapter 3 summarizes three key concepts in this thesis, providing a basic and necessary foundation for framework construction and experiment conduction in the following chapters: 3.2 audience experience for exhibition design, 3.3 enjoyment emotion for exhibition design, and 3.4 behaviour data for exhibition design. Then, GT method is used in Section 3.5 to identify the preliminary exhibition design factors (EDFs), audience experience factors (AEFs), and behavior data (BD) which helps to study, establish the theoretical framework ***Human-exhibition Interaction*** (HEI). Section 3.6 finally discusses the initial work, both concepts and gaps in exhibition design, theory frame and the novel parts in this study.

Chapter 4. Identifying EDFs and AEFs perceived by audiences and used by designers/clients

Chapter 4 presents two investigations that directly enter into the research scenarios, including experiment 1a and experiment 1b. First, it went out into the field of Expo Milano for 16 days to observe, survey and obtain EDFs and AEFs perceived by audiences. Furthermore, and then semi-structured interview was conducted to investigate the EDFs and AEFs used and perceived by both exhibition designers and clients. Also discussed includes research methods and results. Therefore, the relationship between EDFs and AEFs could be proposed in research work. The correlation analysis of EDFs and AEFs perceived by audiences and used by designers or clients was conducted, which provides a further direction to Chapter 6.

Chapter 5. Framework for designing enjoyable exhibition

This chapter describes an available process of how to design an exhibition more enjoyable. In particular, the design process is based on data collaboration and evaluation performance, which include four main stages further introduced in Chapter 5. Based on previous scientific literature, this chapter described its enjoyable integration framework, which illustrated its methods, process and results. The approach was developed with evaluation performance including front-end, formative and summative evaluation; in addition, enjoyment emotion (EE) was embedded into the framework of FDEE.

Chapter 6. Identifying relationship among EDFs, AEFs, and BD (Experiment 2)

Chapter 6 presents the field study conducted in the Art Building at the Ningbo University, aiming at investigating the relationship among EDFs, AEFs, and BD by collecting behavioural data. It was conducted through using timing and tracking approach, including a wearable device, eye-tracking system, and questionnaire. Data analysis was progressed by using the software ErgoLAB. It is also in consonance with the current tendency of the information society and the experience economy. The study therefore confirms the interactive relationship among EDFs, AEFs, and BD.

Chapter 7. Conclusion and future work

The main findings of the research are discussed in Chapter 7. These outcomes mostly include discussion of the new framework of FDEE, involved in data collaboration and evaluation performance in the context of exhibitions. It also presents the limitation of the research undertaken. The overall conclusions are summarized and directions for future work are provided, for addressing research questions from transforming the audience experience to design more effective and enjoyable exhibitions.

1.8 Research scope and note

In the light of the PhD research, focus will be made on the theoretical perspective of design discipline rather than technological exploration, aiming to bridge the gaps among other related fields such as art and design, HCI, social science, etc. This implies that a theoretical framework should be first developed to explain the complex situations and relationships of exhibition design. Then based on science field, data collection and analysis were proposed to research questions. The method of the corresponding question, experiment, validation and limitation will be stated during each study, and further maintained in Chapter 7.

This self-funded PhD study[3] is involved in participants including the designers, clients and audiences in the various exhibitions, and research ethics[4] should be considered whether there are dangerous or aggrieve enabled to experiment participants (Tina, Maxine et al. 2012). All research ethics in this thesis were reviewed and approved by the University of Nottingham's Ethics Committee. Therefore, conducting studies tends to be limited within the scope of ethical considerations.

Research results also pertain to industrial/product design. For further study exploration of this thesis, a wearable device and relevant technologies (detailed in Chapter 6) that based on HEI can reliably enhance audience's experience in exhibitions as well as helping the designers and clients to evaluate or design more effective exhibitions. These are related with industrial/product design and manufacturing, not just with architecture and/or other design disciplines.

[3] The research is also partly funded by the University of Nottingham (Travel Prize), and the Natural Science Foundation of China (NSFC, code. 71401085).

[4] Research Ethics can be checked through UK Policy Framework for Health and Social Care Research issued on 24 March 2016 and ESRC (Economic and Social Research Council).

2 Literature review

2.1 Introduction and aims

This chapter mainly reviews two research themes from exhibition design perspective: exhibition, and exhibition design. Evidence to data indicated that there is a fairly limited research to focus on these two areas. The review of literature in this chapter tends to pave a way for understanding these two themes and following exploration. It first presents the 2.2 review approach applied in this thesis that contains 5 steps. It then examines literature to help narrow and define the research concepts, including 2.3 the roles and functions of exhibition, and 2.4 exhibition design.

2.2 Review approach

A total of five steps of conducting a systematic literature review are presented, the method of which was expended from Valaitis, Martin-Misener et al. (2012). In the following section, we discuss each step that tends to provide how we progress the research questions based on GT method.

Step 1: identifying related research questions and scopes

The PhD study aims to answer what is the relationship among EDFs, AEFs and BD. It includes three sub-questions that described in Section 1.4.

- What are the EDFs and AEFs perceived by audiences and used by designers/clients in exhibitions?
- How can an exhibition be designed to create enjoyment?
- How can behavioural data be used to get more reliable and valid data of enjoyment emotion in exhibitions?

Step 2: identification of relevant studies and development of inclusion/exclusion criteria

In step 2, the development of research strategy was explored; however, there are limited academic publications found through database searching, for instance, with the key words '*exhibition design*' from 2012 to 2016, there are respectively 3130 results presented in Google Scholar and 3576 results in CNKI[5] (searched at 15:00 21st December, 2016). Compared with other design discipline, such as '*industrial design*' around 18400 results in Google Scholar and 26207 in CNKI with the same searching conditions, it indicated that exhibition design is a fresh design discipline and its significance of the study will be interpreted in the next section. Based on this situation, the search approach includes four individual stages: (i) an electronic

[5] China National Knowledge Infrastructure (CNKI) is one of main national information construction projects related to the government department of China e.g. Ministry of Education, Ministry of Science etc.

academic database searching; (ii) an interactive searching; (iii) a manual search of main academic journals; (iv) embedding with personal narrative; (v) searching reference lists of literature reviewed for the related topic.

Especially, a personal narrative was integrated into this search strategy, for example, the researcher directly entered into the exhibition design context from February to June of 2016, conducting a series of design projects and team managements as an executive design director and vice manager at a local exhibition design company, meanwhile as a lecture teaching two undergraduate courses of exhibition design in a local university. These actual activities provided an effective context and meanings in its searching stage helping capture accurate data and research questions, then helping achieve a more comprehensive view of study objects.

Step 3: relevance testing and searchers combined/duplicates

Two levels of literature review were performed to access relevant publications. Firstly, each paper will be quickly checked with the context of Abstract and Conclusion. And then, according to the research questions, the non-related parts of the literature will be eliminated. During the second level, duplicated and incorrect papers will be moved. The criteria of elimination mainly based on:

- not according with the requirements of the research questions;
- clearly not relevant to the study topic;
- not in English or Chinese.

If the relevant testing could not address the research questions, the progress tends to return to step 2 restarting the search. It will be an iterative processed until achieving saturation and the questions related to the study could be figured out in line with the searching procedure.

Step 4 data extracting and coding

In the fourth step, the number of papers (n=2179) related to research questions was extracted from two levels of review were analyzed and coded by applying NVivo 11 (QSR International Pty Ltd.), an analysis program for qualitative data. Every extraction was firstly imported into EndNote for management and analysis, and then imported as an individual document into the software NVivo.

Step 5 checking, summarizing and reporting the results

There are totally 1061 nodes of exhibition design, 698 nodes of audience experience which are recorded in NVivo as examples. The scope of this study relates with different disciplines, for example, it can focus on three fields: Art, Social Science and HCI (human-computer interaction) (Wang 2015), and it also relates with Design, Architecture, and Engineering, etc.; meanwhile, each main

discipline contains branch disciplines. The reason for conducting the review approach is due to a fact that exhibition design itself is not only a new developing subject that can learn by looking at other disciplines, but essentially it also is cross-disciplinary oriented from the real-world experience and requirement from practical projects.

2.3 The roles and functions of exhibition

This section discusses the meaning of exhibition in this thesis. It first reviews its definition which includes its categories particularly in commercial and cultural exhibition, and the developing exhibition to HEI, and then moving on to the structure of exhibition. Finally, dimensions of exhibition are presented in Figure 2.8.

2.3.1 Defining exhibition

The term exhibition has multi-layer meanings and explications. Exhibition can be considered as an efficient medium of communication (Hughes 2010, McKenna-Cress and Kamien 2013); new space of transferring knowledge (Reinhardt and Teufel 2010); a special learning context with free choice (Miles and Alt 1988, Ciamarra 2013), and a tool of persuading or stirring consumer's purchasing behaviour for higher quality design in products or services (Cunningham and White 1974, Shaowen 2013). Moreover, exhibition is a temporary nature, innate activity and daily life connecting with social, cultural and economic aspects (Bayer 1961, Association 1989, Dernie 2006, Zhang 2009, Hou 2015), which tends to be a closed system for information interaction with limited time and space. Some definitions are described below in different points:

Cunningham and White (1974) pointed out that exhibition was a kind of marketing activities for companies with communication, which was also discussed by Shaowen (2013);

Association (1989) argued exhibition as display which was an approach of communicating ideas and information. Humans had many channels and methods of sharing ideas and disseminating information, and exhibition is one form of them.

Hooper-Greenhill (1999) regarded exhibition as an event limited in time and space where messages were created and transmitted, therefore, exhibition was a closed system including a complex information system and specific communication pattern;

Falk and Dierking (2000) said exhibition was sensory and intellectual experience. As the tool of communication, exhibition can influence audiences' thoughts, feelings and learning (Falk and Dierking 2012);

Dean (2002) described exhibition as '*a comprehensive grouping of all the elements (including exhibits and displays) that form a complete public presentation of collections and information for the public use',* and *'a means of communication*' (P.177); as a verb, exhibition could be viewed as '*the act or fact of exhibiting collections, objects, or information to the public for the purpose of education, enlightenment, and enjoyment*' (P.177).

Byers (2008) stated that although exhibition was a display with various components and types, it could be considered as three-dimensional mediums of communication, experiences rather than products. But exhibition is not a neutral mean of communication due to that the meaningful message will be shaped with purpose.

Suzanne, Hourston et al. (2012) noted that exhibition involved a performativity quality where audiences were regarded as a moving and sensory body. Therefore, audiences would experience exhibitions on a visual, tactile and emotional level with corresponding visiting behaviour, which was different with experience in other media such as book and film focusing on intellectual and interpretative level. It allows audiences to form a lasting memory.

Ciamarra (2013) indicated that as a special tool for learning, exhibition provided a narrative way to understand the complicated issues; meanwhile, as a place exhibition embraced emotions and reason together with harmony.

Roppola (2013) considered exhibition was complex spaces based on six aspects: it could be conceived of as experience, learning context, drama theatre, warehouses with cultural and natural exhibits, '*two-, three- and four-dimensional storytellers and sites*' (p.4) for leisure activity.

McKenna-Cress and Kamien (2013) noted exhibition as a focused contract between clients and audiences. As a result, exhibition should pay attention to audiences' needs with an engaging and accessible environment, which would be realized by emotional goals and experiential methods. Additionally, it needed to be noticed with three features: real stuff (objects/collections), authentic experience (internal and external) and social space when regarded exhibition as a tool of communication.

Bollini and Borsotti (2014) found that exhibition was a frontier and experimental design field mixed with cultures and socials, but more transforming to interaction connecting with audiences. Besides as a collection space, exhibition was evolving to focus on the mutual relationship

between audiences and exhibits by an experimental approach, and more concerning on audiences (Bollini and Borsotti 2016).

Forrest (2015) defined exhibition was '*object displays and/or assemblages of exhibits on a given topic or theme*' (p. xvi). Moreover, the difference among exhibitions was becoming blurred due to a fact that from display to experience was the new roles of exhibitions. He considered exhibition as a '*text*' (p.23) based on the view of semiotic and linguistic, and therefore exhibition is a specific dimensional space with constructed meaning in which space is regarded as a language and grammar. Exhibition as the channels of communication, three types were described: spatial channels, narrative channels and multimodal/multimedia channels.

Hou (2015) mentioned that as a part of daily life, exhibition created narratives aiming to effective communication with the audience. It was achieved through some fundamental factors such as audience experience and storytelling. The gap between audience experience and exhibition should be filled by the narrative/storytelling method. Whether exhibition communicating with audiences for the relevant themes and products, or a conceptual concept and social environment, exhibition is a new language.

Kim and Lee (2016) claimed that with the extent role of exhibition, it had been applied as a '*communication medium*' (p.15) in various fields. Exploring means of designing exhibition should be emphasized for more communication that is effective with audiences including their attention and movements, and exhibitions such as exhibition element.

The International Organization for Standardization (ISO) defines exhibition scope in relation to individual and entity, type of event, physical item and miscellaneous (ISO, 25639-1:2008). A doctoral research work at the University of Queensland concluded that transforming from displays to experience tended to be a new role for exhibitions (Forrest 2015), this trend of which also was presented by other studies such as Byers (2008) and Falk and Dierking (2000). Some researchers have proposed that exhibition is the notion (method, form) of communication as a medium (Dernie 2006, Berger, Lorenc et al. 2007), which relates to the communication theory. In fact, communication theory also has been applied to explore exhibition design that will be further illustrated in the next section. However, no internationally-recognized definition of exhibition exists.

2.3.2 Exhibition as medium of communication

For exhibitions, communication is a natural behaviour of human beings. Although there are various theory models, it considers communication occurs needing four essential ingredients (Griffin and McClish 2011): Source-message-channel-

receiver. The message is medium (Baran and Davis 1987, Griffin and McClish 2011). According to the book *Introducing Communication Theory: Analysis and Application* (West and Turner 2006), medium can include message and channel. Hence, in the context of exhibition, it can be summarized with three basic factors arousing communication progress: **Client-exhibition-audience**. Exhibition is regarded as the medium and channel aiming to transform the message between clients and audiences. Whittle (1997) reported that the focus of exhibition communication model had transformed from audiences, to exhibits, to clients, and then to personal meaning-creating or enhancement for audiences. In general, the communicated message requires an entity served as a carrier to the receiver from sender with information or content (Li 2005). Forrest (2015) mentioned that exhibition was a special communication medium with three-dimensional and narrative-creating environment in time and in space. However, Chuan, Kun et al. (2006) proposed the designer as the transmitter was ignored in the communication model, because most of them all concerned the client/source (sender) and the audience/receiver (receiver), or the interactive relationship among them, which is further described in Section 2.4.

Analogy that exhibition is repeatedly linked to other objects such as book, theater and film is preferred and this has been shown in many studies. Table 2.1 summarizes the results described as following. Mediums like film focus on transforming message by narrative or storytelling techniques. Some researchers argued that significant differently with other medium, exhibition is considered as a three-dimensional environment with dynamic time and sequence space allowing free-choice and self-decision behaviour such as moving, looking, touching and smelling, which tends to provide more far-reaching effects on emotion and memory through interaction between exhibitions and audiences (Bal 2007, Suzanne, Hourston et al. 2012, McKenna-Cress and Kamien 2013, Hou 2015). Yet all mediums have their strengths and weaknesses. For example, Falk and Dierking (2012) argued that the traditional exhibition specialized in communicating concrete reality but inefficient in transforming abstract meanings; therefore, multiple forms of media including films and dramas were commonly seen and applied in exhibitions (Lin 2002, Hughes 2010).

Table 2.1. Exhibition compared with other mediums.

		BOOK	THEATER	FILM	GAME	EXHIBITION
Based on Communication Theory	**Medium type**	Linear medium	Linear medium	Linear medium	Non-linear medium	Non-linear medium
	Main aim	Information	Entertainment	Entertainment	Entertainment	Information, entertainment
	Starting with	Outline	Script	Script	Script	Content
	Basic unit	Chapter	Theme	Theme/scene	Scenario/theme	Theme
	Sender	Publisher	Troupe	Producer	Enterprise, Government	Enterprise, Curator, Government
	Transmitter	Writer	Director	Director	Game designer	Exhibition designer
	Receiver	Reader	Audience	Audience	Player	Audience
	Receiver type	Passive	Passive	Passive	Interaction	Active
	Channel	Writing	Performance	Film-making	Game design	Exhibition design
	Factors	Writing factors: word, sentence, chapter and punctuation	Performance factors	Film-making factors: content, lighting, sound, etc.	Game design factors: scenario, color, shape etc.	Exhibition design factors: content, lighting, etc.
	Time	Unlimited time /depending on audience	Limited time/ several hours	Limited time/90-120m	Unlimited time /depending on audience	Explicit and implicit time /depending on audience
	Space	Unlimited space	Limited space	Unlimited space	Unlimited space	Limited/sequence space
	Technique	Narrative	Narrative	Narrative	Narrative, interaction	Narrative
	Approach to see	Readers are static to read while book is turned forward	Audiences are static to see while the plot of drama is moving forward	Audiences are static to see while the plot of film is moving forward	Players are interacting with game while the scenario of game is moving forward	Audiences are moving forward to visit while the theme of exhibition is static
	Characteristics of seeing	Reading book with static content by eye-moving behaviour	Seeing drama with dynamic content by sitting	Seeing film with dynamic content by sitting	Interacting with game by corresponding behaviours	Visiting exhibition with static or dynamic content by corresponding behaviours
	Behaviour	Reading	Watching, sitting	Watching, sitting	Seeing, touching, listening, etc.	Seeing, touching, listening, smelling, etc.
	Dimension	Two-dimensional including emotion and behaviour	Three-dimensional including time, space and emotion	Three-dimensional including time, space, emotion	Four-dimensional	Multi-dimensional including time, space, message, emotion and behaviour
	Supported literatures references	Bayer (1961), p.276; Association (1989), p.182; China Agricultural Exhibition Association (1990), p.172; Carliner (2003), p.73; Lin (2006), p.2; Bal (2007), p20; Hughes (2010), p.130; Locker (2011). P.56; Falk and Dierking (2012), p.102; Macleod, Hanks et al. (2012), p.291, p.xxi; McKenna-Cress and Kamien (2013), p. 278, p.290; Hou (2015), p.21, p.77; Forrest (2015), p.18; Kim and Lee (2016), p.16.				

Exhibition shares common features with other mediums especially with film, theater and book (Table 2.1). For instance, most of them are trying to provide an experienced space and time using the power of narrative and connecting with memory (Abbott 2008, Suzanne, Hourston et al. 2012, Hou 2015). However, several differences are worth noticing: 1) Exhibition contains other mediums. In *Computers as Theater*, Laurel (2013) described an example that '*a new medium begins by consuming old media as its content*' (p.158). For transforming message more effectively, exhibition therefore tends to apply various mediums from film to virtual reality along with the advances of technology; 2) Exhibition as a social and cultural medium. Social and cultural context are involved into the contextual model of learning, which are used to analyze the interaction and experience between audiences and exhibitions (Falk and Dierking 2000); 3) Exhibition as a free-choice and self-decision medium. McKenna-Cress and Kamien (2013) reported audiences could decide their own visiting-path depending on personal requirements and interesting, when they move through designed exhibition space. It is unlike other mediums that have to follow the choreographed narrative by the director of the film or writer of the book; 4) Exhibition allows interaction with behaviour. This likes game, but exhibition provides a more interactive environment where audiences can use various behaviour e.g. look, touch, smell and listen and fully encouraging and arousing their five-senses (Falk and Dierking 2012, McKenna-Cress and Kamien 2013); 5) Exhibition is multi-dimensional. Many studies mentioned that exhibition is a three-dimensional environment (Lin 2006, Mortensen 2011, Suzanne, Hourston et al. 2012), however, exhibition involves more dimensional factors (Section 2.3.6), which is the main character difference with other mediums such as film, book and theater.

2.3.3 Commercial exhibition and cultural exhibition

Various classifications are found in the field of exhibition (shown in Table 2.3). To some extent, exhibition can be divided into commercial exhibition and cultural exhibition in general (Locker 2011, Suzanne, Hourston et al. 2012). However, it is noted that the separation of exhibitions is blurred with commercial exhibition and cultural exhibition all sharing common features and mutual effects as presented in Table 2.1. Kolter and Kolter (1998) discussed the transformation between audiences as customers and curators as marker at museum in the view of marketing. Their academic book *Museum Strategy and Marketing: Designing Missions, Building Audiences, Generating Revenues and Resources* was translated various editions with Italian, Spanish, Korean and Japanese, and supported by the Smithsonian Institution[6] and other USA museums. Locker (2011)

[6] The institution was founded in 1846, as the world-leading largest museum, education, and research complex with 19 museums and the National Zoo, with the mission '*for the increase and diffusion of knowledge*'.

argued that whether in nature, communicating a story in three-dimensional space tended to be the link between commercial and cultural exhibitions. Such a change is provoked in two aspects: one is due to the commercial pressures, cultural exhibitions such as museum have to find a way attracting more audiences with other entertainment environments including cinema or playground; another is because the new generation of audiences as the role of customer and under the effects of new technology are demanding for not only better visiting and services, but more experiences (Dernie 2006). According to Macdonald (2011)'s book *A Companion to Museum Studies*, commercial exhibitions like shops are tending to be museums, one of the cultural exhibition; museums are more like shops – places for providing commercial functions. In this respect, Victoria & Albert Museum, originated from the first world's exposition held in the United Kingdom, offered a good example with the exploration in commercial aspects such as developing the shop and restaurant (McPherson 2006). Israel researchers investigated 119 participants, and stating that enjoyment emotion can be experienced in commercial environment like mall as interactive cultural exhibition such as the museum (Gilboa and Vilnai-Yavetz 2013).

Commercial exhibition is more focusing on economic objective within the narrowed customers/audiences rather than just the general public (audience), which also decides that exhibition design should primarily service and satisfy the commercial interests (Burns 1969). Its communication progress can be corresponding improved as: **Client-exhibition-customer/audience**. As a result, commercial exhibition helps drive the world economic growth with multi-billion dollar business (Locker 2011). As one of important role in commercial exhibition, Herbig (1994) reported that '*bigger companies attend more trade shows than smaller companies*' (p.167) due to six requirements: 1) Identifying prospects, 2) Servicing for live customer/audience, 3) Promoting products, 4) Promoting and establishing company branding, 5) Collecting competitor information, and 6) Selling services or products. However, he also pointed out that it lacked quantitative research and calls for evaluation for enhancing the effectiveness of trade show (Herbig 1994). Although cultural exhibition such as museum blurs its boundary with commercial exhibition, Falk and Dierking (2012) considered cultural exhibition would try to strengthen the educational message of the museum by means of commercial exhibition.

Whether commercial or cultural exhibition they all are influenced by the power of experience, and meanwhile, commercial exhibition directly has the connection with commerce and economy that also involved in the field of cultural exhibition. This is the reason why this PhD study narrows its scope focusing on the classification of commercial exhibition and cultural exhibition.

Table 2.2. Blurring of commercial and cultural exhibition.

			BLURRING			
Commercial exhibition	**Characters**	**Sources**	**Its meaning**	**Characters**	**Sources**	Cultural exhibition
	Means of communication between clients and customers	Cunningham and White (1974)	Cultural exhibition (museum) meets deficits and needs to use commercial exhibition for success (W. A. Burns, 1969, pp.164-165).	Origin from religions such as ancient temple	Liu (1996)	
	Social activity including connecting with key businessmen and providing leisure	Cunningham and White (1974); Shujuan (2006)	In developing cultural exhibition (museum), audiences have being shifted to customer (H.-c. Chen & Ho, 2003, p.9).	Informing the public and changing attitudes and behaviours	Dean (2002)	
	Gathering commercial information	Herbig (1994)	The Convergence of Commerce and Culture: shops are more like museums while museums are more like shops (Macdonald, 2011, p.545).	Means of communication between clients and the public providing informal learning and reflection experience	Dean (2002); Chuan, Kun et al. (2006)	
	Selling, introducing and promoting products and services	Dean (2002); Locker (2011)	Commercial exhibition has the power of experience in museum such as gift shop, restaurant and food (Falk & Dierking, 2012, pp.170-171).	Supporting audiences' personal meaning-making as a societal environment	Macdonald (2007); Falk and Dierking (2012)	
	Compete with others as Business-to-business exhibition	Hughes (2010); Shaowen (2013)	Both commercial and cultural exhibition are becoming customer (audience) focused with broadening leisure section (Forrest, 2015, p.32).	Engaging with history, conservation, preservation and education	Locker (2011)	
	Communicating brand	Dernie (2006); Hughes (2010)	Commercial exhibition/mall tends to be museum-like (cultural exhibition) (Forrest, 2015, p.43).	Collective material culture of societies	Locker (2011)	
	Economic-directed and market-directed	Locker (2011); Chen (2013)	Economic imperative and market-derived help cultural exhibition/museum change to commercial exhibition (Forrest, 2015, p.61).	Communicating meaning with collections and knowledge	Chen (2013); Ahmad, Abbas et al. (2014)	
	Maximizing sales and profits	Forrest (2015)	Servicing as leisure-going activity is involved in to cultural exhibition/museum (Forrest, 2015, p.62).	More complex in assessing criteria than commercial exhibition	Forrest (2015)	
	Common characters					
	Both commercial and cultural exhibition are 'the idea of communicating a story in three-dimensional space'. p.15				Locker (2011)	
	From display to experience. pp.15-16				Forrest (2015)	

2.3.4 Developing exhibition to HEI

The term exhibition covers broad aspects (shown in Table 2.3). From time such as permanent or temporary, to scale such as display or world exposition, or to categories such as trade fair, museum, gallery, visitor center, historic house, landscape interpretation, and park, they all can be categorized into the area of exhibition (Berger, Lorenc et al. 2007, Locker 2011). Along with the emerging and increasing market in global, MICE is proposed to describe exhibition industry that involving meeting, incentive, convention and exhibition (McCartney 2008, Whitfield, Dioko et al. 2014). Essentially Locker (2011) stated that each exhibition was a specific event by telling multi-layers stories with interpretation and narration, allowing effective communication with interactive participation and enjoyment experience (Liu 2011).

Table 2.3. Exhibition categorization.

Exhibition categorization	Sources
Commercial exhibition, educational exhibition, cultural exhibition, museum, art exhibition, street-window display, trade fair	Bayer (1961)
Dynamic mode, automation mode, operand mode, interactive mode	Miles and Alt (1988)
Emotive exhibition, didactic exhibition	Belcher (1992)
Structured exhibition, unstructured exhibition	Falk (1993)
Object-based exhibition, theory-based exhibition, interactive exhibition	Lin (2002)
Object-oriented exhibition, concept-oriented exhibition	Dean (2002)
Narrative space, performative space, simulated experience space	Dernie (2006)
Museum, history museum, science museum, art museum, children museum, public center, visitor center, corporate museum, institutional center, parks, heritage center, botanical garden, trade show, showroom, traveling exhibition	Berger, Lorenc et al. (2007)
Trade fair, brand experience, themed attraction, world exposition, museum gallery, visitor center, historic house, landscape interpretation, art installation	Locker (2011)
Model+ video (M+S) exhibition, model (M) exhibition, video (S) exhibition	Wu, Hu et al. (2013)
Product-oriented exhibition, process-oriented exhibition	Wasserman, Hayde et al. (2015)
Object-based exhibition, information-based exhibition	Kim and Lee (2016)

Getz (1997) considered exhibition as one type of events under the developing background of globalization and experience economy. Event has specific space and time with targeted aims and planned experience, and especially to event experience, which is entirely different with everyday life that also is the reason why people choose to participate events or exhibitions (Getz and Page 2016). For example, Germany researchers investigated the relationship among events, brand and shopping experience in a commercial environment, which presented that event as a prompting tool had an influence on customers' enjoyment, experience such as satisfaction and attitude toward ration brand (Leischnig, Schwertfeger et al. 2011).

Another concern reported by Getz and Cheyne (1997) was that special event was regarded as the tangible product with the example of mega-events such as Olympics and World Fairs, which also was further reported by Roche (2002) that discussing mega-event's three features: dramatic character, mas popular appeal and international significance. Although event study (shown in Figure 2.1) is a developing academic discipline since 19th century with limited literatures (Getz 1997), related studies find two common aspects which can be borrowed by studying exhibition: experience and meaning, which are the nature of event study connecting with social, cultural, economic, and environmental perspective (Getz 2008, Getz and Page 2016); on the other hand, event study is constructed through learning from other disciplines such as social science, marketing, psychology, consumer behaviour, and leisure and tourism studies (Getz and Page 2016).

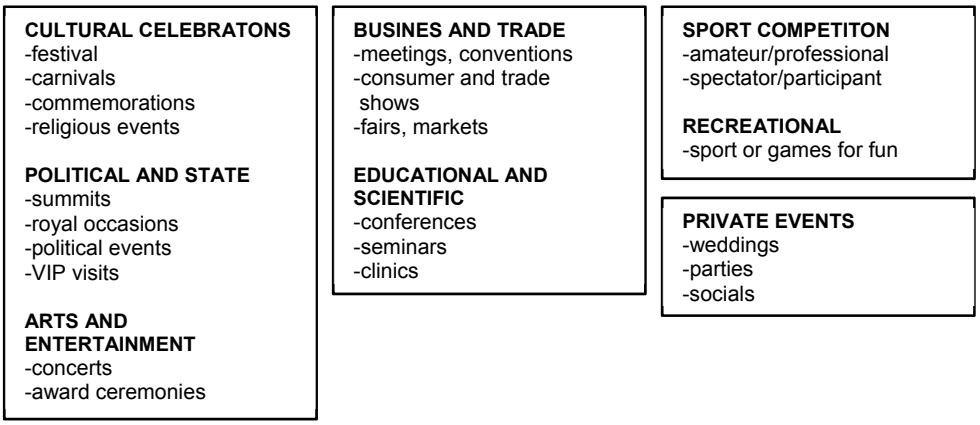


Figure 2.1. Typology of planned events (Getz. 2008).

Technology in HEI

Developing technology shows little doubt in its enormous force on the future of exhibition. Norman (2004) indicated technology as '*a means of communication*' and '*social interaction*' (p.142). Meanwhile, Locker (2011) reported that technology helped exhibition with more effective communication with storytelling, and the isolation problem induced by personal devices application also can be addressed through technological solutions (Gehl 2011), for example, the use of the mobile guide system for exhibition infrastructure described by Lanir, Kuflik et al. (2013). A doctoral research work of Stockholm University in Sweden investigated the technology as the means supporting audiences to have new experiences and learning-related activities in the context of museums (Taxén 2005).

Second reason for applying technology in exhibitions is due to the developing consumer/audience. With the growing use of technologies especially mobile, the trend of consumers/audiences applying technology for consumption-related or visiting-related tasks has been a normal state in daily life from information-searching, sharing to purchase and leisure purpose (Cohen, Prayag et al. 2014). Thus, the new generation of audince/consumer decides technology playing the essential role in future exhibition. Based on the audience-focused view, technology is considered as part of enhancing exhibition experience (Dernie 2006, vom Lehn, Hindmarsh et al. 2007, van Dijk, Lingnau et al. 2012). For instance, Falk and Dierking (2012) mentioned new technologies promised audiences to customize their experiences with the blurring of limitations and boundaries with an example that exhibition contents are presented to the targeted audiences when moving through with Radio Frequency Identification Devices (RFID) tags. McKenna-Cress and Kamien (2013) concluded that audiences were allowed to control their own experience such as they could customize their own sounds and voices involved in an exhibition.

The online and virtual exhibition is developed broadly in recent studies. Balis (2010) reported the first online exhibition, the 2010 Shanghai Expo, as '*an everlasting virtual exhibition for future generations*' (p.17). Liu (2015) concluded that Taobao as the one of online commercial exhibition had become the biggest shopping website in Asia, which was also described by Zhang (2009)'s academic book *Exhibition Research Selected Work of 30 Years in China*. Along with the rapid development of Virtual Reality and Mixed Reality, the potential application in exhibitions is further explored (Adams 1998, Zhu and Tang 2014). Greece researchers concluded that from the audience's view, the virtual exhibition should enable audiences to three tasks:

-navigating in the virtual exhibitions;
-accessing information related with exhibits;
-manipulating objects including rotate, move, assemble or disassemble specific exhibits.

They also indicated four reasons for developing virtual exhibitions, that was, lacking space, simulating environment (that is on longer exist today, being damaged and needing reconstruction, or not being easily experienced), presenting an unsafe or remote environment, and mobile exhibition (Lepouras, Katifori et al. 2004).

Other technologies applying for exhibition were reported such as computer and new media (Dean 2002, Zhang and Zhang 2015), cloud computing (Hu 2012), smart materials like digital screen (Gomez, Popovic et al. 2006), augmented reality (Sylaiou, Mania et al. 2010, Choi and Choi 2014), sensor (Lanir, Kuflik et al. 2013, Yoshimura, Krebs et al. 2016), robot (Burgard, Cremers et al. 1998, Yamazaki, Yamazaki et al. 2012) and wearable technology (Picard and Healey 1997, Ueoka, Hirose et al. 2001). Philips Research Laboratories Eindhoven in the Netherlands described the relationship between technology and human (shown in Figure 2.2), which found a '*positive*' interaction between a declined human workload and enhanced human's pleasure (Westerink, Ouwerkerk et al. 2007). It provided a borrowed perspective to study the upcoming exhibition under developing technologies. But also, Falk and Dierking (2012) reported there were different identify-related motivations between virtual exhibition and physical exhibition, for example, rather than tending to gather information in virtual exhibition, social reason and a sense of place are motivation that audiences choose to enter a physical exhibition. It needs to further evaluate the effects of online or virtual exhibition (Chen, Chen et al. 2013).

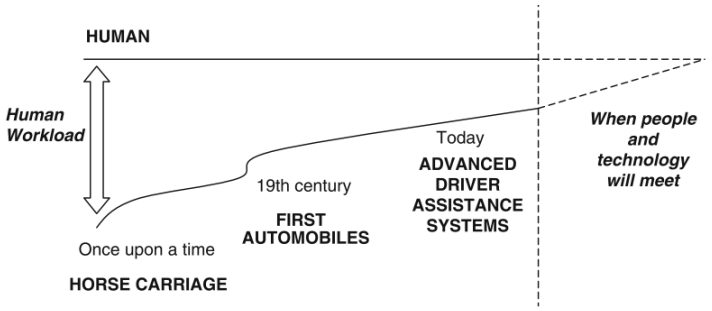


Figure 2.2. Evolution of the user's effort to control a vehicle over the years (Westerink, Ouwerkerk et al. 2007).

Studies of developing exhibition with technology have reached a consensus that physical exhibition cannot be replaced by digital exhibition (Hughes 2010, Falk and Dierking 2012, Chen, Chen et al. 2013). This is due to there is a mutual compensation relationship between online exhibition and physical exhibition (Zhang 2009). Meanwhile, four aspects need to be taken with care: Considering how the technology used or misused (Picard 2000), applying technologies to improve research method (Yalowitz and Bronnenkant 2009), narrating content through technology (Hu 2012), and explaining new technologies to audiences with clear instruction for its application (Fuscaldo 2014).

Based on advanced technology particularly with three digital technologies including Virtual Reality, Augmented Reality and Mixed Reality, the models of development of exhibition are proposed in Figure 2.3 (Choi 2014) with further modification. However, in line with the blossoming of technology, exhibition tends to shift its attention to human-exhibition interaction (HEI), which focusing on audiences themselves and audience-identified to achieve exhibition aims by applying interactive technologies rather than just following technological development. This has been described in detail in Section 3.6.1.

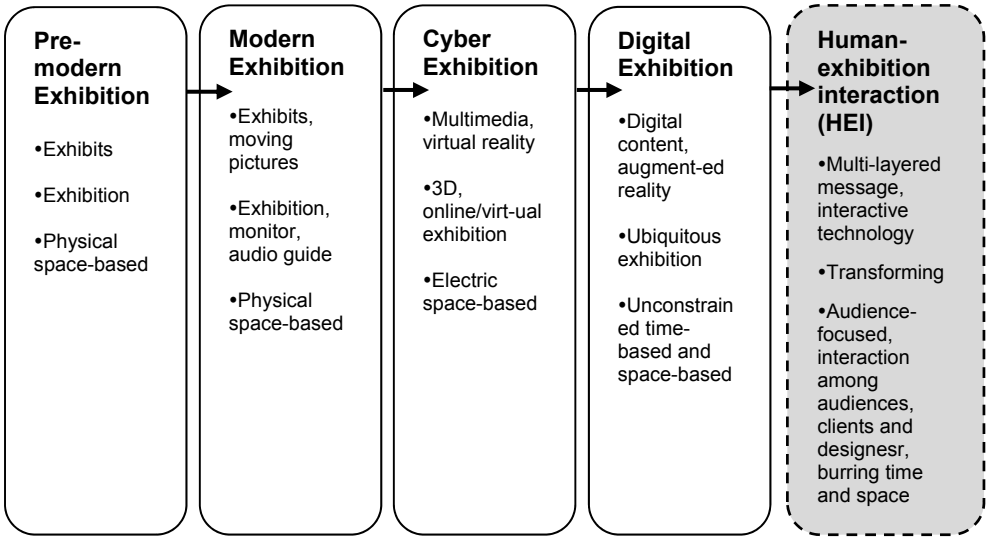


Figure 2.3. The models of development of exhibition (modified from Choi 2014).

2.3.5 Exhibition structure

There are several basic models of exhibition which have been mentioned in the relevant literature (Miles and Alt 1988, Rowson Love 2013, Shaowen 2013, Lin, Ma et al. 2014). The following presents the studied content in detail:

A work in British Museum proposed a three-level exhibition structure bridging the gap between audiences and content of exhibitions (shown in Figure 2.4). By way of structured themes, the exhibition may facilitate learning and understanding. For instance, level 1 with the main chain involves the structured themes of the exhibition; meanwhile, the other side (level 3) considers audiences through the selected knowledge (content). Level 2 focuses on two aspects: first, choosing how to narrow the gap between level 1 and level 3, and secondly modifying the level 1 of exhibition to a certain extent (Miles and Alt 1988).

In Shaowen (2013)'s exhibition model, it involved project selection, plan implementation, brand marketing and information, which aimed to help audiences to contact with the themes of exhibitions in time. As an effective marketing activity, the study introduced automation design for commercial exhibition based on computer technology. A PhD work of Florida State University presented a Focused Exhibition Model by a constructivist and iterative approach, which included curatorial roles, facilitation and exhibition process on the basis of exhibition development teamwork and grounded theory (Rowson Love 2013). With an empirical study in Culture and Creative Expo of Taiwan, Lin, Ma et al. (2014) discovered the relationship between experience and emotion that effecting audiences with narration and interpretation of the themes. This exhibition model follows hierarchical theories from Maslow's (physiological needs, safely needs, love and belongingness needs, self-esteem needs and self-actualizations), Jordan's (functionality, usability and pleasure), Norman's (visceral level, behavioural level and reflective level), to Rongtai Lin's (outer tangible level, mid behavioural level and inner intangible level), and then indicating that it is also available to exhibition such as exhibition content, exhibition service and the audience experience especially in emotional effects to audiences. He presented the '*Exhibition Content - Audience Experience*' model for communication between clients and audiences. All these studies tried to reveal the essence of exhibition from different views; however, there is still a missing that how an exhibition is structured to achieve the purpose of communication between audiences and clients in a basic framework.

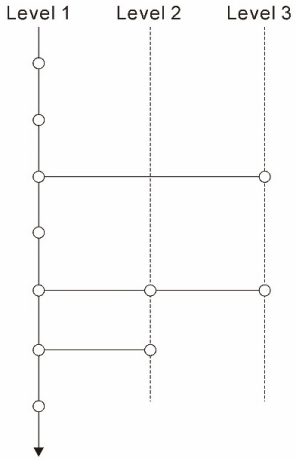


Figure 2.4. A three-level exhibition structure (Miles and Alt, 1988).

Basic elements of exhibition structure

Communicating message to audiences has been regarded as an intrinsic part of exhibition (Hooper-Greenhill 1999, Chen, Chen et al. 2013, Forrest 2015). In the view of communication theory, if exhibition reaches the effect of communication, two basic factors are required: exhibition and human (described in Section 2.3.2). Exhibitions are designed for audiences, from clients and by designers, who are the integral part of exhibition, and thus grouped as Human. On the exhibition side, it should be structured with sub-factors aiming to effective communication, which is in line with other mediums such as film or book (presented in Table 2.1 of Section 2.3.2).

Theme is the main sub-factor of structuring exhibition. To exhibition, theme refers to messages for communication with added meaning and content as a grammar element in a three-dimensional space (Schmitt 2000, Stenglin 2004), which services to structure and guide exhibition (Orhun, Campus et al. 2012). To clients, theme is used to a marketing tool of '*talk to consumers*' (Solomon, 2014, p.424) through targeted theming (Getz 1997, Solomon 2014). For example, Solomon (2014) presented a marketing strategy named retail theming introducing four techniques: Landscape themes, marketscape themes, cyberspace themes and mindscape themes, which tended to construct an imaginative environment such as Starbucks's '*third place*' (Solomon, 2014, p.362). To audiences, theme means an experience opportunity different with daily life such as Disneyland (Pine and Gilmore 1999), and it affects audience's understanding of the exhibition with structured information (Bitgood 1988, Miles and Alt 1988). The book *the Experience Economy: Work is Theatre & Every Business a Stage* claimed that theming the experience was '*scripting a participative story*' (p.48), and theme should capture audience/customer through driving all design factors and staging experiences (Pine and Gilmore 1999). To designers, theme provides a narrative '*hook*' (Locker, 2011, p.7) to communicate with audiences through scripting story,

framing experience and organizing design factors (McLellan 2000, Locker 2011, Rabinowitz 2013). For instance, Chiu (2002) mentioned a theme-oriented mode for design collaboration with structured organization, which can facilitate communication to the success of the project by the study of empirical case and experiment. Moreover, Pine and Gilmore (2011) recognized that each of experiences had a theme, thus theme can be seen as the natural expression of experience and the central of experience design; meanwhile, five principles were presented: Theming the experience, harmonizing impressions with positive cues, eliminating negative cues, mixing in memorabilia and engaging the five senses. Therefore, researchers in Hasselt University of Belgium interviewed with retailers, designers and customers, stating that retail environments focused on designing for experience. Because concentrated theme combined with experience tended to help companies in attracting customers (Petermans, Janssens et al. 2013).

Another sub-factor of exhibition structuring is **content**. Lin (2002) mentioned that the main purpose of exhibition was communicating content, which was also indicated in communication theory: Communication = content + relationship (Griffin and McClish 2011). Topp (2011) stated that content was information containing the all messages transforming to audiences by exhibition. However, difference with the common message and information, the content of exhibition should be structured for narrative as the tool for transforming experience (Miles 1986, Wolff, Mulholland et al. 2012), helping audiences' understanding and time. For example, due to the time- and effort-consuming task for content, Israel researchers at the University of Haifa presented a tool Content Preparation Process with six steps for delivering personalized information to interact with audiences in time (Kuflik, Stock et al. 2011). As one of the main Exhibition Design Factors, content can be turned into a story to narrative the exhibition through mapping space and form (Miles and Alt 1988, Rohloff 2009, Suzanne, Hourston et al. 2012, Elliott 2014); shaping, structuring, framing and presenting content are also proposed by some researchers (Rohloff 2009, Rowson Love 2013). Furthermore, Chinese researchers proposed that content decided the success of exhibition, and finding its relationship was like film script and film, which were the basis of designing an exhibition but needing to service for audiences (Association 1990). Content is considered as king, which is commonly discussed both in User Experience study form the marketing view (Unger and Chandler 2012, Bergstrom and Schall 2014); however, in the field of exhibition, the interaction between contents and audiences requires be further emphasized based on experience and emotion (Sparacino 2002, Coble, Smaldone et al. 2010). Moreover, Csikszentmihalyi (2014) declared that content decided experience through catching audience attention; through literature review, content analysis, survey-questionnaire and statistical analysis, Taiwan researchers explained an analytical model of '*exhibition content-audience*

experience' (p.743) finding the communicative relationship among exhibition content, audience experience and emotion (Lin, Ma et al. 2014). Content is also shaped by many elements such as design progress, group process, experience, audience participant (Taxén 2005).

Exhibition structure based on Semiotics

Semiotics is considered as the study of signs and symbols (West and Turner 2006, Griffin and McClish 2011, Locker 2011, Marcus 2015). UK researchers stated that as a branch of communication theory, semiotics focused on the relationship between signs/symbols and meaning, which had an influence on the results of efficient communication (Allanwood and Beare 2014). Wang (2000), awarded Pritzker Architecture Prize in 2012, proposed a design concept of '*Fictionalizing City*' from the perspective of semiotics, which reflected that city design was a kind of language based on semiotics due to a fact all art including architecture, philosophy, literature, film, painting and music was a structured multi-lingual polymer based on semiotics as scientific method. Semiotics has a close relationship between linguistic describing how meaning is generated and communicated (Lefebvre, Stanek et al. 2014, Johnson 2015). For example, Salen and Zimmerman (2004) explained that like language referring to structured grammar, structure in semiotics helped meaning-making process; therefore, he argued that semiotics was the study of how meanings were made, because from the view semiotics, signs were used by human to '*designate objects or ideas*' (Salen and Zimmerman, 2004, p.5). Moreover, the book *Consumer Behaviour: Buying, Having, and Being* mentioned that semiotics had an essential role in consumer behaviour because it helped marketers communicate with consumers through creating meanings with signs and symbols (Solomon 2014).

Semiotics is a complex system with various branches (West and Turner 2006, Griffin and McClish 2011). However, in terms of design, social semiotic and film semiotic need to be noticed. A doctoral study at the University of Sydney tried to build a grammar of three-dimensional space which based on social semiotics. It explored the methods of how meaning-making was applied in three-dimensional space such as museum exhibition (Stenglin 2004). Wahlin and Kahn (2015) investigated an exhibition design project establishing a propositional conceptual theoretical model with social semiotic. He used social semiotic to understand and examine the potential of meaning-making in exhibition design. In terms of film semiotics, it developed from the early 1960s and involved with film language and textual analysis (Stam 2005). French scholar Mitry (1987) mentioned that since 1919 the first academic paper discussed the film was considered as a language and text. In the last publication in 1987, he defined a structure of film for describing a general and brief progress, in a sense, which could play an inspired role in structuring exhibition.

Mitry (1987) discussed the corresponding and direct relationship between the visual object and language content, which making meanings at the same time. He argued that the basis of establishing a sequential film is the development of visual objects, which make up the main frame of film and thus becomes the structure of film. As shown in Figure 2.5, the left is the continuous visual theme/scene of the film A-B-C-D, and the right is the continuous text/script A'-B'-C'-D'. There is a close connection between theme/scene A and text/script A', both of which have their own meanings. The third layer of meaning is from their direct contact AA', but it is the real meaning which the film presenting. Meanwhile, the theme/scene A triggers B, which lasts the potential or initial messages of A. The created meaning generated from the connection of 'A/B', however, the meaning is affected and modified by the text/script A'. Thus, it can be seen as A/B=AA'+B→X (X means new generated meaning). Then, theme/scene B connects to text/script B, pointing to the theme C visually and therefore generating meaning Y, and so on. But it can be found an interconnection in line with the developing story in the sequence of A-B-C-D; instead, the message with meaning in the sequence of A'-B'-C'-D' is not bounded in order. The right figure presents a fact of low-quality film lacking effective communication with meaning between theme and text, in despite of the film with a beautiful form (Mitry 1987).

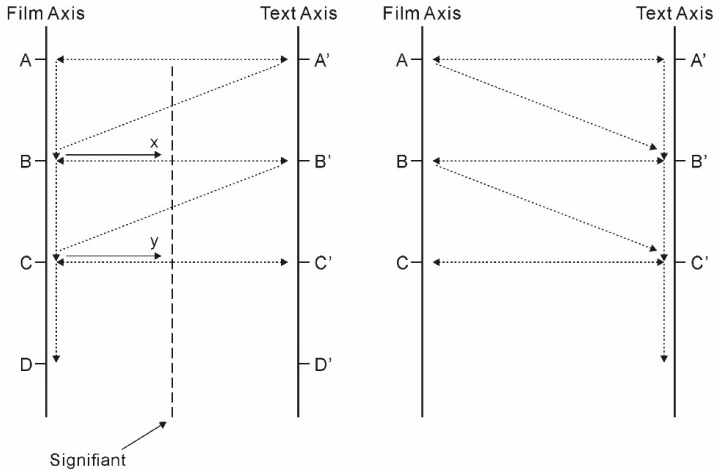


Figure 2.5. The structure of film (Mitry, 1987).

Based on communication theory and semiotic theory (especially in social semiotic and film semiotic), exhibition design means trying to consider how to transform, send messages and information with meanings to the audiences as a kind of visual communication with multi-dimensional sensory (Locker 2011, Topp 2011, Hu 2012). Thus, studying exhibition design has to address the question what is the natural structure of exhibition. Like film to some extent, exhibition is a medium of communication with limited time and space, which contains structured content and visual theme as discussed above and in Section 2.3.2. As two key factors of exhibition, theme is explicit being presented to visual objects through designing

exhibitions, and content is implicit that the first level of communication between clients and designers, and then transforming to audiences once being structured. Therefore, we can explain the structure of exhibition with the help of the semiotics. But it should be noted that this brief description of exhibition structure is presented in general rather than for indicating a strict rule.

It is clear that exhibition is a complex system that can be viewed from many perspectives. However, as the communication medium from the essence, the Figure 2.6 helps us to understand the direct relationship between theme and content by meaning, which is the key of developing and designing exhibition if exhibition achieves its aim of communicating message. From the vertical, it is a three-level basic structure: left is exhibition axis with the theme sequence A-B-C-D, middle is the real meaning of exhibition, and the right is content axis with the theme sequence A'-B'-C'-D'. Attention is that compared with content axis, exhibition axis has the character of limited time and space with the corresponding sequence. From the horizontal, it reveals the interactive and direct connection between the theme and content for real meaning-making based on audiences, designers and clients. The meaning of exhibition has two levels: the first meaning is generated the intuitive relationship between theme and content such as AA', which is the meaning with visual form visited by audiences. Along with the theme development or audiences' movement in theme, the theme A moves into theme B, and meanwhile, the meaning of A is the extent to the theme B in logical. At this point, a meaning is created from the connection of theme A/B, but it is influenced and improved by content A'.

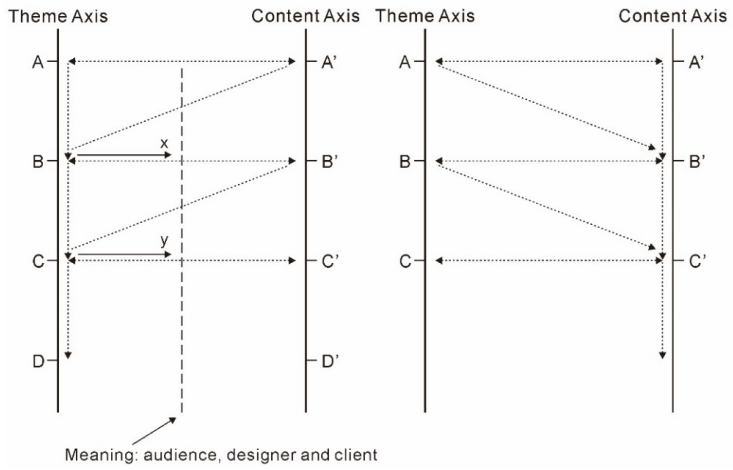


Figure 2.6. Exhibition structure.

In other words, the connection between A and B with new created meaning can be presented as: AA' + B = M^x (M^x means the generated meaning). Then, with the movement of audiences, the theme B connects with the content B', and directs to the theme C in space and time; thus, next meaning Y is created, and so on. Like the film structure, the theme of exhibition is connected to each other in the

sequence of A-B-C-D, but the message of content is not in the close sequence. This is because if no successive themes, the meaning of the exhibition cannot be created from the relationship of B'A'. Therefore, theme of exhibition is closely related to the content of exhibition, which is the foundation of the exhibition structure. However, it is important to note, that the method of meaning making is different among three stakeholders of exhibitions including audiences, designers and clients, which is also the factor of exhibition structure and different with film structure stated by Mitry (1987). The further description is described in section of HEI (Human-exhibition Interaction, Section 3.6.1). The right of Figure 2.6 shows a low-quality exhibition structure that though the theme has possible beautiful form with limited connection between such as A and A', the sequence of themes cannot be structured such as lacking AB, which directly influences the generation of meanings and the communication of exhibitions. Meanwhile, the meanings among audiences, designers and clients also cannot be made, resulting in inefficiency or ineffectiveness communication of exhibitions.

2.3.6 Dimensions of exhibition

The journey of visiting exhibition is limited in time and space, starting from an initial state (basically with an appointed time and space) and ending in some final state (with audiences desired, and clients or designers created). Hooper-Greenhill (1999) in his book *Museum, Media, Message* presented an overlapping of structural and functional analysis of a museum object shown in Figure 2.7, which mentioned three dimensions about museum exhibition including society, time and space; meanwhile it regarded transforming message as the key communication process of exhibition. Zhang (2009) described exhibition based on two dimensions consisting of economic dimension and social dimension. He stated that exhibition could contribute on increasing economic and promoting city image. Time dimension was especially highlighted by Falk and Dierking (2012) that regarded as the fourth dimension of the Contextual Model of Learning for exhibition study. Forrest (2015) argued that exhibition '*can be considered as four-dimensional media*' (p.27) with the term '*channeling*' (p.27) such as spatial channel, narrative channels, and multimodal/multimedia channel. A study supported by Science Foundation Ireland proposed four dimensions of exhibition for guiding their data analysis and exhibition design, including the physical/structural dimension, personal dimension, social dimension and cultural dimension. In conclusion, the mentioned study to exhibition dimension is various, especially focusing on space (Hooper-Greenhill 1999, Stenglin 2004, Forrest 2015), time (Hooper-Greenhill 1999, Falk and Dierking 2012), personal (Ciolfi and Bannon 2007, Getz and Page 2016), cultural and social (Hooper-Greenhill 1999, Kaynar 2005, Ciolfi and Bannon 2007).

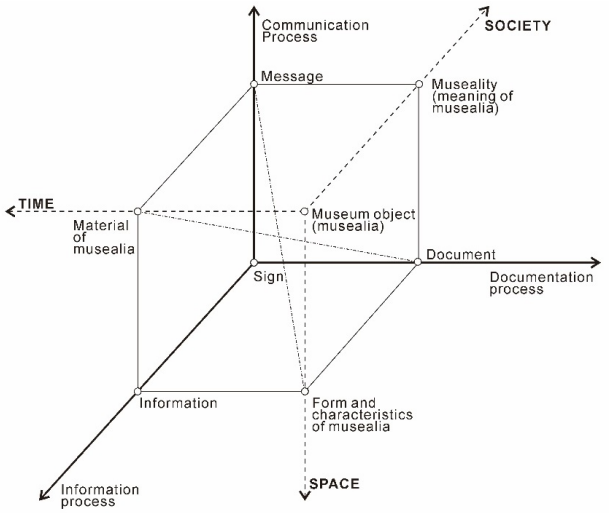


Figure 2.7. Overlapping of structural and functional analysis of a museum object (Hooper-Greenhill 1999).

While exhibition dimensions are considered important to understand and design exhibition, clearer dimensions of exhibition tend to be discussed in order to detect the essence of exhibition. Three dimensions involving the time dimension, space dimension and message dimension are introduced in this thesis, shown in Figure 2.8. Following is further illustration to these three dimensions：

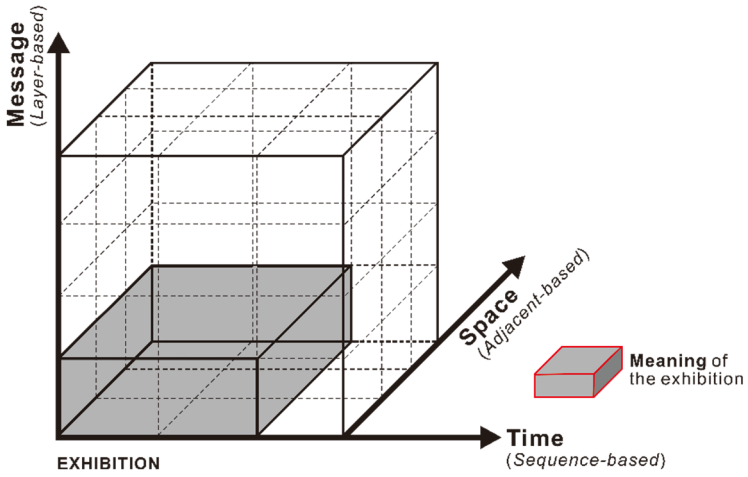


Figure 2.8. The dimensions of exhibition.

Time dimension

Time is a specific and ubiquitous dimension in exhibition. For audiences visiting exhibition, time is the main cost rather than money (Falk and Dierking 2012). Thus, the term of '*time budget*' is proposed for tracking audience behaviour in an exhibition such as what audience visiting, attending, spending, and/or allocating with their experience (Chen and Ho 2003, Csikszentmihalyi 2014). Hou (2015) indicated that the time affected the enjoyment and experience of audiences explained by introducing two concepts: Static time and dynamic time. Static time is first produced by the clients in the space of exhibitions, and it exists whether or not

audiences are involved in but the story is narrated with the time sequence along with the themes. Therefore, static time is fixed once being created that cannot be controlled by clients. Instead, dynamic time is about audiences and varied with their behaviour throughout the exhibition (Hou 2015). However, the roles of exhibition design and designer are ignored in this study. Since exhibition is the medium of communicating messages according to communication theory, so the exhibition design factors as the signs and symbols can design and keep influencing on both static and dynamic time. Furthermore, time is also one of the exhibition design factors. For example, Taylor (1963), Falk (1991) and Crimm, Morris et al. (2009) mentioned time was '*a major parameter of exhibit design and works*' (Taylor, 1963, p.165), and it was also relating with audience experience. The book *What is Exhibition Design* stated that '*designing for time, not place*' (p.38), based on the perspective of experience design (Berger, Lorenc et al. 2007).

Space dimension

Different with the interior and architecture, space in exhibitions has special characteristics. Humans spend most of their lives in the interior space within structured buildings; the interior and architecture provide a physical space for people's living and working (Ching and Binggeli 2012). However, relating to story and content is important for space in exhibitions. Locker (2011) pointed out that exhibition designers used space as a tool to support narrative communicating specific messages to audiences. Hou (2015) mentioned that the size of space could influence the size of narrative due to a fact that story is narrated throughout the time in space. She stated that like a story, space had similar attributes that could have meanings with triggered memories, and each space tends to be a unique narrative. Therefore, the three-dimensional space is considered as the major tool of exhibition design and carrier of messages to develop the content by narrative or story-making (Hughes 2010, Bogle 2013, Hou 2015). For instance, Suzanne, Hourston et al. (2012) emphasized considering space as stories produced was critical thinking but much more needs to be done.

Message dimension

Exhibition is a medium of delivering the message to audiences limited in time and space (Hooper-Greenhill 1999), and each message is created and communicated tending to involve as many audiences as possible (Serrell 2015). For instance, '*everything speaks*' (Dumas, 2005, p.34) in Disney theme park indicates that each factor, and detail '*from the doorknobs to the dining rooms*' (Dumas, 2005, p.34) delivers a message to customers and audiences. It means that exhibition messages are formulated or framed by the exhibition authors such as clients and designers (Hooper-Greenhill 1999); on the other hand, factors including shape, form and space convey a specific messages to audiences/customers in exhibitions (Bitgood 2011, Bogle 2013). As a medium, exhibition is the message in view of

communication theory (Baran and Davis 1987, West and Turner 2006, McKenna-Cress and Kamien 2013). Hooper-Greenhill (1999) described three messages: (1) Messages created and generated by clients; (2) Messages framed and formulated by exhibitions; (3) Messages received and interpreted by audiences. Meanwhile, he indicated that the meanings of initial message could be modified by the medium (exhibition), and the third message absorbed by audiences could be affected by audiences themselves at some degree including previous experience, knowledge, reaction and felling, etc. Although the role of exhibition as medium is highlighted, an important point needs to made is that exhibition cannot interpret message automatically by themselves (Griffin and McClish 2011); but designer through applying various exhibition design factors as tool which is called the signals or symbols in communication theory (Solomon 2014).

Meaning

Seeking for meaning is the nature of human, especially audiences or customers in the context of exhibition (Carù and Cova 2007, Suzanne, Hourston et al. 2012). West and Turner (2006) pointed out that '*meaning is what people extract from a message*' (p.7) with one or multi-layers. To some extent, meaning relates to audiences' experience, emotion that tends to decide whether the exhibition can be remembered with meaningful memories (Fredrickson 2000, Falk 2009, Falk and Dierking 2012, Getz and Page 2016). For instance, Falk (2009) mentioned that '*according to anthropologist Clifford Geertz, meaning is our mind's way of making sense of the world; the translation of existence into conceptual form*' (p.126), based on a fact that human brain retains memories and realize understandings in the help of meaning making (Falk 2009). Thus, there have been some attempts to discuss the meaning of exhibition. Silverman (1999) attempted to divide meaning into three types includes: Objective meaning delivered by designers and clients, subjective meaning generated by audiences themselves, and combination meaning associated with both objective and subjective meaning. However, audiences create their own personal meanings through moving the exhibition, not just one of framed and transmitted by exhibitions (Whittle 1997, Silverman 1999, Bollo and Dal Pozzolo 2005, Falk 2009, Choi 2010, Dooley and Welch 2014). They concluded that meanings generated by audiences were influenced by their cognitive frameworks (Whittle 1997), education background (Silverman 1999), personal needs, prior experience and interests (Falk 2009), their own interpretation and experiences (Choi 2010), background knowledge and activities pursued (Dooley and Welch 2014). Other authors (Djajadiningrat, Overbeeke et al. 2002, West and Turner 2006) had found that interaction was the key to create meaning. Djajadiningrat, Overbeeke et al. (2002), one of the creative director at Philips Design, conducted the project and study that illustrated two factors including

sensory richness and action potential that could be used to carriers of meaning in interaction.

Related to this concern, meaning has been regarded as a significant feature of space (Erickson 1993). It also can have an effect on audience behaviour meeting with their motivation and objectives (Forrest 2013). Difference in meaning for audiences is designers have to realize that framing meaning in the forms and interaction with objects is a necessary work, which has been claimed in product design (Djajadiningrat, Overbeeke et al. 2002, Crilly, Moultrie et al. 2004). Silverman (1999) specifically recognized that in exhibition design, considering understanding the factors and methods that allowed better multiple meanings were required by the research and experimentation. From the perspective of clients and designers, narrative through constructing meaning needs to be noticed. Achiam, May et al. (2014) argued that constructing meaning aiming to narrative should be considered from the point of view clients, designers, and then to audiences. In summary, in the networks of three dimensions of exhibition such as time, space and message, the shared meanings are created and made in the context of exhibition to achieve the communication among clients, audiences and designers. The shared meaning is multi-layers and decided by exhibition design factors and human factors (involving audiences, designers and clients) especially focusing on audiences such as experience, emotion, behaviour, and other characters including personal need, motivation, etc.

In particular, Chen (2005) illustrated the algorithm for meaning communication in exhibition. He considered symbol made meanings in a complex network:

Where,
$\boldsymbol{F}$ is the set of all the individual elements;
$\boldsymbol{M}$ is the whole of meaning in the network;
$\boldsymbol{n}$ is the natural number, $n \geq 1$;

then,

$$F_1 = \{f_1, f_2, \cdots f_n\} \quad (1)$$

$$F_2 = \{h_1, h_2, \cdots h_n\} \quad (2)$$

$\boldsymbol{G}$ is the grammar that enables symbols/elements to make meanings,
$\mathrm{G} = (+, -, \times, \div)$;

then,

$$g_1\{F_1\} = m_1 \quad (3)$$

$$g_2\{F_2\} = m_2 \quad (4)$$

such that,

$$m_1 + m_2 = M_1 \quad (5)$$

Figure 2.9 presents the overall process of meaning-making during exhibition's message-transforming. It explains the major role of exhibition design factors during developing exhibition, which determine the meaning-making and message-transforming, and then influencing audiences' understanding and experience.

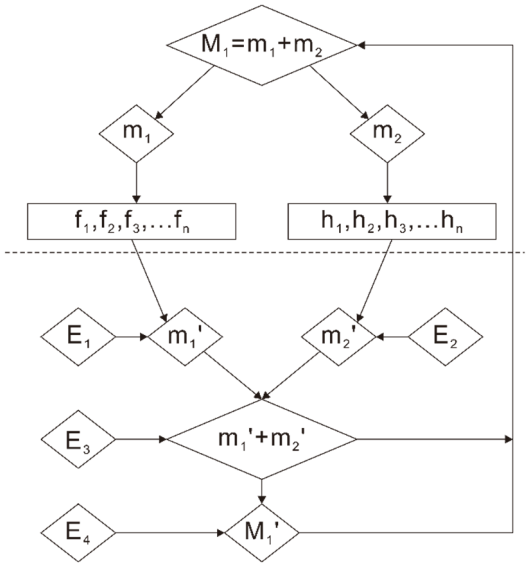


Figure 2.9. Communication process of meaning (Chen, 2005).
Note：**E** indicates the explanatory factor.

2.4 Exhibition design

2.4.1 Mapping exhibition design

The objective of this section is to provide an overview of mapping exhibition design in six developing progresses. The progresses are extracted from the reviewed publications highlighted the concept relevance with exhibition design by using NVivo based on Grounded Theory[7]. They contain (1) An initial progress of *display* both in marketing and cultural fields; (2) *Means* and *design factors* progress originated in Germany Bauhaus; (3) A progress where exhibition design moves into the *developing progress* and *multiple discipline*; (4) *Audience-focused* and *narrative*, where revise the role of human especially for audiences during designing exhibition through a tool of narrative or storytelling; and (5) A progress of *experience-led* and *behaviour* where it tends to explore the nature of audiences helping designers and clients to achieve an more effective communication of designing better exhibition. The developing exhibition design further seems to move into progress of (6) *collaboration*, which pays attention to the interaction among exhibitions such as design factors, process, narrative, and human including

[7] The review and extracting progress is conducted and recorded following serious research procedure in the NVivo, thus which can be further traced for raw information in detail. Around 2076 articles were analyzed until 26th of February 2017.

audiences, designers and clients as the crossing field. The whole mapping is presented in Figure 2.10.

There are few research publications indicating exhibition design, although it has entered into practical application fields since the birth and development of human and human society. Display and exhibition-making are considered as an innate human behaviour in daily lives (Dernie 2006, Hughes 2010), however, the gap between practical project and theoretical research has existed until in 1939 Bayer published an article *Fundamentals of Exhibition Design* based on his marketing, social practices and experiences both in Germany and America. It assumes exhibition design is the means of communication by applying design factors including material, architecture, color, light and movement as a new evolved discipline (Bayer 1939, Bayer 1961). Due to a lack of theory-supported, this period most designing exhibition projects have to search for help from other disciplines that are discussed in Section 2.4.3.

Taylor (1963), a research at the institute for sociological research of the University of Washington, conducted a field study with the methods of interview, questionnaire and observation by video-taping in the United States Science Exhibition at Seattle World's fair founded by the National Science Foundation. On the bases of 9000 participants investigated, the report mentioned that rather than a static display, exhibition design should be focused on the display in a context of dramatic process, time, movement, experience sequence, through using design factors. This starting cluster considered the term of human integrating into studying exhibition design. In summary, designing for display with various means is the major research direction in this progress; design factors are also developed into the integration of exhibition design literature that is highlighted in the next progressing period.

The second progress is emphasized on *means and design factors*. It especially extends the theories and practices of Germany Bauhaus that is the major impacts on exhibition design until today (Miles and Alt 1988). In line with the development of other disciplines such as architecture design and painting art in Bauhaus, the British Museum tried to propose its first step in bridging the gap between exhibition design literature (Miles 1986, Miles and Alt 1988). However, early literatures were more concentrated on exhibition design as educational tools (Guthrie 1983, Miles and Alt 1988), for instance, Miles and Alt (1988) particularly discussed exhibition design from the perspective of psychology and education as special guidance, which was based on the context of cultural exhibition. Corresponding in China, exhibition design is also used to an ideal tool for education and economic communication and further attention to balance the relationship between content and form (Association 1989, Association 1990). Another example of a progress

developed in the field of exhibition design is the design factors (Bitgood and Patterson 1987, Dean 2002). It divided exhibition design factors into three main aspects: Exhibit object/animal factors, architectural factors and audience factors, which also include some sub-factors such as size, motion, novelty etc.(Bitgood and Patterson 1987). How to arrange factors became an '*art and science*' (p.32) in the field of exhibition design, which is discussed from the early 1930s to the late 2000s (Dean 2002). By contrast, green design is proposed to exhibition design aiming to enhance the effectiveness and sustainability of the exhibition through the limiting design factors (Byers 2008).

In third progress, exhibition design moves into a broader discussion of the *developing process* and *multi-disciplinary* from two narrow directions (means and design factors). Practical activities occurred far earlier than theoretical development in the field of exhibition design within a complex procedure and extensive area. An article from Lin (2002) can be regarded as a developing bridge of the gap between the practical project and theoretical study[8]. It constructed a workable exhibition design model, museum exhibition design process model (MEDP), based on the review analysis of architecture, product and exhibition design models. The developing process model explains the nature of exhibition design as multi-disciplinary though exploratory study such as surveys, questionnaires and interviews (Lin 2002). Also, the period of the developing process is further reported during the early 21 centuries, which are more related with design and project management in exhibition-created process (Dean 2002, Lin 2003, Barry, Dexter et al. 2012, Bogle 2013, Ciamarra 2013). Another discussion of the study results from the design process is multi-disciplinary (Demir 2012, Suzanne, Hourston et al. 2012). Demir (2012) discussed the essence of multi-disciplinary with a case study of exhibition design at the Mimar Kemaleddin Museum in Turkey. The multi-disciplinary and complex of exhibition design thus decide its specific approaches for effective communication and experience enhancement such as narrative discussed in forth developing process (Suzanne, Hourston et al. 2012). Meanwhile, Traue (2000) described the contemporary exhibition design in France and Italy under the financial support of the Internal Grants Committee in New Zealand. In view of the audience, the article mentioned several major factors relevant with exhibition design including experience, meaning-making, and proposing that designer should apply design factors capture the attention of audience eye (Traue 2000).

In the fourth progress, categorized as *audience-focused* and *narrative*, two major trends are presented. The first stream focuses its study particularly on human

[8] Lin (2002) had the experience of teaching at Tunghai University and designing on the Taipei Astronomical Museum project in the area of exhibition design, before his PhD research in the UK.

factors that is the major content of Ergonomics as well. It is considered a design factor which can affect the results of exhibition design and audience experience (Dean 2002). For indicating the audiences' understanding for learning in exhibitions, Hein (2002) mentioned there were many literature concentrated on human factors such as human responses to design factors regarding attention, engagement, comfort etc.. Further stream moves into the term of audience-focused (Chen and Ho 2003, Dernie 2006, Locker 2011). For instance, designing experience is audience-focused in exhibitions where is labelled as performance space allowing audiences themselves to move their body as the form of communication (Dernie 2006). It is the developing direction of exhibition design (Chen and Ho 2003). Also Locker (2011) stated that '*exhibitions are designed for people*' (p.38), and thus the center of exhibition design tended to be audience analysis for offering brand experience and effective conversation.

Another stream from audience-focused evolving into the specific approach is *narrative*. Dernie (2006) summarized three approaches to exhibition design on narrative space, performance space and simulated experience. Using narrative space is the most-used practice, which is further detailed into three aspects including formatting, story-telling and collage-narrative (Dernie 2006). Moreover, the story-telling, similar to the method of narrative, again discussed in further studies. However, if clients try to convey messages to the targeted audiences by story-telling, they have to add a '*narrative thread*' (p.104) into the message for story-telling with beginning, middle and end (Berger, Lorenc et al. 2007). In CHESS project[9], a case study of interactive digital storytelling was discussed for the contribution to storytelling on accessing and engaging more a variety of audiences (Pujol, Roussou et al. 2012, Pujol, Katifori et al. 2013). Borrowing from film theory, mise-en-scene was used by Hou (2015) for explaining narrative, who argued that storytelling was one of the powerful means enhancing audience' learning and experience. A three-part framework of narrative-led exhibition design funded by the Australian Research Council is indicated involving story-based approach, concept-based approach and object-based approach (Baker, Istvandity et al. 2016). A specific example is what a researcher in MIT proposed a concept called '*exhibition wearable*', which explored interactive technologies to deliver personal content for targeted-audience and enhance interactivity between exhibitions and audiences by addressing audience's storytelling need (Sparacino and Places 2004).

[9] Cultural Heritage Experience through Scio-personal Interactions and Storytelling (CHESS), a three-year research project focusing on digital storytelling in the context of museum exhibition, which is co-funded by EU's 7th Framework Programme.

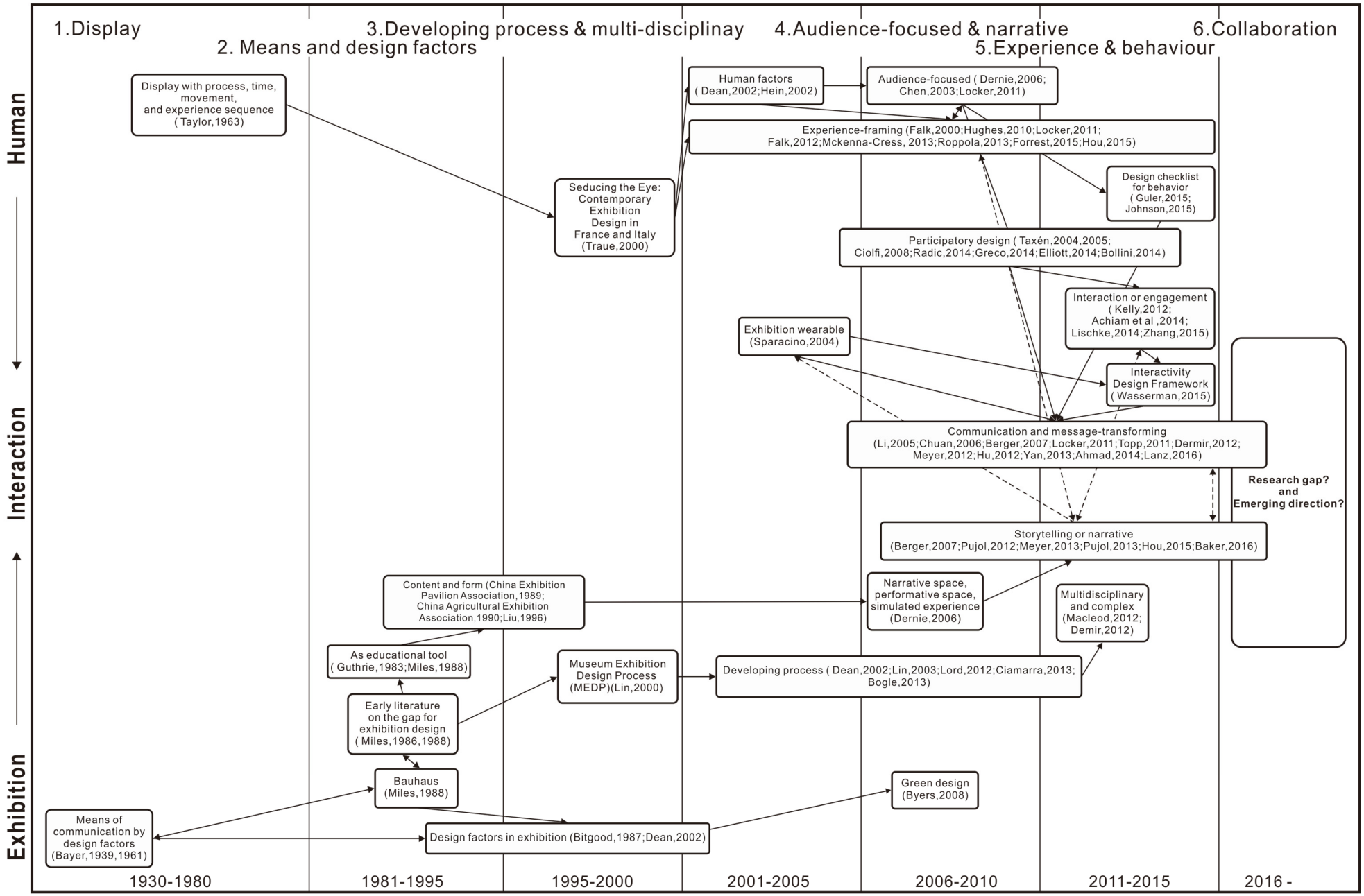


Figure 2.10. Mapping exhibition design.

The fifth progress shifts to *experience-led* and *behaviour* in line with the development of audience-focused and narrative. This period tends to explore the interaction between exhibition and human with complex and interactional relations. Both topics were highlighted in the early 2000s, but focusing more on experience-framing. With the development of exhibition design, highly discussed research areas surrounds various experiences which include the terms of Interactive Experience Model with learning experience (Falk and Dierking 2000); customer experience in brand environment (Hughes 2010); multi-layered and multi-sensory (Locker 2011); museum experience with learning (Falk and Dierking 2012); physical and sensory experience (McKenna-Cress and Kamien 2013); designing for audience experience (Roppola 2013); as well as experience-led exhibition design (Forrest 2015, Hou 2015). To enhance audience experience and design effective exhibition, participatory design is introduced that roots from the research area of Human-computer Interaction (HCI) (Taxén 2004, Taxén 2005). It is basically developed from the audience-focused perspectives (Taxén 2005). A doctoral study work at Politecnico di Milano constructed a design framework and meta-design tool for participatory design in exhibitions in order to improve design process, engagement and audience experience in exhibitions (Radice 2014). The role of participatory in exhibition design is also discussed by researchers in Milan (Bollini and Borsotti 2014). The stream further directs to interaction and engagement between exhibition and exhibition (Kelly 2012, Achiam, May et al. 2014, Lischke 2014, Zhang, de Bont et al. 2015). It tends to be the most important trends of exhibition design.

The second stream of study, behaviour, is less concerned than the studied literature on experience-led. Guler (2015) created an exhibition design checklist for explaining the important relationship between exhibition design and audience behaviour such as their circulation pattern, which was evaluated by investigating 76 participants. The checklist contains 20 items and 7 categories in order to improve designer effectiveness and audience satisfaction. Although behaviour studies were explored as one of main areas in exhibitions since an article by Robinson (1928), there is an obvious gap between behaviour and exhibition design. Along with the stream of audience-focused & narrative and experience & behaviour, exhibition design arrives to the tool of communication and message-transforming (Yan 2003, Li 2005, Chuan, Kun et al. 2006, Berger, Lorenc et al. 2007, Topp 2011, Demir 2012, Hu 2012, Ahmad, Abbas et al. 2014, Lanz 2016). The developing progress conforms to the nature of exhibition as communication medium. Meanwhile, storytelling or narrative is a general approach of communicating and transforming message in terms of exhibition design (Berger, Lorenc et al. 2007, Baker, Istvandity et al. 2016).

The sixth developing process of *collaboration* involves a further question of exhibition design based on the whole development of streams. We have to pore on a question what is the relationship between exhibition and human during the process of designing exhibitions. Then, direction to what is the research gap and emerging field is on the horizon. Schwarz (2016) observed three principles in exhibition design: Respect the objects, respect the buildings, and respect the audiences, which were all pointing towards communication by storytelling. With entering into an increasingly complex and multidisciplinary range, challenge to exhibition design should address a challenge to structure a '*new grammar and syntax*' (p.20) for effective communication (Bollini and Borsotti 2016). Besides the essence of communicating messages, it is clear that exhibition design is not only closely related to display, design factors, developing process as multi-disciplinary, but also accommodate both audience's experience and behaviour through the approach of narrative or storytelling. Thus, mapping of exhibition design becomes constructed as a collaboration progress. Answer in collaboration progress will be described in the next Section 2.4.2.

On the basis of analyzing literature from 1930s to 2000s, a developing progress emerges from exhibition to human, and then to interaction between exhibition and human. Therefore, a model of mapping exhibition design is presented for understanding and exploring the new arising discipline. However, the stream of mapping exhibition design is provided with the form of outline and deduction during the three-year PhD study, in order to introduce exhibition design for the deeper investigation and exploration.

2.4.2 Models of exhibition design

There is a broader discussion about the exhibition design model (Miles and Alt 1988, Seagram, Patten et al. 1993, Lin 2002, Chuan, Kun et al. 2006, Jung and Choi 2014, Huang, Wei et al. 2016). The model (pattern or framework) is explained as '*a repetitive design*' (p.373) and '*a valuable tool*' (p.373) in the field of exhibition design (Bogle 2013). Like the studies in exhibition design, little researches can be found but covering a wide theoretical spectrum from communication theory to Human-computer Interaction (HCI) (shown in Section 2.4.3). In line with the literature analysis of grounded theory (GT), focused main discussion on models of exhibition design in this thesis is categorized as design process, participatory, storytelling or narrative, experience, evaluation, interaction, and as communication:

> **Design Process:** Exhibition design model have been explained as the term *design process* of how a project team starts, organizes, creates and completes the exhibition-making works (Miles and Alt 1988, Bitgood 1994, Carliner 1998, Lin 2002, Hall and Bannon 2005, Hall and Bannon 2005,

Crimm, Morris et al. 2009, Locker 2011, Guler 2015). For example, Carliner (1998) proposed a descriptive model of instructional design including design goals, design resources, design techniques and constraints through GT method. A three-stage model with the iterative process was mentioned by Miles and Alt (1988), which followed a line from the initial problem, tentative theory, to error elimination and then a new problem. More methods of exhibition-developing were suggested to designers involved in six design approaches: the subject-matter approach, aesthetic approach, hedonistic approach, realistic approach, hands-on approach, social facilitation approach and individual-difference approach (Bitgood 1994). From the perspective of multi-disciplinary, Lin (2002) developed a systematic model of Museum Exhibition Design Process (MEDP) for allowing the designers and clients to strengthen the design and project management with flow diagrams (Lin 2003). Funded by EU SHAPE project[10], a Design Process with a case study in Hunt Museum was presented as six steps: Technical experimentation, consultation of relevant policy, design development and evaluation, observational studies, consultation of experts and clients, evaluation of physical/spatial constrains of exhibition (Hall and Bannon 2005, Hall and Bannon 2005). Crimm, Morris et al. (2009) constructed a systematic model regarding exhibition design, which included a Life of Project Process, a Strategic Planning Process, Predesign Planning, Physical and Intellectual Framework. Inspired by Leonardo da Vinci's sketchbooks, identified feedback and evaluation within the exhibition design process was illustrated with a diagram (Locker 2011). It also described three ways of a chronological approach, a thematic approach and a branded approach to help designers' decision-making. Based on previous studies, Guler (2015) indicated a framework with flowchart and checklist for exhibition design in the view of both designers and audiences.

Participatory: Exhibition design model has come in the form of participatory such as organogram model (Hughes 2010), me-to-we design model (Simon 2010), co-design model (Fuks, Moura et al. 2012), collaboration design model (McKenna-Cress and Kamien 2013), and meta-design tool (Radice 2014), which is along with the developing process of exhibition design (shown in Section 2.4.1). All of them considered embracing audiences into design practices rather than just from the point of clients or designers as before. Participatory tends to care for all stakeholders not only clients and designers but also audiences in exhibition design. Hughes (2010) outlined an

[10] Situating Hybrid Assemblies in Public Environments (SHAPE) as the part of EU, focuses on building hybrid public environments, which enhance the interaction between audiences in the context of both physical and digital exhibition space. It involves a consortium with the Royal Institute of Technology (Stockholm, Sweden), King's College London and the University of Nottingham (UK).

'*organogram*' (p.31) that presented the diverse roles and responsibilities for clients working with other experts such as architects, suppliers and contractors in design team. Simon (2010) declared a '*me-to-we*' (p.29) design model with five stages, which drove personal experience (me) to social interaction starting from content (we).

Storytelling or narrative: It is the major approach of designing exhibition not to mention the model of exhibition design. Spectacular Design Model was summarized to help the designers embrace audiences into a story through four overlapping elements such as dramatic effects, plot, grand scale, and authenticity (Counts 2009). Furthermore, a framework of narrativity scale was introduced for touching valid story experience in exhibitions including intentionality, content, telling, audience experience and context. It can allow clients and designers drive story into space, and meanwhile help audiences deepen understanding and memory with experience. Among them, a narrative process of exhibition was described as: author(s) ⟶ story(ies) ⟶ telling(s) ⟶ audience(s) (Suzanne, Hourston et al. 2012). With a practical project of exhibition design, Wahlin and Kahn (2015) summarized a conceptual theoretical model that discussed the relationship among social semiotic, multi-levels, information-gathered (interpreted), content to support designers' activities and communication.

Experience: There is a close relation between storytelling/narrative and experience (Counts 2009). Experience mentioned in the model of exhibition design was particularly concentrated on from 2014 to 2016 (Jung and Choi 2014, Forrest 2015, MacLeod, Dodd et al. 2015, Huang, Wei et al. 2016). For instance, Korean scholars conduct a project-based study trying to connect experience with themes and audiences (Jung and Choi 2014). Another projcet-based study tried to illustrate the relationship among audiences experience, physical environment, emotion and cognition during the journey at exhibition.The project was developed by crossing boundaries among design, academic and project (MacLeod, Dodd et al. 2015). Experience relates to design factors, which was explained in Preceived Atmosphere Instrument Model (Forrest 2015). With providing a '*high value-added*' (p.193) experience, Huang, Wei et al. (2016) explored a QUALIA design model that concluded five elements such as attractiveness, beauty, creativity, delicacy, and engineering. The model bridges the gap among design factors (flow, environment, etc.), audience, and brand with the theoretical basis of Mehrabian and Russell Model and environment psychology.

Evaluation: It is one of the main steps during the design process, and thus exhibition design model is developed especially on evaluation (Lin 2009,

Barriault and Pearson 2010, Topp 2011). With the view of development time, the period accords with the developing progress of exhibition design (shown in Figure 2.10). They included three models of exhibition design: MEDP checklist (Lin 2009), Visitor Engagement and Exhibit Assessment Model (Barriault and Pearson 2010), and Content Assessment Tool (CAT) (Topp 2011). For instance, a checklist model was used to understand and examine the model of museum exhibition design process (MEDP) as a inter-disciplinary design work (Lin 2009). The Visitor Engagement and Exhibit Assessment Model (VEEAM) was structured to systematically explain the visitor-exhibit interaction, which was a behaviour-based approach for evaluation (Barriault and Pearson 2010). It first investigated the engagement behaviour and then analyzing audience experience, which bridged the gap between clients and audiences in exhibition design. Topp (2011) applied a content assessment tool (CAT) to help clients and designers for communicating a clear and effective message through exhibition evaluation.

Interaction: Three models of exhibition design focusing on *interaction* can be analyzed as the transaction approach (Seagram, Patten et al. 1993), attention-value model (Bitgood 2010), and the audience engagement and exhibit assessment model (Barriault and Pearson 2010). Compared with a mandate-driven and market-driven approach, Seagram, Patten et al. (1993) modified a transaction approach model because the consideration of audience-exhibiton interaction could allow an effective and success exhibition design with an enjoyable experience. In Bitgood (2010)'s attetion-value model, engagement (interaction) was discussed as a '*deep sensory-perceptual, mental and/or affective involvement with content*' (p.10). This model associated with engagement/interaction, attention and design factors provides a tool for effective exhibition design. Like discussion on evaluation, visitor engagement and exhibit assessment model (VEEAM) considered the role of audience-exhibition interaction as an effective tool of exhibition design and experience enhancement (Barriault and Pearson 2010).

Communication: In a sense, exhibition design models can be understood as tools of communication among audiences, designers and clients. It is decided by the communicating nature of exhibition design. With communication theory, two models of exhibition design can be founded (Li 2005, Chuan, Kun et al. 2006). Connected with communication theory and exhibition design, four elements including content, transmitter (clients and designers), receiver (audiences) and medium (space) were discussed for clearer and deeper understanding exhibition design, the new developing discipline (Li 2005). Through practiced in the natural history museum Taiwan, an instigating model was constructed to help the designers to create multi-layers experience and

enhance active communication between memes (Chuan, Kun et al. 2006). The new communication model described the core role learning value and meaning-making in exhibition design by comparison of the educational model (curator-centered) and interpretative model (visitor-centered) (Chuan, Kun et al. 2006).

In summary, reports on exhibition design model have been explored for a wider range in line with the developing development of exhibition design. However, the gap between exhibition-human interaction of exhibition design particularly related to exhibition design factors, audience experience, emotion, and behaviour is not fully *understood* due to the complex and multi-discipnary situations.

2.4.3 Theories of studying exhibition design

This brief section presents the main theories of studying exhibition design. Muliti-disciplinary serves as a core characteristic of exhibition design discipline around the literature analysis (Lin 2002, Lin 2005, Dernie 2006, Borsotti and Bollini 2009, McKenna-Cress and Kamien 2013, Forrest 2015). It decides that different with other design disciplines, exhibition design is positioned in the collaboration with different stakeholders involved in exhibition project including clients, audiences, designers and experts from other disciplines (Carliner 1998, Berger, Lorenc et al. 2007, Crimm, Morris et al. 2009, Hughes 2010, Locker 2011, Bogle 2013), and meanwhile borrowing powers from other theories (Berger, Lorenc et al. 2007, Bitgood 2011, Demir 2012, Hou 2015, Zhang, de Bont et al. 2015). Thus, the multi-theories phenomenon is rendered as two characteristics in exhibition design. The first characteristic is the term of ***crossing***, which involves the mulit-disciplines and various theories illustrated in Figure 2.11. For instance, Miles and Alt (1988) mentioned that exhibition design was developed on the basis of education and psychology theory in the 1960s and 1970s for the intent of learning through museum exhibitions. In the late of 1980s, Chinese research discussed the broader crossing of exhibition design around social science and natural science such as art, psychology, applied physics, marketing, engineering, material, and architecture, etc.. Moreover, theories on communication theory, information theory, learning theory, behaviour psychology and sociology were mentioned in Hooper-Greenhill (1999)'s academic book. For design process, crossing of architecture, theory of design and project management was used to construct a new exhibition design model (Lin 2002, Lin 2005). After communication theory noticed in museum study in the 1970s and 1980s (Whittle 1997, Taxén 2004), it was further applied in the field of exhibition design for describing the circular relationship between message and three stakeholders (clients, designers and audiences) during 21st century (Li 2005, Chuan, Kun et al. 2006, Fang 2016). Hence over this period, communication theory can be found as one of mainstream theories of studying

exhibition design. With actual experiences of business-based projects, Berger, Lorenc et al. (2007) pointed out that the crossing feature of exhibition design in the view of design disciplines such as interior design, graphic design, etc., and architecture under the background of '*globalization of design*' (p.22) and mass communication. Focusing on economy and marketing view, Beigium researchers argued that designers needed to know some disciplines and theories with psychology, ergonomics, sociology and semitics, therefore creating influenced experience and effecting customers' behaviours by applying design factors (Quartier, Christiaans et al. 2009). With the fast-developing technology, HCI (Human-computer Interaction), an emerging discipline at a crossroads of computer science, social science, design discipline and others, enters the vision of exhibition design (Taxén 2004, McCarthy and Ciolfi 2008, Pujol, Roussou et al. 2012, Wang 2015, Zhang, de Bont et al. 2015). Film theory (Dernie 2006, Hughes 2010, Suzanne, Hourston et al. 2012, Hou 2015, MacLeod, Dodd et al. 2015) and theatre theory (Counts 2009, Hughes 2010, Suzanne, Hourston et al. 2012) also are discussed or mentioned for exhibition design.

The second characteristic is the ***collaboration*** (shown in Table 2.4). The development of exhibition design is rooted from the practical activities and reality requires, the complex and post-developing situations of which enables exhibition design to search for power from various disciplines (Lin 2003, Lin 2005, Hughes 2010). It simultaneously leads to that exhibition design is evolving as collaboration with different stakeholders related to the exhibition-developing project (Falk 1993, Crimm, Morris et al. 2009, Locker 2011, McKenna-Cress and Kamien 2013). For example, Falk (1993) stated that exhibition design included scientists, exhibition design professionals and evaluation professionals from the perspective of collaboration. Because good communication in design progress can help promote understanding between stakeholders and enhance the effectiveness of design quality, so collaboration tends to be a decision-making way of addressing the complex situation around exhibition design progress (Lin 2003). A chart about design team organization illustrated by Crimm, Morris et al. (2009) relates to project architect, project designer, interior design, sustainable design, mechanical engineer, electrical engineer, lighting design, plumbing engineer etc.. Collaboration design is discussed in other disciplines such as architecture (Kvan 2000, Chiu 2002, Gabriel and Maher 2002), product design (Tung 2012), HCI(Laurel 2013), however, the attention on exhibition design is particularly paid to collaboration design between 2000s and 2010s (shown in Section 2.4.1).

Table 2.4. Collaboration in exhibition design.

Core Team: Idea generator, curator, implementer, designer. Peripheral Team: Educator, editor, production personnel (p.86).	Carliner (1998) Fredrickson Commnications, Inc., USA
Artist, engineer, architect, designer, curator, museum specialist and educator (p.2).	Lin (2002) University of Central England in Birmingham, UK
Director/trust/senior management, curator, educator, collection manager, conservator, exhibition designer, preparator, multi-media designer, audio-visual technician, marketer and/or publicist (p.104).	Stenglin (2004) University of Sydney, Australia
Artists, engineer, architect, designer, curator, museum specialist and educator (p.1).	Lin (2005) Chienkuo Technology University, Taiwan
Architect, event designer, trade show manufacturer, industrial designer, environmental graphic designer, and interior designer (p.88).	Berger, Lorenc et al. (2007) Lorce+Yoo Design; SEGD, USA
Building/sit Design Team: Project architect, project designer, historic preservation/section 106 architect, interior design, sustainable design, accessibility, mechanical engineer, electrical engineer, lighting design, plumbing engineer, fire protection engineer, information technology, food service, retail design, acoustics, security, structural engineer, cost estimating, landscape design, site design/civil engineer, traffic studies, geotechnical engineer, signage/wayfinding, AV consulting. Exhibit/program Team: Exhibit planners, interpretive planner, historian, exhibit evaluator, collections & archives management, focus groups, visitor projections, multi-media producers, graphic design (p.75).	Crimm, Morris et al. (2009) Cultural Design Group; George Washington University; the Society of University Planning, USA
Interactive expert, graphic designer and project leader (p.32).	Hughes (2010) University of Portsmouth and the University of the Creative Arts, UK
Narrative writer, spatial designer, art director, multimedia designer and programmer, film maker, content researcher and hardware technician (p.1).	Leslie (2011) Martello Media, Inc., Ireland
Exhibition designer, graphic designer, industrial designer, art historian, sculptor and audio-visual designer (p.496).	Demir (2012) Gazi University, Turkey
Museum and heritage professional, exhibition designer, architect and artist (p. xx).	Suzanne, Hourston et al. (2012) University of Leicester; University of Nottingham, UK
Business advisor, architect, consultant, conservator, curator, educator, engineer, exhibit planner/designer, graphic designer, landscape architect, manager, scholar, and specialist (p.19).	Bogle (2013) Limn Studios, USA

With the view of audience, Simon (2010) described '*integrating collaboration into visitor experience makes participation available to anyone, anytime*' (p.204), which is an approach to exhibition design for engagement enhancement and goal achievement. This point is different with traditional method of exhibition design that more for client awareness. A project-based study at Harvard University invited 564 audiences into designing exhibition by surveying their needs and memories based on educational theory (Moura, Ugulino et al. 2011). In addition, technology has an obvious effect on collaboration. With the perspective of designer, a joint research with the University of Sydney and Woods Bagot company compared two collaboration approaches (GUI-based and TUI-based collaboration), and finding that 3D virtual environment can allow designer to immerse their more time in design progress (Gero and Lindemann 2005). Augmented reality is also used in human-robot system for enhancing collaboration, because it can allow audiences understand the content by their own perspectives based on the efficient transformation of facial expressions, gestures and body languages (Chen, Billinghurst et al. 2008). New technologies are a centre for collaboration in exhibitions and exhibition design (Moura, Ugulino et al. 2011).

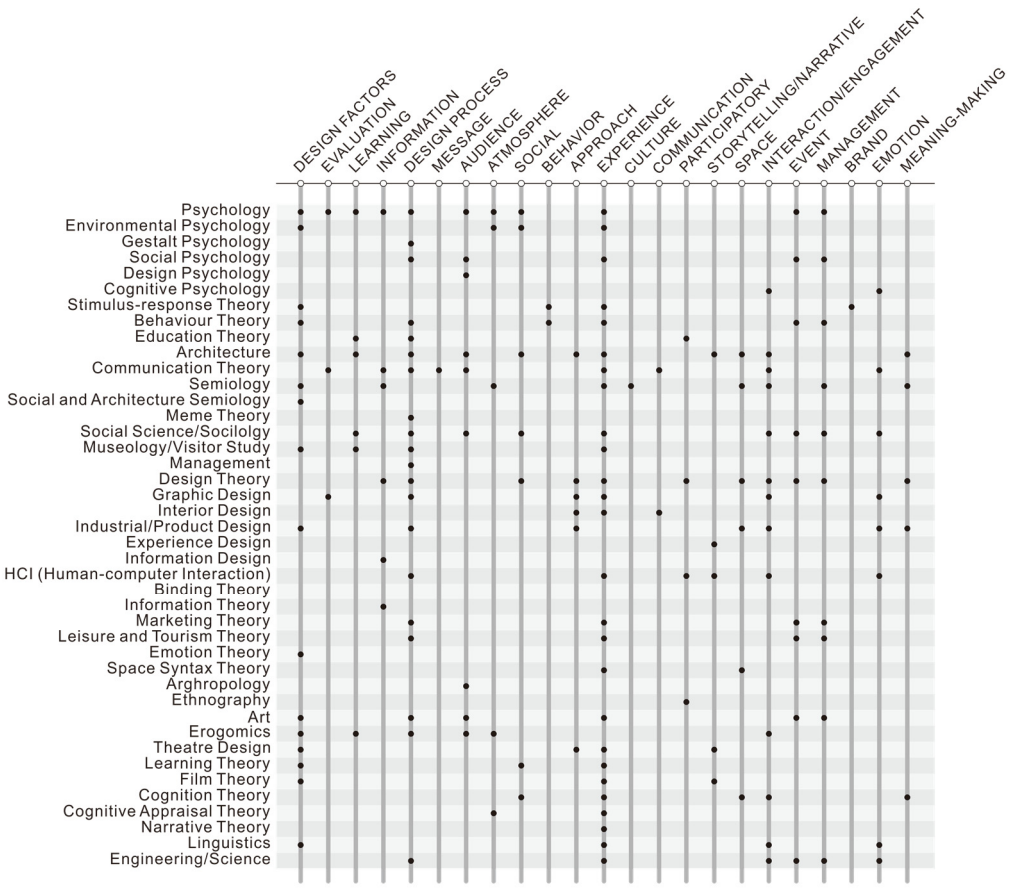


Figure 2.11. The crossing characteristic of exhibition design.

Figure 2.11 helps understand the strings between involved theories and points in the area of exhibition design. A total of 23 strings relevant to the discussed points through analyzing literature for exhibition design are presented, with supported references. The coded strings are extended vertically and overlapped with the 41 theories in a horizontal direction, which is mentioned in the analyzed literature in terms of exhibition design. Block dot is displayed at appropriate intersections, liking a knot which illustrates a theory corresponding a particular string in the net. However, rather than for guidance purpose, Figure 2.11 is trying to outline the relevant relationships of exhibition design during the literature review. The overall aim of this section is to provide a general presentation for deeper understanding the multi-disciplinary characteristic of exhibition design. Meanwhile, the drawing will be dynamic along with the adding dots as a result of the increasing research and academic papers.

Figure 2.11 is developing for the new added theories and study points in line with exhibition design. In this thesis, there is no need for involving all related theories. Given its complex situation and its nature as multi-disciplinary, the selected theories of studying exhibition design in this thesis will be indicated in greater depth in Section 2 focusing on research questions (shown in Section 1.4).

2.5 Discussion of literature

The definition of the main concepts is discussed in this section, which tends to highlight a key background for further understanding and explaining this research in line with two themes as following:

I. **Dimensions of Exhibition.** Although the complexity and multi-disciplines of exhibition (Dean 2002, Forrest 2015, Hou 2015), time (sequence-based), space (adjacent-based), and message (layer-based) can be considered as dimensions of exhibition in general. Accordingly, the shared meaning (multi-layered) is created for achieving the dynamic communication among clients, designers, audiences, and the exhibitions themselves. It tends to provide a whole and basic understanding of what is the exhibition, and why designing an exhibition.

II. **Mapping Exhibition Design.** Only few literature is considered into exhibition design during the last decade, in despite of its booming development in modern society (Hughes 2010, Locker 2011). The section attempts to fill a gap in this area, by using the qualitative analysis software NVivo and scientific research method. Therefore, the main concepts related to exhibition design are mapped and illustrated in a systematic graph with timeframe stream. In addition, models and theories of studying exhibition design are outlined and discussed in depth as well.

Although research into the field of exhibition design as reviewed in this section, is relatively limited. The development to audience experience, enjoyment emotion and behaviour data can be indicated but less well-summarized. It will be presented in the next Chapter 3.

3 Theoretical summary – identifying EDFs, AEFs and BD, and HEI

3.1 Introduction and aims

The chapter of theoretical summary covers four sections for exploring and investigating the relationship among audience experience, enjoyment emotion, behaviour data, and exhibition factors for designing better exhibitions, which are to bridge the gaps among these four areas.

Attention to answer what are the EDFs and AEFs perceived by audiences and used by exhibition designers in exhibitions, GT method is used to identify the factors of exhibition design and audience experience with a systematic literature review. To research question, Section 3.5 reports the results of identifying EDFs and AEFs, the novel part of the study. Finally, another novel part that establishing HEI theoretical framework is discussed in Section 3.6, where overlaps multiple themes of exhibition design, audience experience, enjoyment emotion, and behaviour data.

The purpose of this chapter tends to provide a theoretical context related to inform this thesis. This allows the specific objectives:

1) to examine the related literature for understanding the research concepts;
2) to explore a scientific approach for investigating relevant studies;
3) to identify EDFs, AEFs, and BD for addressing the research questions;
4) to establish a theoretical framework for progress, study and evaluate the research subject.

3.2 Audience experience for exhibition design

3.2.1 The power of audience experience

Like exhibition integrated into our daily lives, audience experience has developed as one part of many experiences throughout an audience's whole lifetime (Falk and Dierking 2012, Csikszentmihalyi 2014, Hou 2015). In terms of exhibition design, there are three stakeholders sharing the power of audience experience. For clients, experience is used as a powerful marketing tool for product/service-selling and money-making in commercial scope (Blythe, Overbeeke et al. 2004, Legrenzi and Troilo 2005, Shaw 2007), through of which the information around target audiences are mastered and analyzed as common examples of Disney (Pine and Gilmore 1999), Starbucks (Solomon 2014) and Häagen-Dazs (Schmitt 2000). For audiences, experience influences their emotion (Berry, Carbone et al. 2002, Shaw 2007), behaviour (Bourdeau and Chebat 2003, Carù and Cova 2007), and memory (Dernie 2006, Falk and Dierking 2012) along with audiences' visiting journey. For designers, creating experience has become a main mission helping the intended achievement of clients and audiences at exhibitions (Dernie 2006,

Berger, Lorenc et al. 2007, Westerink, Ouwerkerk et al. 2007, Forrest 2015). Therefore, an issue why an individual or group invests their time into visiting exhibitions or not tends to be in sight for exhibition design. Understanding audience experience is the first step (Falk and Dierking 2012). The academic book *The Museum Experience Revisitied* that elaborating experience in exhibitions illustrated a complete process by the view of an audience experiencing an exhibition (Falk and Dierking 2012):

> *'I visit the museum hoping to experience X. I use the museum to insure that I experience X. I leave having successfully experienced X. I remember my experience as having been a great way to accomplish X. And finally, I share my experience with others—family, friends, co-workers—whom I encourage to go to the museum because it's a great place for X.'* (Falk & Dierking, 2012, p.89)

Due to the power of audience experience in the commercial and cultural fields, studies have gathered into the experience affecting on audiences, clients, and designers. However, the research gap between the relationship among audience experience, stakeholders and exhibition design needs to be further explored. For instance, after the analysis of qualitative and quantitative data, Forrest (2015) stated that addressing the gap between design factors and audience experience was essential for future exhibition design. This is one reason why '*enhancing audience experience*' is proposed in many studies (Charitonos, Blake et al. 2012, Elliott 2014, Robert, Luyten et al. 2014, Hou 2015) and institutes (Falk and Dierking 2012, Museum 2015). However, with economic development, '***enhancing audience experience***' is tending towards '***transforming audience experience***', which is discussed in the next section and also a main line in this thesis.

Critical aspects of studying audience experience

The following three aspects are central to audience experience as studied in this thesis. The first aspect is '***layer***'. Multi-layer can be considered as a '*filter*' or '*lens*' shaping audience experience (Wan and Zhang 2011, Falk and Dierking 2012) and forming their memories (Falk 2009, Falk and Dierking 2012) in exhibitions. Three layers including personal context, sociocultural, and physical contexts are outlined from the Contextual Model (Falk and Dierking 2012). Needs-based and identity-related motivation are also regarded as the lens and experiential filters (Falk 2009, Falk and Dierking 2012). Investigating influencing factors for virtual exhibition at the Shanghai World Expo 2010, social and cultural were mentioned with prior experience and emotion value (Wan and Zhang 2011). Besides, layers involving cognition, emotion/affection and behaviour were discussed as well in several studies (Westerink, Ouwerkerk et al. 2007, Getz 2008, Forrest 2015, MacLeod,

Dodd et al. 2015). No matter how audience experience is layered, which should be regarded as the whole. It is due to two reasons: One is audiences don't visit just a single exhibition, instead, intersecting with various experiences; another is going exhibition like one part of audiences' whole process, which receiving influences from other experiences with other processes (Taylor 1963, Choi 2010). The result can be explained by Gestala Theory (Falk and Dierking 2012, Hu 2012, McKenna-Cress and Kamien 2013, Forrest 2015).

The term '***journey***' is the second aspect. The period of audience experience (AE) in exhibitions can be divided into before, during and after experience (Overbeeke and Hekkert 1999, Shaw 2007, Falk and Dierking 2012). Before entering the physical exhibition, AE has worked, for example, browsing the digital/online exhibition or talking with other audience/staff may influence the initial experience and decision (Crimm, Morris et al. 2009, Falk and Dierking 2012). Companies particularly try to deeper their understanding for customers/audiences' journey from the experience beginning to its end as commercial strategy (Berry, Carbone et al. 2002). This results in the '*design for experience*' becoming more noticeable to exhibition design (Dernie 2006, Borsotti and Bollini 2009, Dou 2013, Forrest 2015, Hou 2015), not limited to other design disciplines such as product design (Sari and Piia 2012, Fokkinga and Desmet 2013), interaction design (Forlizzi and Ford 2000, Garrett 2010) and experience design (Overbeeke and Hekkert 1999, McLellan 2000). After/post experience is emphasized as integral part of customer/audience experience (Shaw 2007). The concept of experience extension was presented for describing the journey of experience with these three stages by Shaw (2007), the author of *The DNA of Customer Experience*, and the founder and CEO of Beyond Philosophy UK. He particularly pointed out the essential role of pre- and post-customer/audience experience on '*understand the customer's emotional state on entering the experience*' (Shaw, 2007, p.33). A resesarch-led design project conducted by university, museum institution and company in UK and Genmany mapped a physical, emotional and cognitive journeys as the ideal audience experience from the starting to exit from the exhibition (MacLeod, Dodd et al. 2015).

However, journeys with audience experience are '*not linear but circular*' (Falk & Dierking, 2012, p.22). Researchers at Oregon State University built a Museum Experience Cycle for explaining the need and motivation of audiences. Moreover, scholars at Hasselt University Belgium constructed a circular framework of cuctomer/audience experience for commercial environments (Petermans, Janssens et al. 2013). Based on literature review and ethnographic interview, Petermans, Janssens et al. (2013) reported the study from the viewpoints of designers, clients and audiences. As shown in Figure 3.12, three stakeholders involving general and particular aspects of customer/audience experience were

illustrated for designing commercial projects with the constructed theory. General aspect contained 7 factors such as subjectivity, specificity of time and context, interaction, multiple communication channels, spread over period of time, dynamism, and holism; particular aspect covered 11 factors including intention, theme and consistency, experience realms, senses, values, emotion, hedonic and utilitarian aspects, involvement of customers at different levels, immersion, engagement of customers and memorability (Petermans, Janssens et al. 2013).

The third aspect is '***interaction***'. It is related to the engagement between audiences and exhibitions, focused on the behaviour level of audiences and communication purpose in exhibitions. Experience arises from interaction, which is explained in Falk and Dierking (2012)'s the Contextual Model of Learning. Markers have realized that if only in one-way model of communication, the expereince-produced will be restricted to some extent which thus influences the end result of creating a powerful and immersive experience in exhibitions (Carù and Cova 2007). From the perspective of money-making, Shaw (2007) defined the customer/audience experience as '*an interaction between an organization and a customer*' (p.8), which was intermixed together with exhibition itself, the stimulated multi-sensory, and stirred emotion, which was also measured by the expectations of customer/audience. It was also defined in the field of HCI (Human-compoter Interaction) as '*both the process and outcome of the interaction of a user with the environment at a given time*' (Bernhaupt & Mueller, 2016, p.40). Based on the point, a game system presenting an experiential cycle produced through the interaction between user and game was discussed (Bernhaupt and Mueller 2016). Furthermore, content is one fundamental element for achieving interaction in exhibitions, which was indicated in We-Me model introducing the evolution of audience experience along with five stages between exhibitions and audiences (Simon 2010). Therefore, considering how to construct experience through constructing content involving information and message will be a core problem for designing exhibition. Section 7.3 provides more details about this issue.

In conclusion, the real question is not only whether to develop a deep understanding of audience experience, but how to use the appropriate approach of analyzing audience experience so that enabling it from implicit level to explicit level with research progress and technology advancement. This is because compared to audience behaviour, experience (and emotion) has a distinctive feature of subjective dimension, which cannot be directly studied through direct observation. Instead, it needs the input or output of audiences themselves (Forrest 2015). In terms of exhibition design, studying audience experience accords to the evolution of research methods with technology development from interview, questionnaire, self-reports, to videotape, eye-tracking, path-tracking, and physiological-tracking.

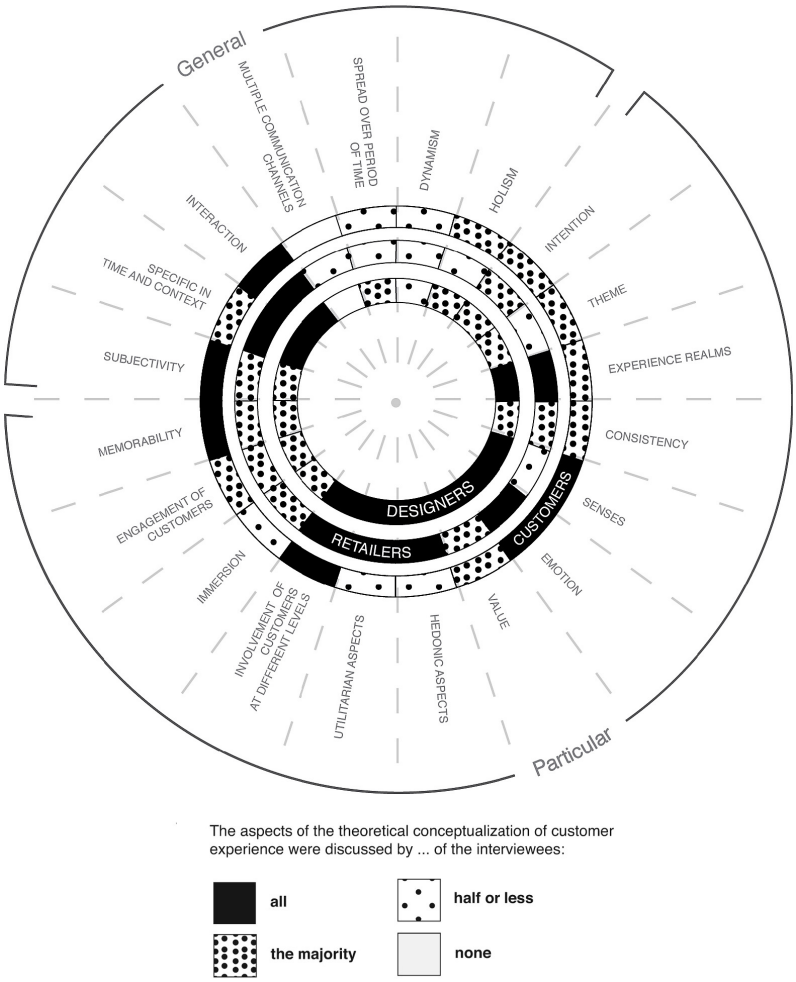


Figure 3.12. Visualization of customer/audience experience by retailers/clients, designers, and customers (Petermans, Janssens et al. 2013).

Embedding audience experience into exhibition design

Previous section discussed that during 2000s, exhibition design shifts to experience-led stream (shown in Section 2.4.1). Audience experience therefore plays a major role in exhibition design (Berger, Lorenc et al. 2007, Borsotti and Bollini 2009, Forrest 2015, Hou 2015). How to embed audience experience into exhibition design became one of the key questions, which refer to around five perspectives (shown in Table 3.5). Examples are from exhibition design factors to audience experience (Berger, Lorenc et al. 2007, Shaw 2007, Falk and Dierking 2012, Forrest 2015, MacLeod, Dodd et al. 2015); from story/narrative to audience experience (Pine and Gilmore 1999, Carù and Cova 2007, Suzanne, Hourston et al. 2012, Lin, Ma et al. 2014); from evaluation to audience experience (Overbeeke and Hekkert 1999, Westerink, Ouwerkerk et al. 2007, Legorburu and McColl 2014, Forrest 2015); from audience experience factors to audience experience (Blythe, Overbeeke et al. 2004, Volker and Martin 2012, McKenna-Cress and Kamien

2013, Petermans, Janssens et al. 2013, Kirchberg and Tröndle 2015, Nesbitt and Maldonado 2016); audience experience cannot be designed (Overbeeke and Hekkert 1999, Blythe, Overbeeke et al. 2004, Carù and Cova 2007, Kirchberg and Tröndle 2015).

Designing for audience experience is a major role in designing exhibition because its specific '*tool*' function of marking, money-making, and communication both on be found that marketing and practical fields like design companies and advisory bodies exploring experience on research, not just from the general view from the academic area. Moreover, previous literatures also demonstrated that audience experience is closely linked to behaviour (Vom Lehn, Heath et al. 2001, Bourdeau and Chebat 2003, Dernie 2006, Carù and Cova 2007, Getz and Page 2016), and emotion (Berry, Carbone et al. 2002, Shaw 2007, Chitturi 2009, Falk and Dierking 2012, Saariluoma and Jokinen 2014, Getz and Page 2016), which are further discussed in following sections.

Table 3.5. Literature of embedding audience experience into exhibition design.

Aspect	Source	Background(s)[11]	
1: Design factors → Audience experience			
Using design factors as tools to create audience experience.	Berger, Lorenc et al. 2007	Lorenc+ Yoo Design; SEGD	USA
Design factors are brough into experience by markers for money-making.	Shaw 2007	Beyond Philosophy	UK
Design factors help maximize the quality of audience experience.	Falk and Dierking 2012	Oregon State University; OSU Center for Research on Lifelong STEM Learning	USA
Desgin factor has impact on audience experience.	Forrest 2015	The University of Queensland	Australia
Studying design factors help design for creating audience experience.	MacLeod, Dodd et al. 2015	University of Leiceste; Duncan McCauley	UK; Germany
2: Story → Audience experience			
Theming an experience means scripting a participative story.	Pine and Gilmore 1999	Strategic Horizons LLP	USA
Audiences access experience through themed/staged environments.	Carù and Cova 2007	Bocconi Universit; Euromed Marseilles	Italy; France
Structured story is a key to the success of audience experience.	Macleod, Hanks et al. 2012	University of Leicester; University of Nottingham;	UK
Experience can be offered by story creations with audiences' own interpersonal connection	Lin, Ma et al. 2014	Taipei College of Maritime Technology; National Taiwan University of Arts	Taiwan
3: Evaluation → Audience experience			
Studying what people do,say and make for evaluating experience.	Overbeeke and Hekkert 1999	Delft University of Technology	Netherlands
Measuring experience is important to enhance positive experience and avoid negative experience.	Westerink, Ouwerkerk et al. 2007	Philips Research Laboratories	Netherlands
Measuring experience is the need for commerce and marketing.	Legorburu and McColl 2014	SapientNitro	USA
Through measuring experience to characterise audience experience.	Forrest 2015	The University of Queensland	Australia

[11] In line with the grounded theory (Charmaz, 2014), the background of the literature tends to provide a visual information for understanding the study in depth.

Continued Table 3.5

4: Experience factors → Audience experience			
Experience is applied from the perspective of designers and users/audiences.	Blythe, Overbeeke et al. 2004	University of York; Eindhoven University of Technology	UK; Netherlands
A compared review of studies on audience experience factors for constructing a framework of audience experience.	Kirchberg and Tröndle 2012	Leuphana University; Zeppelin University	Germany
Experience factors can help exhibition design progress achieving the results of audience experience.	McKenna-Cress and Kamien 2013	University of the Arts	USA
The development of experience factors is a valuable instrument to design for experience for designers and retailers.	Petermans, Janssens et al. 2013	Hasselt University	Belgium
Experience factors intend to drive various types of audience experience.	Kirchberg and Tröndle 2015	Leuphana University; Zeppelin University	Germany
Using experience factors as works of language to shape and bridge exhibition design and audience experience	Nesbitt and Maldonado 2016	Shedd Aquarium	USA
5: Audience experience cannot be designed			
Experience cannot be really designed due to that audience experience need to be constructed with the conditions of provided communication and interaction.	Overbeeke and Hekkert 1999	Delft University of Technology	Netherlands
Designers cannot design experience, but we can design for experience with studying experience.	Blythe, Overbeeke et al. 2004	University of York; Eindhoven University of Technology	UK; Netherlands
Firms can create and manage experiential context, not experience.	Carù and Cova 2007	Universitá Bocconi and SDA Bocconi School of Management; Universitá Bocconi	Italy
There is no 'one size-fits-all' approach to creating the audience experience for exhibition.	Kirchberg and Tröndle 2015	Leuphana University; Zeppelin University	Germany

3.2.2 Framing audience experience

Framing, theming, staging or orchestrating audience experience (AE) are the major mission of designing exhibitions. Although in some practical projects it is easy to overlook on the grounds of cost constraints, the economic impact is also the nature and essence of enhancing audience experience, which allows companies to achieve more far-lasting on audience/consumer. Meanwhile, along with the emerging of the experience economy, marketing and companies are intending to talk of '*exhibition design*' but fail to '*merchandise presentations together into a staged experience*' (Pine & Gilmore, 1999, p.46). Rather than simply '*providing entertainment or engagingly creative*' (Berry et al., 2002, p.1) , AE needs to be framed, staged or orchestrated through certain means. In line with communication theory in exhibitions and exhibition design, framing AE is a form of transformation from constructed information, message to the story, then to meaning-making by content (Pine and Gilmore 1999, Pine and Gilmore 2011) (shown in Section 3.2.1). This is a unique opportunity for being better able to affect audiences with both their emotion or behaviour (Pine and Gilmore 1999, Pine and Gilmore 2011).

Experiences in exhibitions are continuous and different (Falk and Dierking 2012, Allanwood and Beare 2014, Forrest 2015), but each experience has a structure

and should be structured with a stage of beginning, middle and end (Berger, Lorenc et al. 2007, Mortensen 2011, Suzanne, Hourston et al. 2012, Allanwood and Beare 2014), which often take the form of narrative such as storytelling.

Pine and Gilmore (2011), the cofounders of commercial consultancy company in USA, had both academic experience in MIT Design Lab and the University of Virginia. Under the developing background of economic experience, they elaborated the concept of staging audience experience based on performance theory, and moreover, a term of Transformation Economy is being further introduced. Table 3.6 summarizes major aspects throughout the staging/framing audience experience of the books (Pine and Gilmore 1999, Pine and Gilmore 2011). Furthermore, a review of means and theories for framing audience experience, from experience economy to transformation economy, from experience design to transformation design, is discussed in the following section.

Table 3.6. Framing audience experience and its aspects (concluded from Pine and Gilmore 1999, 2011).

A1: Scripting theme	Theme in staging experience drives design factors, 'scripting a participative story', and the foundation of framing experience with 'the vehicle of storytelling and other narratives'.
A2: Staging surprise	Thus, Customer surprise=What customer gets to percieve-What customer expects to get. Drama means 'to do' from the Greek drao; it is the strategy of business to structure the theme, and guidance performance of audiences for enterprises and companies.
A3: Drama dimension	Rather than satisfying customer, surprise need to be staged for bridging the gap of their perceptions and expectations.
A4: Script dimension	The script provides guidance and approach to drama (strategy), which must interpret drama, follow the original meaning, focus on audience. It is the essential code of exhibition/event.
A5: Theater dimension	'Work is theater' in the Experience Economy, and following a strand: [drama=strategy], [script=processes], [theatre=work], [performance=offering]. Therefore, economic offerings relate with experience, commodities, goods, services through scripted drama and staged performance.
A6: Performance dimension	Performance is the offering of economic business developing for customers, containing other three dimensions: theatre, script, and drama.It is staged with structured drama for creating memorable experience.
A7: Audience=customer	'Audience=customer' is the basis for new economic activity, which starts from staging experience and performance.

Means of framing audience experience

Kolter and Kolter (1998), the researchers from Kotler Museum and Cultural Marketing Consultants, Northwestern University and University of Virginia, illustrated a framework of orchestrating experience involving different degrees of audience experiences through the engagement between exhibitions and audiences, augmented service, and exhibition design. '*Competing with experiences*' (p.5) was argued by Berry, Carbone et al. (2002) from Texas A&M University, the officer of Experience Engineering in Minneapolis, and IBM Advanced Business institute. They indicated that the key to the company was to manage the experience. Shaw and Ivens (2005) summarized seven philosophies for building a great customer experience in their book *Building Great Customer Experience*, illustrated in Figure 3.13. The book *The DNA of Customer Expereince* depicted five means for managing experiences such as managing experience as

theatre, using experience to build brand equity, balancing control and spontaneity, managing conflict between creativity and business, and developing and using appropriate measures (Shaw 2007). Five steps and three phases for theming experience were described by Pine and Gilmore (1999), the first to propose the theory of economic economy. Five steps include: 1) Theming an experience intends to '*script a participative story*' (p.48); 2) Designing the themed experience of space, time, and matter can change audiences/customers's '*sense of reality*' (p.49); 3) Structuring space, time, and matter as a whole; 4) Designing '*multiple places within a place*' (p.51) can strengthen theming experience; 5) Staging the experience should stand in the perspective of enterprises and companies. Meanwhile, three stages are represented from diagnose aspirations to stage experience(s), then to follow through (Pine and Gilmore 2011). The basic guidances for framing audience experience within each audiences personal, sociocultural, and physical contexts are outlines involving four aspects: 1) Exploring the needs and interests of audiences; 2) Creating emotionally, sensory, kinesthetically, and intellectually compelling experiences; 3) Allowing experience to afford the choice, control, and ownership of audiences; 4) Supporting audience experience in exhibitions integrating into the everyday and entire life of audiences (Falk and Dierking 2012).

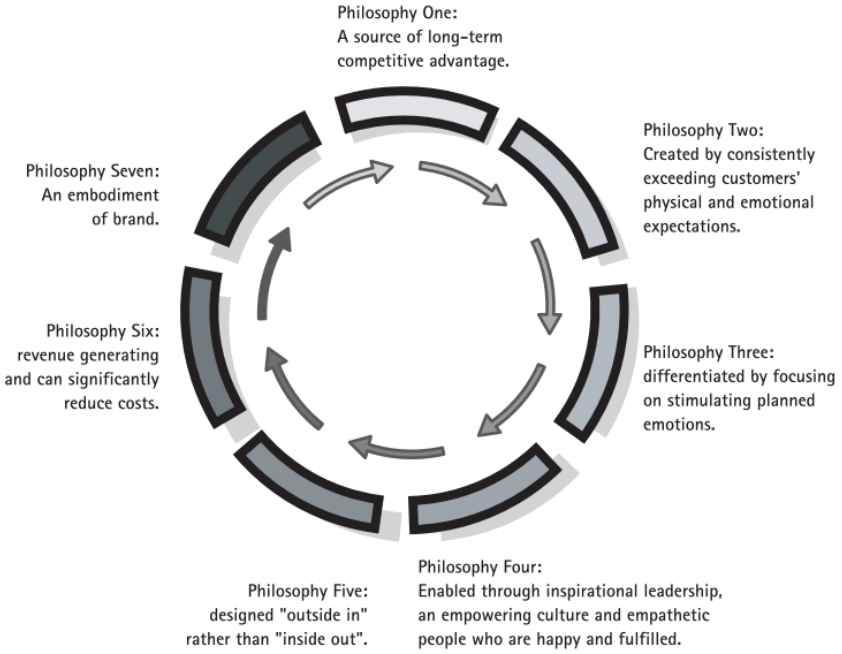


Figure 3.13. The seven philosophies for building great customer experiences virtuous circle (Show, 2005).

In 2013, two cycle frameworks of audience experience were constructed by Petermans, Janssens et al. (2013) (Figure 3.12, Section 3.2.1) and Roppola (2013) (shown in Figure 3.14). Roppola (2013) used GT building a model of framing audience experience, which explained the reason how exhibition design influenced audience experience in a synthesis of framing, resonating, channelling

and broadening. Meanwhile, Israel researchers at Ruppin Academic Center, tried to explore the relationship among enjoyable emotion, behaviour, experience and environment, and framing a conceptualisation of the mall experience. It contained four experience: Seductive, interactive museum, social arena, and functional (Gilboa and Vilnai-Yavetz 2013). In recent years, framing audience experience is highlighted from design factors to emotion dimension in the design field (Forrest 2015, Shafieyoun 2016). For instance, based on investigating 602 audiences with both qualitative and quantitative data, the Perceived Atmosphere Instrument including vibrancy, spatiality, order and theatricality was explored to analyze the '*envionment-experience relationship*' (p. ii) in exhibition context, which related to different facets of audience experience and behaviour (Forrest 2015). The study pointed out that framing audience experience connected with past and previous experience of audiences, and audiences could overlap different frames for different types of exhibition (Forrest 2015). A PhD study conducted in design college of Politecnico di Milano constructed user experience during their hospital journey along with their behaviour sequence, seven emotions, and time. The result found experience was influenced by design factors such as colour, social aspect, light, layout, and art picture based on the theory of Kansei Engineering (Shafieyoun 2016). The Technology University of Eindhoven presented an Expereince Flow Diagram (EFD) to the overall experiences with audiences' time, location, and their behaviours by using the research methods including observation, photographs, video recording, and interview (Ayoola, de Regt et al. 2016).

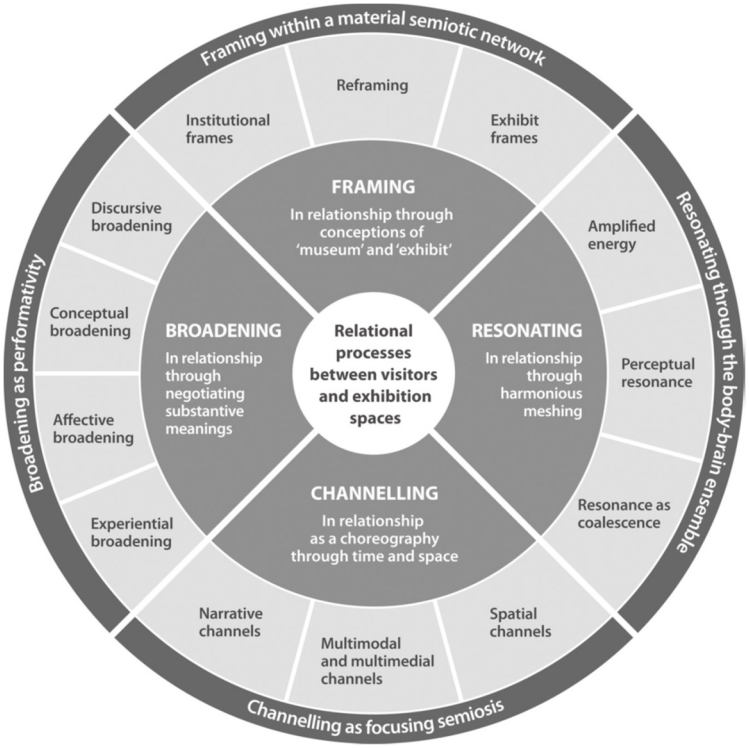


Figure 3.14. Framing, resonating, channeling and broadening (Roppola, 2013).

Considering performance and transformation

Framing audience experience is a dynamic activity. Through constructed journey in exhibition, marketing reach its economic target (Pine and Gilmore 1999, Pine and Gilmore 2011), and also help the achievement of cultural and social objects (Falk 2009, Falk and Dierking 2012). Performance and transformation are two main aspects of framing audience experience. In 1956, a UK researcher from the University of Edinburgh mentioned in his book *The Presnetation of Self in Everyday Life* that like theatrical performance in stage, people commonly performance themselves conveying information in real social life as well (Erving 1956). The term '***performance***' is used as '*all the activity of a given participant on a given occasion which serves to influence in any way any of the other participants*' (Erving, 1956, p.8), which is equivalent to behaviour or activity (Hooper-Greenhill 2007). Furthermore, Schechner (2004) proposed the '*Perforamance Theory*' for introducing Theater. In the '*performance chart*' (p.28), he summarized the relations among space, conventions, drama, director and free. As a broad term, both animals and humans apply performance to deliver message and information through structured drama and theater in daily life. Performance can be considered as a set of transformations between the performer and behaviour, and/or between the performers and audiences (Schechner 2004). In 2007, King's College London and Science Museum London jointly conducted a '*video-based field*' study, which explored how audiences '*transform their activity with and around computer-based exhibits into performances, and how such performances create shared experiences'* (Meisner et al., 2007, p.1531). They labeled audiences as '*performers*', and audiences' behaviours with and around the exhibits as '***performance*s**', presenting that it cannot only be used for '*creating engaging and enjoying experiences*' (Meisner et al., 2007, p.1541.), but for observing as a research approach. Following the previous studies, Performance Model and Enachment Model (shown in Figure 3.15) were presented, tending to stage business performances through '*turning drama into performance*' for customers (Pine and Gilmore 1999, Pine and Gilmore 2011). In Pine and Gilmore's framework, '*business creates for customers*' (p.109) following the fundamental equations：

[audience=customer]
[drama=strategy]
[script=processes]
[theatre=work]
[performance=offering]

Performance provides a possible explanation to why using structured approach such as drama, storytelling, and other narratives for framing audience experience, and therefore achieving communicating message, then to the commercial or

cultural purpose (Erving 1956, Pine and Gilmore 1999, Schechner 2004, Pine and Gilmore 2011).

The emerging Experience Economy drives a trend that business and marketing must settle whether to performance with the '*dramatic structure*' (Pine & Gilmore, 1999, p.153), and '*as an act of theatre*' (Pine & Gilmore, 1999, p.113) or not. Afterwards, '*transformation economic*' is discussed along with the path from services to experiences to transformations (Pine and Gilmore 1999, Hjorth and Kostera 2007, Pine and Gilmore 2011, Sundbo and SËrensen 2013). Pine and Gilmore maintained that when framing an experience, experience economy comes into a transformation voluntarily. The most prominent of transformation economy is that audiences/cudtomers themselves become product/offering. And the changing five economic types including commodities, goods, service, experience, and transformation. And transformations have the profound influence on business/exhibition, client/employer, customer/audience, and even design development (shown in Table 3.7). This determines the major role of ***transformation*** considered in framing audience experience and developing design discipline (Pine and Gilmore 1999, Pine and Gilmore 2011, Sundbo and SËrensen 2013).

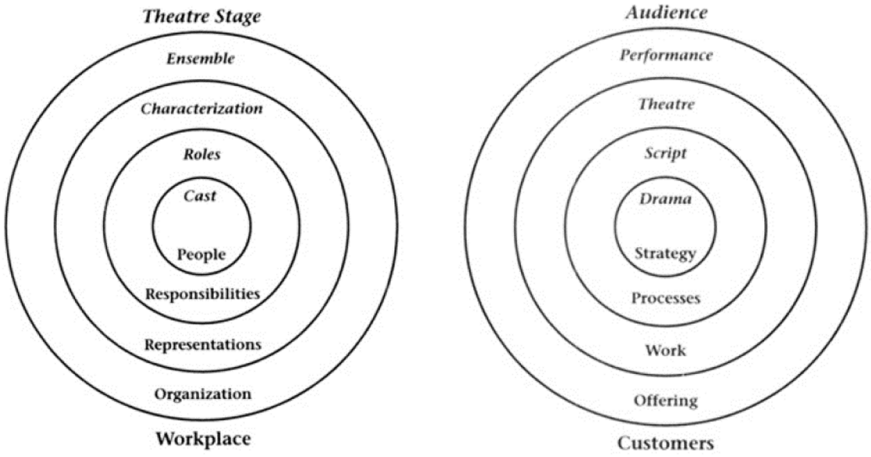


Figure 3.15. Performance model (left) and Enactment model (right) (Pine and Gilmore, 1999 and 2011).

Transformation is the inherent meaning of framing audience experience (Pine and Gilmore 1999, Pine and Gilmore 2011, Sundbo and SËrensen 2013), as well as associated with behaviour within environment (Gray and Salber 2001, Burns, Cottam et al. 2006, Vestergaard, Rikke et al. 2012), and design process (Reymen 2001, Kan and Gero 2009, Pourmohamadi, Gero et al. 2011). It is important to design exhibitions as a result of three reasons: First, transformation is used as a tool for staging experience(s) (Pine and Gilmore 1999, Zamani and Peponis 2010, Pine and Gilmore 2011, Sundbo and SËrensen 2013); second, the exhibition itself is a transforming process (Getz and Cheyne 1997, Hjorth and Kostera 2007); third,

audiences require be transformed outside daily life through the journey of exhibitions (Kolter and Kolter 1998, Vestergaard, Rikke et al. 2012). Based on Performance Theory, Schechner (2004) found that in term of transformation, there was a correlation of three different levels of story (drama), behaviour (body/mind), and audiences (temproary/entertainment or permanent/ritual). He also argued that performance was symbol-making as a kind of language the same as kinetic, visual, spatial, etc, therefore, which always '*involves transformation of the body, and the spaces around it, into full fields of communication*' (Schechner, 2004, p.263).

Table 3.7. New competitive landscape (Pine and Gilmore, 2011).

	Commodities The material is the offering	Goods The product is the offering	Services The operation is the offering	Experiences The event is the offering	Transformations The individual is the offering
Origination	New substances are discovered	New inventions are developed	New procedures are devised	New scripts are depicted	New aims are determined
Execution	Extracting is the core activity of the trader	Making is the core activity of the manufacturer	Delivering is the core activity of the provider	Staging is the core activity of the stager	Guiding is the core activity of the elicitor
Correction	A poor site triggers further exploration	A problem triggers fixing of a mistake	A reaction triggers a response	Forgetting triggers preservation of memory	A relapse triggers stronger resolve
Application	A trade connects in markets	A transaction connects with users	An interaction connects with clients	An encounter connects with guests	Persevering connects with aspirants

Exhibition is a '*transformative space*' (Vestergaard, Rikke et al. 2012, p.1) where facilitates ordinary person experiencing a series of transformations to be an audience during the exhibition journey. For example, in an interview with the study that supported by Danish Agency for Science, the participants mentioned that they were transformed from boring into interesting exhibition by exhibition design (Larsen and Svabo 2014). This point can help design more experienced and transformative exhibition. Carliner (2003) pointed out that audiences should be transformed into other times and spaces through exhibition design. On the other hand, Zamani and Peponis (2010) at Georigia Institute of Technology revealed that the transformation '*in the interaction between architectural setting, exhibition design and curatorial intention'* (p.853), through studying exhibition design factors such as museum exhibition space, and audience's movement behaviour. Through empirical observation study, Vestergaard, Rikke et al. (2012) generalized four steps for exhibition transformation: Arrival, service, orientation and preparation. The research team also reported how mapping space functions into audience transformations as a guidance for designing exhibitions (Vestergaard, Rikke et al. 2012). In the field of marketing, a new theory of Transformative Consumer

Research (TCR) was proposed for addressing social problems and improving social change with positive behaviour (Solomon 2014). And this thesis summarizes related literature which discusses the transformations related to exhibition, audience, experience, emotion, and communication, presented in Table 3.8.

Table 3.8. The overview of transformation studies.

1. Exhibition:	
Transformating exhibition into learning	Falk and Dierking (2000)
Transformating learning into exhibition	Lin (2002); Falk and Dierking (2000)
Transformating experience into exhibition	Dernie (2006)
Transformating content into exhibition	Dernie (2006)
Transformating exhibition into attention and collaboration	Moura, Ugulino et al. (2011)
Transformating exhibition into interaction	Orhun, Campus et al. (2012)
Transformating space functions into exhibition	Vestergaard, Rikke et al. (2012)
Transformating time into exhibition	Tzortzi (2014)
Transformating science into exhibition	Achiam and Marandino (2014)
Transformating design factors into exhibition	Kim and Lee (2016); Bollo and Dal Pozzolo (2005)
2. Audience:	
Transformating interaction into audience	Falk and Dierking (2000)
Transformating audience into experience	McCarthy and Ciolfi (2008)
Transformating person into audience	Vestergaard, Rikke et al. (2012)
Transformating audiences into exhibition	Vestergaard, Rikke et al. (2012); Carr (2001)
3. Experience:	
Transformating need and demand into experience and behaviour	Kolter and Kolter (1998)
Transformating experience into memory	Falk and Dierking (2000)
Transformating experience into learning, emotions and senses etc.	Hooper-Greenhill (2007)
Transformating experience into meaning	Browning, Benckendorff et al. (2008)
Transformating experience into pleasurable and enjoyable emotion	Wilson, Flores et al. (2012)
Transformating exhibition into experience	Lanz (2016); Hughes (2010); Dernie (2006)
4. Emotion:	
Transformating emotion into communication	Overbeeke and Hekkert (1999)
Transformating positive emotion into better life	Csikszentmihalyi and Hunter (2003)
Transformating positive emotion into group of people	Fredrickson (2003)
Transformating marketing into emotion measurement	Pawle and Cooper (2006)
Transformating emotion into experience	Fokkinga and Desmet (2013); Iacobini, Gonsalves et al. (2009)
Transformating emotion into brand	Rosenbaum-Elliott, Percy et al. (2015)
5. Communication:	
Transformating information into communication	Kolter and Kolter (1998)
Transformating message into communication	Hooper-Greenhill (1999)
Transformating exhibition into communication	Hooper-Greenhill (1999)
Transformating communication into meme	Blackmore (2000)
Transformating commercial into communication	Brodie (2009)
Transformating communication into design	Orhun, Campus et al. (2012)
Transformating communication into economic	Gardien, Djajadiningrat et al. (2014)
Transformating design factor into communication	Hou (2015)

Attention should be focused on technology, which has a specific power on transforming experience (Sparacino 2002, Vom Lehn and Heath 2005, Cosley, Lewenstein et al. 2008, Soren 2009). For instance, MIT researcher illustrated a sensor-driven exhibition by applying wearable-computing in order to explore the interaction between audiences and stories. It provided a means to transform exhibition into a storytelling, narrative, and sensor-driven context with experiences; meanwhile, the research lab was also transformed into a museum space (Sparacino, Davenport et al. 2000, Sparacino 2002, Sparacino and Places 2004, Sparacino 2008). She recognized that the wearable and sensor-driven devices tended to enhance and transform audience experience at the context of exhibition both with commercial and cultural values (Sparacino 2002). In 1997 MIT Media Laboratory conducted a '*Tnagible Bits*' project, which included three prototype parts: the metaDESK, transBOARD and ambientROOM. One of the project goals

was to transform exhibition factors such as walls, desktops, ceilings, doors, etc. into an interactive interface among physical and virtual environments (Ishii and Ullmer 1997). Through applying sensors, scholars at the University of Glasgow UK and IBM recognised that information could be transformed into a physical context with control and actions in the form of data (Gray and Salber 2001).

From experience design to transformation design

In line with the mapping of evaluation from agricultural economy to industrial economy to service economy to transformation economy (Pine and Gilmore 1999, Pine and Gilmore 2011), design discipline experiences a series of corresponding transitions as well. Figure 3.16 of the economic pyramid reveals the growing tendency towards the world economy, which was constructed according to Unitied States Bureau of Labor Statistics and Bureau of Exonomic Analysis (Pine and Gilmore 1999, Pine and Gilmore 2011). It is evident that the transformation is marketing and business, but also required by the new generation of audiences in terms of exhibition (Brown, Gilbride et al. 2011):

> *'Attracting the next generation of audiences and visitors will require a transformation in programming, not just better marketing.'* (p.11)

In 2006, the RED[12] team of the UK Design Council issued a report *Transformation Design*, which showed a conclusion and first to bring forward a formal concept of '***transformation design***' (Burns, Cottam et al. 2006). That indicates experience design, flourishing in Experience Exonomy with the idea of user-centered design particularly in the field of HCI (Human-computer Interaction), is turning into design for transformation. Unlike experience design emphasized on user-centered and problem-solving as other design disciplines during the twentieth century (Shedroff 2001, Kuniavsky 2003, Garrett 2010, Gothelf and Seiden 2013, Allanwood and Beare 2014), transformation design has its unique characteristics expressed primarily through the following several aspects.

[12] RED is an inter-disciplinary team with a network of world-leading experts under the guidance of Design Council UK, focusing on exploring and developing design-driven project for social and economic services through innovative thinking and design practice. Detail information can be checked at www.designcouncil.org.uk/red.

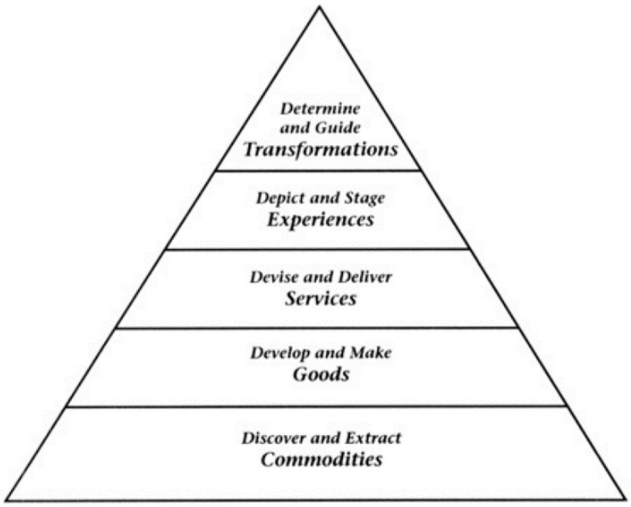


Figure 3.16. The economic pyramid (Pine and Gilmore 1999, 2011).

First, transformation design is understood as the participative process of doing projects with at least three stakeholders: Designers, users and clients (Burns, Cottam et al. 2006, Sangiorgi 2011, Topp 2011). In traditional design means, the decision-making role of designers and clients is over-highlighted, easily resulted in two extremes: at one extreme, clients determine the development of project from it starting and ending, just followed by designers and ignored audiences/customers; the other extreme is that designers provides domination for project progress from the sole aspect, as expert but neglecting the needs of audiences or followed by clients (Lin 2002, Burns, Cottam et al. 2006). In addition, study reported that user-centered in experience design failing in '*promote human interests*' (p.30) effectively, due to that it put most attention on technical problem but missing system development (Gasson 2003). This is one reason the move to participatory design in the context of exhibition design (Taxén 2004, Simon 2010, Elliott 2014). By contrast, transformation design is similar to participatory design (shown in Section 2.4.1) more '*human-centered*' not just '*user-centered*' (Burns, Cottam et al. 2006, Sanders and Stappers 2008, Sangiorgi 2011).

For example, for designers, their role is more like facilities, organizer and coordinator for creating innovations and ideas with the participation of audiences/customers and clients (Burns, Cottam et al. 2006, Sangiorgi 2011); meanwhile, it calls for designers that have to '*immerse themselves*' (p.89) in people's daily life (Cipolla and Bartholo 2014), not just design an immersive environment for audiences (Hughes 2010, McKenna-Cress and Kamien 2013). Considering user/audience, they are placed at the center of the design process with idea-generated and feedback-generated, which then will be transferring into actual practices (Burns, Cottam et al. 2006, Sangiorgi 2011). Along with the concept of '*audience/customer is product*' in Transformation Economic, user/audience is integrated into the whole design process rather than used as the

tool for addressing problem in other design disciplines (Pine and Gilmore 1999, Burns, Cottam et al. 2006, Pine and Gilmore 2011). Referring to clients, transformation design helps them improve efficiency from the point of both social and economic view, by forming a variety of ongoing and systematic tools, skills and process throughout the entire the project not just limited design stage (Burns, Cottam et al. 2006, Sangiorgi 2011).

Second, transformation design points to multi-discipline (Burns, Cottam et al. 2006, Sangiorgi 2011). It is one of the major characteristics of exhibition design different with other design disciplines (Lin 2002, Demir 2012, Suzanne, Hourston et al. 2012). The multi-discipline of transformation design is decided by the need for collaboration with three stakeholders during whole projects, discussed in previous first aspect. In nature, each emerging design discipline tends to contain several of the previous design disciplines (Sanders and Stappers 2008). Therefore, whether from a natural evolution or from the actual requirement, transformation design, '*the newest of the emergent design discipline*' (Sanders & Stappers, 2008, p.10) , can be seen as a more systematic and collaborative design approach with multi-discipline.

Third, transformation design is identified as '*shaping behaviour rather than form*' (C. Burns et al., 2006, p.26). Burns, Cottam et al. (2006) recognized transformation design as an active behaviour including '*the behaviour of systems, interactive platforms and people's roles and responsibilities*' (p.26). This is notably different from the historical design disciplines, which focus on designing with form began from German Bauhaus (László 2012). The researchers of Delft University of Technology compared with traditional and emerging design disciplines (shown in Table 3.9), pointing out that designing for product or a purpose was the main difference of them (Sanders and Stappers 2008). Through compared Table 3.9, it will be shown how designing for the dimension of substance-focused with multi-aspects turns into the dimension of human-focused with multi-levels.

Table 3.9. The comparison between traditional and emerging design disciplines. (Sanders and Stappers 2008).

The traditional design disciplines focus on the **designing of** 'products' ...	... while the emerging design disciplines focus on **designing for** a purpose
visual communication design	design for experiencing
interior space design	design for emotion
product design	design for interacting
information design	design for sustainability
architecture	design for serving
planning	design for transforming

Although few literature discussed the new design discipline since appeared in 2006, transformation design has become a new trend with the developing of Experience Economic and Transforamtion Economic. Moreover, it's worth noting

that exhibition design and transformation design share many of the same characteristics. There is no assuring that what is the specific relationship between exhibition design and transformation design. But since the performance and transformation in the role of framing audience experience, exhibition design is closer to transformation design compared with other design disciplines.

3.2.3 Embedding flow experience into exhibition design

> *'We experience it as a unified flowing form one moment to the next, in which we feel in control of our actions, and in which there is little distinction between self and environment; between stimulus and response; or between past, present, and future.'* (Csikszentmihalyi, 2014, p.137)

In the previous section, we discussed audience experience as a power and framing means in the exhibition design field. This section attempts to reveal the relationship among experience, enjoyment emotion and behaviour/activity/action by embedding flow experience into exhibition design. Table 3.10 is a list of flow concepts highlighting its shared aspects. And apparently, the link among experience, enjoyment and behaviour is complicated, but from a flow standpoint, a success of designing whether product (Norman 2004, Desmet 2012, Shafieyoun 2016), game (Salen and Zimmerman 2004, Jegers 2009, Nacke 2009, Cho and Kim 2012), web (Pace 2004, Cho and Kim 2012), or exhibition (Csikszentmihalyi and Robinson 1990, Csikszentmihalyi and Hermason 1995, Falk 2009, Getz and Page 2016), is achieving an enjoyable state of flow.

Previous literature had illustrated some important issues of the flow experience. Based on literature review, Table 3.10 implies that connecting aspects of as a state, time distortion, interaction with environment, experience, enjoyment, and activity may be a help for understanding the flow experience. Up to a certain point, the nature of flow experience matches the expectations and understanding of the exhibition (shown in Section 2.3.3). Flow experience serves as a measure, design and understanding means that are related with all of these aspects discussed in this thesis such as audience experience, enjoyment emotion, or behaviour data, into which exhibition design is embedded. The flow experience was first proposed by Csikszentmihalyi (1975), the psychologist and theorist at the University of Chicago, and then in his report *The Art of Seeing: An Interpretation of the Aesthetic Encounter*, aesthetic experience at museum was investigated as a specific form of enjoyable flow experience by using anthropological research approach such as semi-structured interview and questionnaire. The result found two factors reaching to flow experience such as challenge and skill, and built two research approaches including '*Interview Questionanre for Museum Professionals*' and '*Aesthetic Experience Questionnaire Form*' (Csikszentmihalyi and Robinson

1990). In 1995, a framework depicting *the Development of Learning through Intrinsic Motivation in Museum Settings* informed when visiting exhibition, audiences required to remain the state of flow experience as a intrinsic rewarding with extrinsic (action) and intrinsic motivation (curiosity and interest), which could be considered as '*a growth of sensory, intellectual and emotional complexity*' (Csikszentmihalyi & Hermason, 1995, pp.74-75). It allows audiences to enhance their learning in the context of exhibition. On this basis, positive psychology through the lens of flow experience was further discussed for '*improving the quality of life at either the subjective or objective level*' (Csikszentmihalyi, 2014, p.236). His academic book focusing on the term of flow had been translated into 23 languages such as English, Thai, Greek, Estonian, Portuguese, and Chinese, etc. and doing research in different countries such as USA, Korea, Japan, Thaliand, Australia, Europe, and a Navajo reservation (Csikszentmihalyi 2014).

In spite of the peak performance and experience provided by flow experience, it also has negative side similar to '*addiction*' which may enable people to time abuse or self-indulgent. The flow experience therefore tends to produce undesirable and unfavorable consequences (Chen, Wigand et al. 2000). Meanwhile, although the flow experience is pursued as an intrinsic rewarding for enjoyment, it cannot occur in every time as a regular attribute of daily life and activity (Voiskounsky 2008). In turn the flow experience as a systemic concept and lens may help to study the embedding processes among various heterogeneous aspects in term of exhibition design.

Table 3.10. Understanding flow experience.

	Supported content	Literature[reference], page
As a state	In which individuals experience happiness/enjoyment and develop the corresponding full-capacity.	Artz (1996), p.8
	That people realizes after finishing a series of steps of engaged task.	Bernhaupt and Mueller (2016), pp.42-43
	An emotional and psychological state of focused and engaged happiness along with the feeling of achievement and accomplishment, and 'a great sense of self'.	Salen and Zimmerman (2004), p.9
	A subjective state that people are completely involved in state of losing in 'time, fatigue and everything else but the activity itself'.	Csikszentmihalyi (2014), p.230
	'Flow is a motivating, captivating, addictive state'.	Norman (2004), p.45
Time distortion	A 'flow' state is that individuals lose all sense of time and purpose.	Allanwood and Beare (2014), p.182
	'You are in a trance where the world disappears from consciousness. Time stops. You are only aware of the activity itself'.	Norman (2004), p.45
	Flow is enjoyable experience when an individual immersived in an activity with the sense of time distortion during the engagement/interaction.	Chen, Wigand et al. (2000), p.263
	Individuals lose track of both time and space during their flow state.	Norman (2002), p.63
Interaction with environment	Enjoyable interaction with an indispensable symbolic environment is identified as the state of flow experience.	Csikszentmihalyi and Halton (1981), p.77,201

Continued Table 3.10

	Flow experience seems to occur in the condition that individual can use some skills with limited environment in the form of physical, emotional, or intellectual interaction.	Csikszentmihalyi (2014), p.137
	Instead of just concerning the person or abstracted context, flow research focuses on person-environment interaction as the dynamic system.	Nakamura and Csikszentmihalyi (2014), p.90
	The engagement/interaction of the flow state is sought by designers in the view of users/audiences/customers in a structured and meaningful environment.	Salen and Zimmerman (2004), pp.4-9
As experience	Flow study provides an understanding of experience when people are 'fully involved in the present moment'.	Csikszentmihalyi (2014), p.239
	Flow theory is a way of understanding optimal human experience that helps people to happiness.	Jegers (2009), p.63
	Flow is a term used to 'describe a peak experience of total absorption in an activity'.	Blythe, Overbeeke et al. (2004), p.91
As enjoyment	Flow including eight elements aims to achieve enjoyment.	Sweetser and Wyeth (2005), p.1
	Flow can be used to design, evaluate and understand enjoyment.	Bernhaupt and Mueller (2016), p.13
	Based on the view of flow theory, the highlighted 'enjoyment rather than pleasure makes life rewarding'.	Csikszentmihalyi (2014), p.224
	Flow is mentioned as 'one of the most well known model for understanding and measuring enjoyment in psychology'.	Saket, Scheidegger et al. (2015), p.2
As activity/ behaviour	Flow is an enjoyable experience when people being in an activity with 'total involvement, concentration and enjoyment, and experiences an intrinsic interest and the sense of time distortion during his/her engagement'.	Chen, Wigand et al. (2000), p.263
	The activity itself becomes autotelic or rewarding in flow.	Chen, Wigand et al. (2000), p.269
	A person fully immersived in the activity for its own sake is one specific feature of the flow state.	Salen and Zimmerman (2004), p.9
	Flow tends to occur by the activity with clear goals, immediate feedback, matched challenges with skills, such as social interaction, challenging work, hobby, game, sport, reading, exhibition, and dance.	Csikszentmihalyi (2014), p.138, 206, 232, 253, 255

The key factors of flow experience

Previous publications have shown that the promising benefits of flow experience help human beings to construct or improve both a better life as individual and a better society as a whole (Csikszentmihalyi and Hermason 1995, Chen, Wigand et al. 2000, Csikszentmihalyi 2014). Research on flow experience often suggests its roles in measurement (Novak and Hoffman 1997, Chen, Wigand et al. 2000, Shafieyoun 2016), marketing (Bloch, Ridgway et al. 1994, Carù and Cova 2007, Solomon 2014), creativity and discovery (Csikszentmihalyi 1996, Vass, Carroll et al. 2002), and design (Artz 1996, Norman 2002, Cho and Kim 2012, Desmet 2012, Shafieyoun 2016). According to this perspective, flow experience factors (Csikszentmihalyi and Hermason 1995, Novak and Hoffman 1997, Chen, Wigand et al. 2000, Salen and Zimmerman 2004, Sweetser and Wyeth 2005, Cowley, Charles et al. 2008, Allanwood and Beare 2014, Csikszentmihalyi 2014, Bernhaupt and Mueller 2016, Tuunanen and Govindji 2016) and their tool or model (Csikszentmihalyi and Hermason 1995, Cowley, Charles et al. 2008, Nakamura and Csikszentmihalyi 2014, Bernhaupt and Mueller 2016, Shafieyoun 2016) are constructed among applications. They may service as a directed design and implementation in depth.

The author of the first publication, Csikszentmihalyi (1996) summarized around nine factors of flow experience started from 1975 (Csikszentmihalyi 1975,

Csikszentmihalyi and Robinson 1990, Csikszentmihalyi and Hermason 1995, Csikszentmihalyi 1996, Csikszentmihalyi and Hunter 2003, Csikszentmihalyi 2014, Nakamura and Csikszentmihalyi 2014):

1. Balance of challenges and skills;
2. Clear and immediate feedback on activities;
3. Clear and concrete goals;
4. Merging of action and awareness;
5. Immersed concentration on activities;
6. Sense of control with the level of arousal;
7. Rewarding and autotelic activities;
8. Time transformation;
9. Loss of self-consciousness.

To explore flow experience factors of the World Wide Web, Chen, Wigand et al. (2000) reported that a multi-measurement approach should be applied for studying flow experience due to five reasons: First, flow experience is '*multi-dimensional*' and '*a complicated construct*' (p.279). Second, people can be identified into people in flow or not in flow for an assessment way. Third, flow experience cannot be taken as a '*generalized experience*' or a '*frequent daily experience*' (p.279), due to its transient time and confined space. Fourth, as the most important and complex indicators of flow experience, more attention should be paid on the challenges and skills. Fifth, valid data may not be collected just by using a single research method such as questionnaire (Chen, Wigand et al. 2000).

To design meaningful game, Salen and Zimmerman (2004) outlined two major respects with eight sub-factors, the effects of flow (the merging of action and awareness, concentration, the loss of self-consciousness, and the transformation of time) and the prerequisite of flow (a challenging activity, clear goals, clear feedback, and the paradox of having control in an uncertain situation). As optimal experience aiming to enjoyment, flow is used as a tool for designing a pleasure game where game is designed as an experiential system embraced user/palyer as a component of it (Salen and Zimmerman 2004).

Through a comparing study, eight factors of flow experience in game were discussed by Sweetser and Wyeth (2005), Australian researchers from the Universtiy of Queenland. They were modified from Csikszentmihalyi and Robinson (1990) including concentration, challenge, skills, control, clear goals, feedback, immersion, and social interaction. A joint study between Finland and New Zealand pointed out that the flow experience could be measured with visualisation by interviewing participants about 35 minutes (Tuunanen and Govindji 2016). They understood flow experience with eight factors as analysis parameter such as

importance, interactivity, arousal, focused attention, control, positive affect, challenge, skill, and telepresence/time distortion.

Researchers also attempted to construct a model for measuring or designing an enjoyable state of flow experience, based on selected flow experience factors. The models of flow experience particularly center on the context of game (Novak and Hoffman 1997, Sweetser and Wyeth 2005, Cowley, Charles et al. 2008, Bernhaupt and Mueller 2016) or exhibition (Csikszentmihalyi and Hermason 1995, Shafieyoun 2016). For instance, along with previous models such as three channel flow model, four channel flow model, Novak and Hoffman (1997) constructed an eight channel flow model involving skill, challenge, control, play, flow, arousal, and anxiety. GameFlow was introduced as an evaluation tool for designers in measuring enjoyment of a game (Sweetser and Wyeth 2005). Furthermore, EGameFlow was developed for measuring the level of enjoyment of e-learning game, consisting of eight factors based on 166 valid samples with survey questionnaires: Immsesion, social interaction, challenge, goal clarity, feedback, concentration, control, and knowledge improvement (Fu, Su et al. 2009). The user-system-experience (USE) model was framed in order to embed flow experience into game-play, which provided an approach to enhance an interaction among experience, player and game system (Cowley, Charles et al. 2008). Jegers (2009) mentioned in his doctoral thesis of Umeå University that creating an optimal experience in game design required to map flow experience, its factors, and specific design discipline. Pelachaud (2013) introduced '*flow zone*' (p.229) in order to explain emotion's major role in game design (Figure 3.17), based on Mihaly Csikszentmihalyi's flow theory originated from the 1970s. In 2016, a presence-involvement-flow framework (PIFF) was reported to study the experience in digital game, which was constructed with three basic concepts: Presence, involvement, and flow. Each concept had subcomponents and related to perception, psychology, spatial and social cognition, and evaluation (Bernhaupt and Mueller 2016).

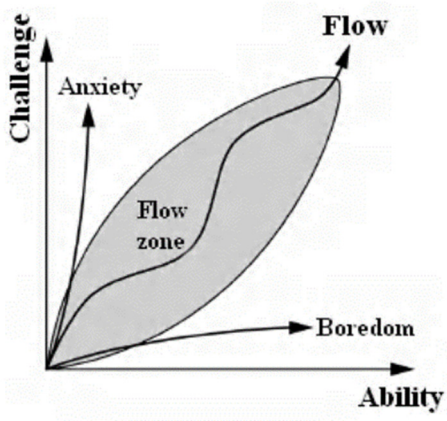


Figure 3.17. The flow zone (Pelachaud, 2013).

In the exhibition aspect, in addition to Csikszentimihaly's model of the process of intrinsic motivation at museum (Csikszentmihalyi and Hermason 1995), a PhD study conducted at Politecnico di Milano presented the Flow Kansei Method to measure emotion when users' flow journey before, during and after exhibitions in hospital. It investigated 200 participants with the questionnaire, observation, videography and interview in two Milan and Rome hospitals (Shafieyoun 2016). The study tried to construct a flow space in the view that the emotional reaction was formed through the balance between the amount of skills and challenges. It would help the designers thinking from the user's perspective, and designing with scientific method inserted into emotion, behaviour and evaluation (Shafieyoun 2016). Given its complicated status and its use as a main lens, more embedding factors of flow experience may allow a systematic design framework.

Although the flow study on exhibition is limited and a gap still exists between flow and exhibition design, flow experience tends to play an indispensable part in the design and evaluation of the exhibition. It's worth mentioning that developing exhibition shares a lot in common with the game in terms of human-exhibition interaction (HEI, shown in Section 3.6.1). Accordingly, related studies of flow experience both in game or other fields will make mutually profits for exhibition design research and it will be further illustrated how they have been taken into account on various factors of flow experience in the following section.

The flow experience transformation

There is a transformation among experience, enjoyment emotion and behaviour/activity in term of flow experience, as shown in Table 3.10. It also may be the reason why people pursue flow experience other than the day-to-day experience and why the flow experience can provide people full-capacitiy and peak performance. A paragraph from the classic book *Emotional Design: Why We Love (or Hate) Everyday Things* (Norman 2004) may describe such transformation, with an example of watching a film:

> *'To be fully engrossed within a movie is to feel the world fade away, time seem to stop, and the body enters the transformed state*.' (p.113)

And it is this transformation, of experience, enjoyment and behaviour, that forms the state of flow experience (Chen, Wigand et al. 2000, Norman 2004, Salen and Zimmerman 2004, Csikszentmihalyi 2014). For example, the transformation of time is discussed as one of flow experience factors. During in flow, the length of time perceived by people is transformed from hours to minutes, or from seconds to hours (Chen, Wigand et al. 2000, Salen and Zimmerman 2004).

Experience transforming in flow experience:

Gaining a break from the stresses of everyday life is the major reason why people moves to visit an experiential exhibition (Csikszentmihalyi and Hermason 1995, Falk 2009, Falk and Dierking 2012, Csikszentmihalyi 2014) or others various activities such as dancing, reading, watching movie (Norman 2004, Csikszentmihalyi 2014), not just the specific objects with information-obtainning, or money-making. Flow experience, referred to '*peak experience*' and *'peak performance*', is the essence of the whole experiences (Blythe, Overbeeke et al. 2004, Pace 2004, Csikszentmihalyi 2014), and transforming experience can be identified as the appearance and means of flow experience.

As a '*optimal experience*' (Artz 1996, Jegers 2009, Csikszentmihalyi 2014, Bernhaupt and Mueller 2016) with common characteristics of others successive or layered experiences in a specific journey with different behaviours/activities, transformation between experiences and flow experience is not inevitable, which will be aroused at least through factors of flow experience (Chen, Wigand et al. 2000, Salen and Zimmerman 2004, Allanwood and Beare 2014, Csikszentmihalyi 2014, Bernhaupt and Mueller 2016, Tuunanen and Govindji 2016).

Enjoyment transforming in flow experience:

Enjoyment has been extensively mentioned in flow study as the achieved goal (Blythe, Overbeeke et al. 2004, Salen and Zimmerman 2004, Sweetser and Wyeth 2005), and measurement (Fu, Su et al. 2009, Tuunanen and Govindji 2016). Meanwhile, flow is also used as an essential approach to measuring or understanding enjoyment (Sweetser and Wyeth 2005, Saket, Scheidegger et al. 2015, Bernhaupt and Mueller 2016). Previous work has noted that the enjoyable transformation of flow experience can facilitate better design (Salen and Zimmerman 2004, Sherry 2004) and marketing result (Novak and Hoffman 1997, Carù and Cova 2007, Solomon 2014).

The concept of '*Media Enjoyment*' theorised by Sherry (2004), who argued that enjoyment of media shared common traits of flow such as focused concentration, loss of self-consciousness, a sense of control, experience distortion, and experience as intrinsically rewarding. Accordingly, the transformation between enjoyment and flow can be implemented under certain conditions such as the balance when the message of media content conforming with individual's abilities including challenges and skills. Sweetser and Wyeth (2005) introduced the term '*GameFlow*' for evaluating enjoyment, which was conceived of as the central to digital game. Achieving the transformation between enjoyment and flow experience is developed into

an evaluation tool for designing, analyzing and understanding games. Additionally, there is a gender difference in terms of entering enjoyable flow state. Sherry (2004) argued that some structural factors of game would more service males than females into experiencing an enjoyable flow.

Behaviour transforming in flow experience:

'*When individuals are fully involved in an activity, they tend to find the activity enjoyable and intrinsically rewarding*' (Csikszentmihalyi, 2014, p.233). This implies that the enjoyable flow experience often related to activities/behaviours (Nacke 2009, Bengler and Bryan-Kinns 2014, Csikszentmihalyi 2014). Focusing attention on the activies/behaviours with enjoyment is mentioned the key skill of flow experience (Csikszentmihalyi and Halton 1981). They described a transforming transaction between person and thing along with three models: Aesthetic quality, attention and goal. Chen, Wigand et al. (2000) from Taiwan and USA discussed the transformation that on the one hand, flow experience could shape activity/behaviour itself, and on the other hand, a merging of activity/behaviour and awareness with high attention tended to provoke an enjoyable flow experience (Chen, Wigand et al. 2000).

The behavioural transforming in flow experience has been central to design field. An example of emotional product design case is the description of during film-watching '*the body enter the transformed state*' (p.133) labeled as flow (Norman 2004). An other example is a behavioural design application which is used to as one of the aspects to measure customer emotion. It is in on the basis of the relationship among designers' environment, user experience and emotion, cognition, and behavioural visceral in product design (Khalid and Helander 2006). The researcher from Parsons, the New School for Design and the department of retail, hospitality, and tourism management at the University of Tennessee, reported that on the view of behavioural perspective, flow had an influence with design factors, and then deciding customers' behaviour. Through testing an alternative model for website design, the study noted the transforming relationship between flow, design factors and customer behaviour (Cho and Kim 2012). The balance between skills and challenges for inspiring flow experience is also discussed as one factor that affects user's emotion. He presented that flow experience was transforming with three timing phases including flow time, wait time, and face time in 5E: Entice (arrival), enter, engage, exit and extend (Shafieyoun 2016).

The flow experience in exhibition design

In 1990, Csikszentmihalyi, the pioneer of flow theory, first explored the connection between flow and exhibition in the context of museum (Csikszentmihalyi and Robinson 1990). In 1995, they developed a framework in order to reveal the reason why audiences entered museums for learning in depth, and after investigation, the finding noted that the enjoying flow experience was the intrinsic motivation due to its results of leading to personal growth (Csikszentmihalyi and Hermason 1995). Nakamura and Csikszentmihalyi (2014) in his publication *The Concept of Flow*, mentioned an example of exhibition design that applying flow principles for designing the Getty Museum in Los Angeles, and including a product design example of Nissan USA for enjoyable flow state. However, there is still a gap between flow and exhibition design.

The first study mentioning flow experience in exhibition design was the publication financed by Victoria University of Wellington and the French Ministry of Foreign Affiairs (Traue 2000), which mentioned that a flow experience with enjoyment would be generated to audiences through exhibition design, similarly to the response of '*ah ha*' or '*eureka*'. Moreover, the relationship among flow experience, enjoyment emotion and design factors had been focused in the design field of product design (Desmet 2012, Shafieyoun 2016), game design (Salen and Zimmerman 2004, Sweetser and Wyeth 2005, Jegers 2009, Nacke 2009), and user interface or web design (Cho and Kim 2012). Only Italian scholar Shafieyoun (2016) investigated the relationship among flow experience, emotion, behaviour and design factors in the special environment of hospital exhibition. For measuring flow and emotion, despite a lack of the necessary experimental equipment, the doctoral study not only developed a method of Flow Kansei Engineering with observation, questionnaire and interview, but also giving a brief discussion such as EMG, ECG, FMRI, PET, ECG, skin temperature, eye tracking, optimal tracking and body tracking, etc..

Hein (2002), the professor of museum education at Lesley College USA, stressed that flow experience can assist learning at museums. Based on leisure studies and social psychology, flow experience was well introduced into the model of event design and management (Getz 2008, Getz and Page 2016). From the better communication point, Falk (2009) discussed that the flow experience could enhance audiences' engagement and understanding, and it was also the requirement by the audiences for the continuous enjoying activity and remaining flow state. It was akin to the immersive state of watching a performance, film, etc., and with a certain flow factor such as the matched skill and challenge. He stated that not just the memorable experience, '*it is truly an exhilarating experience—physically, emotionally and cognitively*' (Falk, 2009, p.140), when audiences go into exhibitions. A review of AE in the museum was conducted by German

researchers at the Leuphana University and Zeppelin University, which highlighted the flow experience in museums along with analyzing its characteristics and comparing with aesthetic experience (Volker and Martin 2012, Kirchberg and Tröndle 2015). In summary, these studies make a direction to flow experience, which occupies an important place in regard to exhibition design and AE of exhibitions.

3.3 Enjoyment emotion for exhibition design

> *'Emotions are an essential part of our lives, they influence how we think and behave, and how we communicate with others.'* (Velásquez, 1997, p.1)

Why we focus on enjoyment? How to achieve an enjoyable design? Can exhibition be designed enjoyably? This section presents the main role of enjoyment emotion (EE) in the field of exhibition design. Enjoyment emotion serves as an evaluating and designing tool used in this thesis. This is because that on the one hand, enjoyment emotion is a flow-like state as evaluation and measurement in a variety of fields (Green, Brock et al. 2004, Sweetser and Wyeth 2005, Fu, Su et al. 2009, Csikszentmihalyi 2014), and on the other hand, enjoyment has a interactive connection with experience, emotion, and behaviour (Petrelli, Not et al. 1999, Gomez, Popovic et al. 2004, Nabi and Krcmar 2004, Shaw 2004, Csikszentmihalyi 2014). This means that the role of bridging the gap among experience, emotion, and behaviour particularly for designing exhibitions to some extent calls for enjoyment study.

3.3.1 Enjoyment emotion

The term enjoyment refers to two meanings in general: Life level and application level. Firstly, enjoyment in daily life is directly associated with enjoyable activities and happiness felling as the individual significance, rewarding, or evaluation (Csikszentmihalyi and Halton 1981, Kekes 2009, Csikszentmihalyi 2014). For example, the publication *The Meaning of Things: Domestic Symbols and the Self*, supported by the USA National Institute, reported that as a goal, the '*good life*' involves enjoyment, which '*leads into the future, must be tended to survive; otherwise, it turns into mere pleasure*' (Csikszentmihalyi & Halton, 1981, p.202). Further, in Kekes (2009)'s book *Enjoyment: The Moral Significance of Styles of Life*, enjoyment is regarded as life itself in nature, and meanwhile, it is the foundation and primary standard of personal evaluation. Making a good life through making enjoyable activities was mentioned by Aristotle as well (Kekes 2009). In addition, Csikszentmihalyi (2014) summarized that enjoyment in everyday life makes intrinsic rewarding as a kind of autotelic experience.

Secondly, enjoyment in application level services as design and evaluation in disciplines like HCI (Blythe, Overbeeke et al. 2004, Kim 2010), game (Bialoskorski, Westerink et al. 2009, Daggubati 2016), media (Sweetser and Wyeth 2005, Tsay 2007) and design (Norman 2002, Norman 2004, Norman 2010, Saket, Scheidegger et al. 2015). For instance, rather than traditional usability in Human-computer Interaction (HCI), a concept of Funology is proposed for designing enjoyment, which also mentioned that HCI had tried to put enjoyment into central over 20 years but was highlighted until the early 2000s (Monk, Hassenzahl et al. 2002, Blythe, Overbeeke et al. 2004). In order to evaluate enjoyment in games and design enjoyable game, the term of GameFlow was introduced along with flow theory developed by Csikszentmihalyi (Sweetser and Wyeth 2005). Along with the study of Sweetser and Wyeth, Taiwan researchers further explored EGameFlow for measuring enjoyment in the context of e-learning game, based on 166 valid samples with a questionnaire survey (Fu, Su et al. 2009). In terms of media, enjoyment was used to understand and measure its effectiveness (Nabi and Krcmar 2004). In this sense, enjoyment may be a dynamic compositions with experience, emotion, cognition, and behaviour (Green, Brock et al. 2004, Nabi and Krcmar 2004, Shaw 2004, Sherry 2004, Vorderer, Klimmt et al. 2004). In the design aspect, enjoyment was mentioned repeatedly by Norman[13], one of the famous professor in design field. He claimed that from usability of industrial design to experience design, emotional and interaction design, enjoyment emotion was important and required the whole three design levels including visceral, behavioural and reflective (Norman 1988, Norman 2002, Norman 2004, Norman 2010).

As one positive type of emotions, enjoyment emotion is recognized with the similar characteristics. In terms of exhibition context, its role in business and marketing attracts more attention, including impacts on decision-making and memory. Particularly, the book *Emotional Signature-The Role of Emotions in Customer Experience*, written by the UK company Beyond Philosophy[14], pointed out that '*Businesses unfortunately, have vague understanding of emotions in general and the principles outlined below attempt to better inform and explain the importance of emotions, particularly in business'* (Walden & Janevska, 2011, p.6) .

[13] Don Norman, the director of Design Lab at the University of California, co-founder of the Nielsen Norman group, and honorary professor at Tongji University, has an interdisciplinary background like engineering, computer science, mathematical psychology, cognitive science and design. He is the pioneer exploring the major concepts of design discipline such as user-centered design, emotional design, and three design levels (visceral, behavioural and reflective) etc.

[14] The world's first Customer Experience consultancy and training company. It was founded in 2002 based on the UK, and has branches and work across USA, China, European, and North America.

Enjoyment definition

There is a wide-ranging discussion about the definition of enjoyment and of what forms its elements (shown in Table 3.11). At the point of interpretation, different definitions help us a better understanding rather than limited lenses with the one definition (Table 3.11). The concept of enjoyment was introduced by Lacan[15] between 1953 and 1954 connecting with the meanings of a '*sexual, elusive, ineluctable, painful, overwhelming, and fascinating pleasure*' (Kingsbury, 2005, p.113), which was translated from the Frence word '*jouissance*' (Kingsbury, 2005, p.113). It was considered as '*an innocent and self-evident psychological phenomenon*' (Kingsbury, 2005, p.113). In this sense, enjoyment is similar with other positive emotions such as fun (Desmet and Hekkert 2002, Monk, Hassenzahl et al. 2002, Blythe, Overbeeke et al. 2004, Norman 2004, Westerink, Ouwerkerk et al. 2007, Roppola 2013, Bernhaupt and Mueller 2016), pleasure (Desmet and Hekkert 2002, Green and Jordan 2003, Blythe, Overbeeke et al. 2004, Nam and Kim 2011, Desmet 2012, Csikszentmihalyi 2014, Lefebvre, Stanek et al. 2014, Sands, Oppewal et al. 2015), and happiness (Velásquez 1997, Saaksjarvi and Hellén 2013, Csikszentmihalyi 2014, Lefebvre, Stanek et al. 2014).

Although all these positive emotions are the cornerstone of life (Monk, Hassenzahl et al. 2002), there are still some differences between enjoyment and them. For example, Norman (2004) pointed out that '*beauty, fun, and pleasure all work together to produce enjoyment, a state of positive affect*' (pp. 94-95). Comparing with pleasure as a single passive and relaxing emotion, enjoyment is strived-achievement, long-term activity, and '*less pleasing than pleasure itself*' (Voiskounsky, 2008, p.74). This study investigated enjoyment emotion, human experience and behaviour in cyberspace environment along with Csikszentmihalyi's flow theory, funded by Russian Foundations for the Humanities project. Moreover, Csikszentmihalyi (2014) compared enjoyment well with the different place of the pleasure. He found that '*enjoyment, rather than pleasure, is what leads to personal growth and long-term happiness*' (p.293). This is due to different from pleasure as a '*homeostatic experience*' (Csikszentmihalyi, 2014, p.219) on the physiological responses such as sex and physical comfort, enjoyment needs activity of using skills in challenges with the examples of sport and music event, work or social interaction, thus resulting in life rewarding (Csikszentmihalyi and Halton 1981, Csikszentmihalyi 2014).

In conclusion, life can hardly do without positive emotions not only including enjoyment, but also pleasure, and fun (Csikszentmihalyi 2014); designers tend to maximize the positive emotions of audiences/customers during their projects as

[15] Jacques Lacan, a famous French psychoanalyst and psychiatrist, with a major impact on post-structuralism, critical theory, linguistics, 20th-cengury French philosophy, film theory and clinical psychoanalysis.

well (Green and Jordan 2003, Blythe, Overbeeke et al. 2004, Salen and Zimmerman 2004, Hughes 2010, Pelachaud 2013). Not to mention the fact that customers/audiences pursue enjoyment, fun, pleasure and happiness during his/her journey of cultural or commercial context, even physical or virtual environment (Blythe, Overbeeke et al. 2004, Parsons, Ballantine et al. 2010). Therefore, '*designing for enjoyment'* and '*providing enjoyment for customer'* have been evolving into a baseline in the developing situation of new economy[16] (Schmitt 2000, Monk, Hassenzahl et al. 2002, Shaw and Ivens 2005, Gobe 2010, Pine and Gilmore 2011, Roppola 2013, Lefebvre, Stanek et al. 2014, Sands, Oppewal et al. 2015).

Table 3.11. Enjoyment definition summary.

	Definition	Author[reference], year, page	Background(s)	
1	Enjoyment is a pleasurable feeling resulting from aimed-activity with interaction. It means self-control, the developing skill and clear goal.	Csikszentmihalyi and Halton (1981), p.76	The University of Chicage, the University of Notre Dame, supported by National Institute on Aging	USA
2	Enjoyment is a subjective experience with the balance between demands and control, and skills and challenges. It is never guaranteed but 'as a context dependent and relational phenomena'.	Blythe, Overbeeke et al. (2004), p.55, p.94	The University of York, Eindhoven University of Technology	UK, the Netherlands
3	Enjoyment is a 'many-faceted concept'. It can help transform learning into enjoyment. Also, enjoyment is 'a response to a particular kind of stimulus'.	Green, Brock et al. (2004), p.318, p.323	The University of Pennsylvania, Yale University, Ohio State University	USA
4	Enjoyment is 'more process-oriented', affect-driven, 'message-related', and 'experience-related', as a 'dynamic construct with affective, cognitive, and behavioural components exerting mutual influence on one another'.	Nabi and Krcmar (2004), p.291, p.294, p.295, p.306	The University of California, Wake Forest University	USA
5	Enjoyment is a complex and dynamic construct, referring to physiological, affective, and cognitive dimensions. It is the core of media entertainment.	Vorderer, Klimmt et al. (2004), pp.388-389	The University of Southern California, Hannover University of Music and Drama, the University of Southern California	USA, Germany
6	Enjoyment is an 'innocent, self-evident, homogenous, peripheral, and psychological phenomenon'.	Kingsbury (2005), p.113	Miami University, supported by *the National Science Foundation*	USA
7	Enjoyment is 'a fulfilling process, but not as a state of fulfillment', which is 'essential to a good life' and also 'the basis of its favorable personal evaluation'.	Kekes (2009), pp.43-44, p.136	The State University of New York	USA
8	Enjoyment includes pleasure, escaping 'anxiety through imagery and symbolism'.	Lefebvre, Stanek et al. (2014), p.111	The University of Strasbourg, supported by the Graham Foundation for Advanced Studies in the Fine Arts, USA	France

The key aspects of enjoyment

Previous studies have found that the term enjoyment emotion shares common characteristics with flow experience (Sherry 2004, Sweetser and Wyeth 2005, Jegers 2009, Saket, Scheidegger et al. 2015). For instance, six elements of the flow model including challenge, focus, clarity, feedback, control and immersion

[16] In this thesis, the '*developing situation of new economy*' points to experience economy (Pine and Gilmore, 1999, 2011), transformation economy (Pine and Gilmore, 1999, 2011), and enjoyment economy (Lefebvre, Stanek et al, 2014).

were outlined for understanding and measuring enjoyment (Saket, Scheidegger et al. 2015). Some studies also explored enjoyment emotion to describe, or involved in components of flow experience (Novak and Hoffman 1997, Chen, Wigand et al. 2000, Pace 2004). In addition to the flow theory, it was developed with the other theories especially focusing on Transportation Theory[17] (Green, Brock et al. 2004, Sweetser and Wyeth 2005, Tsay 2007, Green and Sestir 2008, Daggubati 2016), and Communication Theory (Green, Brock et al. 2004, Vorderer, Klimmt et al. 2004, Li 2005). From the perspective of the two theories, the term **transformation** became one key aspect of enjoyment emotion. Human such as the audiences or customers can be transformed into enjoyment through the journey in an immersive, narrative and interactive environment (Green, Brock et al. 2004, Nabi and Krcmar 2004, Tsay 2007). It means human's behaviour including decision-making can be affected during the transformation (Nabi and Krcmar 2004, Meisner, vom Lehn et al. 2007, Tsay 2007, Green and Sestir 2008, Csikszentmihalyi 2014). Examples were Green's transforming into enjoyment by narrative (Green, Brock et al. 2004); Tsay's research work at the Pennsylvanis State University on enjoyment transformation based on transportation theory (Tsay 2007); immersion's leading role in enjoyment (Daggubati 2016). In that respect, transformation, some of which is based on transportation theory and communication theory, provides a lens for understanding exhibition design.

Other major aspects of enjoyment involve measurement, learning, behaviour, interaction, technology, and story as following:

As measurement. Whether used for measuring or be measured, enjoyment occupied significant status in the field of game (Blythe, Overbeeke et al. 2004, Sweetser and Wyeth 2005, Fu, Su et al. 2009, Jegers 2009, Bernhaupt and Mueller 2016, Daggubati 2016), entertainment (Raney and Bryant 2002, Nabi and Krcmar 2004, Tsay 2007), product (Westerink, Ouwerkerk et al. 2007, Sener and Wormald 2008), exhibition (Moscardo and Pearce 1986, Mitchell, Thompson et al. 1997, Shu and Gneezy 2010, Sylaiou, Mania et al. 2010, Leischnig, Schwertfeger et al. 2011, van Dijk, Lingnau et al. 2012, Cohen, Prayag et al. 2014), and life itself (Kekes 2009, Csikszentmihalyi 2014). Reasonable research method is crucial for measuring and understanding enjoyment emotion due to its complexity and intrinsic nature, but not easy for observating and capturing. Previous research methods include Moscardo and Pearce's '*enjoyment scores*' (Mitchell, Thompson et al. 1997, p.96) for evaluation, Mitchell et al's questionnaire with time among '*before, during and after*' (Mitchell, Thompson et al. 1997, p.426) event, Sylaiou et

17 Transportation theory, is first proposed by Green (2002), stating that story or narrative has the persuasive influence on audiences when they lose or immersive themselves in a narrative world. Meanwhile, reflecting the story, individual's attitudes, intentions and behaviour are changed in return (Green, Brock et al. 2004).

al's '*VR and AR Presence questionnaires*' in a virtual museum (Sylaiou, Mania et al. 2010), van Dijk et al's questionnaire with '*Smileyometer*' (p.252), '*Again-Again table*' (p.252), and '*Children IMI (Intrinsic Motivation Inventory) interest/enjoyment scale*' (p.253) at an interactive museum (van Dijk, Lingnau et al. 2012), Csikszentmihaly's '*Experience-sampling Mehtod,ESM*' (p.21) and '*Experience-sampling Form, ESF*' (p.38) with Flow Questionaire, interview and signaling device (Csikszentmihalyi 2014), Daggubati's questionnaire of assessing immersion and enjoyment (Daggubati 2016), and game measurement including GameFlow (Sweetser and Wyeth 2005), Pervasive GameFlow (Jegers 2009), and EGameFlow (Fu, Su et al. 2009). Additionally, the enjoyment is usually applied as one attribute of different measurements, which have been summarized in Table 3.12.

However, simple and single measures will not suffice for measuring enjoyment emotion (Nabi and Krcmar 2004). France HCI researcher Regina Bernhaupt in the book *Game User Experience Evaluation* indicated that for enjoyment, '*signals such as heart rate (EEG), skin conductance (GSR), facial muscle tension (EMG) or eye tracking, may become integrated into ……evaluations in the future*' (Bernhaupt & Mueller, 2016, p.33). They also mentioned that one of the future challenges was to '*capture, measure and understand*' (p.33) human's body data (Bernhaupt and Mueller 2016). In addition, Mitchell, Thompson et al. (1997) evaluated the relationship between time and enjoyment. The result showed that '*time may have a direct (perhaps structured) effect on enjoyment*' (p.441) before, during or after the event (Mitchell, Thompson et al. 1997).

The term **Enjoyability** is introduced as a measurement instrument to evaluate enjoyment emotion in design, product and events (Bouman and Luteijn 1986, Van Etten, Higgins et al. 1995, May, Sundar et al. 1997, Etten, Higgins et al. 1998, Brush, Chenoweth et al. 2000, Bartneck 2002, Westerink, Ouwerkerk et al. 2007). For instance, Bartneck (2002) mentioned that there was a connection between enjoyability and usability, such as evaluation for the human and computer interaction. The evaluation methods of enjoyability were also discussed, including Pleasant Events Schedule (PES) (Bouman and Luteijn 1986, Van Etten, Higgins et al. 1995, Etten, Higgins et al. 1998), physiological measurements (Bartneck 2002), Fun-Questinnaire (Westerink, Ouwerkerk et al. 2007). Early studies with limited number also showed that most enjoyability study centered on exhibition events (Bouman and Luteijn 1986, Van Etten, Higgins et al. 1995, Etten, Higgins et al. 1998, Brush, Chenoweth et al. 2000).

Table 3.12. Enjoyment as measurement attribute.

Measurement	Attributes	Author[reference],year	Background(s)
Emotion scales	As scale: interested, elated, concentrating, egotistical, *enjoyment*, disgusted, hostile, contemptuous, skeptical, sky, guilty, sad	Russell and Mehrabian (1977)	University of British Columbia; University of California, USA
Questionnaire for patterns of cognitive appraisal in emotion	As scale: pleasant, *enjoy*, obstacle, problem, cheated, fair, other-responsibility, self-responsibiligy, other-control, self-control, uncertain, understand, predict, consider, attention, effort, excert, situational-control	Smith and Ellsworth (1985)	Stanford University, USA
Entertainment overcoming resistance model	As feature: transportation, *enjoyment*, perceived similarity, parasocial interaction, perceived similarity with an efficacious character, perceived similarity, identification	Baran and Davis (1987)	Bryant University; Pennsylvania State University, USA
The Cathexis (concentration of emotional energy on an object or idea) Model	As factors: anger, fear, distress/sadness, *enjoyment*/happiness, disgust, and surprise	Velásquez (1997)	MIT Artificial Intelligence Laboratory, USA
Emotion-measurement scheme	As attribute: sense, feel, think, act, relate, joyful/ralaxed, surprised/excited, warm/*enjoyable*, satisfaction, loyalty	Tsaur, Chiu et al. (2007)	National Chiayi University; Tourism Management at Chinese Culture Universit, Taiwan
User evaluation of HCI concepts	As attribute: *enjoyment*, inspiration, and assistance	Sener and Wormald (2008)	Middle East Technical University, Turkey; Loughborough University, UK
Positive emotions in food experience	As factor: satisfaction, *enjoyment*, desire, amusement, love, stimulation, pleasant surprise, relief, admiration, hope, pride	Desmet and Schifferstein (2008)	Delft University of Technology, Netherlands
Consumer-Product attachment measurement	As attribute: *enjoyment*, memories to persons, places, and events, support of self-identify, life vision, utility, reliability, and market value	Schifferstein and Zwartkruis-Pelgrim (2008)	Delft University of Technology, Netherlands
Perceived service quality measurement	As attribute: five positive emotions (happiness, pleasure, excitement, contentment, and *enjoyment*), and seven negative emotions (anger, frustration, contempt, boredom, disgust, embarrassment, and sadness)	Ladhari, Brun et al. (2008)	University of Moncton; Saint Mary's University, Canada
Positive emotions	As factor: *enjoyment*, gratification, empathy, affection, interest, aspiration, optimism, assurance, and animation	Desmet (2012)	Delft University of Technology, Netherlands
Motivation questionnaire in learning environments	As attribute: interest/*enjoyment*, perceived choice, value/usefulness, perceived competence	Sturm and Bogner (2010)	University of Bayreuth, Germany
Church experience scale (CES)	As factor: *enjoyment*, intellectual stimulation and curiosity, emotional and spirtual experience, immersion, information overload, and knowledge and learning	Othman, Petrie et al. (2013)	Universiti Malaysia Sarawak, Malaysia; The University of York, UK
Assessing specific attributes in user experience	As attribute: visual appeal, perceived efficiency, usefulness, *enjoyment*, credibility, appropriateness of terminology, ease of navigation, responsiveness	Albert and Tullis (2013)	Fidelity Investments, USA
Quality of experience in each flow quadrant for a national sample of American adolescents	As attribute: concentration, importance to future goals, self-esteem, *enjoyment*, wish to be doing activity	Csikszentmihalyi (2014)	Claremont Graduate University, USA
Items of measuring shopping value	As attribute: arousal, pleasantness, *enjoyment*, convenience, risk, store visit satisfaction, shopping orientation manipulation, and event-type manipulation	Sands, Oppewal et al. (2015)	Monash University, Australia; University of Bath, UK
CEGEQ questionnaire for measuring gaming experience	As attribute: *enjoyment*, frustration, CEGE, puppetry, video-game, control, facilitators, ownership, environment and game-play	Bernhaupt and Mueller (2016)	Institut de Recherche en Informatique de Toulouse (IRIT), France; RMIT University, Australia

With learning. Enjoyment helps to enhance learning (Moscardo and Pearce 1986, Csikszentmihalyi and Hermason 1995, Forrest 2015), while learning can be transformed into enjoyment (Falk and Dierking 2000, Packer and Ballantyne 2004, Roppola 2013). It is particularly embodied in the context of museum (Moscardo

and Pearce 1986, Bitgood 1992, Kolter and Kolter 1998, Falk and Dierking 2000, Packer and Ballantyne 2004, Packer 2006, Bitgood 2011, Roppola 2013, Forrest 2015). An example is Roppola's *Designing for the Museum Visitor Experience*, which pointed out that museum was perceived as a '*construct dedicated to the facilitation of learning*' (p.118), and moreover, the learning tended to produce enjoyment for audiences (Roppola 2013). The results were based on *'grounded theory-building process*' (Roppola, 2013, p.61). However, making learning enjoyable is always implied as at the context of exhibition rather than '*formal educational setting*' (p.4), '*one of the visitors major goals is to enjoy themselves whether or not they learn anything*' (S. Bitgood, 1992, p.4) . Another example is Packer et al's term '*learning for fun*' (Packer, 2006, p.329). The study considered audiences '*value and enjoy the process of learning itself, rather than any instrumental reasons*' (Packer, 2006, p.329) from commercial to cultural environments (Packer and Ballantyne 2004, Packer 2006). It investigated 400 participants with the questionnaire and 52 samples with interview.

With behaviour. Enjoyment is related to behaviour. Nabi and Krcmar (2004) suggested four forms of behaviour referring to enjoyment: 1) Past or ongoing visiting experience, 2) Past behaviours with message content, 3) Behavioural intentions with the content held by audience, 4) Behaviour during visiting. It is noted that behaviour has to some extent affected and contribute to enjoyment, with other affective and cognitive components. Meisner, vom Lehn et al. (2007) observed audiences' behaviours with and around exhibits at London's Science Museum through video-recording method, which tried to provide guidelines on exhibition design or management, and funded by ESRC Science in Society Programme and the National Science Foundation. As a result, the field study reported that behaviour could trigger enjoyment. Tsay (2007) further reported his doctoral research at the Pennsylvania State University, that behaviour could be involved in measuring enjoyment. Also, Csikszentmihalyi (2014), discussed the relationship among flow, human behaviour and enjoyment emotion in depth.

With interaction. Interaction has an impact on enjoyment (Raney and Bryant 2002). Based on the view of game, Vorderer, Hartmann et al. (2003) explored the links between interactivity and enjoyment, which allowed individuals engaged in game coping with competitive elements. Green, Brock et al. (2004) mentioned that the '*interactive narrative*' (p.322) and audiences' '*active participation*' (p.322) tended to influence enjoyment. Also Blythe, Overbeeke et al. (2004) considered that designing enjoyable product required design for interaction and engagement from the view of individuals/users, meanwhile, interaction helped enjoyment-produced both from a product design and HCI perspective. This point was also reported by Westerink, Ouwerkerk et al. (2007). Furthermore, Vorderer, Klimmt et al. (2004) pointed out that enjoyment was '*a product of numerous interactions*'

(p.401) between media and user. An empirical study at the Victoria & Albert Museum by Milan researchers confirmed that interaction in exhibition design could influence enjoyment emotion and behaviour of audiences (Legrenzi and Troilo 2005). Scholars at the department of industrial design, KAIST of Republic of Korea, reported that the enjoyment stated in design could be reached through engagement or interaction with a product (Nam and Kim 2011). A design method named Design by Tangible Stories was proposed for the study, supported by the National Research Foundation of Korea. In addition, the role of social interaction in enhancing enjoyment was discussed by Csikszentmihalyi and Hunter (2003), Blythe, Overbeeke et al. (2004) and López Sintas, García Álvarez et al. (2014). For instance, López Sintas, García Álvarez et al. (2014) interviewed 21 audiences at Spain's art museums under the support of the Spanish Ministry of Science and Innovation and the Generalitat de Catalunya, discovering that enjoyment enhancement of their visiting depended on social interaction, which also helped to study and understand audience experience.

With technology. '*Technology offers the potential to make life easier and more enjoyable; each new technology provides increased benefits*' (D. A. Norman, 2002, p.44). It means technology such as a computer has the power to make enjoyment to our life and design (Norman 1988, Norman 2004). Blythe, Overbeeke et al. (2004) mentioned technology offered an opportunity to enjoyment. They proposed three layers of meanings for designing enjoyable technology: 1) *Control and participation with challenges*; 2*) Variation and multiple opportunities*; 3) *Social opportunities in terms of co-activity and social cohesion*. The Human-computer Interaction Group at Cornell University developed the technology of ArtLinks for transforming into audiences' enjoyment in museums, with three goals called '*connection*', '*reflection*' and '*transparency*' (p.403), which also tended to provide a useful suggestion for exhibition designers (Cosley, Lewenstein et al. 2008). Following the INDEPENDENT project funded by the UK Engineering and Physical Science Research Council with a multi-disciplinary, the University of Sheffield explored technology to support people's enjoyable activity from older people to disabilities (Torrington 2009). An Augmented Representation of Cultural Objects (ARCO) system was described by a joint research with Greece and UK, supported by EU ICT project and Victoria and Albert Museum London. It indicated that there was a positive correlation among enjoyment, AR (augmented reality) and VR (virtual reality) presence on the basis of a questionnaire survey for web-based virtual museum exhibition (Sylaiou, Mania et al. 2010). In 2014, Italian researchers Bollini and Borsotti (2014) mentioned in their paper *Exhibition Design: Hybrid Sapce of Advanced Design Innovation* that technology became '*an active stimulation*' (p.2) between audiences and exhibition enjoyment. Another EU-supported study example was the project from Spain company FIVAN, which

focused on neurorrehabilitaiton treatments with the application of the most advanced technology. It tried to explain that technologies such as virtual reality (VR) glasses and head mounted device (HMD) would provide '*immersive enjoyment*' to '*hyperbaric oxygen chamber users'* (Lv, 2015, p.1).

With story. Transportation theory provides an immersive narrative/story to evoke an enjoyment opportunity. With the example of narrative film, Tan (1995) indicated that as rewarding, audiences could experience enjoyment during a process in story. Blythe, Overbeeke et al. (2004) also argued that '*the enjoyment of the audience is one major cognitive factor to be produced by a story'* (p.235). As a consequence, enjoyment can be realized by structuring an interactive story and narration. This is because the approach to interactive storytelling will provide a context with transaction of time and space that exerts an influence on audiences' cognitive, emotional and behavioural processes. A given example was the Geist project, which aimed to stimuli enjoyment emotion narrativing the history of Geist the city of Heidelbert and the thirty years' War by the mobile Augmented Reality technology (Blythe, Overbeeke et al. 2004). Green, Brock et al. (2004) posited that one major factor of enjoyment was to '*take individuals away from their mundane reality and into a story world*' (p.311). Furthermore, research work at the College of Communications of the Pennsylvania State University reported that enjoyment could be created by transportation through the process of learning and information delivery (Tsay 2007).

3.3.2 Designing for enjoyment

'*Designing for enjoyment*' has been reported across a wide range of design fields, referring to HCI (Human-Computer Interaction), design (Paiva 2000, Monk, Hassenzahl et al. 2002, Blythe, Overbeeke et al. 2004, Hazlett 2006), human factors (Blythe, Overbeeke et al. 2004), product/industrial design (Green and Jordan 2003, Blythe, Overbeeke et al. 2004, Desmet 2005, Schifferstein and Zwartkruis-Pelgrim 2008, Nam and Kim 2011, HircherI 2013), emotion design (Norman 2002, Norman 2004), experience design (Sward and Macarthur 2007, Westerink, Ouwerkerk et al. 2007, Fokkinga and Desmet 2013), interaction design (Norman 2010, Obrist, Tscheligi et al. 2010), game design (Salen and Zimmerman 2004, Sweetser and Wyeth 2005, Fu, Su et al. 2009, Jegers 2009, Pelachaud 2013, Bernhaupt and Mueller 2016), interface design (Gomez, Popovic et al. 2006), web design (Pace 2004), visualization design (Saket, Scheidegger et al. 2015), and environment/architecture design (Wakefield and Blodgett 1999, Torrington 2009). In this thesis, the section will briefly introduce the concept of designing for enjoyment from four major areas: Human-computer Interaction (HCI), product/industrial design, game design, and other design disciplines.

Enjoyment in HCI. In Human-computer Interaction (HCI), enjoyment plays a central role due to its intrinsic nature related to human (shown in Section 3.3.1). A Germany study project supported by the European Community argued that developing '*lifelike*' agents helped to design enjoyable human-computer interaction (Paiva 2000). Monk, Hassenzahl et al. (2002) concluded that rather than traditional HCI more focusing on technology level, enjoyment was becoming the objective of HCI research but needing to be further explored. The book *Funology: From Usabiligy to Enjoyment* tried to bridge the gap between enjoyment and HCI, and mentioned that neurologist, physical and social scientist, and arts and humanities scientist had performed much research in the area of enjoyment study. However, compared with the traditional term of usability, the study of enjoyment is a '*late-comer'* (Blythe, Overbeeke et al. 2004, p. XVI) to the field of HCI or evaluation. An approach for measuring enjoyment emotion was discussed by Hazlett (2006), which used facial electromyography (EMG) as measure valence, and thus offered assistants for HCI designers.

Enjoyment in product/industrial design. There is a transformation from usability to experience (Westerink, Ouwerkerk et al. 2007), and then to enjoyment (Green and Jordan 2003, Blythe, Overbeeke et al. 2004). Accordingly, Green and Jordan (2003) stated that '*don't think ease of use, think enjoyment of the experience*' (p.10) in terms of Ergonomice, HCI and product design. However, it should be noted that '*design is not about the smile on the product, it is about the smile in the user's heart*' (Blythe et al., 2004, p.9). The methods of measuring or designing enjoyment emotion in product/industrial design were developed such as Schifferstein and Zwartkruis-Pelgrims' '*consumer-product attachment*' (Schifferstein & Zwartkruis-Pelgrim, 2008, p.2), Desmet's '*PrEmo*' (Pieter Desmet, 2005, p.1), Nam and Kims' '*Ludic Value*' (Nam & Kim, 2011, p.85), and Anja-Lisa Hircherl's '*Joyful participation*' in design process (Hircherl, 2013, p.11).

Enjoyment in game design. Enjoyment of the flow is highlighted by game designers for their players/users, which was declared in Salen and Zimmerman (2004)'s book *Rules of Play: Game Design Fundamentals*. However, like other design disciplines, there has been a lack of studies on enjoyment such as a relevant model with evaluation or design, despite a fact that enjoyment had centered on the area of game (Sweetser and Wyeth 2005). Game design tends to more recognise enjoyment as flow, and sharing the common characteristics for providing guidance to further design or evaluation (Sweetser and Wyeth 2005, Fu, Su et al. 2009, Jegers 2009). As one part of '*emotion-oriented system*', Pelachaud (2013) mentioned that maximizing enjoyment emotion should be the main aim for designing game. Moreover, Pelachaud (2013) pointed out how to use the approach method for evaluating enjoyment emotion, and how to capture

reasonable and valid data were the major future challenge to help understand, design and evaluate enjoyment in games.

Enjoyment in other design disciplines. Literature around enjoyment study both in other design disciplines and previous discussion (HCI, product/industrial design, game design) features two major discussions. The first one is gathered from the applications of designing or evaluating enjoyment. These applications are understood as the commercialization tools, for example, for a new design, technology or innovative product (Wakefield and Blodgett 1999, Paiva 2000, Norman 2002, Blythe, Overbeeke et al. 2004, Norman 2004, Gomez, Popovic et al. 2006, Hazlett 2006, Westerink, Ouwerkerk et al. 2007, Schifferstein and Zwartkruis-Pelgrim 2008, Torrington 2009, Norman 2010, Nam and Kim 2011, Fokkinga and Desmet 2013, HircherI 2013). The second discussion is concentrated on the creation of new enjoyment models (Salen and Zimmerman 2004, Sweetser and Wyeth 2005, Fu, Su et al. 2009, Jegers 2009, Saket, Scheidegger et al. 2015). Enjoyment model construction is related to flow theory or flow model. These offer a reference for studying exhibition design positioned in the latter discussion.

Rather than enjoyment in life, the aspect of design always puts enjoyment in the centre of commercial application with business and marketing. For instance, Schmitt (2000) in his book *Experiential Marketing: How to Get Customers to Sense, Feel, Think, Act, Relate* mentioned that as bottom line, marketing managers '*have to somehow enrich people's lives and provide enjoyment for your customers*' (p.62). Shaw Colin, the founding partner of Beyond Philosophy[18], embodied '*enjoyable*' into '*The Customer Experience Hierarchy of Needs™*' (p.63), to make a success and great business (Shaw 2004), and meanwhile analyzes enjoyment with its sub-elements such as happiness, joy, aiming to enable their customers to '*have a a thoroughly enjoyable experience*' (Shaw & Ivens, 2005, p.89). The author of another book *Emotional Branding*, Gobe Marc, who has worked for Coca-Cola Company, indicated that a '*consumer-oriented retail environment*' (p.199) tended to do everything for customers' enjoyment (Gobe 2010). It is decided by the needs of experience economy (Pine and Gilmore 2011) and consumers demand (Parsons, Ballantine et al. 2010).

The above literature demonstrates enjoyment emotion study in design disciplines, such as product/industrial design, HCI, game design, experience design, emotion design, interaction design, web design, visualization design, and environment design. They tried to design or evaluate an enjoyable applications including both

[18] A world-leading company in the field of Customer Experience, which is located both in the UK and USA. Besides business consulting and activities, it explored the research field on the theory construction of *Revolutionize Your Customer Experience* (Show, 2004) and *The DNA of Customer Experience* (Show, 2007).

cultural and commercial fields. However, the attention was focused on the development of commercial application, or model construction, where design and evaluation of enjoyment emotion are heightened, rather than considering its key role in communication among human, environment, product, experience, and behaviour. It's worth noting that a research gap exists between exhibition design and enjoyment, although some studies have begun to attach importance to design enjoyable exhibition (presented in the next section).

3.3.3 Designing enjoyable exhibition

In this thesis, designing enjoyable exhibition plays a central role. Although there is no cohesive theories and practical guidances of enjoyment emotion in exhibition design, the call for designing enjoyable exhibition has been stated in many of these previous studies (Miles and Alt 1988, Seagram, Patten et al. 1993, Rand 2001, Dean 2002, Blythe, Overbeeke et al. 2004, Stenglin 2004, Kingsbury 2005, Hughes 2010, Locker 2011, Macdonald 2011, Chang 2012, Gilboa and Vilnai-Yavetz 2013, Einarsson 2014, Forrest 2015). For instance, *The Design of Educational Exhibits* considered '*extremely enjoyable*' (p.237) as the measurement of success exhibition design if it was judged by at least 15 percent of audiences (Miles and Alt 1988). Dean (2002), who had over thirty years' experiences for exhibition design, defined enjoyment in the part of an exhibition with education and enlightenment, and mentioned that museum exhibition provided an enjoyable approach to communicate complex information. It was also discussed by Einarsson (2014). In 2004, both digital display (Blythe, Overbeeke et al. 2004) and three-dimensional exhibition (Stenglin 2004) were discussed related to the essential role of enjoyment for exhibition design.

As well, Kingsbury (2005) confirmed that enjoyment was a socio-economic factor of tourism event. Particularly, Hughes (2010) involved in book *Exhibition Design* that both exhibition institutions and designers needed to '*make these visits enjoyable and enlightening*' (p.9), which mentioned '***Enjoyment, I want to have fun***' (p.36) presented in The Vistor Bill of Rights (Rand 2001). Macdonald (2011) argued with an example of UK Museums Assonciation in 1998, that museum exhibition should be a place providing audiences with enjoyment emotion, not just for learning and discorvey/inspiration. Locker (2011) mentioned that exhibition designers should understand audiences' emotional needs including enjoyment, since '*exhibitions are for people*' (p.34). A Taiwan scholar from the University of London indicated that museum exhibitions were '*veritable wonderlands*' (p.7) with the increasing enjoyment for the public (Chang 2012). Solomon (2014) regarded '*enjoyment of shopping*' (p.272) as one trait of influence on consumer behaviour, arguing that '*people who enjoy shopping are more likely to spend time searching for products, resulting in increased product knowledge*' (p.272). However, there

are still research gaps including enjoyment emotion and exhibition design (Forrest 2015). An example was Gilboa and Vilnai-Yavetz (2013)'s exploratory study based on 119 qualitative narratives, who found that '*enjoyable emotion*' (p.250) could be evoked by design factors during consumers' mall trips. But it also pointed out the gap among enjoyment emotion, behaviour, experience, and environment.

In short, the designing enjoyable exhibition literature mainly involves several aspects as follows:

Designing enjoyable exhibition to enhance audience experience. Getz (1997), the first one to propose event study, emphasized that audience experience could be enhanced by maximizing enjoyment with communications, which also could be involved into the part of audience experience (Getz and Page 2016). The Universtiy of Washington, Northwestern University, and George Washington Universtiy conducted a joint research for evaluating events. They compared the before, during and after time of the events, and exploring that audiences tended to gain more enjoyment when they experienced the actual events (Mitchell, Thompson et al. 1997). Also van Dijk, Lingnau et al. (2012) discussed in their paper publication *Measing Enjoyment of an Interactive Museum Experience* that, designing enjoyable exhibition would be one method of improving '*museum-going experience*' (p.249). In 2008, a doctoral research at the University of Western Sydney pointed out the '*the focus is audience*' (p.7), and although each experience had the potential to a success exhibition, it tended to depend on the '*degree of enjoyment*' (p.132) which came from audience experience (Sager 2008). Meanwhile, '*enjoyable experience*' is discussed both for audiences and staffs in term of exhibition design (Seagram, Patten et al. 1993, Shu and Gneezy 2010, Bitgood 2011, Barry, Dexter et al. 2012, Falk and Dierking 2012, Roppola 2013). However, some studies also considered enjoyment as part of experience. For instance, Spain scholars Martín-Ruiz, Castellanos-Verdugo et al. (2010) stated the main role of service experience in '*visitors' evaluation* index' (VEI) (p.590), which included enjoyment as one component. Einarsson (2014) at Uppsala University Sweden concluded that '*enjoyment is what brings people to museums*' (p.6), thus '***enjoyment** is an important museum experience as well*' (p.17). In conclusion, enhancing AE calls for enhancing enjoyment in exhibitions (López Sintas, García Álvarez et al. 2014).

Enjoyment emotion can be provoked through exhibition design factors. Exhibition itself stimulates enjoyment emotion (Tan 2013, Goltsche 2014). For instance, Tan (2013) pointed out that in the view of narrative film, '*the major phasic emotion is enjoyment*' (p.181) and '*an event with a positive valence leads to enjoyment*' (p.181). He also mentioned that surprise was one reason for enjoyment. Note that it exists not only in exhibition, but also includes exhibition

design factors. UK researcher at the University of Cherter summarized that there was a correlation between enjoyment and exhibition design factors (Davey 2005). Furthermore, exhibition should provide enjoyment to audiences through design factors, including environment, exhibits (Zamani and Peponis 2010). Italy exhibition designer Ciamarra (2013) at Fondazione Idis-Citta` della Scienza also indicated that various design factors were used to provoke and create enjoyment. The professor Mattern (2014) at the New School in New York mentioned that under the influence of design factors, audiences could enjoy a '*multisensory and dynamic experience*' (p.141) during their travelling the three-dimensional gallery space. Lefebvre, Stanek et al. (2014) at the book publication *Toward an Architecture of Enjoyment* presented that '*every well-arraged space, appropriated to some extent, provides enjoyment'* (p.52). It means that the effects of design factors can allow enjoyment to audiences at the context of exhibition. Also Legrenzi and Troilo (2005) assumed that exhibition design factors could influence audiences' enjoyment emotion, their behaviour and the level of satisfaction. It conducted the empirical and comparative study in the British Galleries of the Victoria & Albert Museum, and finding that interactive exhibition with better communication could stimulate enjoyment than the traditional one, thus enhancing the experience for audiences. However, the economic and cultural aspects should not be ignored according to the appropriate relationship among emotion, behaviour and exhibition design (Legrenzi and Troilo 2005).

Designing enjoyable and learning exhibition environment. Both enjoyment and learning are highlighted in exhibition design. This is due to a fact that enjoyment in exhibitions is related to information (Taylor 1963, Moscardo and Pearce 1986), audiences' understanding (Moscardo and Pearce 1986), and memory (Falk 2009, Pine and Gilmore 2011). For example, in information regard, a field study supported by the National Science Foundation USA measured the information retention at the Swattle World's Faire, and indicating that the enjoyable exhibition was always the one that '*the greatest information retention occurred*' (Taylor, 1963, p.119). Australia scholars also analyzed the positive relationship between '*information recall*' (p.91) and enjoyment emotion (Moscardo and Pearce 1986). They assumed that enjoyable exhibition might increase information recall and therefore enhance audiences' learning. In the understanding respect, the positive '*enjoyment-understanding relationships*' (p.106) was further developed and reviewed by Moscardo and Pearce (1986). In memory point, Falk (2009) stated that '*enjoyable experiences are memorable*' (p.137). He also argued that a museum exhibition should '*provide a good mix of enjoyment and learning*' (Falk & Dierking, 2000, p.214). Based on the Experience Economy, Pine and Gilmore (2011) mentioned that humans are more likely to remember their enjoyable experience. This is because of enjoyable experience '*stemming directly from the*

process of learning' (Roppola, 2013, p.61). But it is important to note that the most previous studies were mainly gathered in the area of museum exhibition, where may be different with commercial exhibition with more short time, limited space, and multiple purpose.

To design enjoyable exhibition, some models/frameworks are developed in academia. For example, German researchers constructed a conceptual framework of shopping enjoyment with an empirical test (Leischnig, Schwertfeger et al. 2011). The results showed that the level of enjoyment could be evoked by an event, which also is a major drive of customer satisfaction. It also presented that retail brand is affected by customer's enjoyment and satisfaction within an event. Roppola (2013), a researcher and industrial designer at Australia, indicated an institutional frame for exhibition design, including the displayer-of-artefacts frame, the learning frame, ***the enjoyment frame***, and the pilgrimage frame. In his interview study, around fifty-eight audience participants judged their viewing with '*enjoyment*' across the entire six investigated exhibition institutions. It means that '*the enjoyment frame sees visiting as inherently enjoyable*' (p.92), which thus is marketed in his publication as '*museum of all types can be experienced as enjoyable, even memorial institutions*' (Roppola, 2013, p.93). The scholars from Malaysia and UK developed the Church Experience Scale (CES) with five components involving ***enjoyment***, intellectual stimulation and curiosity; emotional and spiritual experience; immersion; information overload; and knowledge and learning. With a compared study between inactive and historic church, they investigated 272 participants with questionnaire in York, UK (Othman, Petrie et al. 2013).

Much of the previous literature towards exhibition enjoyment had been concerned on flow experience (Csikszentmihalyi and Robinson 1990, Falk 1993, Traue 2000), behaviour (Kim Lian Chan 2009, Zamani and Peponis 2010), marketing (Stenglin 2004, Liu 2011), and technology (Blythe, Overbeeke et al. 2004, Sylaiou, Mania et al. 2010, Bollini and Borsotti 2014). They all have pointed to that enjoyment is a major reason why people choose to visit exhibitions (Bitgood 1994, Sager 2008, Falk 2009, Einarsson 2014). For instance, one of interviewed audiences mentioned exhibition visiting '*is an enjoyable break from my daily life*' (Falk, 2009, p.190). This is decided owing to on that the other aspect, exhibition can stimulate audiences enjoyment emotion and enjoyable experience (Tan 2013, Goltsche 2014); on the other hand, audiences seek to be transformed along with their travel in both digital or virtual immersive exhibition environments (Seagram, Patten et al. 1993, Choi 2010).

And yet, there are two aspects to notice in this section: one is that exhibition is not just a simple space for enjoyment (Alt and Shaw 1984) and measuring approach to

success (Serrell 2015). It is still associated with other respects such as marketing (Leischnig, Schwertfeger et al. 2011), human factors like gender difference (Bohl 2012), technologies (Nabi and Krcmar 2004), etc.. Another is that it is difficult for capturing and measuring the levels of enjoyment (Saket, Scheidegger et al. 2015). But with advances in technology, more research methods (presented in the next section) tend to be available for carrying out enjoyment study both in design and evaluation.

3.4 Behaviour data for exhibition design

In the previous sections, we have discussed audience experience and enjoyment emotion for designing better exhibitions. Each of them transformed the audience experience before, during or after exhibitions as they embedded enjoyment into exhibition design. This next section keeps exploring behaviour data, which providing a possibility and support for observing or measuring audience experience, and enjoyment emotion in respect of designing a better exhibition.

3.4.1 Studying human behaviour in exhibitions

Behaviour study in exhibitions is related with the different subject areas, involving psychology (Melton 1933), sociology (Ng 2003, Sager 2008), evolutionary theory (Chiozzi and Andreotti 2001), behavioural psychology (Daae 2014), environmental psychology (Bonn, Joseph-Mathews et al. 2007, Bohl 2012, Brunner-Sperdin, Peters et al. 2012, Steg, van den Berg et al. 2012, Forrest 2015), consumer behaviour (Bonn, Joseph-Mathews et al. 2007, Carù and Cova 2007, Jung and Kwon 2011, Schiffman, O'Cass et al. 2013, Solomon 2014), and social psychology (Vom Lehn, Heath et al. 2001, Daae 2014). In a broader sense, the term Behaviouroal Science was introduced based on the grouping of disciplines. It services to study both individual or social human behaviour (Wolman 1989, Izard 2013). This section instead focuses on the individual audience behaviour for exhibition.

Human behaviour is complex (Blythe, Overbeeke et al. 2004, Pantic, Pentland et al. 2007, Westerink, Ouwerkerk et al. 2007), which is '*deeply rooted in the process of natural selection*' (Crouch, 2013, p.2) and '*the combination of physical, personal, and sociocultural context*' (Falk & Dierking, 2012, p.118). But it is observable and predictable to some extent, which is determined by the evolutionary process, especially embodied in the selection of the gene (Crouch 2013, Rolls 2013) and meme (Blackmore 2000). Unlike other gene-driven animal behaviour, performed human behaviour is also processed under the meme-driven influence (Blackmore 2000). Thus Blackmore (2000) stated in his book *The Meme Machine* that '*to fully understand human behaviour we must consider both genetic and memetic selection'* (Blackmore, 2000, p.24). Accordingly, understanding

audience behaviour in previous studies pointed towards the interactive relationship among experience, emotion, and measurement. Table 3.13 illustrates the interactive relationship of above three aspects.

Table 3.13. The interactive relationship among behaviour, experience, emotion and measurement in exhibition.

Supported content/narrative	Literature[reference], page	Background(s)
Behaviour ◄——► Experience		
As the response to exhibits, audience behaviour considered their experience 'as a series of individual encounters with particular exhibits', and design factors.	Vom Lehn, Heath et al. (2001), p.196	King's College London, UK
Behaviour driven with targets have an influence on customer experience.	Shaw and Ivens (2005), p.178	Dell Computers, USA
'We saw that experience influences behaviour and that behaviour influences the experience'.	Desmet and Hekkert (2007), p.64	Delft University of Technology, The Netherlands
Behaviour is used as tool with emotions for measuring and probing experience.	Westerink, Ouwerkerk et al. (2007), p.2, p.6	Philips Research Laboratories, The Netherlands
Experience attached meanings has an impact on future behaviour, which related with behavioural, emotional and cognitional dimension.	Getz (2008), p.414	University of Calgary, Canada
Behaviour was measured for studying experience. And experience is 'related features in the user's behaviour'.	Law, Bevan et al. (2008), p.43, p.48	COST Office
Experience renders a specific and core part in the area of audience behaviour.	Sager (2008), p.3, p.115, p.116	University of Western Sydney, AUS
Understanding audience experience should consider audience behaviour.	Kim Lian Chan (2009), p.178, p.190	University Malaysia Sabab, Malaysia
Both retail experience and behaviour are elicited by design factors such as sound, space, colour, layout, product display features, facilitating stimuli, crowding, and lighting etc.	Parsons, Ballantine et al. (2010), pp.641-650	University of Canterbury; Acukland University of Technology, New Zealand
Design has an active impact on both behaviour and experience.	Tromp, Hekkert et al. (2011), pp.3-5	Delft University of Technology, The Netherlands
By understanding audience behaviour, designer can create experience 'to meet the aims and objectives of the event'.	Brown and Hutton (2013), p.43	Flinders University, AUS
Audience experience in shopping mall is 'derived from their emotional, cognitive and behavioural reactions towards the mall', and behaviour is also a means of understanding experience.	Gilboa and Vilnai-Yavetz (2013), p.242	Ruppin Academic Center, Israel
The factors of behaviour, environment and design can shape human's response to experience.	Allanwood and Beare (2014), p.364	University of Central Lancashire, UK
Understanding audience behaviour helps to improve museum exhibition's audience experience and environment.	Yoshimura, Sobolevsky et al. (2014), p.1113	Massachusetts Institute of Technology, USA; Near Future Laboratory, Switzerlan; Universitaa Pompeu Fabra, Spain; Northeastern University, USA
Audience experience involves cognitive, affective and behavioural aspects, and be measured by audience behaviour.	Forrest (2015), p.xvii, p.150	The University of Queenland, AUS
Behaviour ◄——► Emotion		
'Behavioural correlates to pleasure in product use'.	Jordan (1998), p.30	Philips Design, The Netherlands
The formula COGNITIVE MEANING + AROUSAL = EMOTION merges the analytical approach of British Empiricism with the mechanistic principles of behaviourism.	Overbeeke and Hekkert (1999), p.77	Delft University of Technology, The Netherlands
'Any behaviour can be used to infer emotion.'	Paiva (2000), p.36	The Instituto de Engenharia de Sistemas e Computadores, Portuga
'Behaviour is a source of direct information about the emotions'.	Wensveen, Overbeeke et al. (2000), p.50	Delft University of Technology, The Netherlands
Exhibition event evokes emotions, and then influence customer behaviour.	Watson and Spence (2007), p.503, p.508	University of Regina, Canda; Bond University, AUS
'Emotions are the result of perception of bodily changes', and 'measurement of the behavioural correlates of emotion'.	Fox (2008), p.31	University of Essex, UK
'Emotions influence consumer behaviour'. 'Busniesses, particularly researchers, need to identify the non-linear relationship between emotions and customer attitudes and behaviour'.	Walden and Janevska (2011), p.3, p.14	Beyond Philosophy, UK
'The setting has essential influence leading to emotional reactions and as a consequence impacting behavioural responses of customers'.	Brunner-Sperdin, Peters et al. (2012), p.24	Innsbruck Universigy School of Management, AUS
'Different emotions have been shown to have different effects on behaviour', which is 'stimulated by the emotion'.	Desmet (2012), p.3, p.13	Delft University of Technology, The Netherlands
Emotions 'have been concerned primarily with how stimuli are decoded to produce emotional states, and with how these states can influence behaviour'.	Rolls (2013), p.213	Oxford Centre for Computational Neuroscience, UK
'Attitude, subjective norm, and positive anticipated emotion influenced visitors' desire to attend the festival, which, in turn, influenced their behavioural intentions.'	Song, You et al. (2014), p.101	Pai Chai University, Kyung Hee University, South Korea; Gulf University for Science and Technology, Kuwait

Continued Table 3.13

Behaviour ◄——► Measurement		
Measuring audience behaviour is crucial to design exhibitions, for evaluating and improving the success of exhibitions.	Bitgood, Patterson et al. (1986), p.475	Jacksonville State University, USA
Behavioral measurement such as stopping, viewing time, social impact, human factors impact, and trace or decay measures is important to assess the success of exhibitions.	Bitgood (1994), p.5	Jacksonville State University, USA
'Behavioural observation can serve to follow both emotional and cognitive processed', which consists of gestures, postures, facial expression.	Westerink, Ouwerkerk et al. (2007), p.2, p.6	Philips Research Laboratories, The Netherlands
Commercial exhibition is measured via evaluating behaviour, which is stimulated by design factors such as lighting.	Quartier, Christiaans et al. (2009), pp.9-10	University College of Hasselt; Hasselt University, Belgium
Measurement methods such as timing and tracking, observation, recording, and paper-and-pencil can be used to improve exhibition design.	Yalowitz and Bronnenkant (2009), p.47, p.52	Institute for Learning Innovation; Boston Museum of Science, USA
Understanding audience behaviour and interaction is vital to measure the success or enjoyment of museum exhibition.	Clinckemaillie (2010), p.6	Worcester Polytechnic Institute, USA
Behaviour is measured as sets of variables to study tourism experience.	Ballantyne, Packer et al. (2011), p.1	University of Queensland, Australia; Oregon State University, USA
Direct observation is a general method to measure audience behaviour including visual observation, stopping and attending, viewing time, time in the exhibit area, and pointing to some aspects of the exhibit.	Bitgood (2011), p.118	Jacksonville State University, USA
There are three factors considered for 'developing a measure of environmental behaviour: what to measure, how to measure it, and how to conceptualise it'.	Steg, van den Berg et al. (2012), p.170	University of Groningen, The Netherlands; van den Berg, Agnes E, The Netherlands; Bournemouth University, UK
Research on audience behaviour helps to develop and evaluate the effects of exhibition event design.	Brown and Hutton (2013), p.43	Flinder University, AUS
Simulation modelling of behaviour is a crucial tool for measuring the related items of meseum exhibitions.	Pluchino, Garofalo et al. (2013), p.1	Universit of Catania, Italy
Audience behaviour is measured to characterise the relationship between Perceived Atmoshpere and audience experience.	Forrest (2015), p.204, p.219	University of Queensland, AUS

Watson (1913)'s behaviour analysis provided one operational foundation for studying human behaviour. He argued that human behaviour is the organism's response to stimuli, and its primary mission of studying behaviour will focus on the intrinsic relation and rule between stimuli and response. In 1928, a professor of Psychology of Yale University investigated the audience behaviour of several USA museums based on two year's observation study (Robinson 1928). It can be seen as the first experimental research on studying behaviour in terms of exhibition, and in addition, **enjoyment** is mentioned as a need for observing audience behaviour. Melton (1933) and Porter (1938) further extended Robinson's research work. Following previous studies, Yoshioka (1942) observed on New York World's Fair, that audience behaviour was influenced by the direction of entrance and exit, route, direction-orientation, or display of exhibition. By the 1960s and early 2000s, these fundamental discussions were translated into design factors effect on behaviours (Melton 1972, Cone and Kendall 1978, Diamond 1986, Bitgood, Patterson et al. 1988, Falk 1991, Sandifer 1997, Turley and Milliman 2000, Chiozzi and Andreotti 2001, Zacharias 2001, Zacharias 2002, Geng 2003, Kottasz 2006, Chen and Tsai 2007, Cai 2010); audience behaviours at commercial exhibitions (Howard and Sheth 1969, Billings 1990, Donovan, Rossiter et al. 1994, Turley and Milliman 2000, Bigne, Sanchez et al. 2001, Zacharias 2002, Groeppel-Klein 2005, Watson and Spence 2007, Girgensohn, Shipman et al. 2008, Kowatsch and Maass 2010); behaviours at virtual exhibitions (Blumberg and Galyean 1995, Perlin and Goldberg 1996, Zacharias 2006, Mahdjoubi, Hao Koh et al. 2014); methods on evaluating behaviour (Lundberg 1984, Devine-Wright and Breakwell 1997, Gero and Lindemann 2005, Zancanaro, Kuflik et al. 2007, Girgensohn,

Shipman et al. 2008, Zhou, Chen et al. 2008, Sookhanaphibarn and Thawonmas 2009, Yalowitz and Bronnenkant 2009, Lockton, Harrison et al. 2010).

Moreover, with the rapid progress in science and technology, research is complementary with the new technologies on studying behaviour (Yoshimura, Girardin et al. 2012), including mobile instrument (Asakura and Iryo 2007), human computing and machine understanding (Pantic, Pentland et al. 2007), Video surveillance (Girgensohn, Shipman et al. 2008, Kiriyama and Sato 2013), RFID (Jung and Kwon 2011, La-or, Virach et al. 2012, Kiriyama and Sato 2013, Ichino, Isoda et al. 2016), NEUROGES coding system (Lausberg 2013), eye-tracking (Eghbal-Azar and Widlok 2012, Filippini Fantoni, Jaebker et al. 2013), Bluetooth (Yoshimura, Sobolevsky et al. 2014, Yoshimura, Krebs et al. 2016), wearable devices (Sparacino 2002, Tröndle, Greenwood et al. 2012, Kirchberg and Tröndle 2015), and sensor (Martella, Miraglia et al. 2016). Since 2000s, behaviour study get moving onto the field of commercial exhibition (Jung and Kwon 2011, Lindstrom 2011, Andrade, Gururangan et al. 2012, Schiffman, O'Cass et al. 2013, Quartier, Vanrie et al. 2014) along with the economic growth in exhibition demand, while the developing of cultural exhibition such as museum. In terms of human behaviour, it was particularly reflected in two aspects on Consumer Behaviour and Sustainable Behaviour.

Recent exhibition research has redirected motivation, decision-making, and designer behaviour towards behaviour study. Motivation in exhibition research is highlighted (Screven 1969, Nicholson and Pearce 2001, Packer and Ballantyne 2002, Falk 2009, Ballantyne, Packer et al. 2011, Falk and Dierking 2012, Hircherl 2013, Daae 2014, Forrest 2015). It might serve to understand the diverse drives that audiences choose to go shopping or visiting in exhibition context. However, it might also be impractical to pursue the motivation to each audience due to its multiformity, interfering with the measurement of the audience behaviour (Lewis.B.N. and Chen 2002). Another fundamental point of such research is decision-making. As a specific audience behaviour, decision-making is centered on studying exhibition by both researcher and designer (Caldwell 2002, Solomon 2014, Zhang 2014). For example, factors impacted on the decision-making process were discussed, which were presented in the book *Consumer Behavior: Buying, Having, and Being* (Solomon 2014). Also, Switzerland researchers indicated that there was a closely intertwined relationship among emotion, cognition brain networks, attention, memory and decision-making (Brosch, Scherer et al. 2013). Thus, emotion enables us to determine our decision (Paiva 2000, Norman 2004, Brosch, Scherer et al. 2013, Gross 2013, Rolls 2013). It provides an overview how audience behaviours such as decision-making are transferred through the mechanism of brain and behavioural systems, which was referenced from *Emotion and Decision-Making Explained* (shown in Figure 3.18), a publication

from Oxford Center for Computational Neuroscience UK (Rolls 2013). Particular attention has been paid to the behaviour of the designer as well (Akin and Lin 1995, Valkenburg 2000, Gero and Lindemann 2005).

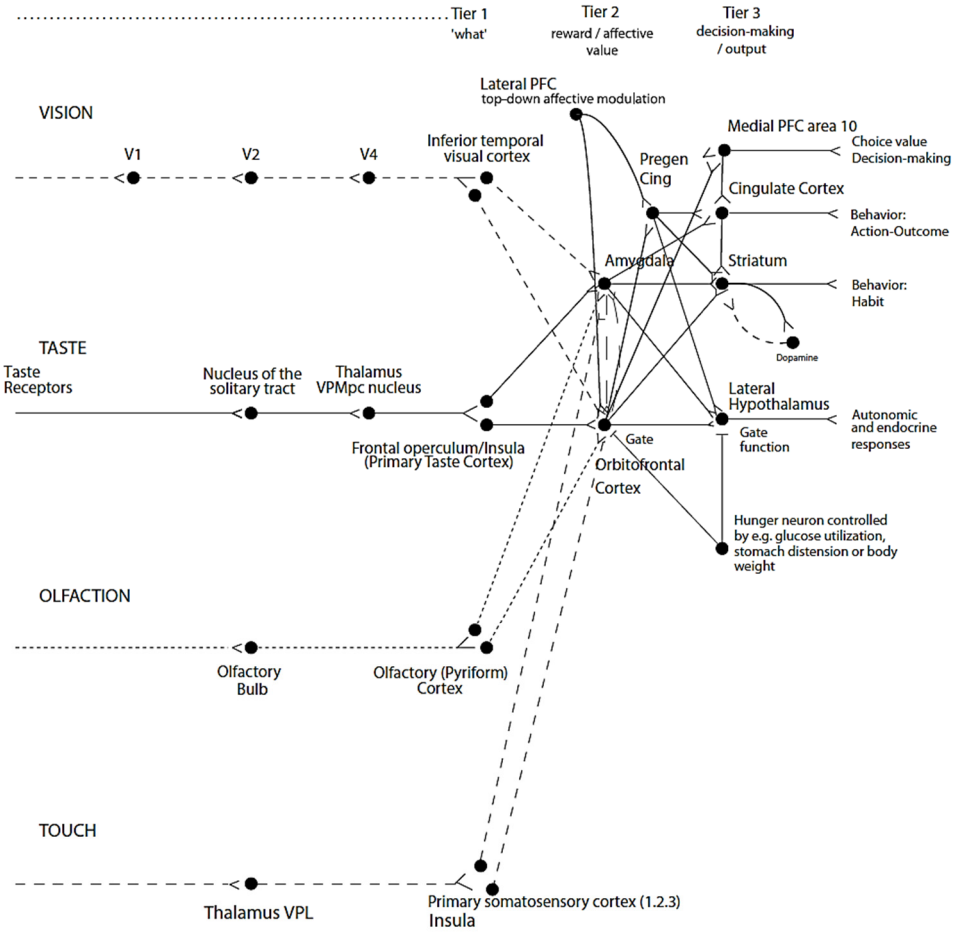


Figure 3.18. The transferring mechanism between human behavior and behavioral system (Rolls 2013).

Research gap exists between the joint exploration of audience emotion, experience with audience behaviour in the context of exhibition, while parts of them have been developed to access to human-exhibition interaction, helping to relieve the limitations of exhibition interactions.

3.4.2 Categorizing human behaviour

As outlined above, human behaviour can service for measuring their experiences and emotions from the exhibition perspective (Devine-Wright and Breakwell 1997), but with complicated characteristics. So is the major task of categorizing or coding audience behaviour at exhibition. This thesis divides human behaviour into two categories: affecting factors and behaviour data. The first includes factors of influencing human behaviour, which has connection with a diversity of design factors such as colour, lighting, etc. Another is to list behaviour presented in targeting environment, from gestures to movement.

Affecting factors:

Previous studies have found that human behaviour is influenced by design factors (Miles and Alt 1988, Daae 2014, Forrest 2015). Most of the papers are especially centred on atmosphere (Kotler 1973, Ariffin, Bibon et al. 2012, Forrest 2015) and environment (Vom Lehn, Heath et al. 2001, Daae 2014, Emo 2014), which has been extensively studied in environment-behaviour research (Ng 2003). For example, the term Atmospherics was proposed as a marketing tool firstly by Kotler (1973), a researcher at Northwestern University.

It was then further progressed in the context of commercial exhibition such as market, mall, retail, and store (Ng 2003, Babin, Chebat et al. 2004, Quartier, Christiaans et al. 2009, Ariffin, Bibon et al. 2012, Bohl 2012). Also the impact of atmospheric on both audience behaviour and emotion of cultural exhibition such as museum, gallery and heritage was explored (Kottasz 2006, Bonn, Joseph-Mathews et al. 2007, Forrest 2015). For instance, A doctoral research work at Universtiy of Western Sydnery discussed the semiotics had a strong impact on audience behaviour, as the language communicating with them and displays (Sager 2008). In addition, behaviour in virtual environment of exhibition were discussed along with the developing new technologies (Curzon and Blandford 2001, Willans and Harrison 2001, Maher, Bilda et al. 2005, Zacharias 2006, Sookhanaphibarn and Thawonmas 2009, Emo Nax 2014).

The time and space are highlighted in the environmental influence of behaviour (Rodriguez and Boks 2005, Hillier 2007, Girgensohn, Shipman et al. 2008), since which has '*recently received increasing acknowledgement and attention'* (Daae, 2014, p.19). University College London also conducted a research work on the affecting factor of environment for behaviour (Emo Nax 2014). It revealed that human behaviour including decision-making, wayfinding and viewing could be influenced by environment based on empirical studies.

Another reported factors of behaviour include servicescape (Bitner 1990, Bitner 1992), colour (Gohar 2008), layout (Gil, Tobari et al. 2009, Parsons, Ballantine et al. 2010, Lu 2011, Yoshimura, Sobolevsky et al. 2014), lighting (Quartier, Christiaans et al. 2009, Quartier, Vanrie et al. 2014), image (Bigne, Sanchez et al. 2001), social (Steg, van den Berg et al. 2012), human variables (Imamoğlu and Yılmazsoy 2009, Bohl 2012, Emo Nax 2014), and new technologies (Uğur, Mangiarotti et al. 2011). For instance, from the marketing angle, Bitner (1990) noted the servicescape's impact on customer and employee (Bitner 1992); meanwhile, Solomon (2014) analyzed the factors influencing the consumer's behaviour related to purchase and post-purchase activities. Gohar (2008) summarized that both the laboratory and field studies had revealed the colour's positive impacts on behaviour, but the results were inconsistent. Moreover,

layout's effects on behaviour were explored by Parsons, Ballantine et al. (2010)'s qualitative methodology with protocol analysis and in-depth semi-structured interview, and Lu (2011)'s doctoral case study at Grorigia Institute of Technology. Belgium scholars conducted a survey with ninety-five participants, indicating that lighting could be used to communicate the message as a design tool on account of its subtle effects on consumer behaviour and experienced emotions at store environment (Quartier, Vanrie et al. 2014). Also human variables are considered as affecting factors of gender and locality-related differences (Imamoğlu and Yılmazsoy 2009), personality traits (Bohl 2012), to eye movement (Emo Nax 2014). Besides individual factors, Steg, van den Berg et al. (2012) mentioned that '*social norms can exert a powerful influence on our behaviour*' (p.187). A co-research project with Politecnico di Milano and Eindhoven University of Technology developed wearable technology in an experimental study, finding that there was a mediate impact on users' behaviour and emotion regarding new technology (Uğur, Mangiarotti et al. 2011).

The book *Environmental Psychology: An Introduction* pointed out that studying the interaction among human behaviour, experience, well-being, and environment should be examined as a discipline (Steg, van den Berg et al. 2012). They suggested that '*behaviour, to a large extent, results from its interaction with the context, including technological products and systems that increasingly shape the behavioural context of people*' (p. 274). As a consequence the study of affecting factors needed to focus on the interactive relationship between audience/user and environements/products, and how behaviour was influenced through (Rodriguez and Boks 2005). For example, the paper *Principles of Exhibit Design* published in 1987 and *Some Evolving Principles of Visitor Behaviour* in 1988 proposed three factors with following sub-factors influencing audience behaviour: 1) Exhibition design factors; 2) Architecture factors, and 3) Audience factors (Bitgood and Patterson 1987, Patterson and Bitgood 1988). The researcher of the University of Warwick explored '*nonverbal behaviour*' (p. IX) and their effects in exhibitions by progressing six experimental studies. The result showed '*the fundamental psychological process of deception*' (p. IX) like emotion, cognition (shown in Table 3.14), and thus behaviour could be improved and enhanced through relevant factors (Zhang 2014).

Table 3.14. Nonverbal cues indicating psychological process of deception with emotions, cognition and behaviors (Zhang 2014).

Psychological		Nonverbal behavioural cues to
Emotions	Fear	Increased physiological arousal; Increased eye blinks; Self-adaptors (touching own clothes, hair, face, etc.); Speech hesitations (mm's and er's); Speech errors (stutters, repetition of words, omission of words);
	Guilt	Gaze
	Deligh	Increase in Smiling and signs of
	Overal	Less eye Less body orientation;
Cognitive		Less Gaze aversion; Fewer hand and arm movements; More speech hesitation and errors; Speak slower, pause more;
Attempted behavioural control	Deliberate	Avoid subjectively believed Avoid gaze aversion; Move deliberately; Planned and rehearsed; Lack in spontaneity;
	Lack of	Facial expressions of High pitch of voice; Performance looks

Stimulus-Organism-Response (S-O-R) model (shown in Figure 3.19) of Mehrabian and Russell (1974) provides the theoretical reference for the impacts of affecting factors on human behaviour and model construction in exhibition context (Donovan, Rossiter et al. 1994, Bohl 2012, Forrest 2015, Huang, Wei et al. 2016). It is also used to support emotion study on exhibitions (Baker, Levy et al. 1992, Machleit and Eroglu 2000, Fang, Wu et al. 2012), and emotion measurement (Russell and Mehrabian 1977, Bradley and Lang 1994, Machleit and Eroglu 2000, Desmet 2010). Accordingly, also audience behaviour and their emotion influenced by design factors are in a continuous state of consideration, of '*cooperating*' instead of '*separating*' (Ryu 2005, Gomez, Popovic et al. 2006, Bohl 2012).

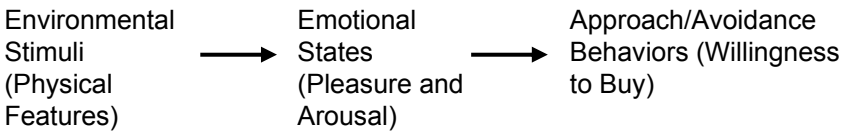


Figure 3.19. The mehrabian-russell affect model (Baker, Levy et al, 1992).

Section of this thesis will further discuss the relationship between affecting factors and audiences under the context of exhibition, through coding technique with software NVivo for revising and reorganizing the qualitative data. Other factors effect on audience behavior like motivation (Screven 1969), attitude, personality and social (Yang and Xu 2009) were mentioned in behavior study of exhibition, but it is not involved in this thesis.

Behaviour Data:

'*Behaviours are expressed in a movement, a glance, the positioning of ones body in space, the placement of a belonging. Actions reveal or express an individual's role within the viewing environment'* (Sager, 2008, p. VII). It means that behaviour data (BD) with accurate and measurable sub-variables could service to provide a possible mechanism for synergetic research between the exhibition design and other related fields. Given that there is no universal standard for categorizing behaviour data in current limited literature, this section has to classify behaviour data as explicit BD and implicit BD, presented in Table 3.15. Explicit behaviour data refer to postures of audiences observed in exhibitions, including eye movement, facial expression, walking, standing, sitting, reading, talking, and hearing. Implicit behaviour data points to measurable physiological parameter, involving Heart Rate Variability (HRV), Electrocardiograph (ECG), Electroencephalogram (EEG), Electromyography (EMG), and Galvanic Skin Response (GSR). Table 3.15 serves to make an overview of academic papers referenced and behaviour data constructed into exhibition context.

Table 3.15. The categorization of behavior data.

BD	Sub-activies	Related Methods	Related studies[reference] in exhibition context
1.Explicit behaviour data/postures	1.1 Eye movement	Theoretical interpretation	Bayer (1939); Liu (1996); Bogle (2013); Traue (2000); Wang (2006); Hughes (2010); Rodgers and Thorson (2012); McKenna-Cress and Kamien (2013);
		Eye tracking	Wessel, Mayr et al. (2007); Kienle, Schlösser et al. (2013); Filippini Fantoni, Jaebker et al. (2013); Emo Nax (2014); De Beugher, Brône et al. (2014); Dalton, Collins et al. (2015); Zank and Kunz (2016); Zheng and Ji (2016)
	1.2 Facial expression	Real-time computer vision techniques	Sparacino, Larson et al. (1999);
		Face tracking for robot guide	Siegwart, Arras et al. (2003); Faber, Bennewitz et al. (2009); Thrun, Beetz et al. (2000); Pateraki, Baltzakis et al. (2009); Nieuwenhuisen, Gaspers et al. (2010)
		Face tracking for virtual agent	Kopp, Gesellensetter et al. (2005);
		Facial Coding System	Matsumoto and Willingham (2006);
	1.3 Gesture	Videl-based recognition for interaction	Kadobayashi, Nishimoto et al. (1998);
		Field study	Hornecker (2008); Hinrichs and Carpendale (2011); Alexander and Andy (2012);
		Gesture recognition for interaction	Roccetti, Marfia et al. (2010); Baraldi, Paci et al. (2014); Fanini, d'Annibale et al. (2015); Bai, Lee et al. (2015); Pao (2015)
		Wearable sensor	Baraldi, Paci et al. (2015)
	1.4 Movement	Theoretical interpretation	Bayer (1961); Bitgood (1988); Bitgood (1992); Bitgood (2002); Dodge, Weibel et al. (2008); Bitgood (2010); Macleod (2005); Yalowitz and Bronnenkant (2009); Zamani and Peponis (2010); McKenna-Cress and Kamien (2013); Forrest (2015);
		Video-recording	Taylor (1963); Girgensohn, Shipman et al. (2008);
		Field study	Borhegyi (1965);
		Case study	Miles and Alt (1988);
		Mixed-method	Devine-Wright and Breakwell (1997); Bourdeau and Chebat (2003); Tzortzi (2014); Savoy (2014);
		Observation	Bourdeau and Chebat (2001); Sparacino (2002); Zacharias (2002); Brignull and Rogers (2003); Peponis, Conroy-Dalton et al. (2003); Peponis, Conroy-Dalton et al. (2004); Kaynar (2005); Bollo and Dal Pozzolo (2005); Wineman, Peponis et al. (2006); Zacharias (2006), Paterson (2014);
		Sensor	Cosley, Baxter et al. (2009); Kiriyama and Sato (2013);
		RFID	Larson, Bradlow et al. (2005); Jung and Kwon (2011);
		Bluetooth tracking	Delafontaine, Versichele et al. (2012); Yoshimura, Sobolevsky et al. (2014); Yoshimura, Krebs et al. (2016);
	1.5 Stopping	Video-recording	Shettel (1968)
		Theoretical interpretation	Bitgood (1988); Bitgood (1994)
		Mixed-mehtod	Bailey, Bronnenkant et al. (1998); Rohloff (2009)
		Observation	Rohloff, Psarra et al. (2009); Yalowitz and Bronnenkant (2009), Arnsdorf (2010); Wu, Hu et al. (2013);
	1.6 Sitting	Field study	Wakefield and Blodgett (1996)
		Theoretical interpretation	Kolter and Kolter (1998); Dean (2002); Gehl (2011); Serrell (2015); Underhill (2009)
		Observation	Chiozzi and Andreotti (2001)
	1.7 Speech	Speech recognition for guide/robot	Gustafson and Sjölander (2002); Graf and Barth (2002); Prodanov, Drygajlo et al. (2002);Tomatis, Terrien et al. (2003); Kopp, Gesellensetter et al. (2005); Bennewitz, Faber et al. (2005); Clodic, Fleury et al. (2006); Faber, Bennewitz et al. (2009); Swartout, Traum et al. (2010);
		Audio recordings	Swartout, Traum et al. (2010);
2. Implicit behaviour data/ physiological	2.1 HRV	Wearable equipment	Tschacher, Greenwood et al. (2012); Tröndle, Greenwood et al. (2012); Tschacher, Greenwood et al. (2012);Tröndle, Kirchberg et al. (2014); Tröndle and Tschacher (2012); Tröndle, Wintzerith et al. (2012); Tröndle, Greenwood et al. (2014); Kirchberg and Tröndle (2015);
	2.2 ECG	Wearable equipment	Peng, Havlin et al. (1995)
	2.3 EEG	Wearable equipment	Banzi and Folgieri (2012); McCullagh (2013); Azevedo, Jorge et al. (2014); Zhong (2015); Abdelrahman, Hassib et al. (2015); Pedersen, Mirza-Babaei et al. (2015)
		Theoretical interpretation	Damala, Schuchert et al. (2013)
	2.4 EMG	-	No found
	2.5 GSR	Wearable equipment	Sparacino (2002); Sparacino (2002); Gonsalves (2010), Tröndle, Greenwood et al. (2012); Tröndle, Greenwood et al. (2014); Kirchberg and Tröndle (2015); Du, Shu et al. (2016);

Behaviour data categorization of this thesis connects two behaviour data types known in the '*exhibition*' behaviour data discussion. From application point, the corresponding references to behaviour data (BD) and sub-BD have been given construction, instead of elaborating upon these concepts which were discussed in detail from the literature such as emotion assessment (Bosma and André 2004, Katsis, Ganiatsas et al. 2006, Wilhelm, Pfaltz et al. 2006, Fox 2008, Gross 2013, Basu and Halder 2014), behaviour study (Andreassi and Filipovic 2001, Pantic, Pentland et al. 2007), HCI (Nakatsu and Reilly 2004, Peter and Beale 2008, Lazar, Feng et al. 2010), and Ergonomics (Rauterberg 1993, Gyi, Sims et al. 2004, Lawson 2011, Chen, Yu et al. 2014), etc. In nature, the explicite behavioural data including both verbal or non-verbal behaviour can be observed, and therefore analysis techniques from '*pencil -and- paper*' to '*timing and tracking*' are progressed in studying exhibition and its audiences (Yalowitz and Bronnenkant 2009, Escuer, Mateo et al. 2014). For instance, Zhang (2014) detected the situational factors for understanding the deceptive nonverbal behaviour and intention in exhibitions, and the coding table is shown in Table 3.16.

Table 3.16. Coding of nonverbal cues – body sections excluding hand/arm (Zhang 2014).

	Variable name[a]	Coding Details
Body	(movements)	(frequency/length)
Hea	Head movement	All types (e.g. nod, shake, turn, tilt, etc)
Eye	Aversion/shifts (all studies)	Brief change of gaze
	Staring at other places	Fixed gaze
	(Study 1 and 2) Staring at folder (Study 2)	Fixed gaze in the direction of the folder
	Avoiding eye contact with others (Study 4)	Gaze
	Eye/eyebrow (all studies)	**Other eye movements to those above**
Trunk	**Indirect orientation while Standing (Study 1)**	**Tilting at waist while being spoken to**
	Lean towards other people while seated (Study 2)	Body moving toward people being talked to
	Lean back while seated (Study 2)	Body moving away from people being talked to
	Position shift (Study 2)	**Changes to the way of sitting that involve multiple body parts**
	Sway (Study 4)	**Waist moving slowly or rhythmically from side to side**
Foot/Leg	Feet and legs (all studies) Foot only (all studies)	Movements of legs and feet
	Leg only (all studies)	Movements of feet without moving legs
		Movements of legs without moving feet

Furthermore, technology allows the possibility of applying other research methods to observe audience's postures in exhibition, for instance, video recording for stopping (Shettel 1968) and movement analysis (Taylor 1963, Girgensohn, Shipman et al. 2008), mobile eye tracking used for capturing audiences' viewing behaviour (Dalton, Collins et al. 2015, Zank and Kunz 2016), facial, speech and

gesture recognition for interaction (Nieuwenhuisen, Gaspers et al. 2010, Pao 2015), sensors for tracking audience movement (Jung and Kwon 2011, Yoshimura, Krebs et al. 2016).

Moussouri and Roussos (2014) pointed out that new technologies like '*varied information technology and communication tools*' (p.270) had been combined into the research field as a distinctive feature. It enables physiological parameters to be captured in a more accurate way, compared to explicite BD. The physiological parameters addressed a concern for data collection and measurement particularly in the areas of HCI (Liapis, Karousos et al. 2014), affective computing (Picard 2000, Whang, Lim et al. 2003, Liu 2014), product design (Westerink, Ouwerkerk et al. 2007, Tanb, Guo et al. 2015), advertising (Holbrook and O'Shaughnessy 1984) and game design (Bernhaupt and Mueller 2016). For example, Greece scholars proposed a PhysiOBS approach to evaluate user emotional experience, which cooperated three data with physiological signals, observation data and self-reported data (Liapis, Karousos et al. 2014). It was co-found by European Social Fund and Greek National Strategic Reference Framework.

The performance of implicit BD has special significance to marketing enhancement. A co-resesarch project conducted by MIT, Northeastern University, Mars Marketing Lab, and Affective company, for instance, indicated that '*Physiological changes in our heart rate, posture, facial expression and voice convey emotion response to the world around us*' (Daniel McDuff, 2013, p.1). The result revealed that the decision-making of emotion could drive sales with the example of advertising, which had received attention from university to company (Holbrook and O'Shaughnessy 1984, NVISO 2011, Daniel McDuff 2013), as shown in Figure 3.20. This development of physiological parameter, basically, comes from two aspects: One is as Picard noted, the professor of Media Arts and Sciences at the MIT Media Laboratory, '*physiological expression is one of many multimodal means of concurrent emotion communication we are exploring*' (R. W. Picard, 2000, p.710) . It related behaviour data to predict emotion (Holbrook and O'Shaughnessy 1984, Nakatsu and Reilly 2004, Shen, Wang et al. 2009), probing experience (Westerink, Ouwerkerk et al. 2007), and measurement (shown in Table 3.13). Another is due to the growing of new technology at a rapid rate, and reducing manufacturing costs in the new economic environment (Andreassi and Filipovic 2001, Whang, Lim et al. 2003). This renders the innovate approach possible and application.

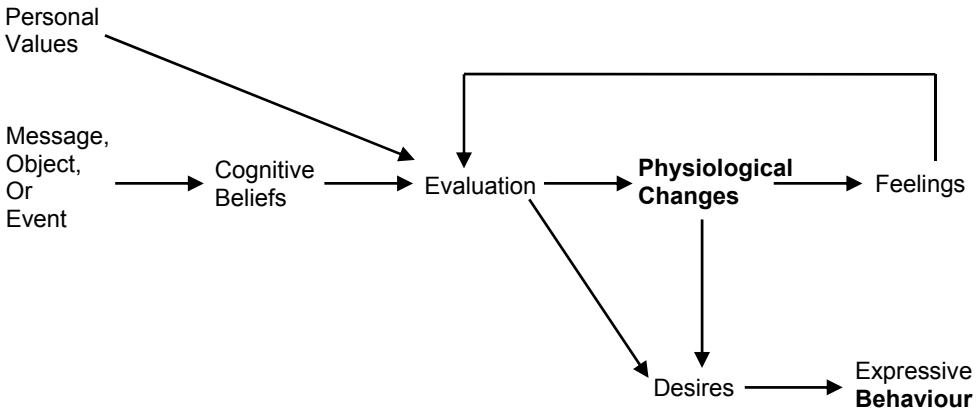


Figure 3.20. Model of emotional, physiological, and behavioral process (Holbrook and O'Shaughnessy 1984).

3.4.3 Embedding behaviour data into exhibition design

As the publication funded by the Dutch national program reported, '*characterizing and quantifying visitors behavior helps museum staff evaluate their curatorial decisions, reporting to stake holders and funders, and building data-driven marketing campaigns and applications*' (Martella, Miraglia et al. 2016). The professor of Oregon State University and director of the Smithsonian Institution, Falk and Dierking, mentioned that audience behaviour in exhibitions could even make a specific influence on their response and behaviour in daily life (Falk and Dierking 2012). Furthermore, it has been argued that understanding audience behaviour is essential for different stakeholders related to exhibition design, like clients, designers, and audiences in terms of design and measurement (Frey and Meier 2006, Bhamra, Lilley et al. 2011, Falk and Dierking 2012, Brown and Hutton 2013). In addition, studying audience behaviour is the key to designing exhibition, enhancing experience (Vom Lehn, Heath et al. 2001, Anderson and Shimizu 2007, Allanwood and Beare 2014, Yoshimura, Sobolevsky et al. 2014, Forrest 2015), and embodying cognition and emotion (Walden and Janevska 2011, Tröndle and Tschacher 2012, Brosch, Scherer et al. 2013, Forrest 2015).

Throughout the previous sections, we have seen how audience experience and enjoyment emotion have embedded into exhibition design. This section is brought to discuss the meaning of embedding behaviour data into exhibition design, based on three aspects: The role of behaviour in design, behaviour study and behaviour data in exhibition design. In each of the aspects embedding happened through exhibition design processes in this thesis and at the end of the conceptual model.

The role of behavior data in design

Behaviour were presented in the design discussion from its early beginnings. For example, Canter and Craik (1981), noted in their review paper that:

> '*the implications for understanding behaviour that follow from the conceptions of environment held by architects, urban designers, engineers, resource managers and other environment scientists and professional with whom psychologists now collaborate are far from fully examined'* (p.5).

A large part of the literature is involved in to the design areas like environment design (Ng 2003, Gehl 2011, Zhao and Siu 2014), architecture design (Oxman, Bax et al. 1995), product/industrial design (Daae 2014, Tromp and Hekkert 2016), engineering design (Purser and Bensilum 2001, Lawson 2011), graphic design (Hircherl 2013), experience design (Law, Bevan et al. 2008, Allanwood and Beare 2014), and interaction design (Little and Nigay 2001, Snibbe and Raffle 2009).

The human behaviour was studied, to analyze how their behaviour had been influenced by designers through using design factors. For instance, Canadian researcher conducted an environment-behaviour research on shopping environments [19], analyzing how audience behaviour and experience were enhanced under the influence of design factors such as atmospheric, physical features like layout and background music, etc (Ng 2003). Hong Kong Polytechnie University investigated the impacts of boundaries of public space on human behaviour in Hong Kong's mass transit railway with a case study, from the viewpoint of user-centred design (Zhao and Siu 2014). Symposium *Design Research in the Neitherlands* convened by Eindhoven University of Technology proposed a functional modelling '*function – behaviour - structure*' (p.128) that behaviour were relative and corrected by design factors (Oxman, Bax et al. 1995). Investigations into Aalto University tried to explore how consumer behaviour were improved by applying sustainable design methods, with designers' '*skills and position'* (HircherI, 2013, p.29). The pioneering researchers of emotion design, Desmet and Hekkert (2007), summarized the interactive relationship between experience and behaviour through the induction of human-product interaction. It was stimulated by designers' construction and interpretation. A project Social Immersive Media developed by Sona Research, Nokia Research Center, and tangible media group of MIT Media Lab presented how social behaviours were promoted by using design, which received support from the National Science Foundation, and collaborated with related companies, the Science Museum of Minnesota, the California Science Center, and the Exploratorium (Snibbe and Raffle 2009).

The literature on behaviour data application on design, is another highly discussion in the role of behaviour in design literature. It is concerned with how to explore and organize behaviour data on the service of a design case. For example, in Danish

[19] Shopping environment refers to markets, shopping centers, and electronic shopping indicated in Ng (2003)'s paper publication.

architect Jan Gehl' book *Life Between Building: Using Public Space*, it outlined three types of outdoor activities in public space: Necessary activities, optional activities, and social activities. Also factors impact on behaviours were explored, and proposed for environment design that '*spaces for walking - places for staying, walking, standing, sitting, seeing, hearing, and talking; a pleasant place in every respect soft edges*' (Gehl, 2011, p.172). In terms of engineering design, Purser and Bensilum (2001) in Building Researdh Establishment UK discussed key factors of occupant behaviour in fire, with the relationship among pre-movement time, travel time, and evacuation times. The work was developed in depth by Lawson Glyn at the University of Nottingham, and he conducted the comparative study on approach analysis, fire drills, virtual environments and a new talk-through approach, for predicting human behaviour in emergencies (Lawson 2011). On the conference of the *International Workshop on Meaningful Measures: Valid Useful Experience Measurement (VUUM)*, the behaviour data were discussed for measurement and design in User Experience (Law, Bevan et al. 2008). Accordingly, Allanwood and Beare (2014) stated that designer should '*try to understand the behaviour of the people they are designing for and create work that blends well with evolved systems*' (p. 24). Papers in another international conference in terms of engineering for Human-computer Interaction, tried to construct behaviour data to design a '*virtual environment*' or '*interactive systems*' (Little and Nigay 2001).

The role of behaviour in product/industrial design is following a specific progress, since its fast growth after World War I and II (Wang 2002). It appeared from the evolution of the design with behaviour and design for sustainable behaviour that both had developed into a particular stage of conceptual development.The evolving phase was moved from design for product, to experience and emotion, then to behaviour with the incentives of economy and marketing (Dorst 1997, Norman 2002, Green and Jordan 2003, Khalid and Helander 2006, Desmet and Hekkert 2007). In 1988, Norman discussed the relationship among behaviour, environment and design from the perspective of Psychology. He proposed an '*approximate model*' (p.48) with seven stages: Forming the goal – forming the intention – specifying an action – executing the action – perceiving the state of the world – interpreting the state of the world – evaluating the outcome (Norman 1988). Moreover, Norman Donald considered behaviour as key part of design processing, for instance, in the description of three of processing: '*visceral, behavioural, and reflective*' (D. A. Norman, 2002, p. 59). This is required for achieving enjoyment objective (Norman 2002). It was further illustrated in his subsequent work *Emotional Design: Why We Love (or Hate) Everyday Things* (Norman 2004) and *Living with Complexity* (Norman 2010). Additionally, the transformation of behaviour in product/industrial design can be seen from the

product, to individual, then to social and environment in the end (Tromp and Hekkert 2016). For instance, the term of DsSB (Design for Sustainable Behaviour) focusing on environment impact was referred in the field of product/industrial design literature (Wever, Van Kuijk et al. 2008, Bhamra, Lilley et al. 2011, Lidman and Renström 2011, Lockton, Harrison et al. 2013, Daae 2014).

Although some studies in design discipline have paid attention on the application of behaviour data as the tool of measurement and design, (as previously discussed), there is still a research gap especially based on the interactive reality of behaviour, experience and emotion. As Norman noted, '*computer scientists call the systematic application of a rule to behavior an algorithm*' (p.81), due to a fact that both '*a fact of life*'(p.86) and human behaviour is complexity (Norman 2010).

Behaviour data in exhibition design

Patterson and Bitgood (1988) reviewed the evolving studies of audience behaviour since Robinson (1928) and Melton (1933). They described the relationship between audience behaviour and effecting design factors. However, studying behaviour in exhibition design is not just a single focus on activities and exhibition itself. The book *The Design of Educational Exhibits* proposed a '*behavioural objectives approach*' (p.62) for exhibition designers, and pointed out that it was significance to define and categorise behaviour because it was related with the learning experience in museum (Miles and Alt 1988). Different with behaviour study in other design disciplines, Vom Lehn, Heath et al. (2001) stated that '*studies of visitor behavior largely characterize their experience as a series of individual encounters wit particular exhibits*' (p.196), and their actions were '*conceived as behavioural or cognitive responses to exhibits*' (p.196). Chinese researchers regarded behaviour study as an approach for promoting communication and marketing in exhibition design (Yang and Xu 2009, Zhang 2009). Additionally, the term audience behaviour is endowed with the result of exhibition experiences (Locker 2011), a series of reactions with design, visiting time, energy, perception limitations, audience physical characteristics, and the complex interactions between design factors and audiences (Guler 2015). A study in Tongji University funded by the National Natural Science Foundation of China defined audience behaviour as all '*psychology-related behavioural response*' and '*visiting activities*' (p.1918), before, during and after their whole visiting process (Wu, Hu et al. 2013).

Peponis, Conroy-Dalton et al. (2004) further analyzed the layout's impacts on audience behaviour to improve exhibition design under the funding from National Science Foundtaton Informal Science Education Grant, USA. They compared audience behaviour in four exhibitions shown in Table 3.17, and established the enhanced positional model and compositional model to interpret the effects of

design factors with audience behaviour, like movement path and engagement patterns.

Table 3.17. Audience behavior with time in four exhibitions (Peponis Conroy-Daltion et al, 2004).

	ZAP! Surgery		Robotics	
	Great Lakes Science	Carnegie Science Center	Great Lakes Science	San Jose Tech
Number of visitors tracked	96	97	103	102
Average total time per visitor (minutes)	22.7	15.9	21.1	16.6
Average total stop time per visitor (minutes)	18.8	12.5	17.4	12.8
Average number of contacts per visitor	28.26	23.80	32.10	23.11
Average number of 1st contacts per individual exhibit	48.74	44.44	57.71	60.60
Percentage of visitors contacting each individual exhibit	51	46	56	59
Average number of repeat contacts per individual exhibit	92.52	80.78	100.68	98.04
Average number of engagements per visitor	10.38	6.03	12.51	9.82
Average number of 1st engagements per individual exhibit	19.93	13.00	24.74	24.40
Percentage of visitors engaging each individual exhibit	21	13	24	24
Average number of repeat engagements per individual exhibit	31.78	17.63	38.55	36.88

Davey (2005) discussed the behaviour data of '*fatigued audience*' involving '*cruising through galleries, relatively rapid rates of viewing without rest periods, and increased selectivity towards exhibits*' (p.18). Meisner, vom Lehn et al. (2007) characterised audience behaviour as '***Performance***', and thus the '*performers*' (audiences in exhibition) '*not only use the exhibits but also creat engaging and enjoyable experience*' (p.1541). The study considers performance (behaviour) as an efficient means to enhance audience experience and the interaction/engagement between exhibition and audience. Gil, Tobari et al. (2009) presented the term '*shopper DNA*' (p.7) in line with customers' various behaviour such as their movement patterns (shown in Table 3.18). It constructed behaviour attributes as:

- Duration of shopping trip, in minutes;
- Average walking speed, in metres per second;
- Average duration of interactions with products, in seconds;
- Conversion ratio, as the % of purchases from all interactions with products;
- Repeat sectors, as the % of store sectors visited more than once;
- Which areas of the store they visit, as the % of the trip in low, medium and high integration areas of the store;
- How far into the store they go, as the % of the trip near, at medium distance and far from the entrance, in metric terms.

Table 3.18. Shopper DNA based on profile and behavior attributes (Gil Tobari et al, 2009).

Attributes	0	1	2	3	4	5	6
Gender	Male	Female					
Age group	-	18-24	25-34	35-44	45-54	55-64	65 and over
Group size	-	Alone	Two	Three	Four	Five	Six or mor
Carrier type	None	Basket	Shallow trolley	Deep Trolley			
Frequency of visit	-	First Time	Regularly	Occasionally			
Shopping mission	-	Main	Top-up	Tonight	For Now	Non-food	
Shopping list	-	Yes	No				
Attitude to promotions	-	Always	Familiar	Familiar	Never		
Satisfaction	-	Very Satisfie	Satisfied	Neither	Dissatisfied	Very dissatisfie	
Shopping Duration	-	<10 min	<20 min	<30 min	<45 min	45 min or more	
Walking Speed	-	Slow	Medium	Fast			
Duration of Interactions	-	Short	Medium	Long			

Forrest (2015) coded observed audience behaviour through reviewing previous behaviour study of exhibition, presented in Table 3.19. It tended to characterise audience experience by using audience behaviour (AB).

Table 3.19. Coding audience behavior (Forrest 2015).

Behaviour Code	Definition	Level of Engagement	Description
N	Not encountered	-	Visitor did not encounter exhibit or pass in its vicinity (excluded from engagement calculations).
1	Ignore	None	Visitor passed by but seemingly ignored the exhibit.
2	Skim	Level	Exhibit was skimmed in passing but was not stopped at (or stopped less than 2 seconds).
3	Attend	Level	Exhibit was attended to briefly (visitor stopped and looked at exhibit for more than 2 seconds but less than 10 seconds).
4	Engage	Level	Exhibit was attended to in some depth (visitor stopped and looked at exhibit for a minimum of 10 seconds).

Another aspect is the behaviour pattern which in other ways might be considered for studying behaviour data. There are two behaviour patterns. First concerns on audience activities as model. Examples were '*stops (…) and does not stop (…) two behavioural categories necessary*' (Miles & Alt, 1988, p.270) , '*necessary activities, optional activities, and social activities*' (Gehl, 2011, p.11), '*ant, fish, grasshopper, and butterfly styles*'[20] (Zancanaro, Kuflik et al. 2007, Sookhanaphibarn and Thawonmas 2009), '*greedy audience, selective audience, and busy audience*' (Sparacino, 2002, p.8), '*specialist pattern, native pattern, tourist pattern, explore pattern, and raider pattern*' (Gil et al., 2009, p.9), '*explores,*

[20] The original paper is the publication from Véron, Eliséo, and Martine Levasseur in 1989 (written in French).

facilitators, professionals/hobbyists, experience seekers, rechargers' (Falk & Dierking, 2012, p.9), '*the single path, multiple path, radial pattern, star pattern, areas of affinity, the fan pattern*' (Hughes, 2010, pp.75-77). Second is about the flow of audience behaviour during viewing exhibition. For instance, Yang and Xu (2009) summarized audience behaviour process as touch (issue recognition) — understand (information search) — accept (project evaluation) — assurance (buying decision) — go exhibition (behaviour after buying). Falk and Dierking (2012) organized exhibition visiting into four stages: Orientation (lasting about three to ten minutes) — intensive looking (lasting about fifteen to forty minutes) — exhibition cruising (lasting about twenty to forty-five minutes) — leaving-taking (lasting about three to ten minutes). Wu, Hu et al. (2013) illustrated a schematic graph for audience's visiting flow (shown in Figure 3.21), in which taking picture coded as 'P', stopping and staying to view coded as 'S', and talking communication among audiences coded as 'T'. Dou (2013) concluded customer behaviour in shopping: Entering --- looking around — consulting or walking to objects — sitting down — experiencing object — buying or leaving. In 2016, a doctoral project of Politecnico di Milano conducted a survey with over 200 participants for the exhibition of the hospital, and it presented their behaviour process as: Arrival — enter — engage — exit — extend (Shafieyoun 2016).

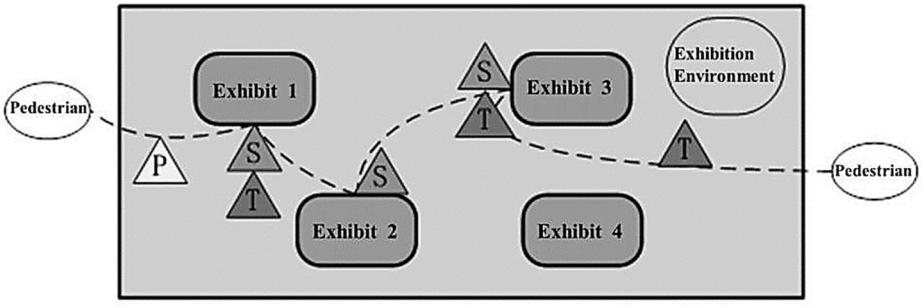


Figure 3.21. Schematic graph for audience's viewing process (Wu Hu et al 2013).

Along these lines, **combination** may be the preferred lens for studying behaviour in exhibition design. Sager (2008) called audience behaviour a '*combination of public social behaviour, museum behaviour, and personal behaviour'* within '*the zone of interaction*' (p.172), and '*their personal, cultural and social contexts*' (p.46). Legrenzi and Troilo (2005) from Milan Italy conducted an empirical study in Victoria & Albert Museum in London, and they confirmed the combined relationship between emotion, behaviour, satisfaction, exhibition factors for enhancing its economic and institutional benefits. Zhang (2009) suggested there was necessary to consider the influence of audience behaviour on economic, social, culture, and environment. Falk and Dierking (2012) mentioned '*the **combination** of physical, personal, and sociocultural contexts can severely constrain behavioural repertories*' (p.118). The last two combinations alluded to behaviour with experience, emotion and design factors (Gilboa and Vilnai-Yavetz

2013, Frew and Williams 2014). It has often been emphasized on its interactive combination between '*behavioural, cognitive and affective aspects*' (Forrest, 2015, p.81), or '*physical, social and cultural elements*' (Forrest, 2015, p.63) .

Many behaviour data studies in terms of exhibition design come with observation method. For instance, Robinson (1928) firstly organized two years of direct observation in several museum exhibitions, by using traditional '*paper-and-pencil*' record approach. Porter (1938) investigated the relationship between audience behaviour and exhibition factors such as audience movement, guide leaflet with the observation method. The two studies were both progressed by Yale University. Along with observation with paper-and-pencil (Robinson 1928, Porter 1938, Goulding 2000, Guy, Dunn et al. 2010), studies were then found the movement involving with video-recording (Taylor 1963, Shettel 1968, Sager 2008, Zhang 2014), survey instruments (interview, focus group, questionnaire)' (Bollo and Dal Pozzolo 2005, Kelly 2012, Liu and Tsaur 2014, Pai and Yeh 2014, Quartier, Vanrie et al. 2014, Song, You et al. 2014), simulation modelling (Pluchino, Garofalo et al. 2013), sensor technologies (Yoshimura, Sobolevsky et al. 2014, Martella, Miraglia et al. 2016, Yoshimura, Krebs et al. 2016), and mixed method with quantitative and qualitative data (Forrest 2015, Ichino, Isoda et al. 2016). This evolvement trend typically has been determined by the evolving of technology (Yoshimura, Krebs et al. 2016). This thesis applied a mixed method for obtaining behavioural data (indicated in Chapter 3), due to the complexity and specificity of exhibition context improvement. The methods of both quantitative and qualitative are related strongly to '***Tracking and Timing***'[21] in the light of exhibition design. However, important thing to note here is that '*not all researchers interpret visitor behaviour in the same way*' (Davey, 2005, p.20).

Embedding into exhibition design

The behaviour data literatures in exhibition design include a small area, which studies the performances of audiences across various aspects of an exhibition as embedding (Sparacino, Larson et al. 1999, Ueoka, Hirose et al. 2001, Sparacino 2002, Wessel, Mayr et al. 2007, Eghbal-Azar and Widlok 2012, Tröndle, Greenwood et al. 2012, Tröndle and Tschacher 2012, Tröndle, Wintzerith et al. 2012, Filippini Fantoni, Jaebker et al. 2013, Krukar 2014, Forrest 2015, Tatler, Macdonald et al. 2016). Developing technologies like '*wearable devices*' have been found to drive the embedding (Sparacino, Larson et al. 1999).

MIT (Massachusetts Institute of Technology) can be considered as the pioneer of this field. In 1997, the term Affective Wearable was firstly introduced to the public

[21] The term of tracking and timing may be started from 1920s' studies of Yale University focusing on the collection of behavior data in exhibition. It was summarized and reviewed by Yalowitz Steven and Bronnenkant Kerry in 2009.

by Picard and Healey (1997). They defined the new conception as an *'affective wearable' is a wearable system equipped with sensors and tools which enable recognition of its wear's affective patterns*' (p.231). Thereafter, the MIT researcher Sparecino Flavia explored approaches to help achieve '*interactive exhibit design*' (Sparacino et al., 1999, p.1), by using technologies from behaviour tracking to wearable computer, and collecting behaviour data such as eye movement, walking movement, gestures, and expressions (Sparacino, Larson et al. 1999, Sparacino, Davenport et al. 2000, Sparacino 2002, Sparacino and Places 2004, Sparacino 2008). She used the term '*Museum Wearable*' (Sparacino, 2002b, p.9) , '*Sto(ry)chastics*' (Sparacino, 2002d, p.3), '*Museum Intelligence*' (Sparacino & Places, 2004, p.2), and '*Body-driven Interactive Narrative Spaces*' (Sparacino, 2004, p.1), in order to enable more effective, interactive communication of meaning and storytelling among audiences, designers, and clients/curators. These studies tended to construct a '*sensor-driven*' (Sparacino, 2002d, p.3), and '*sensor-instrumented interactive narrative space*' (Sparacino, 2002d, p.4) for telling digital story, through transforming technologies (Sparacino 2002). It means the merging of virtual and real environment, and the possibility of transformation for audiences between virtual and real exhibitions. Also, Japanese scholars conducted a joint project of '*wearable computer application*' (p.8) for the World Exposition 2005 in Aichi (Expo 2005) cooperated with the University of Tokyo, Keio University, and Media Fashion Laboratory (Ueoka, Hirose et al. 2001). It combined the communication techniques including global positioning system (GPS), mobile phone, wireless LAN card, Windows CE machine, and head mounted display (HMD).

Eye, one of the five physiological senses, plays a key role in exhibition design (Csikszentmihalyi and Robinson 1990, Traue 2000). Therefore, tracking eye movement, received attention since the availability of mobile eye tracking (MET) in public space, which breaks the limitation just used in a laboratory environment. For example, a study of University of Tuebingen pointed out that MET was a powerful method of data collection in the research of mobile learning in museum exhibition (Wessel, Mayr et al. 2007). German researchers used MET to investigate audiences' natural behaviour at two museum exhibitions in Germany with the discussions of its potentials and limitations (Eghbal-Azar and Widlok 2012). They suggested that such method might become embedded into the combination with other method like observation or videotaping, because it could generate '*very detailed and precise outside the laboratory*' (Eghbal-Azar & Widlok, 2012, p.12) and allowed to store the data for analysis quantitatively or qualitatively. Filippini Fantoni, Jaebker et al. (2013) discussed the limitations of eye tracking studies in USA exhibitions. They found it was time-consuming for calibration needs of the devices, and a significant cost was required that might be a burdensome for most

exhibition institutes. But it is still highlighted that using EMT will enhance the effectiveness of the experiments in both field and laboratory setting. Scholars in UK explored the application of EMT with 24 participants in commercial exhibition for improving the design implication in a realistic shopping center (Dalton, Collins et al. 2015). In 2016, Tatler, Macdonald et al used eye tracking to investigate the responses of design factors like decorative textiles, the expertise of the audiences and the information provided for viewing behaviour in cultural exhibitions with fourteen participants (Tatler, Macdonald et al. 2016). Zheng and Ji (2016) compared different display of clothing with EMT in field study, discussing its exhibition design issues in China.

Eye tracking has been widely applied in the evaluation area of HCI (Bruneau, Sasse et al. 2002, Jacob and Karn 2003, Poole and Ball 2006), user-centred design (Franke, Pannasch et al. 2008), advertising design (Schrammel, Mattheiss et al. 2011), environment design (Schwarzkopf, von Stülpnagel et al. 2013, Emo 2014, Emo Nax 2014), user experience design (Bergstrom and Schall 2014, Guo, Qu et al. 2014), and product/industrial design (Kukkonen 2005, Sun, Xiang et al. 2014). However, the lack of available EMT data to support predictions and evaluation for exhibition design is an issue, and the combination with other methods and embedding of behaviour data is rarely accessed.

Wearable devices also allow an opportunity of embedding physiological parameters into exhibition design and evaluation. Physiological measures are related to autonomic nervous system (ANS), emotional valence and behaviour, and '*provide important insight into behavior' (*p.46) (Andreassi and Filipovic 2001). Particular attention has been paid to the field of HCI (Nakatsu and Reilly 2004) and engineering (Kim, Lim et al. 2006, Abdul Razak, Zayegh et al. 2012). An example for using wearable devices embedded behaviour data was the Swiss National Research Project, eMotion, which tried to map audience experience in museum by combining various behaviour data, such as movement tracking, HRV, and GSR (Tröndle, Greenwood et al. 2012). It investigated 576 participants in field study, and reported the '*significant associations between physiology and aesthetic evaluations*' (Tröndle, Greenwood, et al., 2012, p.2) tended to service as a measurable approach to exhibition design. Accordingly, the work was extended to explore the relationship between exhibition and audience responses such as cognitive, emotional, behavioural ingredients using a mixed-method (questionnaire, interview, observation, and behaviour tracking) (Tröndle and Tschacher 2012, Tröndle, Wintzerith et al. 2012, Tschacher, Greenwood et al. 2012, Volker and Martin 2012, Tröndle, Greenwood et al. 2014, Tröndle, Kirchberg et al. 2014). Although these studies try to find the correlations with exhibition factors and audience experience with behaviour data, it lacks a conceptual model bringing these exhibition subjects and objects of embedding together, and the

interactive relationship among audiences, designers and clients. Further research may show how the construction of audience experience, emotion, and behaviour data for exhibition design is a process of interactive embedding.

In conclusion, the research object would be the embeddedness and embedding of three aspects (audience experience, enjoyment emotion, and behaviour data) and three stakeholder (audiences, designers, clients) in its interaction network during three stages (pre-, during-, and post-evaluation).

3.5 Identifying EDFs, AEFs, and BD

This section presents the results of a qualitative analysis of exhibition design factors (EDFs)[22], audience experience factors (AEFs)[23], and behaviour data (BD)[24] with GT method. 59 EDFs, 18 AEFs and 14 BD were explored in line with exhibition design. Search methods and exploratory methods were refined using software such as NVivo-11 and Endnote X8, and in total 1467 documents were extracted for EDFs while 80 focused on the AEFs, enjoyment emotion, and behaviour data, and these established an interactive relationship among them (presented in Section 3.6.1 human-exhibition interaction, HEI).

3.5.1 Approach for identifying

Literature provides a major form of data due to their uniquely valuable role in grounded theory research (Charmaz 2014, Birks and Mills 2015)**.** In the stage of exploring EDFs. AEFs, and BD, the scholarly literature was applied to offer a theoretical framework based on the reliable analysis. Although abundant materials provide a rich source for identifying, the published literature can access to the accuracy and preciseness of this review (Birks and Mills 2015), especially in the situation of limited studies of exhibition design. In this line of thinking, a systematic review approach is structured in this section that followed and modified from Bandara, Miskon et al. (2011). The framework includes six phases:

(0) defining research questions;
(1) data extraction;
(2) preparing for analysis;
(3) actual coding;
(4) analyzing and presenting the results;
(5) answering research questions and agenda.

[22] Factors used by designers and clients to help design exhibitions for transforming audience experience and enhancing communication, e.g. shape, colour, and lighting, etc.
[23] Factors perceived by audiences that will affect their fellings and desicision-making before, during, and after visiting exhibitions, e.g. satisfaction, enjoyable experience or emotion, learning, and curiosity, etc.
[24] Factors used by observing and measuring audience behavior to help understand audience fellings including experience and emotion.

Compared with traditional systematic literature review, the difference is that the grounded-theory methodology tends to focus on the meaning, mutual creation of knowledge, and legitimization of using various well-estabished theoretical perspective in sociology based on research questions (Gibson and Hartman 2013). The systemic review approach with grounded-theory thus is modified starting at the phase (0) that the research questions are proposed, followed by data analysis and finally aiming to phase (4,5) in which EDFs, AEFs and BD are explored and grouped. Accordingly, also personal narrative with practical experience in exhibition design is embedded into the second segment. The improved approach is depicted in Figure 3.22.

In this identification, a combined support tools were used to analyze (with NVivo 11.0), manage (with EndNote X8), and read (with Adobe Acrobat XI) the qualitative data. Together, these tools enact the multi-approachs and creat an activity system for coding initial nodes and/or detecting the presence of relevant EDFs, AEFs, and BD from the literature, in the data. This study embedded qualitative analysis software packages and database management programs into review approach to collect, capture, code, and analyze the literature within one controlled and limited scope. It services researcher to conduct a scientific research with a large amount of qualitative database (Bazeley and Jackson 2013, Edhlund and McDougall 2016). However, the application of the supporting tools requires researchers to invest their hours for the software knowledge trained before the formal study, in comparison to traditional methods (Denzin and Lincoln 1994, Woods, Paulus et al. 2015).

3.5.2 Procedure for identifying EDFs, AEFs, and BD

In line with the above approach, an in-depth description is progressed in the following. It is based on the '*systematic, tool-supported method*' (Bandara et al., 2011, p.1) and grounded theory (GT). Identifying analysis in this thesis is a marriage of two methods. The procedure includes six main steps (shown in Figure 3.22):

0. ***Defining research question:*** This step serves the goal of confirming study scope by defining what is the answered questions. The basic research question is targeted on '*What are the EDFs and AEFs perceived by audiences and used by designers and clients in exhibitions?*' It is defined through the approach of focus group and literature review. The focused group meetings were conducted during September to November inviting four scholars and designers from UK, Itay, and China.
1. ***Data extraction:*** Initial data is extracted from relevant databases (Google Scholar, Baidu Scholar, Microsoft Academic, Scopus, ACM Digital Library, IEEE Xplore, ScienceDriect, Web of Science, Wiley Online Library,

Springer Link, SAGE Jourals, CNKI, and NDLTD). It then moved to EndNote Library for literature management and initial analysis, which will divide the collected data into primary papers and secondary papers[25].

2. ***Preparing for analysis:*** Two matters are conducted in this phase: '*what to capture*', and '*how to capture things effectively*' (Bandara et al., 2011, p.7). The capture work follows '*a proposed high level pre-codification scheme for IS literature reviews*' [26] (Bandara et al., 2011, p.7). All data are transformed from EndNote to NVivo. During the preparing stage, NVivo 11.0 is used as pre-coding and analysis tool.
3. ***Actual coding:*** It codes all relevant data for answering the research question. Initial main themes related to the research question are created to reflect the data structure. Each theme includes coded key nodes and child nodes (Edhlund and McDougall 2016). Also during the coding stage, data is revised, and coded literature and nodes with the relationships can be analyzed by querying functions. The qualitative software was used accordingly for reorganizing, revising and analyzing data (Bazeley and Jackson 2013).
4. ***Analyzing and presenting the results:*** Through constant comparative method and memo-writing (Charmaz 2014), factors can be identified from detected literature and coded nodes in an iterative process. While reaching a '*theoretical saturation*' with '*the core category and subsidiary categories, sub-cagegories and their properties*' (Birks & Mills, 2015, p.19) , the identification results of EDFs, AEFs and BD can be presented in combination with nodes and their sub-nodes. MS Excel is used to statistical correlation data in this step.
5. ***Answering research questions and agenda:*** According to the research question and scope, final factors are constructed through the group method. Each EDF, AEF and BD are supported by three relevant key literature and personal narrative, which is detected from NVivo in systematic and comparative analysis.

3.5.3 Results and analysis

59 exhibition design factors (EDFs) ,18 audience experience factors (AEFs) , and 14 behavior data (BD) were explored in line with the scientific approach (shown in Figure 3.23, 3.24, 3.25). Each EDF, AEF and BD are accordingly described with meanings by personal narrative, based on (a) series of practical design projects

[25] Bandara Miskon et al. (2011) defines primary papers as '*papers that focus on topic',* and secondary paper as '*papers that do not dedicate to the topic but discusses the topic indirectly in the full text*'.

[26] The scheme includes definitions, objectives, characteristics, historical analysis, reported success factors, reported issues/failure factors, research methods, theories, future-work, and contexts of reported studies (Bandara Miskon et al. 2011).

from February to June 2016 along with a large amount of primary data (e.g. project documents, drawings and meetings in a local exhibition design company); (b) Two teaching courses of exhibition design in a local university (commercial exhibition design,code and exhibition prop design, code,); (c) Around nigh years experience of exhibition design and teaching relevant. Furthermore, three supported references were embedded into the diagram. These services as a given context for understanding EDFs, AEFs, and BD in depth.

The qualitative analysis software NVivo was used for extracting, coding and analyzing the data, which enabled the massive body of data manageable. NVivo also served to present the original data with visual means (Appendix I NVivo example '*exhibition design factors*').

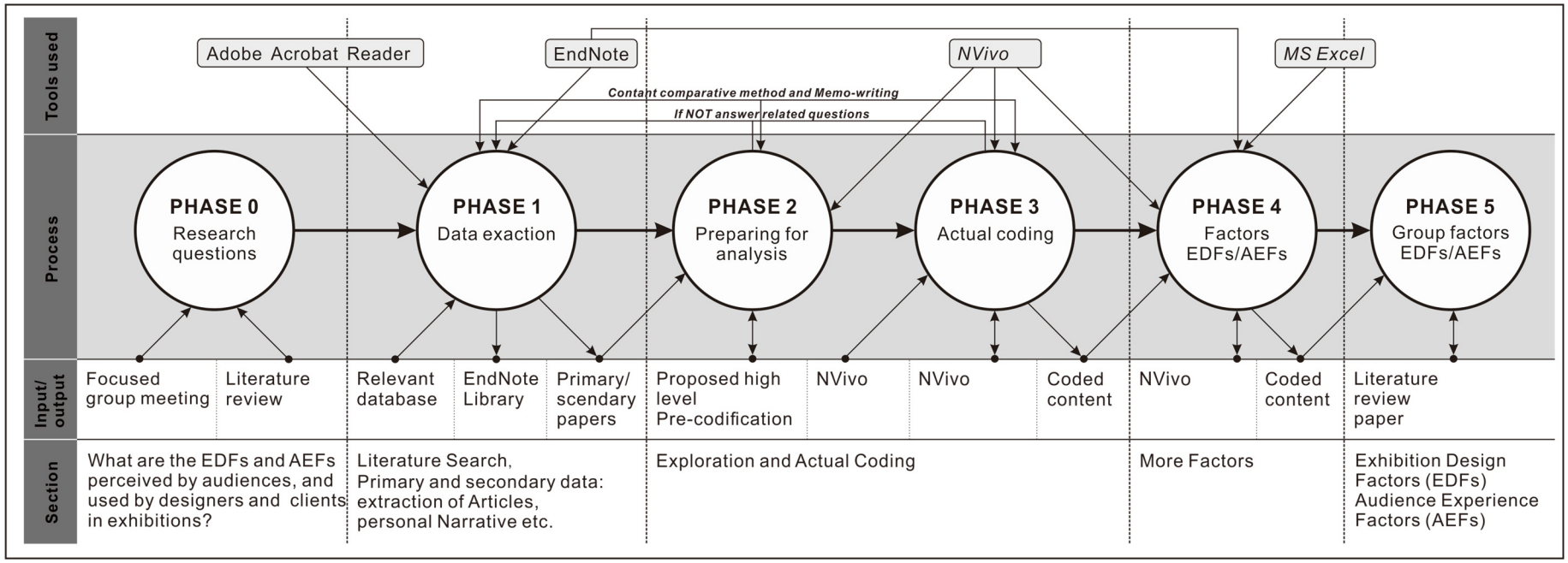


Figure 3.22. Research approach for identifying EDFs and AEFs (modified from Bandara et al., 2011).

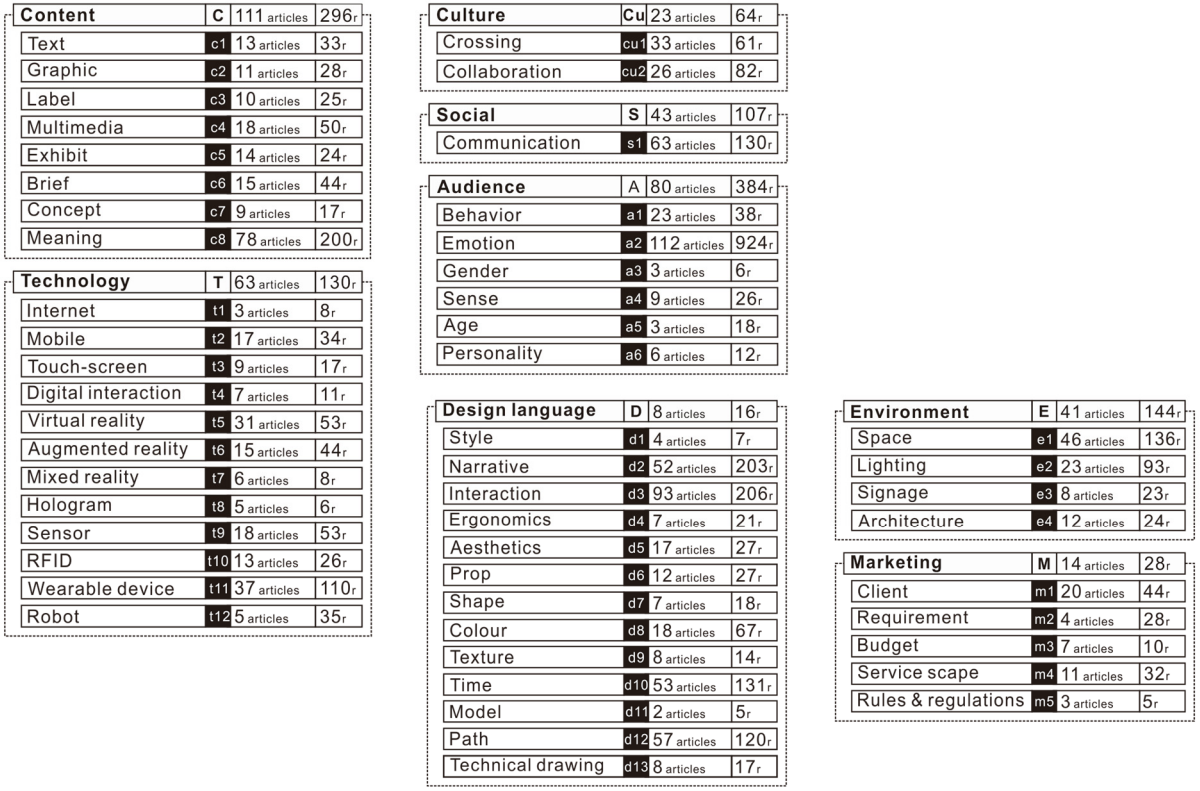


Figure 3.23. Exhibition design factors.
Note: As an example, the 'content' was coded as 'C', with 111 supported articles and 296 references in all. It is recorded and reviewed in the software NVivo. Also, NVivo services to progress the data collection, analysis and management.

Posture	P	4 articles	6_r
Eey-tracking	p1	37 articles	115_r
Face-tracking	p2	22 articles	102_r
Speech-tracking	p3	5 articles	12_r
Gesture-tracking	p4	7 articles	12_r
Movement-tracking	p5	33 articles	117_r

Physiological index	Pi	28 articles	213_r
ECG	pi1	2 articles	11_r
EMG	pi2	14 articles	41_r
PPG	pi3	0 articles	0_r
RESP	pi4	0 articles	0_r
PPG	pi5	0 articles	0_r
SKT	pi6	7 articles	22_r
EDA	pi7	0 articles	0_r
BP	pi8	2 articles	3_r
OS	pi9	1 articles	1_r

Figure 3.25. Behaviour data.

Pre-experience	Pr		
Motivation	pr1	16 articles	66_r
Attention	pr2	26 articles	131_r
Curiosity	pr3	9 articles	10_r
Interesting	pr4	4 articles	24_r
Cool	pr5	1 articles	1_r
Learning	pr6	37 articles	95_r

During-experience	Du		
Participation	du1	16 articles	31_r
Engagement	du2	37 articles	73_r
Authenticity	du3	1 articles	2_r
Creativity	du4	4 articles	6_r
Service	du5	14 articles	26_r
Leisure	du6	4 articles	8_r
Fun	du7	6 articles	13_r
Emotional	du8	112 articles	924_r

Post-experience	Po		
Understanding	po1	3 articles	22_r
Satisfaction	po2	12 articles	20_r
Reflection	po3	9 articles	10_r
Memory	po4	10 articles	36_r

Figure 3.24. Audience experience factors.

3.5.4 Discussion

Exploring the exhibition-design-factors study, such as included factors of atmospheric, layout, colour, lighting, and social (as described in Table 3.20), is a typical need for communication as '*language*' (Bayer, 1961, p.257) to '*tell a story*' (Berger et al., 2007, p.104), in terms of exhibition design. Exemplary statements are to '*all the elements suited to the purpose of communicating the idea are included in it*' (Bayer, 1939, p.17), that '*the elements of communication and display must be incorporated and integrated into scheme*' (Bayer, 1961, p.257) or is '*each shape, form, or space conveys a particular message about the exhibition or display*' (Bogle, 2013, p.293). Therefore EDFs should be designed to '*explain more complicated information*' (Ciamarra, 2013, p.86). It is due to all of those EDFs will have an impact on physical response, which may directly influence '*whether or not stay in and enjoy a particular environment*' (Bitner, 1992, p.64).

Exhibition design factors (EDFs) have an influential role to play in audience experience, emotion and their behaviour (Patterson, Bitgood et al. 1988, Falk 1993, Schmitt 2000, Legrenzi and Troilo 2005, Falk and Dierking 2012, McKenna-Cress and Kamien 2013, Forrest 2015, Guler 2015); moreover, it can be used by designers, seen by audiences and clients in a visual way, based on the purpose of communication (Dernie 2006). In addition, Falk and Dierking (2012) mentioned a '*Multi-Factor Study'* (p.209), a two US National Science Foundation (NSF) funded projects with 217 audiences, the results of which presented *'how the complex communications of factors influenced visitor leaning'* (p.209). Therefore, EDFs can be considered as the essence of communication through designing exhibition to the narrative and story-telling (Dean 2002, Chuan, Kun et al. 2006, Locker 2011, Topp 2011), and '*key objectives can be translated into a three-dimensional experience*' (Hughes, 2010, p.37). It is the meaning of studying EDFs in the field of exhibition design.

However, studies lacking systematic and combined analysis of these factors are likely to be an issue in the developing exhibition design network (Macdonald 2007). As Bayer (1961) pointed out, '*the combined means of visual communication constitutes a remarkable complexity'* (p.258), and thus '*in exhibition design, balance is usually considered to be a harmonious or satisfying arrangement of shapes and spaces*' (Bogle, 2013, p.317).

Table 3.20. Summary of reported EDFs.

	Reported exhibition design factors (EDFs)	Auther[reference], year, page
✙	Painting, photography, diagram, lettering, word, architecture, sculpture, tone, light, film, ground-plan, theme, movement, material.	Bayer (1939), pp.17-18, p.22, p.24
✛	Printing, sound, picture, painting, photograph, sculptural media, material and surface, colour, light, movement, film, diagram, and chart.	Bayer (1961), p.258
✙/✛	Object/animal factors (size, motion, novelty, other intrinsic qualities, sensory qualities, interactive elements, and triangulation), architectural factors (visibility, proximity, position of the exhibit object, realism, sensory competition, other design factors), visitor factors (demographic characteristics, special interests, object satiation, social influences, etc.).	Bitgood and Patterson (1987), pp.4-5
✙/✛	Exhibit design factors (size, motion, aesthetic factors, novelty or rarity, sensory factors, interactive factors, and triangulation), visitor factors (visitor participation, object satiation, special interests, demographic factors, other psychological factors), and architectural factors (visibility, proximity of animal/object, realism of exhibit area, and sensory competition).	Patterson and Bitgood (1988), pp.40-47
✙	Exhibit components [objects, communication media (label, diagram, video/movie, computer museum guide, etc.), text information (typeface, point size, word length, sentence length, etc.); exhibit configuration: spatial relationships, other types of relationships (size, colour, etc); extra-exhibit factors: social influences (family, adult, and school), physical influences (door, architectural style, window, ceiling, wall, floor, sight, sound, temperature, audio tour, map, etc)].	Bitgood (1992), pp.4-10
✛	Objective physical factors (lighting, color, signage, texture, material, style of furnishing, layout, wall décor, temperature, etc.), and servicescape.	Bitner (1992), p.65
✛	Atmospheric factors: ambient cuse (lighting and music), social cues.	Baker, Levy et al. (1992), p.445
✙/✛	Setting [location (accessibility, parking, visibility, centrality, clustering, appropriateness to the festival theme, cost of use/rental), site characteristics (infrastructure, support services, size/shape, aesthetics, capacity, acoustics/noise, ventilation/wind, surface texture), social-cultural context (heritage value, community significance, sysbolism), generic event settings (assembly, procession, open space, exhibition/sales, activities, concert hall)], management systems [the festival programme (rituals, celebration, grames, competitions, amusements, entertainment; art, spectacle, commerce, education, other sensory sitmulation), amenisties/services (comfor; seating, food and beverates, welcome and hospitality, temporary sevices, special needs), controls (ticketing, security/safety/risk management, traffic flow, environmental), design (decorations; costumes, theming, atmosphere), site planning (legility, design capacity)], and people [staff and volunteers (uniforms/designations, customer orientation, service quality), participants (performers, vendors, suppliers, sponsors), and audience (numbers, demographics, origins, expectations, behaviour)].	Getz and Cheyne (1997), p.159
✙	Content [types (theme, topic, specified), issues (research, accuracy)], Objects [types (object, document, photograph), users (plot point, expectation, preference), source (acquired, loaned), issues (conservation, microclimate, light, contact with humans, security, safety, bullet proofing)], Floor space [tools (central concept, wall, ceiling, floor, lighting), issues (fixed architectural elements, traffic pattern, ADA)], Media [types (label, video, sound effect, computer), issues (production cost, equipment, sound bleed)].	Carliner (1998), p.79
✛	Primary elements with five senses: color, shape, and typeface (for sight); loudness, pitch, and meter (for sound); material and texture (for touch), etc.	Schmitt (2000), p.97
✙	Value, color, texture, balance, line, and shape.	Dean (2002), p.46
✙	Storyline, design style, exhibits, diorama, graphic concinnity, graphic aesthetic, text readability.	Chen and Ho (2003), p.8
✙	Path, modules, lighting, visual communication, and interactive and multimedia tools.	Legrenzi and Troilo (2005), p.5
✙	Atmospheric, layout, design, social.	Bonn, Joseph-Mathews et al. (2007), pp.347-348
✛	Atmospheric factors (colour, design, lighting, and layout).	Ariffin, Bibon et al. (2012), p.380
✙	Media, sociality and space.	Macdonald (2007), p.149
✛	Atmospheric cues (product display features, colour, space, layout, lighting, sound, design features, comfort features, employees, and crowding).	Parsons, Ballantine et al. (2010), pp.644-645
✙	Text, artifacts, interaction, images, materials and content.	Topp (2011), p.31, p.67
✙	Lighting, spaciousness, orderliness, style, color strings, texture settings, texture settings, and exhibition proportions.	Fang, Wu et al. (2012), p.178
✛	Environment component [ambient factors (air quality, noisy, scent, cleanliness), design factors (aesthetic like architecture colour style, material, scale shape, texture, pattern, and Functional like layout, comfort, signage, accessories), social factors (audience like number, appearance, behaviour, and service personnel like number, appearance, behaviour)].	Bohl (2012), p.6
✛	Colour, shape, material.	Zi-qi (2012), p.25
✙/✛	Space, audience, and message.	Wang (2012), p.6
✙/✛	Space, colour, material, lighting, etc.	Hu (2012), p.119
✙	Shape, form, space, color and value, density, form, shape, and texture.	Bogle (2013), p.293, p.317
✙	Exhibits, didactic and graphic panels, furniture, technical equipment, multimedia products, audio-vido, etc.	Ciamarra (2013), p.86
✙	Amospherics, and servicescape [external variables (architectural style, exterior decoration and signage, setting of museum, positioning of entrance), general interior variables (color, lighting, flooring, material, visitor, comfor), layout and design (space, program, catering, retail, visitor flow, location of tickeing), point of purchase and decoration (exhibits, dispalys, images, signage, labers), human variables (staff, interaction with other visitor, crowding)].	Forrest (2013), p.206
✙	Orientation and navigation, spaciousness and display density, design and display style, lighting, colour,	Forrest (2015), p.126
✛	Emotional design (signboard design, product package, surroundings, music, illumination, spaciousness, design style of exhibition, product information display), brand trust (brand perception and image, product, staff), convenience (location, product variety, after-sales service), user relations (service speed, promotional activities, contributions to community, brand value), action experience (product appearance, functional test available).	Lin and Cheng (2015), p.70

✙ Indicates the cultural exhibition.

✛ Indicates the commercial exhibitoin.

In the field of exhibition design, AEFs were used to the evaluation and understanding for their experience during viewing exhibitions (shown in Table 3.21). For instance, Philips Research conducted a X-factors project aiming to gain the main factors that determined user experience in view of marketing (Westerink, Ouwerkerk et al. 2007). They developed experience measurement tools through exploring the x-factors. Another example can be seen from the book *Customer Experience: How Emotions Drive Value*, which compiled the factors pro-, during and post-customer experience by constructing models (with emotion, experience) that served a business to assess customer experience (Shaw 2007). Audience experience has received attention from institutes and clients due to their key role in decision-making and communication (shown in Section 3.2.1). Exhibition, however, is '*nonlinear experience*' (Falk, 1993, p.134) that cannot be compared with other communication mediums such as book or film. It is thus difficult to understand audience experience since '*they react and respond to a complex physical, social, and informational environment'* (Falk, 1993, p.137).

Meanwhile, note that for most audiences, viewing exhibition '*is just one of many experience in a day, week, and lifetime of experience*' (Falk & Dierking, 2012, p.17), and '*exhibitions are more than sensory experiences, they are also intellectual experiences*' (Falk & Dierking, 2000, p.128). In conclusion, the experience is deserved and felt by audiences, but '*still controlled by the exhibition designers*' (Greco, 2014, p.5). Audience experience thus is a '*fundamental factor for making design decisions*' (Hou, 2015, p.12) in terms of exhibition design.

Table 3.21. Summary of reported AEFs.

	Reported audience experience factors (AEFs)	Auther[reference], year, page
✙	Excitement (thrill, adventure, fantasy, immersive experience), amusement (fun, play, pleasure, laughter, sociability, diversion), contemplation (musing, meditation, reverie, reflection, aesthetic experience), learning (curiosity and discovery, observation, pattern discernment, instruction, skill-building practice, experimentation); mesuem-going experiences (recreation, sociability, learning experience, aesthetic experience, celebrative experience, and issue-oriented experience).	Kolter and Kolter (1998), p.136, p.303
✛	Entertainment, educational, esthetic, escapist.	Pine and Gilmore (1999), p.30
✛	Comfort, punctuality, caring, and enjoyable.	Shaw (2004), p.158
✙	Poetic aspect, aesthetic aspect, narrative aspect, authentic aspect, social aspect, imitation aspect.	Chuan, Kun et al. (2006), p.12
✙	Pre-visit (social background, entrance narrative, expectations, state of mind, servicescape, attributes of physical environment, iconological competence, and mood level), visit (experiences, satisfying experiences, pleasure, (dis) confirmation, aesthetic/flow experiences), post-visit (learning, satisfaction, psychological well-being, and autotelic reward).	Volker and Martin (2012), p.447
✛	Seductive (impulse buying), interactive museum (exploration), social arena (socialising), and functional (planned purchase).	Gilboa and Vilnai-Yavetz (2013), p.245
✛	General aspects (subjectivity, specificity of time and context, interaction, multiple communication channels, spread over period of time, dynamism, holism), and particular aspects (intention, theme and consistency, experience realms, senses, values, emotion, hedonic and utilitarian aspects, involvement of customers at different levels, immersion, engagement of customers, and memorability).	Petermans, Janssens et al. (2013), pp10-14
✙	Arousal, flow, control, boredom, relaxation, apathy, worry, anxiety.	Csikszentmihalyi (2014), p.75
✙	Attention, fascination, aesthetic appreciation, peacefulness, autonomy, togetherness, personal growth, reflective engagement, connection, compassion, privilege, excitement, spiritual engagement, physical activity and tension.	Forrest (2015), p.166
✙	Contemplative experience, enthusing experience, social experience.	Kirchberg and Tröndle (2015),p.174
✙	Attention, fascination, aesthetic, together, excitement, privilege, compassion, connection, reflective engagement, peacefulness, personal growth, autonomy, spiritual engagement, physical activity, tension.	Forrest (2015), p.198
✙/✛	Attention, fascination, aesthetic appreciation, togetherness, excitement, privilege, compassion, connection, reflective engagement, peacefulness, personal growth, autonomy, spiritual engagement, physical activity, and tension.	Nesbitt and Maldonado (2016), p.66

✙ Indicates the cultural exhibition.
✛ Indicates the commercial exhibitoin.

3.6 Theoretical framework for HEI

This section develops the framework HEI (human-exhibition interaction), discusses the performance evaluation, and highlights the novel parts in this study. The related main concepts have been reviewed, and the study results have been presented to service the reader in understanding the transformation of audience experience to design enjoyable exhibition.

3.6.1 HEI: designing exhibition with EDFs, AEFs, and BD

There are a vast variety of literature related to interaction between human and environment/system. When transforming to the exhibition, research gaps can be difficult to bridge due to the complexity of exhibition design that involves three stakeholders (clients, designers, and audiences) at least, '*as the performance of multi-disciplinary design tasks*' (Lin 2002). Besides design research, interests in this field typically include ambient intelligence; building information modelling (BIM); game study; human-computer interaction (HCI); Urban HCI; computer-aided design (CAD); computer science; ergonomics and human factors; health management; Kansei engineering; as well as intelligence science & technology (IST). This thematic cluster developed into the coherent body of the diverse of interactions that related to HMI (human-machine interaction) (Calvosa and Visconti 2008, Pelachaud 2013), BMI (body-mind interaction) (Picard 2000, Trappl 2002), CEI (consumer-environment interaction) (Massara and Pelloso 2006, Massara, Liu et al. 2010), HHI (human-human interaction) (Picard 2000, He and Han 2006), HRI (human-robot interaction) (Goodrich and Schultz 2007, Murphy, Nomura et al. 2010), and HTI (human-technology interaction) (Mahlke and Minge 2008, Szalma 2014).

Miles and Alt (1988) and Bitgood (1992) have discussed the communicative interaction between exhibitions and audiences in the area of exhibition design study. Afterwards there were many important contributions in understanding how exhibition influenced audience responses with experience, emotion, and behaviour. In particular, Bitgood (2006) assumed that both exhibition factors and audiences should be considered together based on their interactive connections among audience perception and cognition, attention, behaviour, and exhibition design, etc. To this day, some new HEI frameworks have been developed on exhibition design that involve different exhibition contexts, including service organizations (Bitner 1992), retail environments (Massara, Liu et al. 2010), Internet and e-commerce (Stafford, Stafford et al. 2004), science and culture exhibitions (Snibbe and Raffle 2009), museums for learning (Vavoula, Sharples et al. 2009), external events (Deckers, Levy et al. 2012), shops and malls (Gilboa and Vilnai-Yavetz 2013), virtually and physically museum exhibitions (Lischke 2014). Furthermore, Roppola (2013) highlighted the role of understanding the relationship

between audiences and exhibitions. He summarized and interrelated findings from the papers in terms of HEI from 1980 to 2000, and then constructing a HEI model with terms of framing, resonating, channelling and broadening.

Consequently, there are three characterises of HEI can be extracted from these studies. The first characteristic is ***the correlations between exhibition factors and audience responses*** that include at least three elements: Experience, emotion, and behaviour. For example, in addition to the model embedded with exhibition factors, experience, emotion, and behaviour (Massara, Liu et al. 2010), it was reported that '*there is a relationship between exhibition environment, emotions behaviors that follow, and satisfaction*' (Legrenzi & Troilo, 2005, p.4), and within exhibitions audiences '*interact with exhibits, environments and each other to produce affective, cognitive and behavioural outcomes*' (Forrest, 2015, p.63). The second characteristic of HEI is ***the technology impact*** that enables the direct interaction and communication between exhibitions and audiences to be achieved in a wide variety of methods. Studies combined exhibition construction and new technologies for enhancing more positive audience experience (vom Lehn, Hindmarsh et al. 2007). It covers the latest technologies at present (eg. virtual reality, augmented reality, mixed reality, muliti-touch system, wearable equipment, and sensors, etc.), and also has provided a number of significant contributions to developing interactive projects in exhibitions. The third characteristic is ***the narrative/storytelling*** that services to immerse audiences for better long-term memories than general exhibition types. Related examples are the technological and interactive constructions of exhibitions with narrative medias or systems (Blythe, Overbeeke et al. 2004, Cavazza, Charles et al. 2004, Cavazza, Lugrin et al. 2007, Snibbe and Raffle 2009, Pujol, Roussou et al. 2012, Ali 2014).

Existing studies imply a focus on attention of HEI applications especially towards the interactive projects and exhibition guider. For instance, a UK collaborative study presented a '*mixed reality system*' (Brown, MacColl et al. 2003, p.1) that helped audiences to view web, virtual reality and physical exhibitions in real time. It is called '*hybrid exhibits*' (B. Brown et al., 2003, p.3) that allowed to enhance the social experience with collaborating ways in view of audiences. A design research program '*Switch*', funded by the Swedish Energy Agency, applied interactive technologies to present exhibition installations that showed how human life is influenced and promoted by interaction and product design (Mazé and Redström 2008). In 2012, the CHESS project (Cultural Heritage Experiences through Socio-personal Interaction and Storytelling) implemented an interactive, narrative, and technological exhibitions that enabled audiences to enhance their experience (Pujol, Roussou et al. 2012). Additionally, an electronic guidebook (Woodruff, Aoki et al. 2002), a portable interactive guide (Hope, Nakamura et al. 2009), and the

official electronic exhibition guide (Bieber and Giersich 2001) were described as examples of HEI application.

HEI had been constructed and reconstructed over the years. It had become as a matter of course how the exhibition was designed for communication. For example, Seagram, Patten et al. (1993) indicated that the nature of the relationship between exhibitions and audiences should be the heart of designing more '*successful, cost- effective exhibits*' (p.34). However, there also are research gaps in HEI as an emerging '*new*' development. It might involve two aspects. One is there is '*a lack of shared knowledge, concepts and vocabulary among exhibition designers, museologists and visitor researchers*' (Forrest, 2015, p.4); another is that it is necessary to build a systematic framework based on the view of three stakeholders: clients, designers and audiences (Lin 2002, Hughes 2010). This is because the previous HEI studies only focused on the interaction between clients and exhibitions, designers and exhibitions, or audiences and exhibitions separately, rather than jointly and collaboratively.

Communication through exhibition design

Discussions on '*Exhibition as medium of communication*' have been presented in Section 2.3.2, as an embedding nature. As Chiozzi and Andreotti (2001) said in the Milan Natrual History Museum project, the most important factor influencing audiences in exhibitions is '*the communication technique used in the exhibition areas*' (p.153). This drives exhibition design to consider HEI as a taken-for-granted way of how to service audiences and clients more effectively. Although communication progress in exhibitions is complex (Kolter and Kolter 1998), it is clear that '*communication is the transmission of a message from a sender to a receiver via a medium (or channel) of transmission*' (Schiffman et al., 2013, p.185). It means that at least *three stakeholders* (sender=client, transmitter=designer, receiver=audience), *one medium* (exhibition), *feedback loop* (feedback=evaluation), *message* should be enclosed in the communication progress (Rodgers and Thorson 2012, Schiffman, O'Cass et al. 2013, Solomon 2014), though exhibition as the mass communication from the few to the majority (Li 2005, Forrest 2015, Kim and Lee 2016) as shown in Figure 3.26.

- ***Client (sender)***

  Exhibition **messages** are generated and shaped by the clients such as curator, government, exhibition institution, or company/enterprise (Lin 2002, Hughes 2010, Locker 2011, Bogle 2013, McKenna-Cress and Kamien 2013). Before an audience involved in exhibition design, clients decided the entire design progress with full authority including plan, select, change, and control an exhibition design project (Bitner 1992, Chuan, Kun et al. 2006, Hou 2015). And different with other design projects such as product design, clients are normally

embedded into the presentation and conduction of the design project (Carliner 2003, Lin 2009). Accordingly, the traditional role of the clients has transformed to communication with the audiences by telling stories (Chuan, Kun et al. 2006, Hughes 2010, Suzanne, Hourston et al. 2012). A doctoral research at the Flordia State University summarized three roles of client: Geographer, connector, and archivist (Rowson Love 2013). It is essential for clients to understand how audiences '*perceive the message that exhibitions are communicating*' (Hou, 2015, p.16). However, it is notable that the sender/client may neglect the feedback from the audience in the whole communication progress (Kolter and Kolter 1998).

- ***Designer (transmitter)***

'*Exhibition designers work in multidisciplinary teams with their clients to help them tell their stories to their desired audience'* (Berger et al., 2007, p.8). Indeed, it is aimed at improving and intensifying communication, due to the human being '*exposed today to a never-ending attack of influences, messages, and impressions*' (Bayer, 1961, p.257). As transmitter, exhibition designers are responsible to '*articulate the intended messages*' (Dernie, 2006, p.6), encode the messages (Shannon and Weaver 2015), transmit ideas through a medium/exhition (Umiker-Sebeok 1994), and transform messages/knowledge '*tangible and accessible*' (Schwarz, Bertron, & Frey, 2005, p.23), by using design language such as drawings, modes, digital animations, storytelling, scriptwriting, graphic design, interactive design, product specification (Carliner 1998, Crimm, Morris et al. 2009, Hughes 2010, Suzanne, Hourston et al. 2012, Bogle 2013) and skills in '*writing, management and interpretation*' (Dean, 2002, p.2). Designers have to bridge the gaps between curator/sender and audience/receiver with **meaning-making** (Chuan, Kun et al. 2006). It calls for coding and modelling communication in exhibition design, to '*delivery environments that are accessible, educational and enjoyable*' (Locker, 2011, p.33). As with client/sender, however, the feedback role in the communication process is insufficient for designer/transimitter to some extent in practical projects.

- ***Audience (Receiver)***

Rather than the encode function of the transmitter, that of the receiver/audience is to decode the messages (Shannon and Weaver 2015). Respect for audiences and design for audiences has been central to exhibition design and this thesis research (shown in Section 2.4). It is also the reason why designers and clients are required to understand the physical, emotional and experiential aspects of a wide variety of audiences (Locker 2011, Lu 2011, Hou 2015), in addition to exhibition design factors (Bitgood 1992). Accordingly, audiences are '*one of the critical succesful factors of an exhibition*' (Hou, 2015, p.6). The term

Meme[27] is used to illustrate how an exhibition transforms audiences into the direct and powerful communicators and replicators spreading encoded messages to more people (Chuan, Kun et al. 2006). It is extensively applied in the field of commercial activities, and examples include the advertising of Coca-Cola slogans, and various commercial television programs (Brodie 2009). In the science area, memetics (meme) can be regarded as the DNA of human society, which is based on Darvin's evolution theory of species by natural selection (Brodie 2009, Crouch 2013). In addition, the **enjoyment** performs an evaluation role in exhibition design, illustrated in Section 3.3.3.

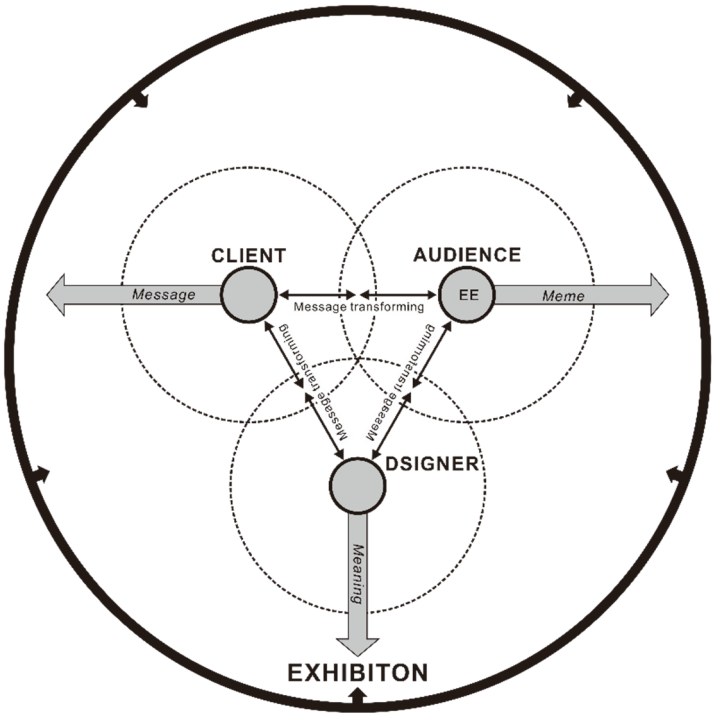


Figure 3.26. Basic framework of communication process in exhibition design.
(Note: 'EE' means 'enjoyment emotion' in the graphic of the basic framework)

- ***Message-transforming***

Message-transforming is the '*encoded*' (p.61) nature of exhibition communication progress (Forrest 2015). It is also one essential factor in the communication process (Kolter and Kolter 1998, Rodgers and Thorson 2012). In addition to the looping message-tranforming among clients, designers and audiences, effective communication also requires the participation of audience feelings including their emotion and experience (Falk and Dierking 2012, Chen, Chen et al. 2013). Also Picard and Blocher (1999) mentioned that like language using words and grammar, behaviour data such as eye contact, gesture were a kind of meesage-transforming as well. This thesis particularly focuses on the

[27] The word was coined in 1976 along with the postulated gene analogue (Blackmore, 2000). It is defined in the Oxford Advanced Learner's Dictionary as '*an idea that is passed from one member of society to another, not in the genes but often by people copying it*'.

behaviour data (Section 3.4) and enjoyment emotion (Section 3.3) with their evaluation role in designing exhibitions.

- ***Interaction through feedback, evaluation and communication***

Communication process among clients, designers and clients is looped. It can be considered '*interaction*' if all relevant factors have been included into the relationship between human and exhibition Figure 3.27. The in-depth descriptions of the interaction were discussed in many studies in the past (Cone and Kendall 1978, Borchers 2001, Vom Lehn, Heath et al. 2001, Macleod 2005, Carù and Cova 2007, Sager 2008, Barriault and Pearson 2010, Hughes 2010, Locker 2011, Falk and Dierking 2012, McKenna-Cress and Kamien 2013, Roppola 2013, Collins 2014, Wasserman, Hayde et al. 2015). So is indicated that '*for many designers, interaction is the key to a good exhibition*' (Hughes, 2010, p.85), and '*designing the interaction was the most difficult components of the process*' (Macleod et al., 2012, p.175) . It thus calls for interaction for motivating audiences (Lischke 2014).

Based on communication theory (Baran and Davis 1987, West and Turner 2006) and the instigating model of exhibition design (Chuan, Kun et al. 2006), there are three levels for achieving interaction in exhibitions: *Feedback, evaluation, and communication*.

Feedback: It is one of the basic components in the loops of communication process (Baran and Davis 1987, West and Turner 2006, McQuail 2010, Griffin and McClish 2011). One main reason is feedback can alert the sender/client and transmitter/designer as to whether the encoded messages through medium/exhibition were received actually by receiver/audience (Schiffman, O'Cass et al. 2013). This tends to help designers and clients to improve or enhance better exhibition design (Whittle 1997, Lin 2002).

Evaluation: Whittle (1997) proposed that the exhibition designer could adopt feedback from evaluation to modify the message-transforming in the design process. Evaluation has been highlighted in the study of exhibition design (Lin 2002, Chuan, Kun et al. 2006), but neglected in practical projects due to its theoretical gap and input costs (Bellizzi and Lipps 1984). In terms of exhibition design, evaluation is normally used as an assessment tool for exhibition (Dean 2002, Berger, Lorenc et al. 2007, Barriault and Pearson 2010, Bitgood 2011, Bogle 2013).

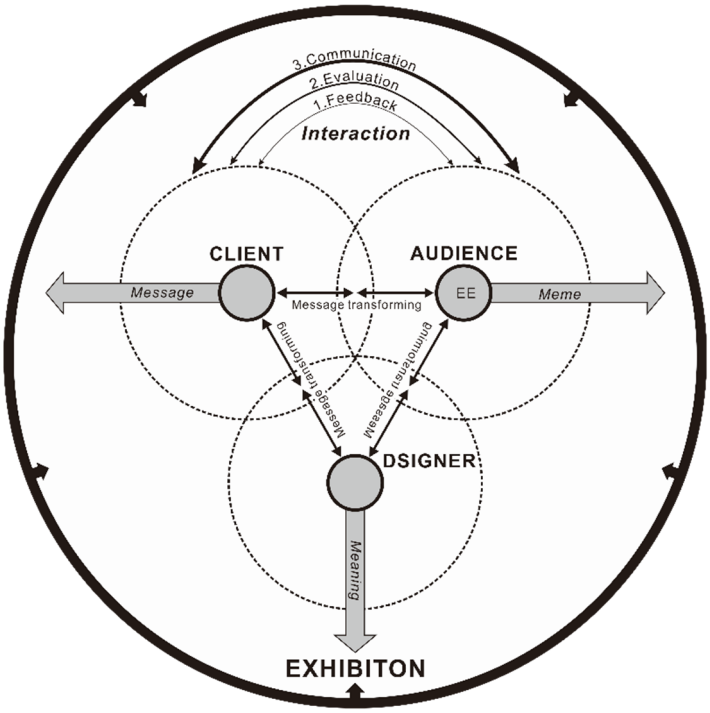


Figure 3.27. Expanded framework of human-exhibition interaction (HEI) as a communication process.

Communication: The complete communication is constructed through the feedback and evaluation among clients, designers, audiences, and exhibitions. Communicative interaction frames HEI (human-exhibition interaction). Meanwhile, feedback and evaluation can be used to assess the effectiveness of communications (Cunningham and White 1974, Chen and Ho 2003). It includes explicit communication (e.g. themed exhibitions) and implicit communication (e.g. art installations) for exhibition design (Bitner 1992, Locker 2011). In many cases explicit communication is delivered by designers and driven by clients, to create an exhibition environment that '*convey messages that can be understood by and an audience*' (Locker, 2011, p.30) .

Interaction with EDFs, AEFs, and BD

HEI (Figure 3.28) refers to interactive communication among exhibition design factors (EDFs), audience experience factors (AEFs), and behaviour data (BD). Previous studies have tried to discuss the triple interaction both in exhibition design and other study fields. For instance, Picard (2000), a prominent researcher in affective computing, pointed out that the emotion and behaviour/physilological signals were necessary for understanding, memory, and communication. This perspective lends the exhibition, computer, and machine to act as a communication channel for transforming human experience and emotional and connecting people. As such, this is related to data collaboration based on view of three stakeholders: clients, designers and audiences. Darwin's expression theory and Mehrabian & Russell' S-O-R (Stimulus-Organism-Response) model provide

the theoretical basis for HEI (Mehrabian and Russell 1974, Darwin, Ekman et al. 1998).

A clear and effective communication needs four steps for message-transforming and meaning-making: *Encoding, transmitting, decoding, and evaluating/feedback*. Particularly, noise in communication theory has an influence on the effectiveness of communication (Chuan, Kun et al. 2006). Along the line, EDFs as the noise of the communication process, that are used by designers or clients, can stimulate human emotion, experience and their behaviour directly in exhibition design.

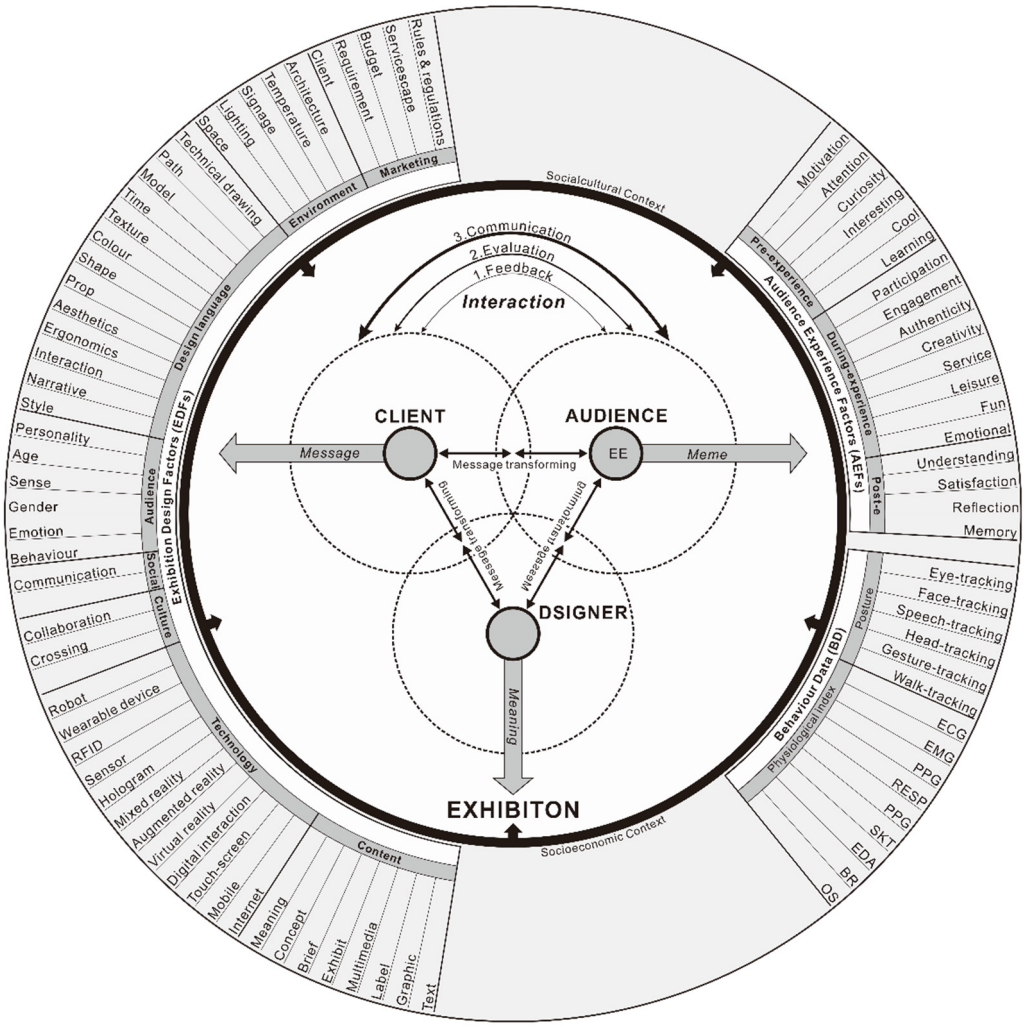


Figure 3.28. Framework for HEI (human-exhibition interaction) with EDFs, AEFs, and BD in exhibition design.

Context of social, culture, and economic

Falk and Dierking build a contextual model of learning for museum exhibition, which introduced the sociocultural context as the lens in particular (Falk and Dierking 2000, Falk and Dierking 2012). They argued that besides the personal and physical context, sociocultural provided insights into why, who, and what visit exhibitions. Moreover, audience experience is a '*continually shifting interaction among personal, sociocultural, and physical context*' (Falk & Dierking, 2012, p.26).

Also Falk and Dierking (2000) mentioned that economics drove a new transformation of exhibition under the experience economy proposed by Pine and Gilmore (1999). The book *Communication and Economic Theory: How to Deal with Rationality in a Communicational Environment* discussed the relationship between communication and economic context. It pointed out that such communication factors including '*meaning*', '*shared symbols*', '*cultural factors*' had existed in Douglass C. North's work presented in Nobel Prize (Priddat 2014).

According to this perspective, viewing exhibition continuously occurs within the social, culture and economic context. As a consequence, every audience experience, emotion, and behaviour is embedded within the macro sociocultural and socioeconomic context of the exhibition, and is mediated by micro sociocultural and socioeconomic interactions with other human involving three stakeholders (clients, designers, and audiences).

3.6.2 Discussion

Most of these studies have tried to understand the relationships among EDFs, AEFs, and BD for human-exhibition interaction (HEI); however, further in-depth research is needed to progress or confirm these interactive and dynamic relationships, by more quantized and combined (Bitgood and Patterson 1987, Chen and Ho 2003, Ng 2003, Macdonald 2007, Bitgood 2009, Choi 2010, Bitgood 2011, Petermans, Janssens et al. 2013, Cohen, Prayag et al. 2014). Due to the '*wide gap*' (Bitgood, 2009, p.109) and '*rare*' (Bitgood, 2011, p.70) situation in terms of exhibition design, *'today, the challenge for the exhibition design direction approach is to find a new grammar and syntax to synthesize the different communication modalities*' (Bollini and Borsotti, 2016, p.20). Companies in exhibition design have become aware that designing exhibition is not enough, but designing for experience and HEI is still considered as the next level of both economic-cultural competition. Exhibition design is no longer only about visual implementations and ergonomic applications, but about designing exhibitions that are enjoyable and support human basic needs and values involving three stakeholders (clients, designers, and audiences). Accordingly, audience experience (AE) should be a key concern of exhibition design and development.

There are many academic studies and practical projects for HEI (Section 3.6.1), but not an agreed one and combined framework. However, attempts to identify this criterion all focus on that it is an interactive communication between exhibition and human. In addition, they stressed the objective nature of audience: audience behaviour could be observed for evaluating and designing exhibitions (Porter 1938, Falk 1993, Lu 2011), and the subjective of audiences that their responses and feelings were affected by exhibition design factors (Falk and Dierking 2012, Forrest 2015). For practical aspect, the biggest problem generally is that '*they lack*

substantive quantitative research' (Herbig, 1994, p.167) for designing more effective exhibitions (Jung and Kwon 2011). Moreover, there are no comprehensive empirical research investigating audience experience with various behavior data particularly in the context of both commercial and cultural exhibitions (Tröndle, Wintzerith et al. 2012).

Based on Miles and Alt (1988), the illustrated study on HEI (human-exhibition interaction) can be summarized into a basic equation of the following type:

$$\left\{ \boldsymbol{A} \overset{r}{\longleftrightarrow} \boldsymbol{B} \overset{r\,(X_{ij}\,Y)}{\longleftrightarrow} C \overset{r\,(X_{ij}\,Y)}{\longleftrightarrow} \boldsymbol{D} \atop \overset{r}{\longleftrightarrow} E \overset{r}{\longleftrightarrow} \right\} \tag{1}$$

Where,

$\boldsymbol{A}$ is the sender;

$\boldsymbol{B}$ is the transmitter;

$\boldsymbol{C}$ is the medium;

$\boldsymbol{D}$ is the receiver;

$\boldsymbol{E}$ is the feedback/evaluation

$\boldsymbol{X_{ij}}$ is the factor/noise;

$\boldsymbol{Y}$ is the result/meaning;

$\boldsymbol{r}$ is the nature of message-transforming.

HEI (human-exhibition interaction) is a looped communication structure. From the sender ($\boldsymbol{A}$), a factor ($\boldsymbol{X_{ij}}$) used by the transmitter ($\boldsymbol{B}$) is transforming message ($\boldsymbol{r}$) with some results/meanings ($\boldsymbol{Y}$) to the receiver ($\boldsymbol{D}$). From receiver ($\boldsymbol{D}$), the feedback/noise ($\boldsymbol{E}$) transforms the message ($\boldsymbol{r}$) to the transmitter ($\boldsymbol{B}$) and sender ($\boldsymbol{A}$). Where X_{ij} is the number of factors by group *i*, with various stakeholders such as audiences, clients, designers, j under the sociocultural or socioeconomic context.

$$HEI = f(EDFs, AEFs, BD) \tag{2}$$

3.6.3 Conclusion

A great deal of study has built a model that tried to explain the communicative relationship between exhibition and human for exhibition design. Examples were '*a summary of the exhibit-visitor analysis'* (Bitgood 1992), '*a comprehensive model of exhibit communication*' (Whittle 1997), '*communication model of goal-oriented/free evaluations*' (Hooper-Greenhill 1999), '*museum exhibition communication model*' (Lin 2002), '*pyramid scheme of museum communication*' (Chen 2005), '*communication model of exhibition design process*' (Li 2005), '*the instigating model*' (Chuan, Kun et al. 2006), '*integrated marketing communication*' (Kotler and Armstrong 2010), '*design relevant model on designing for perceptual crossing between subject and artefact, including external event*' (Deckers, Levy et al. 2012),

'*analysis framework of exhibition content-audience experience*' (Lin, Ma et al. 2014), '*the elaboration likelihood model of persuasion*' (Solomon 2014), '*models of communication between all parts of the application*' (Lischke 2014). Interestingly, these studies paid their most attentions on the interactive relationships among clients (sender)-exhibitions (medium)-audiences (receiver), while omitting the meaning-making role of designer as '*transmitter*' and the influence of EDFs as '*noise*' for exhibition design. Instead, designer (transmitter) and EDFs (noise) are the communicative aspects of interaction-driven that should be embedded into exhibition design.

Despite increasing attention on HEI regarding EDFs, AEFs, and BD in exhibition development and study, there seem to be a lack of a clear introduction to human-exhibition interaction. In addition, quantitative research on HEI in exhibition contexts seems to be truly rare. As exhibition design is an emerging discipline, literature from various adjacent disciplines tends to be embedded into existing studies on exhibition environments and the human-exhibition relationship. To understand audience, we also have to understand the dynamics relationship. Furthermore, to understand the particular HEI model as a whole, it also needs to understand communicating, interacting, and looping as dynamics among three stakeholders: clients, designers, and audiences, connecting with EDFs, AEFs, and BD.

3.6.4 Performing evaluation in exhibition design

'*Exhibition serves both communications and selling activities of a marketing company*' (Cunningham & White, 1974, p.234). And '*unquestionably, good exhibition, film, and program design matters to the museum visitor*' (Falk, 2009, p.91). In general, the communication nature of exhibition design and HEI (human-exhibition interaction) determine the evaluation as an integrated and embedded part in exhibition design (Bitgood and Loomis 1993, Hooper-Greenhill 1999, Chiozzi and Andreotti 2001, Boehner, DePaula et al. 2005, Davies and Heath 2014). As a consequence, evaluation is vital in connecting, understanding, and communicating audiences for exhibition design as a communication progress (shown in Table 3.22). It has been recommended for clients as they consider audience-viewing outcomes '*measurable*' (Hughes, 2010, p.29) to help build '*better, more cost-effective*' (Falk & Dierking, 2000, p.203) exhibitions as '*decision-makers*' (Economou, 2004, p.40); for designers as they use evaluation and feedback to modify, improve, analysis and enhance their works as '*developing and evaluating tools*' (Berger et al., 2007; Bogle, 2013; Forrest, 2015; Hughes, 2010; Knez & WRIGHT, 1970; Locker, 2011); for audiences as they can have direct impact on designers through evaluation if particularly audiences '*have*

Table 3.22. Targets and measures/parameters for evaluating exhibitions.

	Targets of evaluation	Measures/parameters	Auther[reference], year
Positive measures	Exhibition audience	Experience	Chuan, Kun et al. (2006); Falk (2009); Barrass and Laws (2014)
		Behaviour	Porter (1938); Miles and Alt (1988); Falk (1993); Bitgood (1994); Devine-Wright and Breakwell (1997); Chiozzi and Andreotti (2001); Yalowitz and Bronnenkant (2009); La-or, Virach et al. (2012); Ichino, Isoda et al. (2013); Davies and Heath (2014)
		Audience response: cognition, behaviour, and subjective response	Ichino, Isoda et al. (2013)
		Positive response, negative response	Sands, Oppewal et al. (2015)
	Exhibition progress	Time/dwell time/utilization times	Bitgood, Pierce et al. (1987); Bitner (1990); Devine-Wright and Breakwell (1997); Hooper-Greenhill (1999); Chiozzi and Andreotti (2001); Yalowitz and Bronnenkant (2009; Hughes (2010); Bollo and Dal Pozzolo (2005); Pluchino, Garofalo et al. (2013); Forrest (2015)
		Display density	Liu (1996); Forrest (2015)
		Engagement/interaction (orientation, exploration, discovery, immersion)	Chiozzi and Andreotti (2001); Barriault and Pearson (2010); Clinckemaillie (2010)
		Exhibition design factors	Shettel (1968); Shettel (1968); Falk (1993); Hoffman and Turley (2002); Forrest (2015)
		Design installation process: internal communication, museum hierarchy, budgetary restrictions, and volunteers	Fuscaldo (2014)
	Exhibition effectiveness	Diligent visitor index (DVI)	Serrell (1997); Bollo and Dal Pozzolo (2005); Serrell (2010); Savoy (2014)
		Sweep rate index (SRI)	Serrell (1997); Bollo and Dal Pozzolo (2005); (Yalowitz and Bronnenkant 2009); Serrell (2010); Savoy (2014)
		Attendance	Cunningham and White (1974); Dean (2002); Carliner (2003)
		Information	Falk (1993)
		Visibility/viewabiligy/understandability/ dramatic appeal	Bitgood, Pierce et al. (1987)
		Viewing strategy (browser, follower, searcher, and researcher)	Chiozzi and Andreotti (2001)
		Attracting power (stopping)/holding power (stopping)/attention	Porter (1938); (Shettel 1968); Screven (1976); Miles and Alt (1988; Bitgood (1994); Sandifer (2003); Chen and Ho (2003); Bollo and Dal Pozzolo (2005); Hillier and Tzortzi (2006); Yalowitz and Bronnenkant (2009); Chiozzi and Andreotti (2001); Macdonald (2011); Falk and Dierking (2012); Lanir, Kuflik et al. (2013); Wu, Hu et al. (2013)
		Readability	Shettel (1968); McManus (1989); Hughes (2010); Locker (2011)
		Visibility	Rohloff (2009); Wineman and Peponis (2010); Lu (2011); Lu and Peponis (2014)
		Orientation /circulation/movement/flow	Devine-Wright and Breakwell (1997); Bitgood (2011); Gretchen, A et al. (2012); Savoy (2014)
		Narrativity	Hall and Bannon (2005); Abbott (2008); Suzanne, Hourston et al. (2012)
Negative measures	Audience response	Fatigue	Porter (1938); Davey (2005); Bitgood (2009); Bitgood (2009); Bitgood (2010); Falk and Dierking (2012); Forrest (2015)
		Sensory overload	McKenna-Cress and Kamien (2013)

expectations about the quality, accessibility, functionality and aesthetics of the designed environment' (Devine-Wright & Breakwell, 1997, p.1).

The view of evaluation has shifted from clients/designers, to audience-centered (Taxén 2005), and then to professional elevator. In particular, Miles and Alt (1988) developed a basic formula：

$E_1 \longrightarrow V_1 \longrightarrow R_1$

Where,

$\boldsymbol{E_1}$ is an exhibition;

$\boldsymbol{V_1}$ is an audience exposed to a real exhibition;

$\boldsymbol{R_1}$ is his/her reaction to the exhibition E_1 ;

$E_2 \longrightarrow V_2 \longrightarrow R_2 \longrightarrow INT. \longrightarrow EVAL. \longrightarrow R_3$

Where,

$\boldsymbol{E_2}$ and $\boldsymbol{R_2}$ are the reaction of V_2 to E_2 obtained by an interviewer, $INT.$.

Then,

The interviewer $INT.$ and the evaluator, $EVAL.$ Interpret R_2 and arrive at R_3 which they suppose is an estimate of R_1.

However, there may be a '*recurrent problem*' (Miles and Alt 1988, p.236) during the massage-transforming of exhibition communication progress regarding from mock-ups tested for real exhibitions in an experimental context. Although in current practical projects, designers and clients are responsible for the evaluation of exhibition design with the aims of time-effective, cost-effective, or better quality of design and development (Berger, Lorenc et al. 2007), professional evaluator is called to help '*evaluate future plans, present processed, and past achievements*' (Miles & Alt, 1988, p.218) . It is also proposed to other studies (Shettel 1968, Hooper-Greenhill 1999, Zhang 2009). Furthermore, along with the evolution of exhibition design (Section 2.4.1), the method of participatory design by collaboration among three stakeholders (clients, designers, and audiences) has been proposed for the more effective communication (Taxén 2004, Taxén 2005, Simon 2010, Radice 2014).

Evaluation/feedback is an essential aspect as an assessment tool in a variety fields such as product/industrial design, architecture design, ergonomic, and HCI. However, it cannot be defined simply as a mechanism that '*evaluates a state or event as good or bad*' (p.72), instead, it should be '*different in different contexts*' (Trappl, 2002, p.72). In addition to systematic assessment for decision-making (Screven 1976, Bitgood and Loomis 1993, Falk 1993, Economou 2004), exhibition design attempts to illustrate evaluation as a message-transforming of communication progress (Miles and Alt 1988, Whittle 1997, Hooper-Greenhill

1999, Lin 2002, Barry, Dexter et al. 2012, Bogle 2013), the enhancement of audience experience (Whittle 1997, Dean 2002, Chen and Ho 2003, Barriault and Pearson 2010, McKenna-Cress and Kamien 2013, Barrass and Laws 2014), the understating for audiences (Silverman 1999, Dean 2002, Boehner, DePaula et al. 2007, Hughes 2010), redesign (Falk 1993, Berger, Lorenc et al. 2007, Forrest 2015), serve to future exhibition, goal-setting and both product- and management-oriented (Hooper-Greenhill 1999, Dean 2002, Chuan, Kun et al. 2006, McKenna-Cress and Kamien 2013). The dimensions of exhibition with limited time and space (shown in Section 2.3.6) decide that **evaluation** is focused on a variety of categories for communication purpose. Examples include '*front-end evaluation, formative evaluation, and summative evaluation*' (Seagram, Patten et al. 1993, Hooper-Greenhill 1999, Dean 2002, Bollo and Dal Pozzolo 2005, Barry, Dexter et al. 2012, Serrell 2015), '*front-end, formative, remedial, and summative evaluation'* (Falk and Dierking 2000, Radice 2014), '*pre-evaluation, formative evaluation, and post-evaluation or summative evaluation*' (Berger, Lorenc et al. 2007), '*micro evaluation, meso evaluation, and macro evaluation*' (Vavoula, Sharples et al. 2009), '*front-end evaluation, formative evaluation, and summative evaluation*' (Bitgood 2011), and '*comprehensive evaluation, front-end evaluation, formative evaluation, and summative evaluation*' (Bogle 2013).

A key characteristic for evaluations to ensure effective communication in exhibition design is that they are relevant in all different main stages of the design projects (e.g. planning, preparation, and pre-, during and post-installation/construction) (Bitgood 2002, Bitgood 2011) and that they should employ different types of measures and techniques (Shettel 1968, Hillier and Tzortzi 2006, Barry, Dexter et al. 2012, Radice 2014). Three targets for exhibition evaluation were summarized as: Exhibition design factors, exhibition audience factors, and effectiveness factors (Shettel 1968); audience quality, audience activity, and exhibit effectiveness (Bellizzi and Lipps 1984); exhibition audience, exhibition process, and exhibition effectiveness (Dean 2002, Lin 2002). It is also accompanied by a series of measures/parameters, which are presented in Table 3.17. Accordingly, methods and tools for exhibition evaluation are outlined in Table 3.18 for references. Note that '*physiological or other behavioral and empirical measures*' (Boehner et al., 2007, p.287) have been developed in the field HCI, computer science and industrial/product design (Katsis, Ganiatsas et al. 2006, Boehner, DePaula et al. 2007, Liu 2014), but there is still a gap in terms of exhibition design in despite of some initial attempts in data collections with behaviour data (Tröndle and Tschacher 2012, Tröndle, Wintzerith et al. 2012, Tschacher, Greenwood et al. 2012).

In summary, similar with the role of '*usability*' in industrial/product design, experience design, ambient intelligence or HCI (Green and Jordan 2003, Norman

2004, Goodman, Kuniavsky et al. 2012, De Ruyter, Kameas et al. 2015, Panagopoulos, Kalatha et al. 2015), '*effectiveness*' plays the key position in evaluating exhibition design. For example, Bitgood (1994) stated three aspects of designing effective exhibition (p.4):

- The possible criteria for assessing the success of an exhibition;
- Common exhibition design approaches or strategies;
- The research and evaluation strategies used to gather information on exhibition effectiveness.

In the essentiality view, the measure nature of effectiveness is not the audiences, clients, designers or exhibitions themselves but its effectiveness of message-transforming regarding information and communication whether for commercial exhibition or cultural exhibition (Cunningham and White 1974, Hooper-Greenhill 1999). It is related to exhibition design factors (EDFs), audience experience factors (AEFs), behavior data (BD) (Shettel 1968, Economou 2004, Bitgood 2010, Coble, Smaldone et al. 2010, Bitgood 2011, Locker 2011, Falk and Dierking 2012, Forrest 2015). Emotion also plays a divisive role in evaluation systems (Trappl 2002, Khalid and Helander 2006, Lidman and Renström 2011). For instance, Boehner, DePaula et al. (2007) in the area of HCI indicated an interactional model based on '*a notion of emotion as transferable, communicable units*' (p.287). Within the model, the evaluator should create the emotion, and use observable phenomena for making measurable and accountable emotion as a good evaluation method. It is mentioned in the field of exhibition design as well but no in-depth studies for further exploratory (Holbrook and O'Shaughnessy 1984, Dean 2002). The evaluating role of enjoyment emotion (EE) has been discussed in Section 2.6. From the perspective, the term '*enjoyability*' as one index is presented (Bartneck 2002, Westerink, Ouwerkerk et al. 2007), as the attention for mass communication tends to be enjoyment with game rather only message-transforming itself with work (Stephenson 1964, Li 2005, Zong 2014). *Measurement of effectiveness can be both qualitative and quantitative*' (Crimm et al., 2009, p.23). The previous evaluation methods and tools have been summarized and outlined in Table 3.23. Data-driven evaluation thus tends to be possible methods for conducting evaluation (Bellizzi and Lipps 1984, Miles and Alt 1988, Seagram, Patten et al. 1993, Radice 2014, Martella, Miraglia et al. 2016). Although evaluation can be conducted quickly and inexpensively than research that is more expensive and time-consuming (Bitgood, Patterson et al. 1988), and it is recommended integrated in exhibition design as a strong component (Crimm, Morris et al. 2009), the complexity and multi-disciplines of exhibition design make the evaluating of

Table 3.23. Tools and techniques for evaluating exhibitions.

Tools for evaluating exhibition	Auther[reference], year, backgrounds
Strategies for Determining Exhibit Effectiveness	Shettel (1968), American Institutes for Research, USA
Simplified Flow Chart of Goal-referenced Evaluation	Screven (1976), University of Wisconsin-Milwaukee, USA
Classification of Evaluation Techniques	Miles and Alt (1988), British Museum, UK
A Model of Service Encounter Evaluation	Bitner (1990), -
Exhibit/Program Evaluation Progress	Bitgood and Loomis (1993), Jacksonville Stage University/Colorado State University, USA
Mayflower Exhibit Evaluation Matrix	Hein (1995), Lesley College, UK
Exhibition Evaluation Questions	Dean (2002), Texas Tech University, USA
Self-evaluation Inquisition	Chen and Ho (2003), National Yunlin university, Taiwan
A Feedback Process in Design Collaboration	Lin (2003), Tunghai University, Taiwan
The Kelvingrove Evaluation Strategy	Economou (2004), University of the Aegean, Greek
Net Promoter® Score Calculation	Shaw (2007), Beyond Philosophy, UK
Requirements Analysis and Evaluation Activities at the Three Levels	Vavoula, Sharples et al. (2009), University of Leicester/University of Nottingham/Oxford Brooks University/University of Birmingham, UK
MEDP Outline Checklist	Lin (2009), Ling-Tung University of Technology, Taiwan
British Museum Evaluation Framework	Clinckemaillie (2010), Worcester Polytechnic Institute, USA
Visitor Observation Form	Coble, Smaldone et al. (2010), Stephen F. Austin State University/West Virginia Universit/San Antonio/Little Rock, USA
The Visitor Engagement and Exhibit Assessment Model	Barriault and Pearson (2010), Laurentian University/ Science North/Science Communication, Canada
Quality Table for Hotels	Nagamachi and Lokman (2010), Air Force Institute of Technology (AFIT), Japan
Brand Presence® Management	Gobe (2010), Coca-Cola Company, USA
Evaluation Checklist	Bitgood (2011), Jacksonville Stage University, USA
Content Assessment Tool	Topp (2011), Iowa State University, USA
Evaluation Skills from Jeff Hayward	McKenna-Cress and Kamien (2013), University of the Arts, USA
Experience and Evaluation Framework	Barrass and Laws (2014), University of Canberra, Australia
The Performance Evaluation Analysis Table	Choi and Choi (2014), Seoul Women's University, Korea
RFP Form	Fuscaldo (2014), Southern Illinois University, USA
A meta-design tool	Radice (2014), Politecnico di Milano, Italy
Evaluating Tools with Designers	Dong, McGinley et al. (2015), BRUNEL University/Tongji University/Royal College of Art, Mimar Sinan Fine Arts University, UK/China/UK/Turkey
The Perceived Atmosphere Instrument	Forrest (2015), The University of Queensland, Australia
Evaluation Methods for Visitor Attention and Communication	Kim and Lee (2016), Yonsei University, Korea
Techniques used for evaluating exhibition	**Auther[reference], year, backgrounds**
Paper and pencil; video tape analysis; Mock-up; questionnaire	Shettel (1968), American Institutes for Research, USA
Interview	Cunningham and White (1974), University of Manchester/ Electrical Machinery Industry, UK
Multi-method: structured interviews; observation mapping; self-competition questionnaire survey	Devine-Wright and Breakwell (1997), V&A Museum, UK
Touch-questionnaire; interview	Hooper-Greenhill (1999), the University of Leicester, UK
Pre-or post-interview, questionnaire, survey, mockups, models, or mini-exhibits, observation, unobtrusive observation: tracking and timing visitors as they move through various exhibitions observational checklists and behavioral rating sheets to codify visitor behavior videotape and analysis	Dean (2002), Texas Tech University, USA
Pre-and post-visit surveys; pre- and post-program questionnaires; pre- and post-program drawing tasks; student journals; ethnographic data collection (a descriptive narrative prepared by an observer who records speech, actions, and the body language of students and the teacher), observations; interviews; 'thinking-aloud' interviews with single, adult visitors; exit questionnaire; tracking study; visit memories, obtained from a postal survey of visitors; data on numbers of 'hits' on two touch screens; study of school use of specific components, involving observations, interviews, tape recordings of visits; visitors' written comments.	Hein (2002), Lesley College, UK
Behavioral observation; staff/visitor interview; workshop	Taxén, Hellström et al. (2003), The Royal Institute of Technology/ The Museum of Science and Technology, Sweden
Observation	Bollo and Dal Pozzolo (2005), Fondazione Fitzcarraldo, Italy
Questionnaire; behavioral observation; semi-structured interview; grounded theory	Taxén (2005), Kungliga Tekniska högskolan University, Sweden
Ergonomics; Anthropometric study	Locker (2011), University of Lincoln, USA
Visitor self-report; behaviour mapping	Gretchen, A et al. (2012), University of Arizona, Tucson/Penn State University/Colorado State University, USA
Qualitative methods: focus group; comment books/talk-back boards; open-ended; unstructured interviews Quantitative methods: intercept interview; observation; online survey	McKenna-Cress and Kamien (2013), University of the Arts, USA
Observation; questionnaire; interview	Bogle (2013), University of the Arts, USA
Staff interview; questionnaire	Fuscaldo (2014), Southern Illinois University, USA
Exit survey; interview; unobtrusive observation; self-report	Serrell (2015), Serrell & Associates, USA

exhibition quite difficult (Cunningham and White 1974, Falk 1993, Kelly and Wensveen 2014, Forrest 2015), and it is rarely progressed in the installation stage (Bitgood, Pierce et al. 1987). Another reasons remain the '*the long time frame and high cost*' (p.79) of the this evaluation and study (Carliner 2003), and traditional methods could not provide the reasonable data for accurately capturing audience responses (Chen and Ho 2003, Clinckemaillie 2010). However, '*all these methods are tools*' (p.456), which are means to gain information for supporting design decision or design thinking (McKenna-Cress and Kamien 2013). In line with visitor study, evaluation study has been developed from 1965s (Borhegyi 1965), but still, '*evaluation requires a systematic approach to measuring success*' (Crimm et al., 2009, p.23).

3.6.5 Novel parts in this section

The literature study in this thesis bridge the theoretical gaps in the fields of exhibition design. The following findings of this section are summarized now as a mean for understanding the next empirical section of the thesis findings. They may serve as a basis for further exploration of designing an enjoyable exhibition to which audience experience is transformed. They aim at highlighting the overarching themes of discussion involving into this thesis as a whole.

I. Transforming Audience Experience. The call for framing and transforming audience experience is indicated in this section. The applications of design techniques and management are emphasized in a real project (Dean 2002, Lin 2002, Schwarz, Bertron et al. 2005, Locker 2011, Bogle 2013). The real question is not only to use design techniques such as design software or mock-up, but how to meet the needs of audience, so as to pertain to frame and transform audience experience with flow experience in the context of an exhibition.

II. Designing Enjoyment Exhibition. The key aspects of enjoyment and as measurement attribute are introduced in various domains (shown in Section 3.3.1). However, these research studies did not consider the enjoyment application in the field of exhibition design, rather they put forward a conceptual suggestion in emotion or experience study, instead of its influence as evaluation measurement. Once audience experience is assessed, it tends to use enjoyment emotion (EE), the flow-like stat, as a central measure both in life level and application level in terms of exhibition design.

III. Embedding Behaviour Data into Exhibition Design. There is an interactive and embedded relationship among behaviour, experience, emotion and measurement in the exhibition (shown in Table 3.13, Section 3.4). From the beginning of studying exhibition design, the behavioral

observations have been used in gaining data for evaluating purpose (Robinson 1928, Melton 1933, Porter 1938, Borhegyi 1965, Howard and Sheth 1969, Melton 1972). However, there is still a research gap in categorizing human behaviour and supported theories for exhibition design. The thesis divided behaviour into explicit behaviour data/postures and implicit behaviour data/physiological parameters. Further research points to the application of technology such as wearable and sensor, etc.

IV. **Identifying Exhibition Design Factors (EDFs), Audience Experience Factors (AEFs), and Behaviour Data (BD).** Exhibition designers and clients use these factors in order to exert an impact on audiences for message-transforming. Contributing factors were reported in previous studies but no detailed research method. Instead, a systematic review method, '*systematic, tool-supported method*' (Bandara, Miskon et al. 2011, Burda and Teuteberg 2013), with GT method is used for extracting the relevant factors in this thesis. Scientific means provide a reference for exploring exhibition design in depth. In total 59 EDFs, 18 AEFs, and 14 BD are extracted for exhibition design (presented in Section 3.5).

V. **Human-exhibition Interaction (HEI).** A main contribution to this thesis is the looping and dynamic HEI model. Communicative interaction between human and environment/system has been discussed in the previous literature. So have interactions between human (clients, designers, and audiences) and exhibition with EDFs, AEFs, BD, and EE. This thesis connects such features in one framework and basic formula, and constructs them empirically by focus group, systematic review, and grounded theory. The interaction may explain a variety of phenomena of exhibition design model beyond one of enjoyable exhibition design change, which is the focus of the study.

VI. **Performing Evaluation in Exhibition Design.** Related studies in exhibition design have tried to support designers or clients with the scientific techniques or tools (summarized in Table 3.23, tools and techniques for evaluating exhibition) by using behaviour data. However, none of these studies can obtain accurate data rather than only relying on paper and pencil, or timing and tracking approach. Instead, this section proposes a method of collaboration data-driven.

4 Identifying EDFs and AEFs perceived by audiences, and used by designers/clients

This Chapter tends to focus on addressing the research questions: What are the EDFs and AEFs perceived by audiences and used by designers in exhibitions? It includes two sub-questions: What are the EDFs and AEFs perceived by audiences in exhibitions? And what are the EDFs and AEFs used by exhibition designers in exhibitions?

4.1 Chapter overview

This chapter presents research into the identification of the factors that are perceived by audiences and used by exhibition designers in exhibitions. This includes surveys conducted in Expo Milano 2015 set up to investigate audiences respond to EDFs and AEFs. It also presents a semi-structured interview study: EDFs and AEFs used by designers and clients during designing an exhibition.

4.2 EDFs and AEFs perceived by audiences (Experiment 1a)

4.2.1 Introduction

This section describes research into factors identification progressed in Expo Milano 2015 for understanding the relationship among EDFs, AEFs and audience responses in exhibitions. The research work investigated 10 pavilions (Brazil Pavilion, Italy Pavilion, USA Pavilion, UK Pavilion, Germany Pavilion, Korea Pavilion, Kazakhstan Pavilion, United Arab Emirates Pavilion, Switzerland Pavilion, and CCUP Pavilion), all in the World Exposition, Italy. The aim at this research was to investigate the EDFs and AEFs of audience perceptions and data which were obtained from the field of the World Exposition. The entrance and exit questionnaire and semi-structured interview were used as the approach for identifying exhibition factors and audience responses in Expo exhibitions.

It also received the permission of the University Research Ethics Committee of the University of Nottingham, and the invitation letter authorized by the Milan Expo. The field study received support and assistance from CCUP (China Corporate United Pavilion Expo 2015 Milano Italy). It was financed by the GTA program of the University of Nottingham and the Ningbo Health City Company.

4.2.2 Method

Ten countries' pavilions were investigated in Milan Italy over 16-day period between 4th October and 20th October 2015[28]. In total 500 participants filled the entrance- and exit-questionnaire before visiting the exhibition of the pavilion and

[28] The survey was conducted by the assistant of a pavilion staff, and a local Italian.

after navigating through the pavilion (Figure 4.29 and 4.30). There is no specific sample inclusion and exclusion criteria in terms of this experiment but a random sample of adults, children or groups due to the limited time and conditions in the field of Expo Milano. The experiment was carried out in ten pavilions. These ten pavilions were chosen because of their different cultural backgrounds. One other thing to note is that before the formal study, around 20 participants were surveyed in the exit of CCUP, to check and review the validity and reliability of the questionnaire. Two items were found in this informal pilot study: First, most participants located in Italy claimed they cannot understand the questionnaire well due to the incorrect or inherent complexity of Italian language; second, it is hard for just one researcher himself to conduct the survey because it required at least three main parts: the carrying of experiment materials including gifts to participants as compensation, the disturbing and preserving of the large amounts of printed questionnaire, seeking and inquiring the potential participants. Thus, this experiment has to turn to search a local Italian as research assistant. In addition, 10 participants were interviewed for questionnaire validity after the formal survey in Milano Expo. The original copies will be preserved in the University of Nottingham, which were recorded in the form of local Italian language.

This questionnaire survey was mainly conducted to test the exhibition design factors (EDFs) and audience experience factors (AEFs) perceived the audiences in the World Exposition[29], the largest international exhibition in the world. It provides an appropriate opportunity of obtaining data from the field.

Figure 4.29. The scenes in Expo Milano 2015. (the entrance of Korea Pavilion)

[29] Expo Milano 2015 was approved by BIE (Bureau International des Exposition) that was found in 1928 Paris since the Great Exhibition in London in 1851. Its website can be checked in *http://www.expo2015.org*.

Figure 4.30. The scenes in Expo Milano 2015. (the exit of Germany Pavilion)[30]

Questionnaire design

The questionnaire was designed for sampling survey to acquire empirical data, including all factors of the proposed model to investigate the perceived EDFs and AEFs. Considering the limited time of audiences, we decided to use a shorter version of the questionnaire in the experiment. The questions and methods in the questionnaire are based on a review of literature (Kolter and Kolter 1998, Ryu 2005, Ryu and Jang 2007, Smithsoniam 2012, Forrest 2015) and specific research questions. And the exhibitions selected for the experiment primarily include following ten themes of exhibitions: '*the Nursery of Italy*' (Italy pavilion), '*Grown in Britain & Northern Ireland*' (UK pavilion), '*Fields of Ideas*' (Germany pavilion), '*American Food 2.0: United to Feed the Planet*' (USA pavilion), '*You Are What You Eat*' (Republic of Korea), '*the Land of Opportunities*' (Kazakhstan), '*Food for Thought – Shaping and Sharing the Future*' (United Arab Emirates), '*Confooderatio Helvetica*' (Switzerland), '*Feeding the World with Solutions*' (Brazil pavilion), and '*Seeds of China*' (China Corporate United pavilion). The survey facility was revised and finalized based on the feedback from three researchers in the University of Nottingham, two exhibition experts in CCUP, a research assistant studying marketing from Milano Italy, and a pilot sample of 15 audiences visiting CCUP pavilion and 10 interviewees visiting 10 pavilions in Expo. Hence, the validity of the questionnaire was regarded as adequate. It contains two kinds of questionnaire: Enter-questionnaire (pre-visit) and exit-questionnaire (post-visit) (Ballantyne, Packer et al. 2011). The enter-questionnaire consists of three parts (shown in Appendix II). Part 1 of the questionnaire presents demographic information of respondents, such as gender, age, nation, and past visiting

[30] The photographs used in this thesis were all taken by the researcher, which of them included 2000 pictures shoot in the scenes of Expo Milano 2015.

experience and expected experience and emotion via a categorical scale (Table 4.24). Part 2 deals with the measurement of expected audience experience factors with 18 items extracted from previous studies (indicated in Section 3.5). Part 3 investigates the respondents' personality information. Respondents will report their agreement level for each item with a four-point Likert-style rating scale (Tröndle, Greenwood et al. 2012, Kanhadilok and Watts 2014), from '*not me at all* (=1)', '*a little me* (=2)', to '*me* (=3)' and '*very much me* (=4)'. The exist-questionnaire also consists of three parts (Appendix II). Part 1 deals with respondents' demographic information. Part 2 deals with the measurement of perceived audience experience with the same 18 items with enter-questionnaire. Part 3 deals with the measurement of perceived EDFs with 23 items covering the identified EDFs in Section 3.5.3. It is constructed on a five-point Likert-type scale (Rubin and Chisnell 2008, Albert and Tullis 2013), from '*strongly disagree* (=s) to '*strongly agree* (=5)'.

Participants and procedure

Data (pre- and post-visit questionnaires) were collected from the entrance and exit of the 10 pavilions in the field of Expo Milano. Each pavilion received up to 50 questionnaires (entrance=25, exit=25) summing up to a total of 500 respondents (mean age=51, *SD*=13, 288 females). Respondents received gift with Chinese cultural style for participation, a common compensation for respondents' time and attention[31]. The entrances of the pavilion were made for queuing up due to the large amount of the audience numbers; but the exits were made with no limitation. Both entrances and exits were time intervals for controlling the flow of audiences. These allowed respondents have been a shopping opportunity for a significant time for study participants. During the time of the study, the researcher and assistant both wore an official certificate of Expo Milano, which insure the study cannot be interrupted by pavilion managers due to the strict security measures in the field of Expo, and help to gain the confidence of audiences with limited time and attention (shown in Figure 4.31).

In survey, participants to the pavilion were invited to participate in the study about their exhibition experience by using undifferentiated random sampling method, immediately during their lining up for formal visiting or after their visiting the exhibition. Those who agreed were told about how the questionnaire is marked. The survey mainly focused on audiences' basic data, pre- and post-visit feelings. The principle of voluntary participation was stressed to insure every responder responding his/her true experience. Since Italian- and English-speaking audiences were the main target groups of the Expo included in the experiment, the questionnaires were indicated in English and then translated into Italian by a native

[31] Each audience (e.g. adult 14+years) will spend around 39 € per day in open data, according to official ticket price list of Expo Milano 2015.

Italian research assistant who was proficient in both the English and Italian languages, and a certain research skill. The survey was started with a briefing of the experiment verbally or written according to actual field condition, after which, they were asked to complete the general questionnaire form. Trained interviewers were asked to seek potential respondents randomly around 2-weeks periods. They asked respondents an initial question to the attendance of the study with a brief introduction. The questionnaire required approximately an average of 7 min to complete. In all, it obtained 500 completed questionnaires that are used in analyses reported below.

Figure 4.31. Participants for this survey in the field of Expo.

Table 4.24. Demographic factors in 10 pavilions.

Demographic Factors		Pre-visiting (n=250)																				Post-visiting (n=250)																				Total	
		Italy pavilion		UK pavilion		Germany pavilion		USA pavilion		Republic of Korea pavilion		Kazakhstan pavilion		United Arab Emirates pavilion		Switzerland pavilion		Brazil pavilion		CCUP pavilion		Italy pavilion		UK pavilion		Germany pavilion		USA pavilion		Republic of Korea		Kazakhstan pavilion		United Arab Emirates pavilion		Switzerland pavilion		Brazil pavilion		CCUP pavilion			
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Age of responders	Up to 19 years	3	12	1	4	2	8	3	12	6	24	9	36	10	40	0	0	13	52	5	20	2	8	4	16	9	36	4	16	4	16	5	20	4	16	5	20	12	48	1	4	102	20
	20-29 years	6	24	9	36	12	48	8	32	11	44	3	12	7	28	10	40	1	4	4	16	7	28	9	36	2	8	7	28	9	36	7	28	9	36	10	40	1	4	4	16	136	27
	30-39 years	7	28	2	8	0	0	3	12	1	4	5	20	3	12	8	32	2	8	2	8	3	12	4	16	4	16	4	16	1	4	1	4	2	8	3	12	0	0	6	24	61	12
	40-49 years	5	20	5	20	4	16	5	20	5	20	2	8	1	4	5	20	2	8	6	24	9	36	3	12	5	20	6	24	6	24	1	4	0	0	2	8	2	8	3	12	77	15
	50-59 years	1	4	7	28	4	16	4	16	2	8	4	16	0	0	1	4	0	0	4	16	2	8	3	12	1	4	3	12	2	8	4	16	6	24	1	4	6	24	4	46	59	12
	60 years and older	1	4	1	4	1	4	0	0	0	0	2	8	1	4	0	0	2	8	4	16	1	4	0	0	4	16	1	4	2	8	6	24	3	12	4	16	4	16	5	20	42	8
	Missing	2	8	0	0	2	8	2	8	0	0	0	0	0	0	1	4	5	20	0	0	1	4	2	8	0	0	0	0	1	4	1	4	1	4	0	0	0	0	2	8	20	4
	Total	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	500	100
Gender	Male	8	32	8	32	8	32	8	32	6	24	8	32	7	28	13	52	6	24	10	40	10	40	2	8	11	44	6	24	9	36	11	44	11	44	12	48	14	56	8	32	176	35
	Female	17	68	17	68	15	60	12	48	17	68	16	64	15	60	12	48	13	52	12	48	15	60	19	76	13	52	17	68	15	60	13	52	14	56	11	44	10	40	15	60	288	58
	Missing	0	0	0	0	2	8	5	20	2	8	1	4	3	12	0	0	6	24	3	12	0	0	4	16	1	4	2	8	1	4	1	4	0	0	2	8	1	4	2	8	36	7
	Total	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	500	100
Do you live in Italy or another country?	Italy	24	96	24	96	22	88	24	96	21	84	25	100	25	100	25	100	25	100	25	100	25	100	25	100	22	88	24	96	25	100	22	88	25	100	24	96	24	96	21	84	477	95
	Malta	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.2
	France	-	-	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.2
	Belarus	-	-	-	-	2	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.4
	Switzerland	-	-	-	-	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	4	-	-	-	-	-	-	-	-	1	4	-	-	2	8	5	1
	USA	-	-	-	-	-	-	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.2
	Belgium	-	-	-	-	-	-	-	-	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.4
	Poland	-	-	-	-	-	-	-	-	2	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.4
	France	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	4	-	-	-	-	1	4	-	-	-	-	-	-	-	-	2	0.4
	Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	4	-	-	-	-	-	-	-	-	-	-	-	-	1	0.2
	Belize	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	4	-	-	-	-	-	-	-	-	1	0.2
	Brazil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	4	-	-	-	-	-	-	-	-	1	0.2
	Salvador	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	4	-	-	1	0.2
	China	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	8	2	0.4
	Missing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	500	100
Are you visiting this exhibition alone or with others?	I am alone	1	4	0	0	2	8	1	3	0	0	0	0	1	4	1	4	1	4	2	8	0	0	3	12	1	4	0	0	0	0	2	8	1	4	1	4	1	4	3	12	21	4
	One or more adults	23	92	22	88	21	84	19	76	23	92	18	72	19	76	21	84	13	52	19	76	21	84	17	68	13	52	17	68	21	84	19	76	22	88	21	84	9	36	21	84	379	76
	One or more under18	1	4	3	12	3	12	2	8	5	20	7	28	3	12	3	12	7	28	4	16	3	12	3	12	13	52	6	24	5	20	4	16	2	8	3	12	14	56	2	8	93	19
	Missing	0	0	0	0	0	0	3	13	0	0	0	0	2	8	0	0	4	16	0	0	1	4	2	8	0	0	2	8	0	0	0	0	0	0	0	0	1	4	0	0	15	3
	Total	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	500	100
Is this your first time visiting Expo in the world?	Yes	22	88	24	96	24	94	23	92	23	92	23	92	20	80	23	92	19	76	23	92	23	92	25	100	22	88	20	80	25	100	22	88	23	92	24	96	24	96	21	84	453	91
	No	3	12	1	4	1	4	2	8	2	8	2	8	2	8	2	8	1	4	2	8	2	8	0	0	3	12	5	20	0	0	2	8	1	4	1	4	0	0	4	16	36	7
	Missing	0	0	0	0	0	0	0	0	0	0	0	0	3	12	0	0	5	20	0	0	0	0	0	0	0	0	0	0	0	0	1	4	1	4	0	0	1	4	0	0	11	2
	Total	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	500	100
Did you come to the Expo today specificity to see this pavilion?	No	11	44	18	72	15	60	14	56	16	64	8	32	10	40	18	72	12	48	14	56	11	44	19	76	15	60	18	72	11	44	11	44	10	40	15	60	19	76	12	48	277	55
	Yes	14	56	7	28	10	40	11	44	9	36	17	68	12	48	7	28	8	32	10	40	14	56	6	24	10	40	6	24	14	56	13	52	15	60	10	40	5	20	13	52	211	42
	Missing	0	0	0	0	0	0	0	0	0	0	0	0	3	12	0	0	5	20	1	4	0	0	0	0	0	0	1	4	0	0	1	4	0	0	0	0	1	4	0	0	12	2
	Total	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	25	100	500	100

4.2.3 Data analysis

Data collected from the questionnaires were computed using the Statistical Package for Social Science (SPSS) software. It was used to produce the descriptive and inferential statistics. The final sample consists of 500 valid and usable data set.

4.2.4 Results

Subject demography

There were 176 males (35 percent) and 288 females (58 percent) percent surveyed, which amounted to 500 respondents (Table 4.25 above). The majority of the respondents were in between the age of 9 and 49 years old (74 percent). A large proportion of the respondents (95 percent) lived in Italy, and visiting the specific exhibition with one or more adults (76 percent). In total 91 percent of audiences were first time for visiting this exposition, but most of them are not intentionally to view the pavilion but more random (Figure 4.32).

Evaluation of ten pavilions

Table 4.26 presents descriptive statistics. The first column of enjoyable emotion, overall experience and audience characters with 12 items were investigated, which can provide a basis for assessment of the ten chosen pavilions. Furthermore, part of audience characters tended to offer an understanding context for each pavilion evaluation. For instance, the '*Good*' item of overall experience in Germany Pavilion and USA Pavilion during both pre-visiting and post-visiting was all enhanced respectively from 48 percent to 52 percent, and 32 percent to 48 percent. However, the enjoyable emotion of USA Pavilion was decreased from 88 percent (n=25, pre-visiting) to 84 percent (n=25, post-visiting) while for Germany Pavilion, it was increased from 84 percent (n=25, pre-visiting) to 92 percent (n=25, post-visiting). The highest means of audience characters in USA Pavilion and Germany pavilion were '*I like to improve knowledge*' (n=25, M=3.40, SD=.70) and '*I like to spend leisure time with others*' (n=25, M=3.18, SD=.95) separately.

Figure 4.32. Exhibitions of Germany pavilion (top) and Kazakhstan pavilion (bottom) in Expo Milano 2015.

Table 4.25. Evaluation of ten pavilions in Expo Milano.

ITALY PAVILION

		Pre-visiting (expected)		Post-visiting（rate）		Total	
		N	%	N	%	N	%
Enjoyable Emotion	No	5	20	3	12	8	16
	Yes	**20**	**80**	**21**	**84**	**41**	**82**
	Missing	0	0	1	4	1	2
	Total	25	100	25	100	50	100
Overall Experience	Poor	1	4	2	8	3	6
	Fair	2	8	3	12	5	10
	Good	**9**	**36**	11	44	20	40
	Excellent	**9**	**36**	7	28	16	32
	Superior	4	16	1	4	5	10
	Missing	0	0	1	4	1	2
	Total	25	100	25	100	50	100

Audience Characters	**I like to …**	**N**	**Mix**	**Max**	**M**	**SD**
	Bring people together	25	1	4	2.80	1.04
	Construct things	25	1	4	2.24	1.09
	Logical games	25	1	4	2.64	.95
	Spending leisure time outside	25	1	4	3.08	.81
	Help others	25	1	4	2.83	.91
	Being trendy	25	1	4	2.36	1.03
	Jogging	25	1	4	2.28	1.20
	Know how things are made	25	1	4	2.96	.93
	Improve knowledge	25	1	4	**3.24**	1.01
	Play competitive sports	25	1	4	2.08	1.07
	Shopping	25	1	4	2.36	1.11
	Spend leisure time with others	25	1	4	3.00	.91

UK PAVILION

		Pre-visiting (expected)		Post-visiting（rate）		Total	
		N	%	N	%	N	%
Enjoyable Emotion	No	2	8	1	4	3	6
	Yes	**23**	**92**	23	92	**46**	**92**
	Missing	0	0	1	4	1	2
	Total	25	100	25	100	50	100
Overall Experience	Poor	0	0	0	0	0	0
	Fair	3	12	5	20	8	16
	Good	**14**	**56**	11	44	25	50
	Excellent	7	28	6	24	13	26
	Superior	1	4	1	4	2	4
	Missing	0	0	2	8	2	4
	Total	25	100	25	100	50	100

Audience Characters	**I like to …**	**N**	**Mix**	**Max**	**M**	**SD**
	Bring people together	23	1	4	2.78	.99
	Construct things	24	1	4	2.66	1.27
	Logical games	23	1	4	2.60	1.19
	Spending leisure time outside	23	2	4	3.26	.81
	Help others	23	1	4	3.08	.79
	Being trendy	23	1	4	2.60	1.03
	Jogging	23	1	4	2.08	1.20
	Know how things are made	24	1	4	2.91	.92
	Improve knowledge	24	1	4	**3.33**	.81
	Play competitive sports	24	1	4	1.87	1.11
	Shopping	24	1	4	2.75	1.07
	Spend leisure time with others	24	1	4	3.20	.93

Continued Table 4.25

GERMANY PAVILION

		Pre-visiting (expected)		Post-visiting（rate）		Total	
		N	%	N	%	N	%
Enjoyable Emotion	No	1	4	2	8	3	6
	Yes	**21**	**84**	**23**	**92**	44	88
	Missing	3	12	0	0	3	6
	Total	25	100	25	100	50	100
Overall Experience	Poor	0	0	1	4	1	2
	Fair	0	0	0	0	0	0
	Good	**12**	**48**	**13**	**52**	25	50
	Excellent	8	32	6	24	14	28
	Superior	4	16	4	16	8	16
	Missing	1	4	1	4	2	4
	Total	25	100	25	100	50	100

Audience Characters	I like to …	N	Mix	Max	M	SD
	Bring people together	25	1	4	2.68	1.03
	Construct things	24	1	4	2.79	.83
	Logical games	25	1	4	2.76	.92
	Spending leisure time outside	23	2	4	3.30	.76
	Help others	24	2	4	2.96	.69
	Being trendy	25	1	4	2.16	.94
	Jogging	25	1	4	2.16	.85
	Know how things are made	25	1	4	3.20	.81
	Improve knowledge	25	2	4	**3.40**	.70
	Play competitive sports	25	1	4	2.56	1.19
	Shopping	25	1	4	2.40	1.11
	Spend leisure time with others	25	2	4	3.20	0.70

USA PAVILION

		Pre-visiting (expected)		Post-visiting（rate）		Total	
		N	%	N	%	N	%
Enjoyable Emotion	No	3	12	3	12	6	12
	Yes	**22**	**88**	**21**	**84**	43	86
	Missing	0	0	1	4	1	2
	Total	25	100	25	100	50	100
Overall Experience	Poor	0	0	0	0	0	0
	Fair	6	24	4	16	10	20
	Good	**8**	**32**	**12**	**48**	20	40
	Excellent	6	24	5	20	11	22
	Superior	1	4	2	8	3	6
	Missing	3	12	2	8	5	10
	Total	25	100	25	100	50	100

Audience Characters	I like to …	N	Mix	Max	M	SD
	Bring people together	25	1	4	3.00	0.95
	Construct things	20	1	4	2.70	1.12
	Logical games	23	1	4	2.34	1.19
	Spending leisure time outside	24	2	4	2.95	0.85
	Help others	23	1	4	3.13	1.01
	Being trendy	20	1	4	2.35	1.13
	Jogging	24	1	4	2.25	1.03
	Know how things are made	23	1	4	3.00	1.00
	Improve knowledge	22	2	4	**3.00**	0.81
	Play competitive sports	22	1	4	2.54	1.01
	Shopping	23	1	4	2.69	1.06
	Spend leisure time with others	22	1	4	3.18	0.95

Continued Table 4.25

SOUTH KOREA PAVILION

		Pre-visiting (expected)		Post-visiting （rate）		Total	
		N	%	N	%	N	%
Enjoyable Emotion	No	4	16	1	4	5	10
	Yes	**21**	**84**	24	96	45	90
	Missing	0	0	0	0	0	0
	Total	25	100	25	100	50	100
Overall Experience	Poor	0	0	0	0	0	0
	Fair	1	4	0	0	5	10
	Good	**10**	**40**	6	24	16	32
	Excellent	**10**	**40**	9	36	19	38
	Superior	4	16	10	40	14	28
	Missing	0	0	0	0	0	0
	Total	25	100	25	100	50	100

Audience Characters	I like to …	N	Mix	Max	M	SD
	Bring people together	24	2	4	3.25	.89
	Construct things	24	1	4	3.29	.90
	Logical games	24	1	4	2.66	1.04
	Spending leisure time outside	24	2	4	3.41	.65
	Help others	23	2	4	3.30	.70
	Being trendy	24	1	4	2.37	1.27
	Jogging	23	1	4	1.87	1.09
	Know how things are made	24	2	4	3.45	.83
	Improve knowledge	24	2	4	3.41	.82
	Play competitive sports	22	1	4	2.50	1.30
	Shopping	24	1	4	2.62	1.13
	Spend leisure time with others	23	2	4	**3.47**	.66

KAZAKHSTAN PAVILION

		Pre-visiting (expected)		Post-visiting （rate）		Total	
		N	%	N	%	N	%
Enjoyable Emotion	No	5	20	1	4	6	12
	Yes	**19**	**76**	**23**	**92**	42	84
	Missing	1	4	1	4	2	4
	Total	25	100	25	100	50	100
Overall Experience	Poor	0	0	0	0	0	0
	Fair	2	8	2	8	4	8
	Good	7	28	3	12	10	20
	Excellent	**11**	**44**	8	32	19	38
	Superior	3	12	**10**	**40**	13	26
	Missing	2	8	0	0	2	4
	Total	25	100	25	100	50	100

Audience Characters	I like to …	N	Mix	Max	M	SD
	Bring people together	22	2	4	3.22	.86
	Construct things	22	1	4	2.86	1.12
	Logical games	22	1	4	2.77	1.06
	Spending leisure time outside	22	2	4	3.22	.75
	Help others	22	2	4	3.00	.81
	Being trendy	21	1	4	2.81	1.24
	Jogging	22	1	4	2.40	1.29
	Know how things are made	23	1	4	2.82	.98
	Improve knowledge	21	2	4	**3.47**	.67
	Play competitive sports	22	1	4	2.59	1.14
	Shopping	22	1	4	3.00	1.23
	Spend leisure time with others	22	2	4	3.36	.78

Continued Table 4.25

UNITED ARAB EMIRATES PAVILION

		Pre-visiting (expected)		Post-visiting （rate）		Total	
		N	%	N	%	N	%
Enjoyable Emotion	No	3	12	2	8	5	10
	Yes	**18**	**72**	22	88	40	80
	Missing	4	16	1	4	5	10
	Total	25	100	25	100	50	100
Overall Experience	Poor	0	0	2	8	2	4
	Fair	0	0	2	8	2	4
	Good	**9**	**36**	5	20	14	28
	Excellent	5	20	12	48	17	34
	Superior	8	32	5	20	13	26
	Missing	3	12	0	0	3	6
	Total	25	100	25	100	50	100

Audience Characters	I like to …	N	Mix	Max	M	SD
	Bring people together	25	1	4	3.24	.96
	Construct things	25	1	4	3.04	.73
	Logical games	24	1	4	2.66	1.12
	Spending leisure time outside	25	2	4	3.36	.63
	Help others	25	1	4	3.32	.80
	Being trendy	23	1	4	2.56	1.12
	Jogging	23	1	4	2.65	1.02
	Know how things are made	25	2	4	3.24	.83
	Improve knowledge	25	1	4	3.44	.82
	Play competitive sports	25	1	4	2.56	1.29
	Shopping	25	1	4	2.92	1.18
	Spend leisure time with others	25	2	4	**3.68**	.62

SWITZERLAND PAVILION

		Pre-visiting (expected)		Post-visiting （rate）		Total	
		N	%	N	%	N	%
Enjoyable Emotion	No	3	12	4	16	7	14
	Yes	**22**	**88**	21	84	43	86
	Missing	0	0	0	0	0	0
	Total	25	100	25	100	50	100
Overall Experience	Poor	0	0	2	8	2	4
	Fair	4	16	3	12	7	14
	Good	**17**	**68**	8	32	25	50
	Excellent	**3**	**12**	6	24	9	18
	Superior	1	4	5	20	6	12
	Missing	0	0	1	4	1	2
	Total	25	100	25	100	50	100

Audience Characters	I like to …	N	Mix	Max	M	SD
	Bring people together	25	1	4	2.88	1.01
	Construct things	24	1	4	2.87	1.07
	Logical games	25	1	4	3.24	.92
	Spending leisure time outside	25	2	4	3.28	.61
	Help others	24	1	4	2.83	.96
	Being trendy	23	1	4	2.04	.92
	Jogging	24	1	4	2.20	.97
	Know how things are made	24	2	4	3.25	.73
	Improve knowledge	24	3	4	**3.50**	.51
	Play competitive sports	24	1	4	2.66	1.04
	Shopping	23	1	4	2.56	1.03
	Spend leisure time with others	24	2	4	3.29	.75

Continued Table 4.25

BRAZIL PAVILION

		Pre-visiting (expected)		Post-visiting（rate）		Total	
		N	%	N	%	N	%
Enjoyable Emotion	No	0	0	0	0	0	0
	Yes	**20**	**80**	24	96	44	88
	Missing	5	20	1	4	6	12
	Total	25	100	25	100	50	100
Overall Experience	Poor	0	0	0	0	0	0
	Fair	2	8	2	8	4	8
	Good	**6**	**24**	**9**	**36**	15	30
	Excellent	6	24	6	24	12	24
	Superior	5	20	6	24	11	22
	Missing	3	12	2	8	5	10
	Total	25	100	25	100	50	100

Audience Characters	I like to …	N	Mix	Max	M	SD
	Bring people together	23	1	4	2.91	.84
	Construct things	23	1	4	2.43	.78
	Logical games	21	1	4	2.47	1.12
	Spending leisure time outside	24	2	4	3.08	.71
	Help others	23	2	4	3.17	.83
	Being trendy	22	1	4	2.63	1.00
	Jogging	25	1	4	2.44	.86
	Know how things are made	24	1	4	3.00	.78
	Improve knowledge	23	1	4	2.87	.86
	Play competitive sports	24	1	4	2.70	1.12
	Shopping	23	2	4	3.13	.919
	Spend leisure time with others	23	2	4	**3.43**	.72

CCUP PAVILION

		Pre-visiting (expected)		Post-visiting（rate）		Total	
		N	%	N	%	N	%
Enjoyable Emotion	No	0	0	2	8	2	4
	Yes	**20**	**80**	**23**	**92**	43	86
	Missing	5	20	0	0	5	10
	Total	25	100	25	100	50	100
Overall Experience	Poor	0	0	1	4	1	2
	Fair	1	4	3	12	4	8
	Good	**8**	**32**	7	28	15	30
	Excellent	5	20	**8**	**32**	13	26
	Superior	**10**	**40**	5	20	15	30
	Missing	1	4	1	4	2	4
	Total	25	100	25	100	50	100

Audience Characters	I like to …	N	Mix	Max	M	SD
	Bring people together	22	2	4	3.13	.88
	Construct things	22	1	4	2.63	1.00
	Logical games	23	1	4	2.65	1.02
	Spending leisure time outside	24	1	4	3.29	.95
	Help others	22	1	4	3.22	.97
	Being trendy	22	1	4	2.63	1.00
	Jogging	24	1	4	2.83	.86
	Know how things are made	23	2	4	**3.34**	.71
	Improve knowledge	21	1	4	3.33	.85
	Play competitive sports	23	1	4	2.65	.98
	Shopping	23	1	4	2.82	1.11
	Spend leisure time with others	24	1	4	3.12	.89

Perceived AEFs and EDFs

The experiment results showed that there was an important relationship between each exhibition design factor and different audience feelings including experience and emotion. To explore AEFs perceived by audience, a multiple response (MR) analysis was performed, and shown in Table 4.27. The second column show the tested AEFs, the third reports how many the AEFs perceived by audiences in individual 10 pavilions during pre-visiting period, the fourth reports how many the AEFs experienced by respondents during post-visiting, the fifth shows for how many AEFs were reported by respondents in all. The results indicated that the Engagement (n=24, 4.8 percent) and Cool (n=22, 4.4 percent) were the minimum AEFs reported, meanwhile Curiosity (n=223, 44.6 percent), Motivation (n=222, 44.4 percent), and understanding (n=219, 43.8 percent) were the maximum AEFs experienced. In addition, five other AEFs were reported in pre-visiting such as '*create new culture*' (UK pavilion), '*no queue*' (Germany pavilion), and '*food*' (Kazakhstan pavilion), and post-visiting such as '*flexible space*' (Germany pavilion), and '*vanguard*' (Republic of Korea pavilion). The part of exit-questionnaire in which respondents were asked to rate their ***enjoyment*** with the 23 items inside of the pavilion by using 5-point Likert scale (shown in Table 4.25). The last column of Table 4.28 shows that the Mean and Std. deviation of cases that were reported for each pavilion. The experiment results indicated that exhibition design factors could be perceived by audiences with different scaling in the pavilions. For example, the row of '*computer interactive*' reports that the highest mean in 10 pavilions is Kazakhstan pavilion (M=4.25, SD=.71), while the lowest mean of pavilions is Switzerland pavilion (M=2.78, SD=.90).

Furthermore, the correlation factors analysis of AEFs and EDFs was conducted based on the results of the survey in Expo Milano shown in Table 4.27 and Table 4.28. The total sample of 347 AEFs (M=5.75, SD=3.49) before and after visiting and 230 EDFs (M=3.71, SD=.37) perceived after visiting perceived by audiences in ten pavilions was progressed in the SPSS. It found that there is no significant correlation between them (ρ=0.037, sig=0.588) in this questionnaire survey, shown in Talbe 4.27. It may result in the limitation of the research method, but a correlative and interactive relationship has been presented in Chapter 6. However, the results of this experiment tend to answer the research question indicated in this thesis: What are the EDFs and AEFs perceived by audiences in exhibitions?

Table 4.26. Correlations of EDFs and AEFs perceived by audiences.

		EDFs	AEFs
EDFs	Pearson Correlation	1	.037
	Sig. (2-tailed)	-	.588
	N	230	217
AEFs	Pearson Correlation	.037	1
	Sig. (2-tailed)	.588	-
	N	217	347

Table 4.27. AEFs perceived by audiences in Expo Milano.

		Pre-visiting (n=250)																				Post-visiting (n=250)																Total	
		Italy pavilion		UK pavilion		Germany pavilion		USA pavilion		Republic of Korea pavilion		Kazakhstan pavilion		United Arab Emirates pavilion		Switzerland pavilion		Brazil pavilion		CCUP pavilion		Italy pavilion		UK pavilion		Germany pavilion		USA pavilion		Republic of Korea		Kazakhstan pavilion		United Arab Emirates pavilion		Switzerland pavilion		Brazil pavilion		CCUP pavilion			
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Perceived AEFs by audience	Motivation	7	6.3	9	9.2	12	10.5	15	16.1	18	15.1	17	13.4	15	11.9	7	6.9	6	6.7	9	7.3	12	16.9	6	5.3	12	15.4	8	10.5	17	14.5	16	13.3	11	10.5	7	5.6	12	9.4	6	6.6	222	44.4
	Satisfaction	7	6.3	2	2.0	3	2.6	5	5.4	2	1.7	5	3.9	3	2.4	2	2.0	11	12.4	5	4.0	1	1.4	4	3.5	3	3.8	-	-	9	7.7	3	2.5	3	2.9	7	5.6	8	6.3	6	6.6	89	17.8
	Understanding	14	12.6	11	11.2	18	15.8	8	8.6	12	10.1	9	3.9	15	11.9	12	11.8	5	5.6	9	7.3	4	5.6	15	13.3	6	7.7	10	13.2	12	10.3	16	13.3	15	14.3	11	8.9	9	7.1	8	8.8	219	43.8
	Engagement	4	3.6	-	-	1	0.9	-	-	-	-	1	0.8	-	-	2	2.0	-	-	3	2.4	-	-	1	0.9	2	2.6	1	1.3	1	0.9	1	0.8	1	1.0	3	2.4	2	1.6	1	1.1	24	4.8
	Emotional	3	2.7	8	8.2	4	3.5	8	8.6	2	1.7	6	4.7	6	4.8	6	5.9	4	4.5	9	7.3	4	5.6	7	6.2	-	-	5	6.6	5	4.3	8	6.7	6	5.7	9	7.3	4	3.1	1	1.1	105	21.0
	Service	2	1.8	2	2.0	5	4.4	4	4.3	6	5.0	2	1.6	3	2.4	5	4.9	2	2.2	5	4.0	1	1.4	7	6.2	6	7.7	1	1.3	4	3.4	2	1.7	3	2.9	7	5.6	7	5.5	1	1.1	75	15.0
	Attention	5	4.5	9	9.2	12	10.5	8	8.6	8	6.7	13	10.2	14	11.1	10	9.8	8	9.0	10	8.1	6	8.5	8	7.1	7	9.0	7	9.2	11	9.4	13	10.8	8	7.6	8	6.5	8	6.3	7	7.7	180	36.0
	Curiosity	14	12.6	14	14.3	10	8.8	7	7.5	13	10.9	16	12.6	16	12.7	10	9.8	10	11.2	7	5.6	9	12.7	11	9.7	10	12.8	9	11.8	10	8.5	18	15.0	11	10.5	10	8.1	9	7.1	9	9.9	223	44.6
	Creativity	7	6.3	3	3.1	1	0.9	4	4.3	9	7.6	5	3.9	4	3.2	2	2.0	1	1.1	5	4.0	3	4.2	7	6.2	4	5.1	3	3.9	2	1.7	5	4.2	4	3.8	2	1.6	7	5.5	1	1.1	79	15.8
	Cool	1	0.9	1	1.0	1	0.9	1	1.1	1	0.8	1	0.8	-	-	2	2.0	1	1.1	3	2.4	-	-	-	-	1	1.3	1	1.3	1	0.9	-	-	-	-	1	0.8	3	2.4	3	3.3	22	4.4
	Interesting	3	2.7	5	5.1	8	7.0	6	6.5	3	2.5	5	3.9	3	2.4	4	3.9	5	5.6	6	4.8	3	4.2	3	2.7	2	2.6	2	2.6	3	2.6	3	2.5	1	1.0	5	4.0	6	4.7	2	2.2	78	15.6
	Fun	6	5.4	2	2.0	7	6.1	7	7.5	7	5.9	10	7.9	8	6.3	6	5.9	10	11.2	10	8.1	6	8.5	9	8.0	8	10.3	6	7.9	10	8.5	6	5.0	5	4.8	10	8.1	8	6.3	13	14.3	154	30.8
	Leisure	6	5.4	2	2.0	2	1.8	2	2.2	3	2.5	4	3.1	2	1.6	3	2.9	4	4.5	5	4.0	5	7.0	8	7.1	3	3.8	1	1.3	3	2.6	2	1.7	1	1.0	8	6.5	7	5.5	3	3.3	74	14.8
	Learning	7	6.3	10	10.2	9	7.9	4	4.3	10	8.4	8	6.3	11	8.7	11	10.8	6	6.7	8	6.5	3	4.2	10	8.8	3	3.8	7	9.2	9	7.7	8	6.7	11	10.5	10	8.1	6	4.7	11	12.1	162	32.4
	Participation	6	5.4	5	5.1	3	2.6	4	4.3	7	5.9	2	1.6	6	4.8	3	2.9	4	4.5	10	8.1	3	4.2	5	4.4	2	2.6	4	5.3	4	3.4	4	3.3	6	5.7	7	5.6	8	6.3	4	4.4	97	19.4
	Memory	6	5.4	3	3.1	4	3.5	3	3.2	6	5.9	7	5.5	7	5.6	6	5.9	6	6.7	7	5.6	4	5.6	3	2.7	2	2.6	1	1.3	4	3.4	4	3.3	5	4.8	6	4.8	3	2.4	2	2.2	89	17.8
	Reflection	6	5.4	4	4.1	4	3.5	2	2.2	4	3.4	8	6.3	3	2.4	6	5.9	2	2.2	5	4.0	2	2.8	2	1.8	5	6.4	6	7.9	4	3.4	3	2.5	6	5.7	9	7.3	10	7.9	5	5.5	96	19.2
	Authenticity	7	6.3	8	8.2	10	8.8	5	5.4	8	6.7	8	6.3	10	7.9	5	4.9	4	4.5	7	5.6	5	7.0	6	5.3	2	2.6	4	5.3	8	6.8	8	6.7	8	7.6	4	3.2	10	7.9	8	8.8	135	27.0
	Others	-	-	Create new culture		No queue		-	-	-	-	Food		-	-	-	-	-	-	-	-	-	-	-	-	Flexible space		-	-	Vanguard		-	-	-	-	-	-	-	-	-	-	-	-
	Missing	0	0.0	1	4.0	1	4.0	0	0.0	1	4.0	2	8.0	3	12.0	1	4.0	7	28.0	5	20.0	1	4.0	1	4.0	1	4.0	1	4.0	0	0.0	0	0.0	4	14.3	2	8.0	1	4.0	2	8.0	34	6.8
	Total	111	100	98	100	114	100	93	100	119	100	127	100	126	100	102	100	89	100	123	100	71	100	113	100	78	100	76	100	117	100	120	100	105	100	124	100	127	100	91	100	2124	100

4.2.5 Discussion

Summary

This research provides several potential practical and theoretical contributions. First, experimental result is presented suggesting enjoyment emotion may be used for evaluating exhibition design. In particular, the results indicate audiences' reactions including experience and emotion with various EDFs. Second, the research suggests the audience experience is different between pre-visiting and post-visiting pavilion. Third, this research suggests further how EDFs perceived by audiences before and after their visiting exhibitions (Table 4.28). There is no significant correlations among EDFs and AEFs perceived by audiences during this study as shown in Table 4.28 and 4.27; however, along with the developing technology, muli-method applied in experiment can provide a better understanding for the correlation exploration such as wearable sensors and eye-tracking devices. Chapter 6 presented the results correlated with EDFs, AEFs, and BD.

Summarizing, these results demonstrate that the EDFs and AEFs among the exhibitions of the pavilions can be perceived by audiences at various scales with their felling including experience and enjoyment emotion. Also, the relationship among EDFs, AEFs and enjoyment emotion of an audience reported thus can be different among ten pavilion exhibitions. Additionally, we explored the means for evaluating each exhibition per pavilion (Table 4.25).

Limitations

This experiment has an intrinsic limitation. Often there is a possibility of low response rate when the potential responders in a limited time and field conditions (Frew and Williams 2014). To enhance a better response rate, the researcher progressed the exploratory study in the entrances and exits of the pavilion between 8:00 AM and 7:00 PM by wearing official credential and overall, with a Chinese type gifts or the badge of CCUP for three aims: First is to attract potential responders' attentions; second is to use them as compensation for their participation; third is to increase the trust degree among audiences, pavilion mangers, and the researchers. Moreover, this field study focused on the exhibitions inside the buildings rather than considering the influence of the buildings themselves. And yet, it is easily found in the real world that some museum buildings with beautiful form or shape cannot meet the requirements of exhibitions that involve the structured time and content. Meanwhile, the results in night were excluded in this investigation due to the limitations of its funds and personnel. However, one thing to note is there is an experience difference for visiting pavilions between day and night, naturally.

Table 4.28. EDFs perceived by audiences in Expo Milano.

	Italy pavilion			UK pavilion			Germany pavilion			USA pavilion			Republic of Korea pavilion			Kazakhstan pavilion			United Arab Emirates pavilion			Switzerland pavilion			Brazil pavilion			CCUP pavilion			Total	
	N	M	SD	N	M	SD	N	M	SD	N	M	SD	N	M	SD	N	M	SD	N	M	SD	N	M	SD	N	M	SD	N	M	SD	N	M
Availability of information/pamphlet	23	3.65	.48	25	3.16	1.06	23	3.34	1.19	24	2.79	.88	25	3.84	.80	22	3.40	.90	24	3.08	1.01	24	3.25	1.03	25	3.44	.86	22	3.72	.45	237	23.7
Photos on the walls	22	3.77	.68	22	3.63	.72	25	3.52	1.38	23	3.52	.94	25	4.24	.59	20	4.30	.57	24	3.91	.88	24	3.75	.73	25	3.72	.79	24	4.08	.65	234	23.4
Exhibition multimedia (video, audio,	23	3.69	.63	24	3.58	.65	25	3.76	.96	23	3.78	.85	24	4.62	.57	21	4.52	.67	24	4.33	.63	25	3.56	.82	23	3.78	.95	24	4.12	.67	236	23.6
Meanings of exhibition	22	3.90	.68	24	3.37	1.09	25	2.96	1.56	24	3.33	1.09	22	4.22	.68	21	4.14	.65	24	3.91	.71	24	3.62	.96	23	3.69	.82	22	3.81	.73	231	23.1
Computer interactive	22	3.45	.73	22	2.90	.92	25	3.04	1.69	25	3.08	1.11	24	3.91	.92	20	4.25	.71	24	3.79	.77	23	2.78	.90	23	3.52	.89	21	3.61	.92	229	22.9
Variety of culture	23	3.39	1.07	23	3.65	1.07	25	3.88	1.16	21	3.81	.87	22	4.27	.76	22	3.72	1.03	24	4.25	.79	24	3.45	1.06	24	4.08	.71	23	4.13	.75	231	23.1
Sharing experience with other people	22	3.45	.91	22	3.31	.94	25	3.32	1.54	23	3.65	.93	23	3.95	.92	20	3.85	.93	24	3.58	.82	24	3.41	1.13	23	3.73	.86	20	3.90	.78	226	22.6
Watching, walking and sitting	23	3.73	.61	24	3.20	1.14	25	3.20	1.68	24	3.20	1.25	25	4.08	.81	21	3.81	.87	24	3.66	1.00	23	3.73	.915	24	4.04	.85	24	4.00	.65	237	23.7
I feel happy, enjoyment, surprise, etc.	23	3.60	.89	22	3.54	1.01	25	3.16	1.74	22	3.22	.86	25	4.08	.95	21	4.14	.85	24	3.79	.83	25	3.48	1.12	24	4.04	.75	21	3.95	.74	232	23.2
Style of exhibition design	23	3.73	.61	23	4.04	.92	25	3.28	1.51	22	3.45	.96	25	4.28	.79	23	4.00	.85	24	4.20	.72	23	3.60	.98	22	3.68	1.17	21	4.04	.80	231	23.1
Story-telling/narrative	23	3.60	.72	23	3.56	1.12	25	2.76	1.89	22	3.50	.96	23	3.95	.97	21	4.00	.77	24	3.87	.94	22	3.27	1.12	22	3.50	1.26	23	3.73	.96	228	22.8
Quality of art	24	3.58	.82	22	3.77	.97	25	3.48	1.35	23	3.56	.89	25	4.48	.50	22	4.09	.92	24	4.20	.83	23	3.95	.82	21	3.81	.92	22	3.86	.71	231	23.1
Quality of shape	24	3.95	.55	21	4.28	.95	25	3.40	1.68	23	3.78	.90	24	4.33	.70	21	3.95	.80	24	4.41	.71	23	3.87	.96	22	4.04	.89	22	4.00	.87	229	22.9
Colour of exhibition	24	3.79	.72	24	4.20	.97	25	3.64	1.38	23	3.78	1.04	23	4.21	.73	21	4.28	.64	24	4.20	.88	21	3.76	.88	21	4.00	1.04	24	4.08	.71	230	23.0
Texture of exhibition	23	3.69	.55	24	4.12	.79	25	3.08	1.65	23	3.39	.94	24	4.20	.72	21	4.04	.66	22	4.13	.77	22	3.86	1.03	21	4.09	.83	22	4.13	.56	227	22.7
Material of exhibition	22	3.77	.52	20	3.85	1.18	25	3.16	1.62	21	3.57	.74	25	4.16	.74	22	4.13	.63	23	3.87	.69	22	3.54	.96	22	3.77	1.02	21	3.71	.84	223	22.3
Time of visiting exhibition in the pavilion	23	3.00	.95	24	3.16	1.16	25	3.36	1.46	24	3.04	1.19	24	3.75	1.11	22	3.77	1.02	23	2.30	1.10	23	2.78	1.04	23	3.30	1.29	23	3.26	1.17	234	23.4
Communication with the staff	24	3.62	.92	22	3.09	1.15	25	3.24	1.47	25	3.12	.92	24	3.79	1.28	22	3.63	1.04	23	3.65	.83	22	3.13	1.03	23	3.30	1.14	23	3.73	1.25	233	23.3
I can visit the exhibition efficiently	23	3.73	.81	24	3.33	.96	25	3.56	1.12	21	3.28	1.00	25	3.92	.99	21	3.71	.95	21	3.61	1.02	22	3.50	1.05	23	3.43	1.03	20	3.60	.99	225	22.5
Setting	24	3.79	.83	23	3.47	1.03	25	3.84	1.37	23	3.56	.89	25	4.32	.62	21	3.95	.74	23	3.87	.75	24	3.58	.65	23	3.73	1.05	22	3.77	.75	233	23.3
Lighting	22	3.86	.63	23	3.60	1.11	25	3.96	1.09	21	3.61	.97	25	4.08	.75	24	4.08	.92	23	4.30	.76	23	3.95	.76	23	4.17	.77	24	4.04	.62	233	23.3
Music	22	3.77	.75	23	3.26	1.13	25	3.32	1.51	22	3.54	1.10	25	4.20	.81	22	4.22	.75	23	4.04	.76	23	3.73	.86	22	3.90	1.10	23	4.13	.62	230	23.0
Smell	20	3.40	.82	22	3.22	1.15	25	3.16	1.79	21	3.71	.84	25	4.04	.97	22	3.81	.90	23	3.65	.88	23	3.60	1.03	24	4.00	1.14	22	3.77	.97	227	22.7

4.3 EDFs and AEFs used by designers and clients (Experiment 1b)

4.3.1 Introduction

This study investigated the EDFs and AEFs used, and the response provided by designers and clients in the context of designing exhibitions. During the investigation, the study received the support and assistance from Ningbo Exhibition Office[32]. For instance, former deputy mayor of Ningbo Jianhou Wang approved an instruction '*please let exhibition office cooperate with*' for the research project. Through a series of email, telephone and meeting contacts, an initial government contact arranges a total three local exhibition design companies and two local exhibition design experts for further understating as backgrounds. In addition, the researcher was nominated as a judge of expert committee with five peoples in the first *Ningbo Exhibition (Instance) Competition* (hosed in the Ningbo International Exhibition & Convention Centre,14th January, 2017,), which allowed the researcher could observe and obtain the first-hand information particularly in the practical area of exhibition design.

A series of structural questions was used that examines how perceived views on exhibition and its development, used exhibition factors, nature of exhibition design, tools in exhibition design, and evaluation. Through interviewing exhibition designers, this study explored their responses on exhibition design, and EDFs and AEFs used in exhibition development. Through interviewing clients such as company managers, design planners, and government officials, this research has established a further understanding of their both opinions, EDFs, and AEFs applied in exhibition projects. The results provide an insight into how clients and designers perceive related key factors in exhibition development. It addresses research questions presented in Section 1.4, with important implications for the further understanding of HEI.

4.3.2 Method

This study applied a semi-structured interview method for the purpose of collecting views and responses (raw data) from 11 participants, and it employed both qualitative and quantitative approach in the development of data analysis. It was recorded by Sony Digital Voice Recorder, and voice memos software of iPhone 6. Data analysis was performed for organizing the raw data into a coding progress, and further for identifying perceived EDFs and AEFs.

Interviews embedding a questionnaire, were conducted by a trained researcher for enhancing the validity and reliability of the responses. Although the samples were selected with clear research aims and questions, the interviews were progressed

[32] The official website of Ningbo Exhibition Office is: http://expo.ningbo.gov.cn.

at different locations and on different days depending on responders' convenience. It tends to meet two targets: first, reduce the response-bias of location, data, and time during the experiment period; second, increase the conduction possibility of the interview due to the reality that all clients and designers have to be involved in a busy schedule. The detailed process is demonstrated in the following Section 3.3.4.

4.3.3 Interview design

The study focused on the need, access, and application of EDFs and AEFs during design progress, and the current situation in the field of exhibition design. The interviews were designed to optimize the ability of the interviewees to tell us what they thought of the exhibition design and how they used EDFs and AEFs during exhibition development. As such, a semi-structured interview was applied in this experiment.

The interview started with the collection of key demographic data such as name, gender, nationality, residence, occupation, age, educational experience, recent visiting exhibitions and their enjoyment emotion. In-depth interviews with clients and designers and the use of questionnaires in the survey established a comprehensive database. This database was used for the understanding of exhibition factors applied by clients and designers during design projects with a final list of 68 items to identify EDFs, and of 20 items to identify AEFs, used by clients and designers. The questionnaire section was designed using 10-point Likert type scales (1=unimportant to 10=very important).

4.3.4 Participants and procedure

Sample

Data were collected in the summer of 2016 from a total of 11 participants (client=7, designer=4) who had involved or designed both cultural and commercial exhibitions. Participants were selected on the basis of two standards as inclusion and exclusion criteria in this interview survey: Firstly, the client participants should be the person in charge of the unit with the experiences related to exhibition projects; secondly, for designer participants, they should have received their design degree on 2010 or before. Also, they should have experience of designing and building either commercial or cultural exhibitions. As Participants in China were individually interviewed by the researcher in a face-to-face encounter lasting 60 minutes duration on average, and in some case up to 90 minutes. Participants in other countries were interviewed by email method. They were encouraged to freely discuss their views of exhibition and exhibition design.

Semi-structured interviews took place in offices, in email or in the homes of interviewees. It was decided by the busy situation of the interviewees both

designers and clients that they have to usually travel different sites with projects. The proposed interview locations were thus depended on their available schedule and conditions. Participants were voluntarily recruited through two ways: some are accessed by interpersonal relationship, and others recruited with the email inquiry or social internet. The face-to-fact interview was semi-structured in nature with specific open-ended questions, and was conducted in a relaxed conversational environment. These questions were driven by the participants' answers to ensure '*first-person descriptions*' (Petitmengin 2009).

Procedure

After a warming-up and self-introduction stage, interviewees were given 10 minutes to fill in participant information, and the relevant definitions used in the experiment were introduced to interviewees such as EDFs, AEFs, MEME, and Tools (shown in Appendix III). Then s/he was asked to give an in-depth description of their experience and their viewpoints. A stimulus with a diagram of exhibition design progress instructed to the participants focused on three types of stakeholders: clients, designers and audiences within the whole communication progress of exhibition design (shown in Table 4.29 and 4.30). Of the flow diagram, interviewees were asked to choose the most influential part in exhibition design progress with their reason for another 10 minutes. Furthermore, they were also asked to rate the exhibition factors. The interviews were then transcribed and translated into English from Chinese, following which a content analysis, coding progress and statistical analysis were carried out.

Ethical considerations

The experiment obtained ethical approval for the qualitative study from the University of Nottingham's Research Ethics Committee. Participant-consent-form and participant-information-sheet issued by the research ethics committee of the University of Nottingham were provided all interview participants, to insure the respondents' confidence and devote themselves with relaxation manner and accurate attitude. Although most participants accepted to present their name in our academic publications, the anonymity of individuals and organisations needs to be ensured in this thesis, with careful considerations of ethical issues.

Table 4.29. Backgrounds of interview subjects investigated (clients).

Coded identifier	Gender	City of Residence	Age	Education	Visiting experience		Time of interview
					Recent visiting	Enjoyable or not?	
Pc1	Male	Hangzhou, China	66+	Professor	West Lake Exposition	Yes	2nd August, 2016
Pc2	Male	Ningbo, China	36-50	Master	-	Yes	9th August, 2016
Pc3	Male	Ningbo, China	66+	Professor	Expo Shanghai 2010, Ningbo Education Museum	Yes	12th August, 2016
Pc4	Male	Ningbo, China	66+	Bachelor	-	-	27th August, 2016
Pc5	Male	Shanghai, China	36-50	Doctor	-	-	30th August, 2016
Pc6	Female	Ningbo, China	36-50	Bachelor	High-level talent intelligence introduction fair, Smart city expo,	Yes	14th October, 2016
Pc7	Male	Ningbo, China	51-65	Bachelor	Fashion fair, residential product exposition	Yes	4th November, 2016

Table 4.30. Backgrounds of interview subjects investigated (designers).

Name (identifier)	Gender	City of Residence	Age	Education	Exhibition design experience		Time of interview
					Working years	Recent projects	
Pd1	Male	Ningbo, China	21-35	Bachelor	Since 1986-1995	Ningbo Academy of Agricultural Science	21st July, 2016
Pd2	Female	London, UK	21-35	Master	Since 2006	Defining British Art exhibition, a landmark exhibition to celebrate Christie's 250th anniversary	16th August, 2016
Pd3	Male	Milano, Italy	21-35	Master	Since 2006	Kristalia-Salone Del Mobile 2016, Sabiana Expocomfort 2016	7th September, 2016
Pd4	Male	Ningbo, China	21-35	Bachelor	Since 2006	Rail Transit-Home of Volunteers	14th October, 2016

4.3.5 Data analysis

Data collected from the interview were organized, analysed in NVivo software that '*supports qualitative and mixed methods research*'[33], and computed using the SPSS software that focuses on statistical analysis widely used in social science. The qualitative data analysis software NVivo 11 plus was used to conduct a content analysis for the interview transcripts and coding progress. The quantitative analysis software SPSS 22 was used to produce the descriptive and inferential statistics. Audio recordings of interviews were transcribed in Chinese and translated into English. It followed a two-stage analysis procedure with the data collection after each interview, and following a grounded theory analysis (Clarke, Saville et al. 2014).

As a result of this study, 11 single samples of designers' and clients' subjective view of exhibition development, project conduction/management, evaluation for exhibition design, EDFs, and AEFs used. A total of 69 EDFs and 20 AEFs were examined in the experiment. The focus of data analysis was on the factor identification in exhibition development that was used by clients and designers.

4.3.6 Results

Most participants (70%) lived in China and the other two in Italy and UK respectively. Interviews were conducted by researcher in Chinese language (n=9) or in English (n=2) language. The sample comprised 9 males (90%) and 2 females (10%), who spanned a range of ages between 21 and 66+ years (M=50). Participants in China were individually interviewed by the researcher in a face-to-face encounter lasting 60 minutes duration on average, and in some case up to 90 minutes. Participants in other countries were interviewed by email method. They were encouraged to freely discuss their views of exhibition and exhibition design.

EDFs and AEFs used by designers and clients

The findings of the semi-structured interviews indicated that a total of 69 EDFs items (shown in Table 4.31) and 20 AEFs items (shown in Table 4.32) were used by both exhibition designers and clients investigated. Among EDFs, there are 15 EDFs in all (Mean≥9.00), including exhibition design factors (M=9.67, SD=070), content (M=9.45, SD=1.03), design language (M=9.30, SD=.82), client (M=9.30, SD=1.16), aesthetics (M=9.30, SD=1.05), exhibit (M=9.27, SD=1.10), marketing (M=9.27, SD=1.10), budget (M=9.20, SD=1.03), signage (M=9.09, SD=1.22), collaboration (M=9.00. SD=1.05), audience (M=9.00, SD=1.33), style (M=9.00, SD=.94), colour (M=9.00, SD=1.33), space (M=9.18, SD=.75), and lighting (M=9.00, SD=.77).

[33] Referenced from the official website of QSR International Pty Ltd: http://www.qsrinternational.com/what-is-nvivo.

For AEFs, there is one factor, Mean≥9.00 (satisfaction, M=9.10, SD=.87) and five factors (8.50≤M≤9.00) such as service (M=8.90, SD=1.22), creativity (M=8.63, SD=1.68), understanding (M=8.54, SD=1.43), authenticity (M=8.54, SD=1.29), and engagement (M=8.50, SD=1.43). In addition, Pc1 mentioned '*new, strange, and special*' as AEFs, while the interviewee Pd3 reported that:

> 'We have to create curiosity in the audience' and 'leisure-curiosity-fun as element to improve and to have good response from audiences' (Pd3).

Table 4.31. Exhibition design factors (EDFs) used by designers and clients.

EDFs used	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Exhibition design factors	9	8	10	87	**9.67**	.70
Content	11	7	10	104	9.45	1.03
-Text	11	6	10	98	8.91	1.30
-Graphic	11	5	10	93	8.45	1.50
-Label	11	5	10	88	8.00	1.54
-Multimedia	11	7	10	90	8.18	1.25
-Exhibit	11	7	10	102	9.27	1.10
-Brief(report/proposal)	10	5	10	75	7.50	1.84
-Concept	11	5	10	91	8.27	1.61
-Meaning	11	5	10	91	8.27	1.61
-Others	2	5	10	15	7.50	3.53
Technology	11	5	10	96	8.73	1.61
-Internet	10	5	10	84	8.40	1.95
-Mobile	11	5	10	90	8.18	2.04
-Touch-screen system	11	5	10	85	7.73	1.90
-Digital interaction	11	5	10	87	7.91	2.02
-Virtual reality	11	5	10	86	7.82	1.88
-Augmented reality	11	2	10	80	7.27	2.64
-Mixed reality	11	2	10	80	7.27	2.64
-Hologram	11	2	10	83	7.55	2.38
-Sensor	11	2	10	85	7.73	2.49
-Laser cutting	11	2	10	79	7.18	2.31
-Robot	11	2	10	71	6.45	2.65
-Others	2	4	7	11	5.50	2.12
Culture	11	6	10	98	8.91	1.44
-Crossing	9	5	10	73	8.11	1.83
-Collaboration	10	7	10	90	9.00	1.05
-Others	0	-	-	-	-	-
Social	10	6	10	85	8.50	1.43
-Communication	9	7	10	82	9.11	1.36
-Others	1	10	10	10	10.00	-
Audience	10	6	10	90	9.00	1.33
-Behaviour	10	5	10	77	7.70	1.76
-Emotion	10	6	10	81	8.10	1.66
-Gender	10	4	9	71	7.10	1.72
-Sensation	10	5	10	76	7.60	1.57
-Age	10	4	10	76	7.60	1.64
-Personality	10	5	10	81	8.10	1.59
-Others	0	-	-	-	-	-
Design language	10	8	10	93	9.30	.82
-Style	10	8	10	90	9.00	.94
-Narrative	9	6	10	78	8.67	1.32
-Interaction	9	8	10	80	8.89	.92
-Ergonomics	10	7	10	85	8.50	1.17
-Aesthetics	10	7	10	93	9.30	1.05
-Prop	9	6	10	72	8.00	1.22
-Shape	10	6	10	84	8.40	1.50
-Colour	10	6	10	90	9.00	1.33
-Texture	10	5	10	76	7.60	1.57
-Time	10	5	9	77	7.70	1.33
-Model	11	5	10	88	8.00	1.67
-Motion	11	5	10	91	8.27	1.48
-Technical drawing	10	5	10	75	7.50	1.50
-Others	1	9	9	9	9.00	-
Environment	11	5	10	95	8.64	1.56
-Space	11	8	10	101	9.18	.75
-Lighting	11	8	10	99	9.00	.77
-Signage	11	6	10	100	9.09	1.22

Continued Table 4.31

-Temperature	11	4	10	83	7.55	1.86
-Architecture	11	7	10	92	8.36	.80
-Others	0	-	-	-	-	-
Marketing	11	7	10	102	9.27	1.10
-Client	10	7	10	93	9.30	1.16
-Requirement	10	7	10	87	8.70	1.25
-Budget	10	7	10	92	9.20	1.03
-Servicesscape	11	6	10	96	8.73	1.27
-Rules and regulations	10	6	10	85	8.50	1.43
-Others	0	-	-	-	-	-

Table 4.32. Audience experience factors (AEFs) used by designers and clients.

AEFs used	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Audience experience factors	11	6.0	10.0	93.0	8.45	1.21
-Motivation	11	7.0	10.0	93.0	8.45	1.12
-Satisfaction	10	8.0	10.0	91.0	**9.10**	.87
-Understanding	11	5.0	10.0	94.0	8.54	1.43
-Engagement	10	5.0	10.0	85.0	8.50	1.43
-Emotional	10	5.0	10.0	78.0	7.80	1.93
-Service	11	6.0	10.0	98.0	8.90	1.22
-Attention	11	5.0	10.0	93.0	8.45	1.63
-Curiosity	10	5.0	10.0	82.0	8.20	1.61
-Creativity	11	5.0	10.0	95.0	8.63	1.68
-Cool	11	4.0	10.0	78.0	7.09	2.07
-Interesting	11	5.0	10.0	88.0	8.00	1.73
-Fun	11	5.0	10.0	87.0	7.90	1.64
-Leisure	11	5.0	10.0	86.0	7.81	1.83
-Learning	11	5.0	10.0	91.0	8.27	1.48
-Participation	11	5.0	10.0	88.0	8.00	1.78
-Memory	11	5.0	10.0	79.0	7.18	1.47
-Reflection	11	5.0	10.0	79.0	7.18	1.53
-Authenticity	11	7.0	10.0	94.0	8.54	1.29
-Others	0	-	-	-	-	-

In line with the results presented in Table 4.31 and 4.32, the analysis was further progressed in a correlation between EDFs and AEFs used by designers or clients. It analyzed the samples with 68 EDFs (M=7.83, SD=2.12) and 19 AEFs (M=8.15,SD=.56), which found that there is significant correlation (ρ=.51, sig=0.02) between EDFs and AEFs in the semi-structure interview survey (shown in Table 4.33). This tends to provide a basic research direction to explore the interactive relationship among exhibition factors such as in the level of algorithm model, further indicated in Chapter 7.

Table 4.33. Correlations of EDFs and AEFs used by designers or clients.

		EDFs	AEFs
EDFs	Pearson Correlation	1	.511
	Sig. (2-tailed)	-	.025
	N	68	19
AEFs	Pearson Correlation	.511	1
	Sig. (2-tailed)	.025	-
	N	19	19

Tools used by designers and clients

Participants were required to rate the eight tools that were used by designers and clients during their exhibition design projects. The highest two rates of tools as presented in Table 4.34 are '*advice from client*' (M=8.82, SD=1.66), and '*design software*' (M=8.67, SD=1.73). In particular, more design softwares were reported by three exhibition designers, including '*3dmax, Photoshop, CAD*' (Pd1), and

'*Vector works, Cinema 4D, Photoshop, InDesign/Illustrator*' (Pd2). Most clients considered '*professional advice from designer*' (Pc1, Pc2, Pc3, Pc6, Pc7) as '*used very often*', while many designers chose '*design software*' (Pd2, Pd3, Pd4). However, it doesn't mean '*client*' was omitted, instead, the predominant role of the client was highlighted by both Chinese, UK, and Italy exhibition designers. Although the '*advice from researcher*' was emphasized, few participants mentioned that for exhibition development, there might be a gap between theory and practice (Pc5, and Pd1), which particularly reflected in designers rather than clients. For example, the lowest score of interviewee Pc5 mentioned that '*exhibition is a practical knowledge*' instead of '*work behind closed doors*' and '*theoretically*'.

Table 4.34. Tools' daily use in designers' and clients' professional careers of exhibition design.

Tools used	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Advice from designer/client	11	5	10	97	**8.82**	1.66
Professional advice from researcher	11	3	10	75	6.82	2.44
Feedback from audience	11	2	10	75	6.82	2.44
Interaction with audience	11	4	10	83	7.55	2.16
Standards	11	2	10	83	7.55	2.69
Databases	11	2	10	75	6.82	2.63
Literature	11	4	10	74	6.73	2.19
Design software	9	5	10	78	8.67	1.73
Others:	3	5	9	21	7.00	2.00
Others:	1	9	9	9	9.00	-
Others:	1	9	9	9	9.00	-

Evaluating exhibition design

Ten out of eleven interviewees (a missing from Pd2) considered it was important to evaluate exhibition design (shown in Table 4.35). For instance, interviewee Pc3 indicated that:

> 'Evaluating the effectiveness of exhibition design makes sense not only to this exhibition, but also to the future exhibition. It can summarize some of which are successful, and which are not' (Pc3).

Most of interviewees rated '*evaluation before exhibition built*' as the maximum score, because it is concerned '*as basis*' (Pc1) and '*fundamental*' (Pd3), '*don't waste money*' (Pc3), '*execution and improvement*' (Pc4), '*the first step*' (Pc7), '*blueprint*' (Pc5), '*subsequent beautiful project*' (Pc6), and '*security*' (Pd4). During-evaluation was highlighted by all interviewee as well because it directly affects the final result of exhibition design through interaction between clients and designers. As described by interviewee Pd3, it '*helps you to correct problems during the real assembly, and to find the right solution to satisfy better the client*'. There were others who considered '*after exhibition built*' was ignorable or insignificant (Pc5, Pd4). But it was still regarded as a kind of further development (Pc2, Pd3),

ongoing modification (Pc4, Pd1) or experience-sharing (Pc2, Pc3, Pc6, Pd1). However, most interviewees reported that they couldn't find sufficient tools for evaluating exhibition design.

Table 4.35. The importance of evaluating exhibition design based on designers' and clients' experiences.

Evaluations used	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Evaluation before exhibition built	10	5	10	86	**8.60**	1.83
Evaluation during exhibition built	10	3	10	79	7.90	2.28
Evaluation after exhibition built	10	2	10	68	6.80	2.82

Identifying the most influential part in exhibition design progress

Interviewees were required to mark a graph about which ones are the most influential part of exhibition design process, and provide their reason. Figure 4.33 illustrates an exhibition design model modified from the communication model (Cobley 1996). It means there is an interactive communication among clients as senders, designers as transmitters, exhibition design as channel, audiences as the receivesr, and feedback/evaluation, along with essential parts including message, meaning/concept, information/content, decision-making/memory, meme, EDFs, and AEFs.

The result shows that there are different options between client and designer interviewees (shown in Table 4.36). For client interviewees, '*designer*' was marked by most client interviewees (86%), while just fifty percent of designer interviewees chose the part of 'client'. In particular, the interviewee Pc2 mentioned that although the clients should be the key part in practice,

> 'It may actually be possible to consider audience as the main aspect. But now the real life is client-oriented, otherwise I (client) won't get it through. In fact, you are the exhibition designer, who should be audience-targeted rather than client-targeted; however, in the real world, it is always client-targeted, isn't it? Because I paid the bill, so you have to care for me. Otherwise, this will depend on the level of the client.' (Pc2)

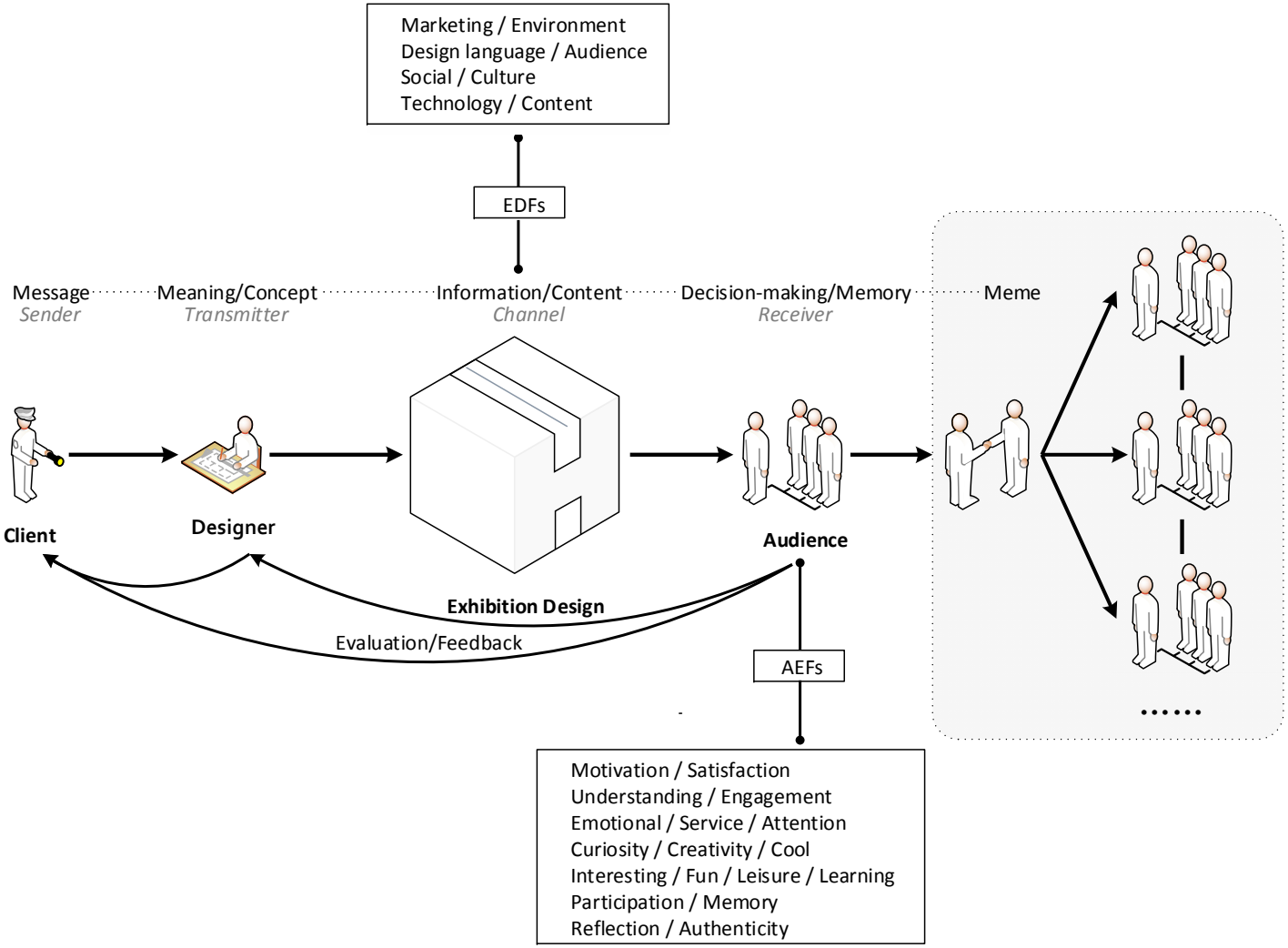


Figure 4.33. Exhibition design progress (modified from Cobley, 1996).

Almost all of the parts illustrated in the graph were marked except AEFs and Meme. This implies that although the role of the audience had been received some attention, unfortunately it still lacks systematic and targeted instructions or tools during designing exhibition. For example, a total of 85% client interviewees and 50% designer interviewees reported it needs to understand audiences and their feedback, however most of them considered it was not clear during exhibition design process. In interesting part is both UK and Italy exhibition designers claimed it was '*essential requirement*' (Pd2) and '*only instrument*' (Pd3) to help design better exhibitions through understanding audiences and their feedback; instead, two Chinese exhibition designers though it not as an essential section.

Table 4.36. Most influential part in exhibition design process marked by clients and designers.

Marked part	Identifier	Supportive quotes from interviewees
Designers	Pc1	'Designer is very important because he/r is the active constructor.'
	Pc4	'You design for audience, right? But if you have to make a good work, it must need someone to work it out. This is a basic due to ninety percent or ninety-five percent of audiences who don't know how to design it.'
	Pc7	'The designer likes a central nervous system, including the requirements of clients and audiences, which is a kind of information integration system integrated through design. It is connecting link between clients and audiences.'
Meaning/Concept	Pc1	'This is the decisive factor.'
	Pd3	'Concept-important but can develop during the process, starting as an unexpressed idea and arriving to be developed as a big theory.'
Clients	Pc2	'But in reality, it is client in the real life, because the client is paying money'
	Pd3	'The key to reach the best results.'
Feedback/ Evaluation	Pc3	'I think its success or failure of an exhibition design must depend on the core issue.' 'This is not only to view your design itself, but rather to understand the feedback of audiences. Therefore, it is very important, which means the feedback from audiences is of much concern.'
	Pd3	'Sometimes not so valued but in trade stands I believe that it would have been considered the trademark to insure customer faithfulness.'
All part	Pc5	'All are important, I feel there is no single most important part. Every section is essential, and it won't do well if each part won't do well.'
Exhibition Design	Pc6	'I think exhibition design must be the most important. Because you present this kind of model, and only when the model is shown, your front can be satisfied, and your following can also be met.'
	Pd3	'Executive process: during this phase the starting concept or architectural first drawings find solutions or failures, so I believe that is a central part of the entire process, in which you could find changes and perhaps new directions to the first ideas you had considered at the starting point.'
	Pd4	'I believe the display would be more important. This is because since we have made it this far, it means the work was ok, and the clients have accepted.'
Clients and Audiences	Pd1	'Because they interact with each other. For example, like politically speaking, production decided consumption and consumption also stimulated production, and thus they are complementary. ' 'There was the development of exhibition between the two: one is client, and another is audience, which means the communications or conversations between them. But there is a mutual promotion between the two subjects, which can enhance the development of exhibition design.'
Exhibition design/EDFs	Pd2	'Exhibition design (marketing/environment/designlanguage/audience/social/culure/technology /content) is the most influential and important part of the overall process. It is the incubation box where all can happen and where good design can be developed in order to achieve the final goal, previously defined in the brief.'

4.3.7 Discussion

This section investigated the application of EDFs and AEFs in the view of clients and designers. Interviews with clients and designers to the exhibition design have revealed that the specific role of exhibition design in the development of sociocultural and socioeconomic context, whereas it requires more attention with both systematic theoretical and practical support. Although EDFs and AEFs have been found in both perception of clients and designers, we suggest that HEI framework with embedded EDFs, AEFs, and BD offers a valuable direction for strengthening the communication role of exhibition design. More exhibition design studies tend to develop the theory and practice of the applications of HEI in exhibition design. Although '*the above is very complete, and nearly all listed*' (P8), a UK designer (Pd2) indicated that:

> 'It is difficult to give a generic vote to several factors' due to that 'they constantly change in terms of role, function and importance in each specific exhibition'. (Pd2)

Interviewees can identify the differences between the commercial exhibition and cultural exhibition. Compared with cultural exhibition that focuses on '*cultural heritage and display*' (Pc1), '*public benefit*' (Pc2), '*cultural development*' (Pc4), '*non-profit*', '*education*' and '*cultural-communicated*' (Pc5), '*government-led*' (Pc6), '*service for publication*' (Pc7), '*promoting humanistic spirit*'(Pd1), '*provide new knowledge*' (Pd2), '*produce a content*' with '*cultural/historical aspects*' (Pd3), and '*more artistic*', '*more abstract*' and '*more ideas*' (Pd4), commercial exhibition highlights '*substance-oriented*' (Pc1), '*content and money-making*' (Pc2), '*domestic and foreign trade*', '*economic benefits*' and '*national influence*' (Pc4), '*sale promotion and brand promotion*' (Pc5), '*substantial benefits and profits-obtained*' (Pc6), '*service for business*' (Pc7), '*commercial communication between companies and consumers aiming to profits*' (Pd1), '*sell to clients/customers*' (Pd2), '*subjected to industry way*' and '*stressing but fascinating*' (Pd3), and '*business for money*' (Pd4). However, it was also pointed out concerning the blurring trend between commercial exhibition and cultural exhibition (Pc1, Pc2, and Pc5).

Interviewees presented their opinions on exhibition design and the difference among product/industrial design, interior design and other design disciplines. They emphasized that as a new discipline, exhibition design should be further developed thus meeting the requirements for the development of economy and society. The reality is that current exhibition designers were diverted from other professions or disciplines rather than specialized knowledge of exhibition design (Pc1, Pc2, Pc4, Pc5, Pd1).

But the establishment of the exhibition design should care for employment (Pc2), the needs for marketing (Pc7), teaching materials, construction of teacher troops,

and teaching pattern (Pc2, Pc3), and social needs (Pc4, Pc6). Particularly, the interviewee P5 described that if establishing the subject for exhibition design, four aspects should be involved: multivariate, trans-boundary, integration, and value recreation (Pc5). The interviewee P1 proposed that:

> 'It must be a basic subject, basic theory, basic thinking, and basic orientation. So I personally suggest and hope to which a university can establish the subject of exhibition design for solving the problem in theory at first' due to that 'most of our disciplines or colleges are too distributed' (Pc1).

Limitation

There are a few limitations of the study. The first is the omission of other exhibition factors that were used by clients and designers. Although the chosen EDFs and AEFs are the main part of these factors under the identification method of systematic review, the more developed factors are an objective existence in exhibition design. We can identify 23 EDFs and 32 AEFs by grounded theory, interview analysis, and questionnaire analysis. However, none of these objective exhibition factors were systematically all included in the experimental setup. The dynamic and developing exhibition factors should be investigated in future studies.

Second limitation concerns the research methods. Making participants to answer and rate a set of questions and items allowed us to have an experimental control over the investigated exhibition factors. However, no one can guarantee that clients and designers would consider unrelated or non-typical factors. Accordingly, the accuracy and uniqueness of the study are considered limited. But based on the current situation that little empirical knowledge regarding the EDFs and AEFs in the exhibition design domain, the study can provide an insight into how clients and designers apply EDFs and AEFs in exhibition design and development.

5 Framework for designing enjoyable exhibition (FDEE)

This chapter aims to answer the research question: How can an exhibition be designed by using EDFs and AEFs? It divides into two sub-questions including how are enjoyable exhibitions designed by using EDFs and AEFs? And how can the exhibition design framework be applied to design exhibitions that creats enjoyment?

5.1 Chapter overview

This chapter presents a new framework for designing an enjoyable exhibition. It falls within the broad category of framing audience experience and HEI, which was discussed in previous research (Section 3.6.1) and Section 3.2 with the characteristics of circular journeys (Falk 2009, Falk and Dierking 2012), and interaction (Carù and Cova 2007, Falk and Dierking 2012). This type of framework was also noted to consider the performance and transformation (Section 3.2). The framework developed in the chapter combined the discussion on the basis of HEI model (Section 3.6.1). This combination enabled enjoyable exhibition design to be made both in theory and technique. It also can be considered as an exploration of starting to design a better exhibition for both audiences and clients.

5.2 Three stakeholders

5.2.1 Considering audiences

Considering audiences is the first and essential step to design enjoyable exhibition, as shown in Figure 5.34. They are accustomed to be ignored due to the limitations in reality such as the level of budget, clients or designers (discussed in Section 4.3). However, the audiences who are involved in the sociocultural and socioeconomic, have the essential power on deciding their time to visit, or leave the exhibition (Chen and Ho 2003, Falk and Dierking 2012, Bogle 2013). We thus should '*respect for*' (Schwarz et al., 2005, p.23) audiences with audience desired, audience agenda, and audience questions (Kolter and Kolter 1998, Falk and Dierking 2012, Bogle 2013).

Figure 5.34. Basic framework for considering audiences in exhibition design.

5.2.2 Clients and designers

The exhibition message is generated by clients, and sent to designers, the transmitter during the exhibition development process (Chuan, Kun et al. 2006). As Figure 5.35 indicated, clients makes decisions that determine what the messages should be delivered, and what the designer should be the transmitter (Whittle 1997, Lin 2002), with purpose of economic, marketing, and communication (Shaw 2007, Falk and Dierking 2012, Hou 2015). Messages they communicate include explicit message and implicit message (Locker 2011). The first is related to how exhibitions are objective arranged with obvious EDFs generally (Kolter and Kolter 1998, Dernie 2006), while the second is subjective about those experiential and emotional associations help process the message (Choi 2010, Locker 2011, Rodgers and Thorson 2012). Audience/consumer seeks meaning in nature (Carù and Cova 2007), and exhibition focuses on meaning making (Section 2.3.6). Accordingly, the final outcome should be the results of meaning making from exhibition designers (Berger, Lorenc et al. 2007, Bitgood 2010). Clients, designers, and messages are all influenced within sociocultural and socioeconomic contexts (Falk 2009, Falk and Dierking 2012).

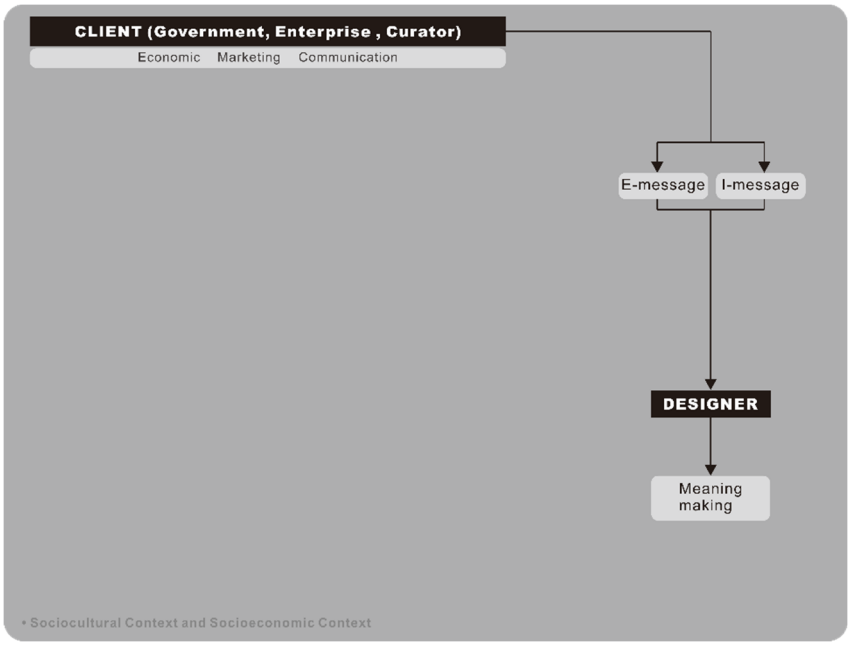


Figure 5.35. Basic framework with clients and designers in exhibition design.

5.2.3 Combining clients, designers and audiences

Although '*human are experts at meaning-making*' (Falk & Dierking, 2012, p.195), exhibition design needs to be driven by the interaction that communicating message among clients, designers, and audiences shown in Figure 5.36 (Achiam, May et al. 2014). In general, story-telling is used as the key tool by the designers in terms of meaning-making (Berger, Lorenc et al. 2007, Wasserman, Hayde et al. 2015). Besides story-telling/narrative, framework of designing enjoyable exhibition (FDEE) considers the design process as the performance at exhibitions. During the performance, the BD from audiences and EDFs used by designers should be identified for exhibition design. Furthermore, designers have to realize the application of AEFs in the aspect of meaning-making (Silverman 1995, Falk and Dierking 2012, Roppola 2013), which actually are also desired by audiences during viewing exhibitions. Accordingly, exhibition has become a transformative space where facilitates audiences experiencing an enjoyable transformation during their exhibition journey.

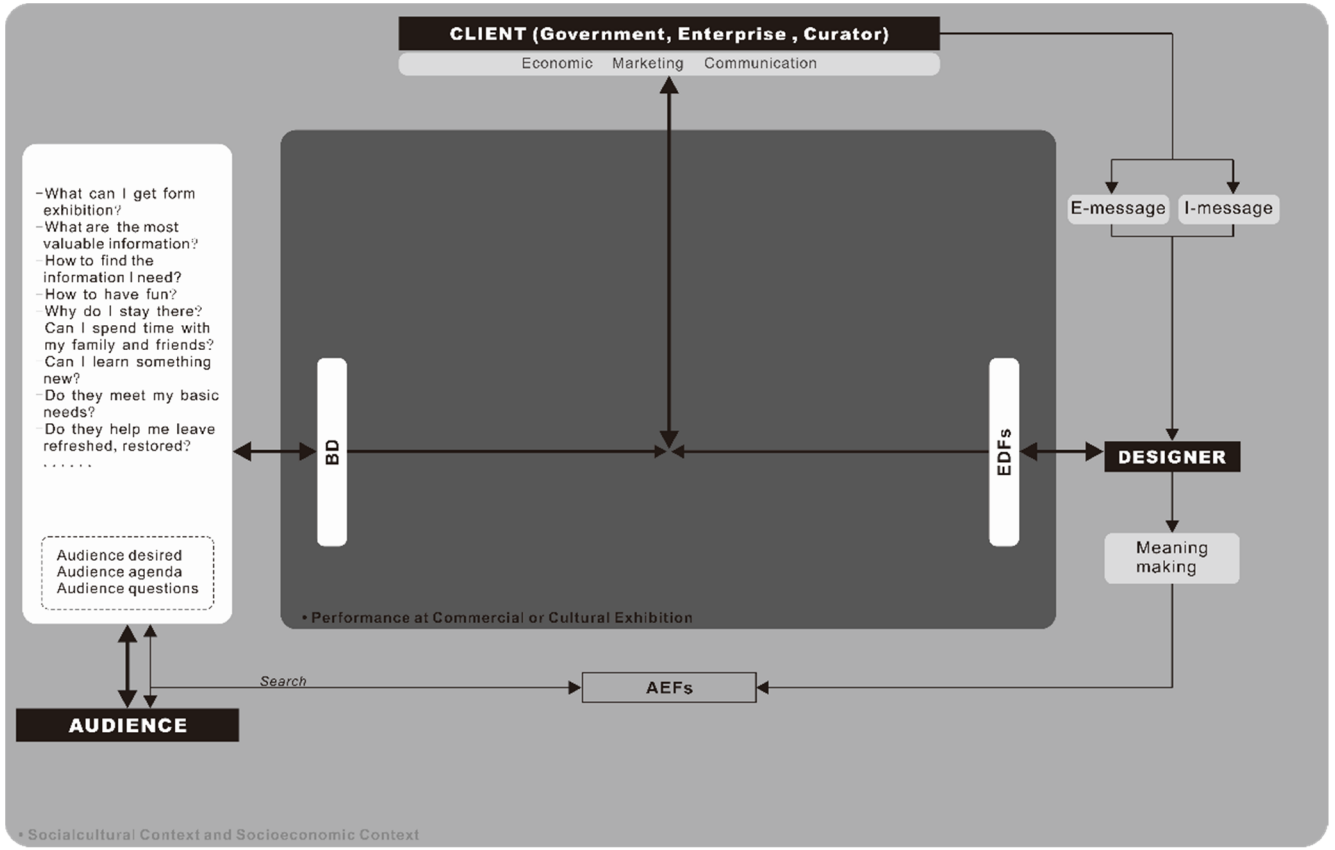


Figure 5.36. Expanded framework of combining three stakeholders.

5.3 Collaborative data for evaluation

During performance and transformation of enjoyable exhibition, the method of collaborative data is used, including EDFs (Figure 3.23), AEFs (Figure 3.25), and BD (Figure 3.24). As Figure 3.25 illustrated, BD includes postures and physiological index, with sub-factors; EDFs contain 56 factors in all, including content, technology, culture, social, audience, design language, environment, and marketing, of which also has sub-factors; AEFs involved a total of 23 factors, according to three types: pre-experience, during-experience, and post-experience. It is suggested that the evaluation for the performance and transformation may be conducted by an evaluator, due to the previous studies that found there were limitations for evaluating exhibitions just depending on designers or clients themselves (Miles and Alt 1988, Berger, Lorenc et al. 2007, Bogle 2013). Because it is not easy for them to evaluate an exhibition from a systematic and holistic standpoint, rather than from their own business only. It involves three evaluation stages (front-end evaluation, formative evaluation, and summative evaluation) and two basic tools (measures/parameters, and study tools). The results of evaluation based on collaborative data are provided to three stakeholders for further improvement and development.

Figure 5.37 maps which parts of the framework were developed for designing an enjoyable exhibition. It brings together three stakeholders (clients, designers, and audiences), collaborative data (EDFs, AEFs, and BD), and enjoyment emotion (EE) in the FDEE model, with the conceptual HEI framework described in the Chapter 5.

The performance evaluation regards the '**matching**' of collaborative data as one essential aspect for measurement. For example, during a front-end evaluation, if the audience will pay little viewing time on the exhibition and leave it quickly, the collaborative data with BD, EDFs, and AEFs will be reported to exhibition designers and clients for better modification and development. The results of the report might facilitate designers to improve a new design project for client's decision-making. The improved design project then will influence audiences' behaviour, experience and emotion layer by layer. Chapter 3 provides a theoretical basis that AEFs tend to be transformed to enjoyment, and enjoyment can be measured and visualized by BD. In addition, the communicative interaction among them has been presented in HEI model (Section 3.6.1).

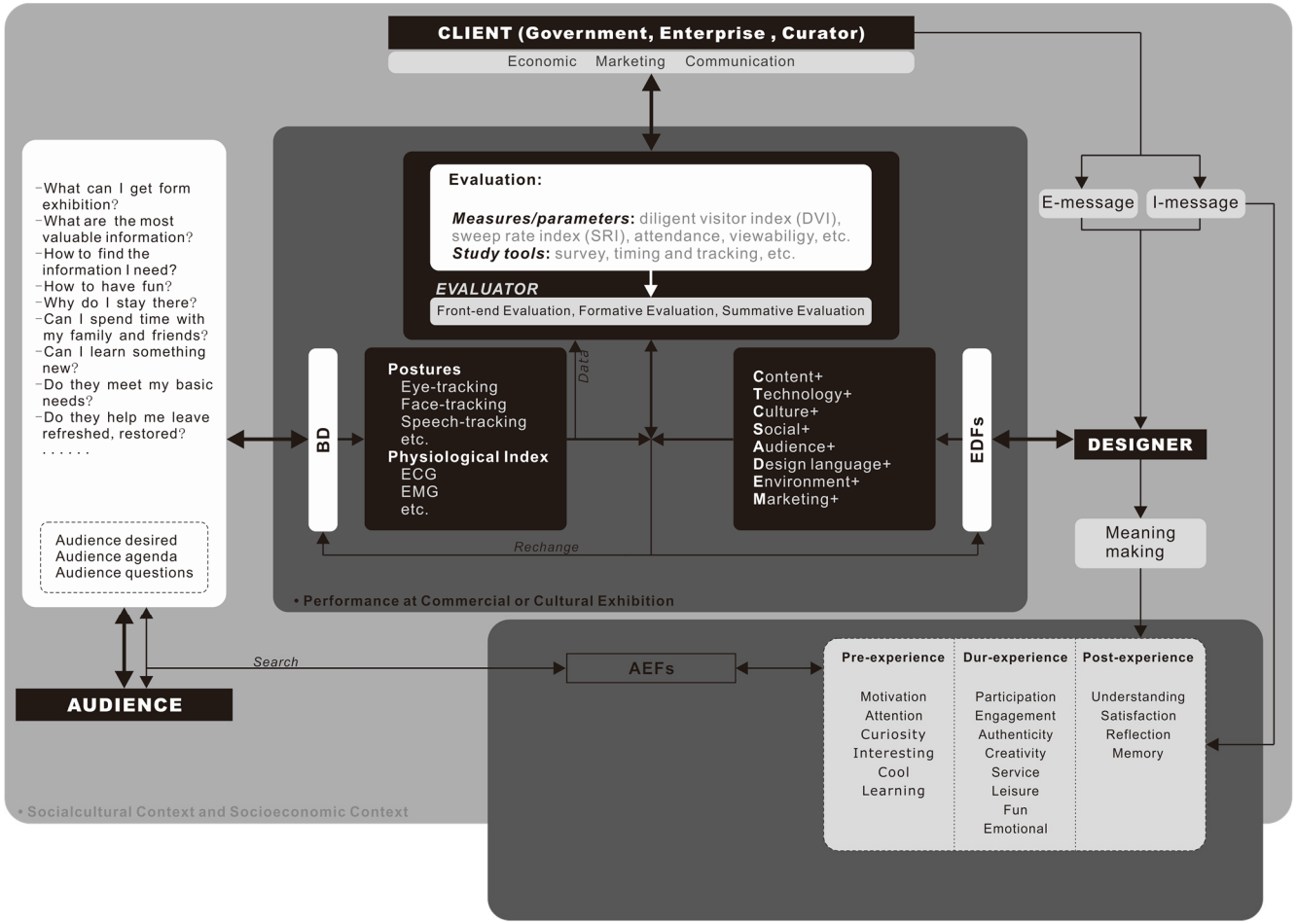


Figure 5.37. Extended framework embedded collaborative data.

Enjoyment emotion is used as an evaluator of audience experience. It bridges the gap between audiences and designers supported with quantitative and empirical data. Exhibition designers will try to transform audiences into a flow state in line with nine factors of flow experience, and then pointing to enjoyment (Section 3.2). Clients' implicit message also can be visualized and met by the transformation from AEFs to enjoyment emotion. Whether from flow experience to enjoyment emotion tends to be another critical aspect for evaluation. Audience, as end-receiver of message-transformed, can gain enjoyment through the meaning-making of the exhibition designers.

In summary, there are two 'switches' of Yes or No added in the framework (shown in Figure 5.38). First refers to whether it is a positive matching among EDFs, BD, and evaluation. If it is marked as Yes, it means the design results can service audiences' visiting in exhibitions. Or else audiences will try to rechange their behaviour, and leaving the exhibition environment designed by EDFs. In this case, it can help exhibition designers to develop a more enjoyable exhibition. Second is whether audiences can be enjoyable during their exhibition journey. If yes, it means a FDEE framework was worked in exhibition development; if not, collaborative data can service designers to redesign their projects. Enjoyment required an interactive transformation with audience, and an enriching and improving transformation with designers. And the first switch offers quantitative data for evaluating the state of enjoyment for exhibition design.

5.4 Discussion and summary

The previous section has shown a developed framework of the FDEE model state. The framework informs that an enjoyable exhibition could be achieved under the combination of FDEE. It also shows that HEI model provides insight into the role played through collaborating data and three stakeholders. For someone interested in the audience-focused nature of better exhibition programs, maybe a pointer provided from the FDEE. However, two things are worth mentioning when considering the enjoyable design framework: one is that the framework is looping and iterative, according to the critical aspects of studying audience experience (Section 2.5.1) and the nature of design process (Brown 2008, Crimm, Morris et al. 2009, Albert and Tullis 2013, Allanwood and Beare 2014, Cash and Štorga 2015); another is although evaluator is suggested to conduct the evaluation for exhibition design, designers or clients can also use FDEE framework serviced for exhibition development.

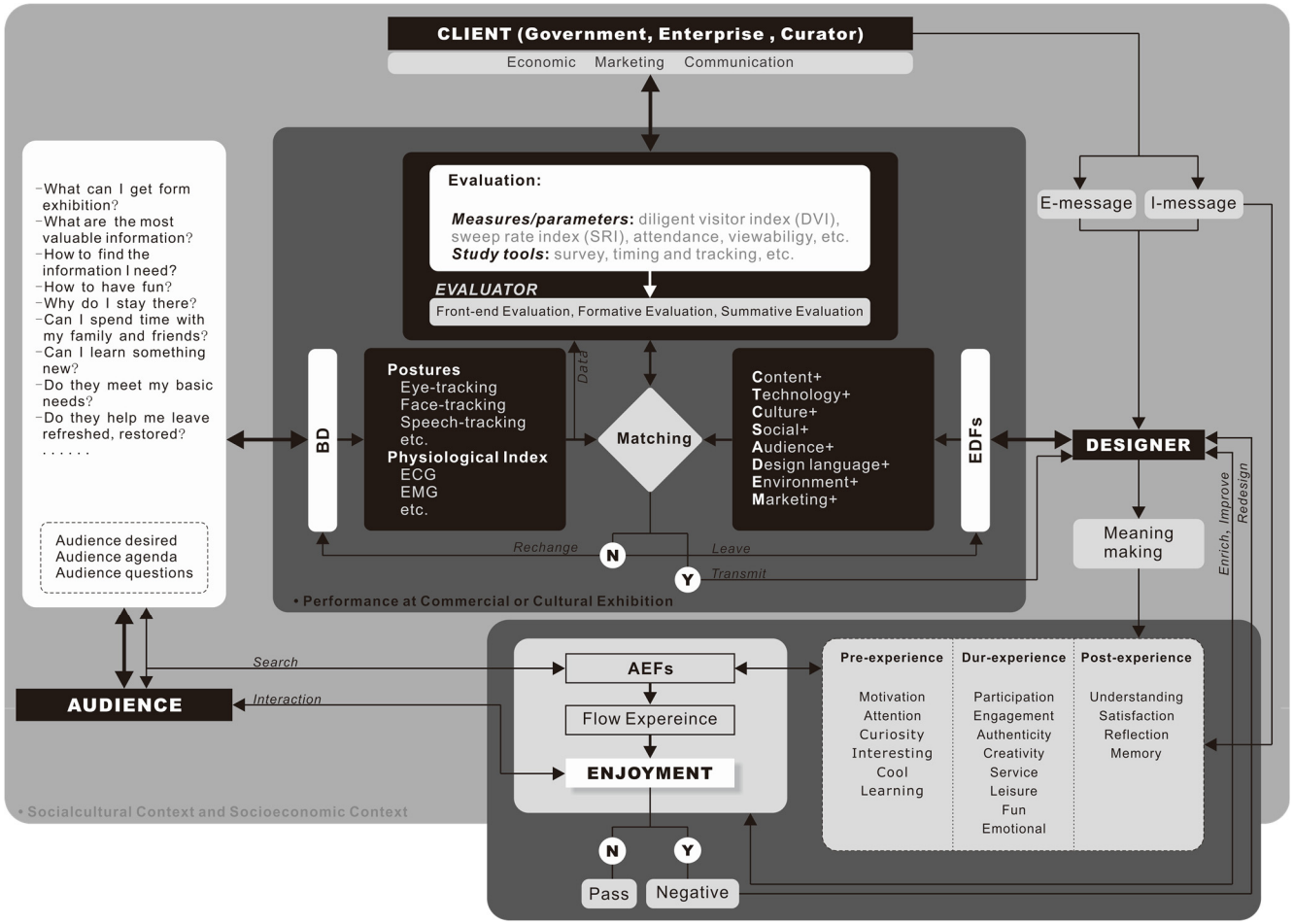


Figure 5.38. Framework for designing enjoyable exhibition (FDEE).

The previous section has shown a developed framework of the FDEE model state. The framework informs that an enjoyable exhibition could be achieved under the combination of FDEE. It also shows that HEI model provides insight into the role played through collaborating data and three stakeholders. For someone interested in the audience-focused nature of better exhibition programs, maybe a pointer provided from the FDEE. However, two things are worth mentioning when considering the enjoyable design framework: one is that the framework is looping and iterative, according to the critical aspects of studying audience experience (Section 2.5.1) and the nature of design process (Brown 2008, Crimm, Morris et al. 2009, Albert and Tullis 2013, Allanwood and Beare 2014, Cash and Štorga 2015); another is although evaluator is suggested to conduct the evaluation for exhibition design, designers or clients can also use FDEE framework serviced for exhibition development. Because in many cases, exhibition projects have to receive the constraint of budget, thus there are no additional funding on an evaluator (Bogle 2013); moreover, evaluation is, in itself, one of the inner natures that support their decision-making during designing exhibitions (Barriault and Pearson 2010).

This chapter has developed the conceptual framework for this thesis. After an illustration of literature review, HEI model, and exploratory experiment 1a, experiment 1b, and experiment 2, they were used to present a refined conceptual framework FDEE. It was then shown how each part of the FDEE framework was brought together from previous chapters' findings. Table 7.43 (Section 7.2) indicates the framework map this thesis contributed to how they address the research questions; how they design an enjoyable exhibition. The following chapter will reconnect to the framework and illustrate what is the relationship among BD, EDFs and AEFs with empirical study.

6 Identifying relationship among EDFs, AEFs, and BD (Experiment 2)

Experiment 2 tries to settle the third question group in this chapter: How can behavioural data be used to get more reliable and valid data of enjoyment emotion in exhibitions? It involves two sub-questions such as what are the methods, approaches and tools about enjoyment emotion in exhibitions? And how can behavioural data be used to understand the impact of EDFs in enjoyment emotion in exhibitions?

6.1 Introduction

The research work conducted in this chapter presents the relationship among EDFs, AEFs, and BD during audiences' viewing in exhibitions, by using a mixed method. This included investigations through enter- and exit-questionnaire, timing and tracking, and observation, which in particular enabled wearable equipment including eye-tracking, wireless sensors to identify exhibition factors. The equipment used in this experiment received the support from the Nottingham-HeFeng Innovation Laboratory[34]. The scenario under investigation was a series of exhibitions in the Art building at the College of Science & Technology Ningbo University, which displayed student design works from four specialities: Drawing, illustration design, product design, and environment design. This building with two-story exhibition halls was chosen as the layout was sufficient to offer a visiting routes and time for observation, and received the support of the Dean of the college. Furthermore, it can be regarded as a controlled experimental environment, which facilitates the access to site approval, participants, and equipment protection. The progress of the experiment with wearable equipment aroused the attention and interesting of potential participants. However, it may be interference of the experiment conduction and potential risk of touching the equipment in an accident.

The conduction of wearable equipment for obtaining BD in the exhibition field has many inherent difficulties. The first one is relevant with a large body of publications observed in the field of HCI, engineering, and product/industrial design, but studies on exhibition design and audiences are still underutilized (discussed in Section 2.7.3). This creates a huge disruption in between wearable equipment/computer as an emerging technology that has a potential implication on the application of engineering and computer science, and exhibition design as a developing discipline required more accurate data servicing for the complicated system

[34] It is a new laboratory built together by the University of Nottingham and Ningbo Industrial Investment Group Co., Ltd with 1.5 million funding. It will be in operation at Hefeng Creative Square in Ningbo, in August, 2017.

including exhibition environment, clients, designers, and audiences, rather than only user and product.

The second difficulty was related to the use of the wearable equipment, as our target participants were neither familiar with the use of the wearable equipment nor has ever used other wearable equipment for exhibition-visiting. Therefore, two student assistants were recruited and trained before the former experiment, and research question in exit-questionnaire was included for checking the application of wearable equipment during audiences' exhibition journeys.

6.2 Method

To understand how audiences view through exhibition, observational research was conducted at the College of Science & Technology Ningbo University between 19th and 21st June 2017. In total of 12 participants navigated through a series of exhibitions wearing wearable equipment including the Tobii Glasses eye tracking system and wearable sensors (Figure 6.39, Figure 6.40, and Figure 6.41). In addition, participants were required to complete an enter- and exit-questionnaire before and after their visiting.

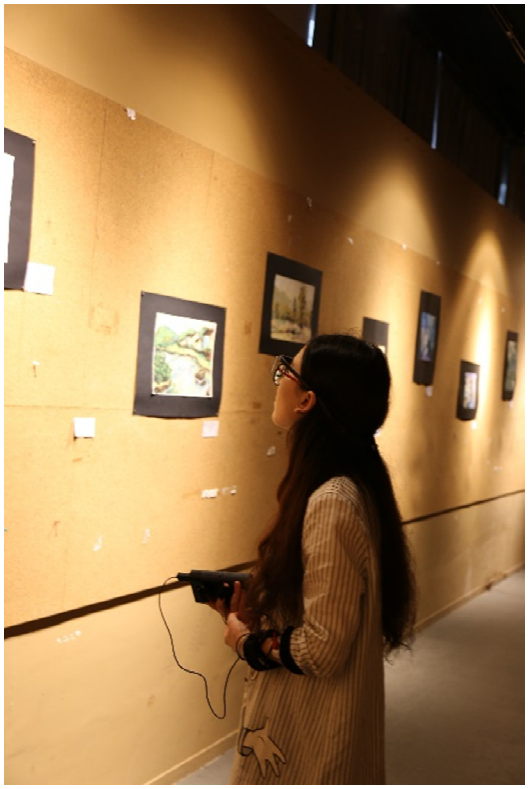


Figure 6.39. Participant 1 wearing apparatus in experiment field[35].

[35] The faces of participants in this experiment were not hidden due to that their wearing eye-tracking device could provide a presentation for better understanding the field study.

Figure 6.40. Participant 8 wearing apparatus in experiment field.

Figure 6.41. Participant 11 wearing apparatus in experiment field.

6.2.1 Experiment design

Field study took place in the exhibition halls at the local university, a five-floors building with a central exhibition hall, a waiting area with exhibition, a professional exhibition showroom, and five sets of show-windows in the corridors (Figure 6.42). We used the first-floor and second-floor exhibition areas as the experimental site.

For enter-questionnaire, we opted 4-point scale Likert-like to obtain personal characters of participants including the statements '*not me at all*', *'a little me*', '*me*', and '*very much me*'. For exit-questionnaire, it used five-point Likert-like consisted of the 'very slightly or not at all' statement, followed by the '*a little*', '*moderately*', 'q*uite a bit*', '*extremely*' statements that were attributed a 1 to 5 score during the analysis.

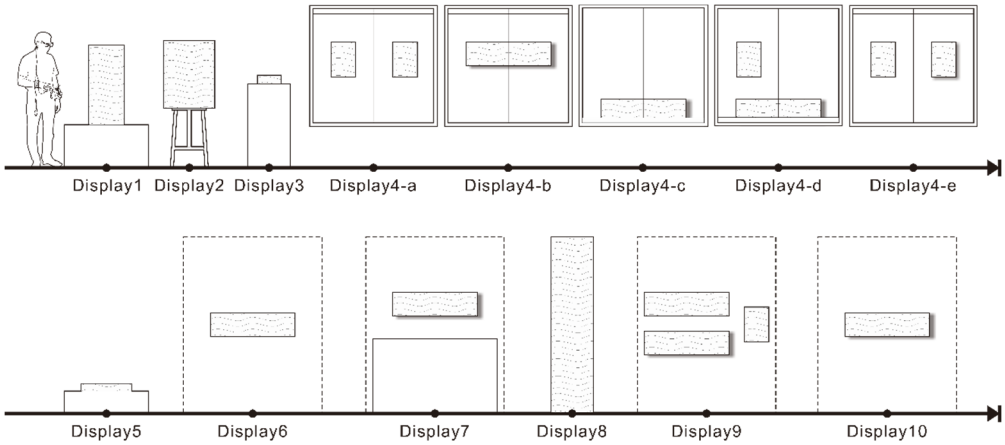


Figure 6.42. Coding exhibition by types of display with a visiting sequence.

In the visiting phase, participants were asked to navigate through six types of exhibition areas with the arranged space sequence (shown in Table 6.37). In addition, all investigated exhibitions were coded with ten different forms for data analysis in depth (Figure 6.42). Investigated exhibition space was classified as the first floor (1), second floor (1), exhibitions (7), transitions (5), and displays (10). Display can be considered as a basic unit during this experiment. It was used for data analysis in the following section. The time each participant navigated through during different exhibition space was presented in Appendix IV.

Table 6.37. Requested participants' visiting sequence in this experiment.

	Visiting sequence in exhibition	Types of Display	Environment
0	Preparation room	-	NI
1	Exhibition 1 for environment design	Display1	NI
2	Exhibition 2 for environment design	Display2	NI
3	Exhibition 3 for environment design	Display3	NI
4	Transition space 1	-	NI
5	Exhibition 4 for art display and drawing work	Display4a, 4b, 4c, 4e, 4d	GI/AI
6	Transition space 2	-	NI
7	Exhibition 5 for drawing and model work	Display5, 6	AI
8	Transition space 3	Stairs	NI
9	Exhibition 6 for product design	Display4-a, 4-d	GI/AI
10	Transition space 4	Stairs	NI
11	Exhibition 7 for visual communication design	Display7, 8, 9， 10	NI
12	Transition space 5	Stairs	NI
0	Preparation room	-	NI

NI=natural illumination, GI=general illumination, AI=accent illumination

Participants and procedure

Experiment 2 was conducted in 20th June, 2017. Total 12 participants (3 males and 9 females) of different age groups (20-52, with a mean of age 26.67) were finally recruited from a local university college, the institute of Art and Design. These participants were among the bachelor's students, teaching staff or support staffs. This selected samples include the audiences of students and staffs in the college for the convenience of experimental conduction and participant recruitment, and securely keeping of the wearable devices that only were allowed to be borrowed outside with quite limited time. Children and family groups were excluded in this field experiment. In addition, two student research assistants were recruited during the experiment conduction.

Before the former experiment, the researcher was trained by KingFar International Inc. for device operation in two days. After the process of participant recruitment and site survey, 12 audiences were observed and recorded with questionnaire, eye-tracking, and wireless sensors. In particular, the wearable equipment – eye-tracking system and the belt bag containing the wireless sensors (SKT, HRV, EMG, and EDA) - needed to be appropriately adjusted in advance of each experiment.

Figure 6.43. The procedure before visiting exhibition.

Despite the fact that all events were video-recorded by the Tobii Glasses 2 recorder, all participants were also observed throughout the whole viewing journey by one of the research assistants (Figure 6.43). The first task audiences were asked to preform was to sign a consent form[36] and fill in a brief enter-questionnaire (approximately two to three minutes). The enter-questionnaire questions helped as a warm-up and explored general questions, including the demographic information of participants such as their visit experience and emotion, age, gender and residence, desired AEFs, and personal characters. Once the enter-questionnaire was completed, the audiences were asked to wear the glasses and wearable equipment with the assistance of research assistants. Before starting the experiment and walking out the preparation room, the wearable equipment need to be adjusted with two items: 1) The straps of glasses and wearable equipment should be corrected to secure but comfortable fit; 2) Each participant should follow the system-guided calibration procedure of Tobii Eye Tracker, and then follow the assistant-guided calibration procedure of ErgoLAB. After calibration the recording performed and they were asked to freely navigate in the exhibitions from the first floor to second floor according to their preferences but with a prearranged visiting sequence. Duration of the journey ranged between 15 and 25 minutes depending on participants' particular interests. After the visiting, a brief exit-questionnaire then followed. It evaluated the experience and emotion for this visiting, and identifying the perceived AEFs and EDFs.

[36] The experiment has received the permission from the University Research Ethics Committee of the University of Nottingham.

Apparatus

In the experiment, Tobii Pro Glasses 2 and wireless sensors for BD were used (shown in Figure 6.44). A Tobii Glasses Eye Tracker (Tobii Technology, Stockholm, Sweden) was applied to record the eye movements with a sampling rate of 30Hz WITH 56'×40' visual angle for recording (Hurley, Holmes et al. 2016). It has an infrared (IR) camera with a monocular video-based pupil. Tobii Studio Professional version 2.3 was used to record and download the gazing data recordings. Wearable equipment with wireless sensors was used to collect the behaviour data. This experiment selected four types of BD including EDF, SKT, HRV, and EMG for data analysis. The recorded BD was collected and analysed by the software ErgoLab version 2.3 (KingFar International Inc. Tianjin, China).

Figure 6.44. Apparatus used in this experiment.

6.2.2 Data analysis

We used several techniques to gather and analyse the data from this study. In this thesis, we focus on the findings from the observation data. Observations with wearable equipment were designed to explore the relationship among BD, AEFs, and EDFs with the support of quantitative data and empirical study. As such, data analysis relied on the software SPSS and ErgoLAB. In addition to elicit answers from specific questions by questionnaires, the BD of participants was extracted with the wearable equipment.

6.3 Results

The collaborative data contributed to what was obviously a relationship among BD, AEFs, and EDFs, although not without its complicated structures with developing technologies. We illustrate the results from the experiment in three sections. The first section discusses the basic demographic information of audiences by using a questionnaire survey, and the perceived EDFs, AEFs, evaluation of overall experience, and enjoyable emotion. The second section presents the use of eye-tracking system and wearable equipment, for exploring the interactive relationship among BD, EDFs, and AEFs, and lastly it shows the extent to which the collaborative data supported an interactive and dynamic relationship and an integrated approach for measuring exhibition design.

6.3.1 Perceived EDFs, AEFs and basic information

There were 24 usable questionnaires (12 enter-questionnaire, 12 exit-questionnaire). Around ninety-two percent (N=12) of the participants resided in Ningbo. Seventy-five percent of the participants were female and the mean age was 27 years old, and most of them (91.7%) came to visit the exhibition intentionally with one or more adults (75%). Although all participants were recruited from the college, almost ninety-two participants indicated that they were the first time in this visiting (shown in Table 6.38).

Table 6.38. Demographic information of participants.

Demographic Factors		N	%
Age of participants	20 years	5	41.7
	21 years	3	25.0
	23 years	1	8.3
	34 years	1	8.3
	48 years	1	8.3
	52 years	1	8.3
	Missing	0	0
	Total	12	100
Gender	Male	3	25.0
	Female	9	75.0
	Missing	0	0
	Total	12	100
Do you live in Ningbo or another city?	Ningbo	11	91.7
	Jiaxing	1	8.3
	Missing	0	0
	Total	12	100
Are you visiting this exhibition alone or with others?	I am alone	3	25.0
	One or more adults	9	75.0
	One or more under 18	0	0
	Missing	0	0
	Total	12	100
Is this your first time visiting the exhibition?	Yes	11	91.7
	No	1	8.3
	Missing	0	0
	Total	12	100
Do you come here today specificity to see this exhibition?	No	1	8.3
	Yes	11	91.7
	Missing	0	0
	Total	12	100

Enjoyment emotion was highlighted by all participants both before and after their exhibition journey (Table 6.39). For the part of the overall experience, it was a difference between pre-visiting and post-visiting but mainly concentrated on the item '*excellent*' (N=13, %=54.1). The percent of '*excellent*' declined from 66.7% of pre-visiting to 41.7% of post-visiting, while the '*good*' item increased to 25% in post-visiting. In addition, '*improve knowledge*' (M=3.08, SD=.79) and '*spend leisure time with others*' (M=3.08, SD=.66) were both the highest score in terms of participant characters. It accords with the recruited participants they were involved in an academic context basically.

Table 6.39. Enjoyable, overall experience, and participant characters.

		Pre-visiting		Post-visiting		Total	
		N	**%**	**N**	**%**	**N**	**%**
Enjoyable or not	No	0	0	0	0	0	0
	Yes	12	100	12	100	24	100
	Missing	0	0	0	0	0	0
	Total	12	100	12	100	24	100
Overall Experience	Poor	0	0	0	0	0	0
	Fair	0	0	0	0	0	0
	Good	0	0	3	25	3	12.5
	Excellent	8	66.7	5	41.7	13	54.1
	Superior	4	33.3	4	33.3	8	33.3
	Missing	0	0	0	0	0	0
	Total	12	100	12	100	24	100
	I like to …		**N**	**Mix**	**Max**	**M**	**SD**
Participant Characters	Bring people together		12	1.0	4.0	2.50	.79
	Construct things		12	1.0	3.0	2.41	.66
	Logical games		11	1.0	3.0	2.27	.90
	Spending leisure time outside		12	2.0	4.0	2.75	.62
	Help others		11	2.0	4.0	2.81	.60
	Being trendy		12	2.0	3.0	2.58	.51
	Jogging		12	1.0	4.0	2.25	.86
	Know how things are made		12	1.0	4.0	2.58	.90
	Improve knowledge		12	2.0	4.0	**3.08**	.79
	Play competitive sports		12	1.0	4.0	1.91	.99
	Shopping		11	2.0	4.0	2.90	.70
	Spend leisure time with others		12	2.0	4.0	**3.08**	.66

There is a decline between AEFs desired by participants in pre-visiting and AEFs perceived by participants in post-visiting, with the examples of motivation (100% to 41.7%), curiosity (75% to 50%), interesting (58.3% to 25.0%), fun (58.3% to 33.3%), and memory (25.0% to 0%), etc. However, five AEFs were increased after participants' visiting, such as satisfaction (41.7% to 50.0%), understanding (33.3% to 41.7%), creativity (8.3% to 16.7%), leisure (16.75 to 33.3%), and reflection (0% to 16.7%). Total two AEFs (attention, and cool) remained the same fifty percentage (shown in Table 6.40).

Table 6.40. Expected and perceived AEFs.

	Pre-visiting		Post-visiting		Total	
	N	Total	N	Total	N	Total
Motivation	12	100	5	41.7	17	60.7
Satisfaction	5	41.7	6	50.0	11	39.2
Understanding	4	33.3	5	41.7	9	32.1
Engagement	2	16.7	1	8.3	3	10.7
Emotional	4	33.3	2	16.7	6	21.4
Service	6	50.0	5	41.7	11	39.2
Attention	6	50.0	6	50.0	12	42.8
Curiosity	9	75.0	6	50.0	15	53.5
Creativity	1	8.3	2	16.7	3	10.7
Cool	6	50.0	6	50.0	12	42.8
Interesting	7	58.3	3	25.0	10	35.7
Fun	7	58.3	4	33.3	11	39.2
Leisure	2	16.7	4	33.3	6	21.4
Learning	4	33.3	2	16.7	6	21.4
Participation	2	16.7	4	33.3	6	21.4
Memory	3	25.0	0	0	3	10.7
Reflection	0	0	2	16.7	2	7.1
Authenticity	5	41.7	2	16.7	7	25.0
Others	0	0	1	8.3	1	3.5
Missing	0	0	0	0	0	0
Total	12	100	12	100	12	100

All EDFs listed in the questionnaire were perceived by 12 participants (Table. 6.41). The highest score for enjoyable EDFs (M≥4.00) was '*quality of shape*' (M=4.10, SD=.87) and '*texture of exhibition*' (M=4.00, SD=.94), while the lowest score was '*availability of information/pamphlet'* (M=1.81, SD=.90). It's worth noting that this exhibition was only about student design/art works' presentation with a traditional means, not using interactive technologies (M=2.66, SD=1.23) or multimedia (M=2.58, SD=1.44) that were marked by some participants. They may consider the equipment used in the experiment as the part of this exhibited content.

An interesting point during the field study was that for '*what impressed me the most*', 6 participants selected eye-tracker, 6 participants for wearable equipment, and one participant for gift. Among them, it was indicated that '*it is the first time I try'* (wearable equipment, P1), '*it is an amazing feeling*' (eye-tracker and wearable equipment, P7), '*light, and natural*' (eye-tracker, P9), and '*high-end, and elegant*' (wearable, P10).

Table 6.41. Perceived EDFs.

EDFs perceived	N	M	SD
Availability of information/pamphlet	12	1.91	.90
Photos on the walls	11	3.90	.94
Exhibition multimedia (video, audio, interactivity)	12	2.58	1.44
Meanings of exhibition	12	3.50	1.44
Computer interactive	12	2.66	1.23
Variety of culture	11	3.54	.82
Sharing experience with other people	11	2.81	1.07
Watching, walking and sitting	11	3.54	.82
I feel happy, enjoyment, surprise, etc.	11	3.81	.98
Style of exhibition design	11	3.36	.92
Story-telling/narrative	10	3.20	.91
Quality of art	10	3.60	1.34
Quality of shape	10	4.10	.87
Colour of exhibition	10	3.90	1.10
Texture of exhibition	10	4.00	.94

Continued Table 6.41

Material of exhibition	10	3.40	.96
Time of visiting exhibition in the pavilion	10	2.90	1.37
Communication with the staff	11	3.54	.93
I can visit the exhibition efficiently	12	3.25	.96
Setting	10	3.00	.94
Lighting	11	2.09	1.04
Music	10	2.20	1.22
Smell	12	3.41	.90

6.3.2 Identifying BD by using eye-tracker and wearable equipment

Table 6.42 shows BD of all participants (N=12) can be identified during their journey in exhibitions by recorded quantitative data. For instance, P1's collected data include five types of BD, including EDA, EMG, SKT, PPB, and eye-tracking data (left pupil and right pupil). It was presented with min amplitude, max amplitude, mean amplitude, amplitude standard deviation, RMS amplitude, and time.

Table 6.42. Identified BD in the experiment.

P	BD	Min Amplitude	Time of Min Amplitude	Max Amplitude	Time of Max Amplitude	Mean Amplitude	Amplitude Standard Deviation	RMS Amplitude
p1	EDA1	0.38	00:00:38.953	0.46	00:15:47.328	0.42	0.02	0.42
p1	EMG1	-1766.20	00:16:15.412	2013.00	00:16:15.474	-26.26	49.51	56.04
p1	SKT1	2.17	00:14:48.563	35.76	00:14:40.094	34.17	0.59	34.18
p1	PPG1	0.10	00:13:51.094	99.98	00:13:54.125	30.14	7.92	31.17
p1	LeftPupil	2.53	00:17:40.220	6.89	00:18:43.840	4.50	0.60	4.54
p1	RightPupil	1.24	00:00:00.000	6.58	00:08:52.120	4.38	0.72	4.44
p2	EDA1	0.00	00:08:15.891	18.10	00:07:49.000	12.48	1.99	12.63
p2	EMG1	-869.20	00:01:38.055	571.80	00:01:30.040	-29.62	42.65	51.92
p2	SKT1	31.86	00:02:18.594	35.52	00:00:00.031	34.36	0.52	34.36
p2	PPG1	0.24	00:00:21.891	99.98	00:00:18.828	30.22	7.03	31.02
p2	LeftPupil	0.00	00:09:20.320	6.43	00:09:20.260	4.43	1.31	4.62
p2	RightPupil	0.00	00:08:54.720	6.12	00:05:19.380	3.82	1.44	4.08
p3	EDA1	5.83	00:00:20.359	6.82	00:00:00.000	6.38	0.28	6.38
p3	EMG1	-252.20	00:00:00.612	205.60	00:00:00.481	-23.64	41.08	47.39
p3	PPG1	15.80	00:00:16.281	59.20	00:00:04.250	29.92	8.69	31.16
p3	SKT1	31.52	00:00:18.188	31.81	00:00:00.000	31.67	0.07	31.67
p4	EDA1	0.00	00:07:24.984	3.49	00:03:06.406	2.44	0.42	2.47
p4	EMG1	-2377.60	00:07:27.777	3051.40	00:07:27.812	-25.31	92.40	95.80
p4	SKT1	26.74	00:07:13.594	29.51	00:00:00.063	27.49	0.66	27.50
p4	PPG1	0.07	00:02:14.109	99.98	00:00:10.359	30.17	27.17	40.61
p4	LeftPupil	2.23	00:08:04.740	5.55	00:03:42.520	3.92	0.71	3.98
p4	RightPupil	0.00	00:08:50.620	6.72	00:03:40.180	4.06	0.99	4.17
p5	EDA1	0.00	00:05:57.063	2.07	00:03:45.719	1.37	0.56	1.48
p5	EMG1	-3296.00	00:06:39.304	3061.80	00:06:27.400	-24.32	822.95	823.31
p5	SKT1	26.96	00:06:50.156	29.66	00:00:00.719	28.29	0.61	28.30
p5	PPG1	0.05	00:06:09.219	99.98	00:06:09.016	30.28	12.70	32.83
p5	LeftPupil	0.00	00:06:50.780	6.47	00:04:18.540	4.12	1.36	4.34
p5	RightPupil	0.00	00:06:50.800	6.52	00:04:16.740	4.32	1.35	4.53

Continued Table 6.42

p6	EDA1	0.00	00:11:14.375	6.94	00:02:41.609	3.45	1.50	3.76
p6	EMG1	-3276.80	00:12:36.854	3061.60	00:12:38.469	-30.03	469.81	470.77
p6	SKT1	28.31	00:12:45.656	33.49	00:11:02.125	32.25	1.10	32.27
p6	PPG1	0.32	00:11:29.938	99.98	00:11:23.797	30.28	13.05	32.97
p6	LeftPupil	0.00	00:14:27.780	6.32	00:09:10.360	3.84	1.49	4.12
p6	RightPupil	0.00	00:14:26.820	5.80	00:07:08.000	3.64	1.38	3.89
p7	EDA1	0.00	00:10:51.672	8.97	00:10:28.172	6.02	0.87	6.08
p7	EMG1	-3273.60	00:06:34.592	3061.80	00:10:23.104	-25.91	341.23	342.21
p7	SKT1	30.60	00:07:39.969	33.61	00:00:08.563	32.01	0.87	32.02
p7	PPG1	0.29	00:05:38.609	99.98	00:01:34.859	30.28	10.57	32.08
p7	LeftPupil	1.88	00:01:37.960	6.84	00:09:00.560	3.77	1.26	3.97
p7	RightPupil	0.88	00:00:00.000	6.45	00:08:55.680	3.56	1.07	3.72
p8	EDA1	4.05	00:00:02.938	9.20	00:06:05.844	6.25	1.06	6.33
p8	EMG1	-2266.80	00:09:02.593	3053.40	00:09:02.458	-25.45	85.01	88.73
p8	SKT1	32.02	00:01:15.406	35.01	00:08:22.875	33.39	0.79	33.40
p8	PPG1	0.29	00:00:26.563	99.98	00:00:25.813	30.15	5.46	30.64
p8	LeftPupil	0.00	00:10:24.640	7.44	00:05:35.640	5.18	1.33	5.35
p8	RightPupil	0.00	00:09:42.140	7.45	00:04:37.880	4.90	1.79	5.21
p9	EDA1	0.00	00:09:07.516	15.23	00:07:56.609	8.15	1.97	8.38
p9	EMG1	-3233.80	00:09:22.492	3055.00	00:09:22.047	-22.64	125.52	127.54
p9	SKT1	29.14	00:09:22.594	33.48	00:00:04.781	32.61	0.59	32.62
p9	PPG1	0.34	00:00:24.500	99.98	00:00:24.734	30.26	16.05	34.26
p9	LeftPupil	0.00	00:09:56.160	5.75	00:05:32.180	3.89	0.57	3.94
p9	RightPupil	0.00	00:09:56.180	6.22	00:00:03.960	3.97	0.59	4.01
p10	EDA1	5.02	00:00:07.641	7.20	00:10:03.156	5.82	0.45	5.83
p10	EMG1	-3258.80	00:07:06.622	2297.40	00:09:13.307	-25.63	204.63	206.23
p10	SKT1	30.57	00:07:06.000	33.62	00:00:00.469	31.86	0.82	31.87
p10	PPG1	0.34	00:00:32.563	99.98	00:02:25.422	30.12	11.18	32.13
p10	LeftPupil	2.17	00:03:26.260	7.70	00:05:10.700	4.62	0.98	4.72
p10	RightPupil	2.36	00:01:16.100	6.71	00:07:12.120	4.10	0.84	4.19
p11	EDA1	0.38	00:09:34.578	1.07	00:15:43.766	0.48	0.11	0.50
p11	EMG1	-3272.00	00:16:25.002	3059.00	00:16:26.009	-28.81	150.43	153.16
p11	SKT1	33.85	00:16:25.469	35.53	00:03:34.500	34.70	0.25	34.71
p11	PPG1	0.00	00:15:31.969	99.98	00:01:05.297	30.17	13.30	32.97
p11	LeftPupil	0.00	00:18:36.720	6.16	00:11:44.880	3.54	1.20	3.74
p11	RightPupil	0.00	00:18:36.720	7.10	00:11:34.400	3.46	1.13	3.64
p12	EDA1	0.00	00:11:57.828	11.49	00:11:36.125	8.58	1.58	8.73
p12	EMG1	-3273.60	00:11:54.746	3061.80	00:11:49.281	-24.36	433.50	434.19
p12	SKT1	34.21	00:12:02.938	36.64	00:09:55.031	36.07	0.34	36.07
p12	PPG1	0.34	00:04:16.047	99.98	00:04:27.094	30.24	15.17	33.83
p12	LeftPupil	0.00	00:13:10.760	6.98	00:05:57.340	4.04	1.19	4.21
p12	RightPupil	0.00	00:13:10.760	6.63	00:07:15.700	3.94	1.13	4.10

6.3.3 Interactive and dynamic relationship among EDFs, AEFs, and BD

Appendix V summarized the corresponding relationship among EDFs, AEFs, over experience and eye-tracking collected in a field study with both questionnaire survey, eye-tracking study, and wearable equipment. For example, P1 marked her over experience as ‘excellent’ for pro-visiting and ‘good’ for post-visiting, which was traced in the enter-and exit-questionnaire. The questionnaire also presented the EDFs and AEFs perceived by P1 during her visiting. Furthermore, eye-tracking system provided a repeatable review means for the specific EDFs in corresponding exhibition context. As Appendix V shown, the red dots are the fixation of P1, the size of which will be changed along with the fixation time; the red line symbolizes the trajectory of P1 fixations. The greater red dot means more fixation time. Accordingly, eye-tracking used in the experiment contributes to a practical approach to identifying EDFs, while questionnaire also offers a possibility to obtain the necessary data for measuring audience reactions.

It was found that each EDFs perceived by participants can be recorded by the corresponding BD (as shown in Figure 6.45), despite each participant with different demographic factors and personal characters, tends to have different presentations of BD (EMG, HRV, SKT, and EDA). Accordingly, each participant with each specific exhibition and time can be summarized by a detailed BD report for further measurement or analysis in depth (Figure 6.46-6.49). It shows an example that the BD of participants were identified during visiting display 4b. The results confirm the theoretical frameworks of HEI and FDEE discussed in this thesis.

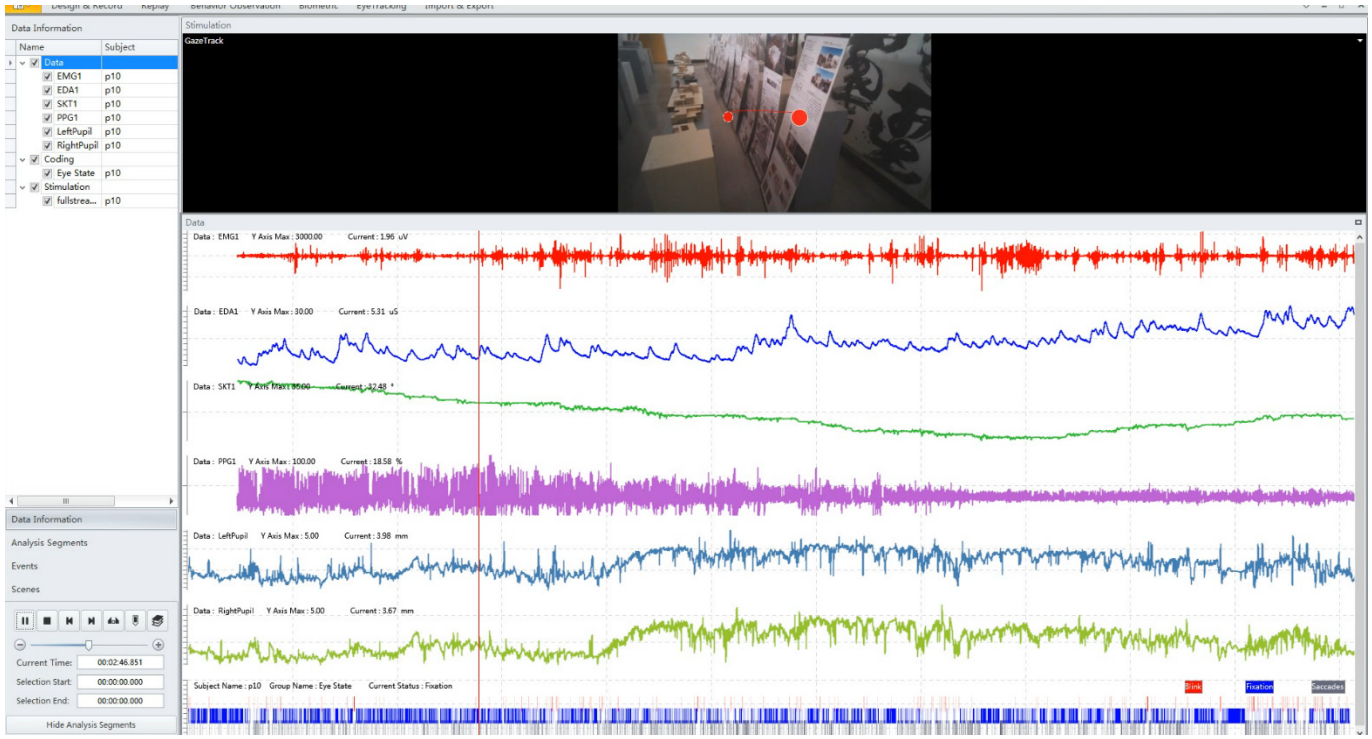


Figure 6.45. The interactive relationship between EDFs and BD.

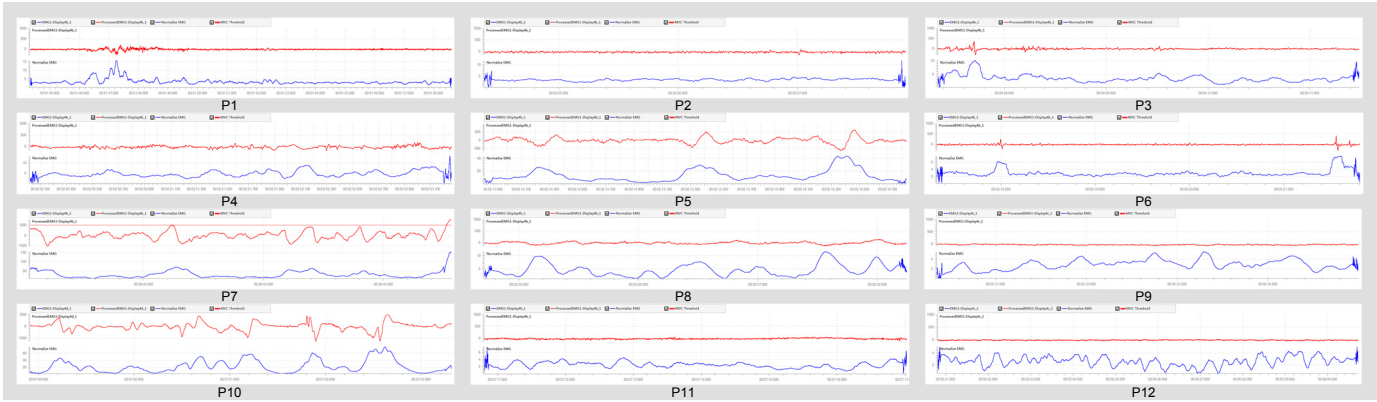


Figure 6.46. The EMG example of participants during visiting display-4b.

Figure 6.47. The HRV example of participants during visiting display-4b.

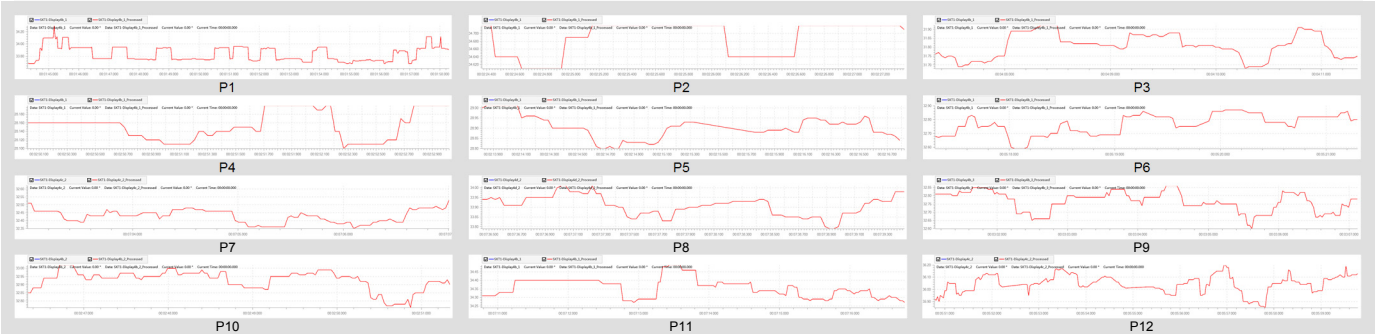


Figure 6.48. The SKT example of participant during visiting display-4b.

Figure 6.49. The EDF example of participants during visiting display-4a.

6.4 Discussion

Clients and designers are searching for ways to transform their messages more effectively (Chapter 2). Despite the long-standing efforts of exhibition design since the Great Exhibition, we are assuming that the exhibition industries have not yet utilized exhibition design ideally, perhaps due to limited knowledge on audience responses especially with empirical study. Consequently, the thesis aimed to provide evidence drawn from audiences' psychophysiological responses regarding BD, experience, and emotion synchronously. This study hence examined the influence of EDFs on audiences' BD that related to AEFs and emotion (discussed in Chapter 7), using an experimental design with quantitative data.

From a practical point, these findings can service for clients and designers to understand how essential it is to invest attention on evaluating the effectiveness of exhibition design with collaborative data within the HEI context. Although reasonable viewpoints will debate that whether exhibition design is effective or not, it appears that exhibition practitioners may get a measurable return by choosing designing more enjoyable exhibitions in HEI. This provides general guidelines on developing better exhibitions.

Although there is no research conducted on the exploration of collaborative data with BD, EDFs, and AEFs, and enjoyment emotion, several previous studies had tried to develop the exhibition industry by using wearable techniques. It can be traced with the examples of the '*wearable computer*' (p.8) servicing for Open Air Exhibition in Japan Expo 2005 (Ueoka, Hirose et al. 2001), '*museum wearable*' (p.3) for enhancing the interactive communication between exhibition and audiences in MIT museum by providing personalized audio-visual messages with augmented reality or mixed reality (Sparacino 2002, Sparacino 2004), and '*data glove*' (p.1) for collecting audiences' psychological and physiology data in the National Research Project *emotion-mapping museum experience* in Switzerland (Tröndle, Greenwood et al. 2012). However, as discussed in Philips Research, '*a distinction can be made between laboratory environment testing and field testing*' (Westerink et al., 2007, p.164) . Current technologies on wearable techniques or computer still require be further improved for helping participants enter into a natural and comfortable context (Lymberis 2004). Hence, the gap between research and marketing may be a next research direction.

It can be considered a limitation for using a student sample of small size because of the limited self-funding research. Future research could collect samples through extending samplings with a wider scope of audiences from elders to children, or with family group, and processing environments such as fair, amusement park, or

shopping mall. Future studies may also conduct observation with more BD, such as EEG, FSR, PPG, or with more particular experimental factors involving temperature and humidity, illumination, barometric pressure, and noise. Other follow-on researches may replicate this experiment in a controlled laboratory environment by using new technologies including virtual reality, augmented reality, or mixed reality. Future studies could work toward a specific comparative study between physical and virtual exhibition conditions. Given these points, it is available that the achieved findings in this thesis would be replicated in mixed research method adopted in a comparative approach between physical and virtual exhibitions. In conclusion, the results show that there is an interactive relationship among BD, EDFs, and AEFs. It provides a research basis and direction for the following research that may focus on the translation via an efficient algorithm.

7 General discussion and conclusion

7.1 Chapter overview

The purpose of this final chapter is to present how the research work conducted in this thesis has addressed the initial research questions. It aims to anchor an initial research problem:

What is the relationship among EDFs, AEFs, and BD?

The chapter discusses the main findings of this thesis, based on the conducted research and previous scientific work. It also presents the original contributions to knowledge. The research findings across this thesis will be summarized in three final conceptual statements. Finally, it indicates the limitations of the future directions of the research.

7.2 Summary of research findings

The outcomes of this research are summarized in Table 7.43, with a mixed research method. It presents, along with the development of three stages (background, analysis, and experimentation), this research realized the result with its questions and aims through the methods as conducted and described in the previous chapters. Table 7.43 summarized the findings from the studies and investigations implemented throughout this thesis.

Table 7.43. PhD result map: background, analysis and experiment.

	1st YEAR	2nd YEAR	3rd YEAR	
	BACKGROUND	ANALYSIS	EXPERIMENTATION	
	Systematic Literature Review and Experiment 1	**Framework Construction**	**Experiment 2**	**Thesis Writing**
Questions	**RQI:** What are the EDFs and AEFs perceived by audiences and used by designers in exhibitions? • What are the EDFs and AEFs perceived by audiences in exhibitions? • What are the EDFs and AEFs used by exhibition designers in exhibitions?	**RQ2:** How can an exhibition be designed to create enjoyment? • How are enjoyable exhibitions designed by using EDFs and AEFs? • How can the exhibition design framework be applied to design exhibitions that creates enjoyment?	**RQ3:** How can behavioral data be used to get more reliable and valid data of enjoyment emotion in exhibitions? • What are the methods, approaches and tools to get reliable and valid quantitative data about enjoyment emotion in exhibitions? • How can behavioral data be used to understand the impact of EDFs in enjoyment emotion in exhibitions?	What is the relationship among EDFs, AEFs, and BD?
Aims	• To identify and analyze EDFs in exhibitions; • To identify and analyze AEFs in exhibitions.	• To define a framework of designing enjoyable exhibitions.	• To identify the relationship among EDFs, AEFs, and BD.	• Designing an enjoyable exhibition in the collaborative data with EDFs, AEFs, and BD.
	• To provide applied knowledge for supporting: - Exhibition designers in design more enjoyable exhibition; - Company in select, evaluate and plan their exhibition strategy; - Governments and public bodies in evaluating and planning exhibition design policies; - Audiences in interacting with exhibitions.			
Methods	Systematic literature review Grounded theory	Questionnaire to audiences, semi-structured interview to investigate exhibition designers and clients	Grounded theory	Field study: collecting behavior data through using eye tracking system, wearable devices, and questionnaire	Discussion Conclusion Future work
Results	HEI	EDFs， AEFs， and BD	FDEE	Audience's reactions to exhibition design factors	PhD thesis

7.3 Discussion of research findings

An overview of the research findings is illustrated in this section. Each of the research questions aimed is therefrom investigated respectively with various research methods.

It can be seen from Table 7.43 that research questions were addressed by both qualitative and quantitative method, and accordingly supported with both qualitative and quantitative data (indicated in Chapter 1). The identification of EDFs, AEFs and BD, by using grounded theory paves a way to the result of HEI. The presentation of HEI framework, as illustrated in Chapter 2, provides a theoretical basis for the data analyses in the following studies. The field study in Expo Milano 2015 explored the EDFs and AEFs perceived by audiences by investigating 10 pavilions in ten countries. The research then turned to investigate clients and designers for what the EDFs and AEFs they used in developing exhibition by the method of semi-structured interview. Thereafter, the FDEE framework was constructed on the basis of previous studies and investigations. Using wearable apparatus (eye-tracker and wearable equipment) confirmed the interactive relationship among EDFs, AEFs and BD, which laid the foundation for measuring audience reactions particularly concentrating on audience experience and enjoyment emotion. The next section will further discuss other research findings explored in this thesis.

7.3.1 Integrated extension of HEI-based exhibition design for the FDEE

Figure 5.38 in Chapter 5 illustrated the **FDEE**, which focus on presenting the transformation of audience experience and message through the loop form. In this section, Figure 7.50 reveals the performance of key aspects within FDEE through layered form. Based on the modification from Braun, Burwitz et al. (2015)'s BPMN extension model, Figure 7.50 connects HEI and FDEE with two parts: a and b. This part shows the central layer of FDEE, audience-focused, encircled with three layers: designers, clients, and HEI-based framework. Each layer has a connection with the key aspects shown in part b. For instance, the layer of designers, the nearest one with central layer, is directly linked to the aspect of EDFs that contains the term '*group*', which means that grouping EDFs used by designers tends to be the main content regarding this aspect. Meanwhile, EDFs ties to BD and messages, with main contents '*implicit BD, explicit BD*', and '*implicit messages, explicit messages*' respectively. All these layered and connection of key aspects help to understand the application of FDEE. However, it cannot do provide detailed information to the experimentation and iteration involved in this thesis.

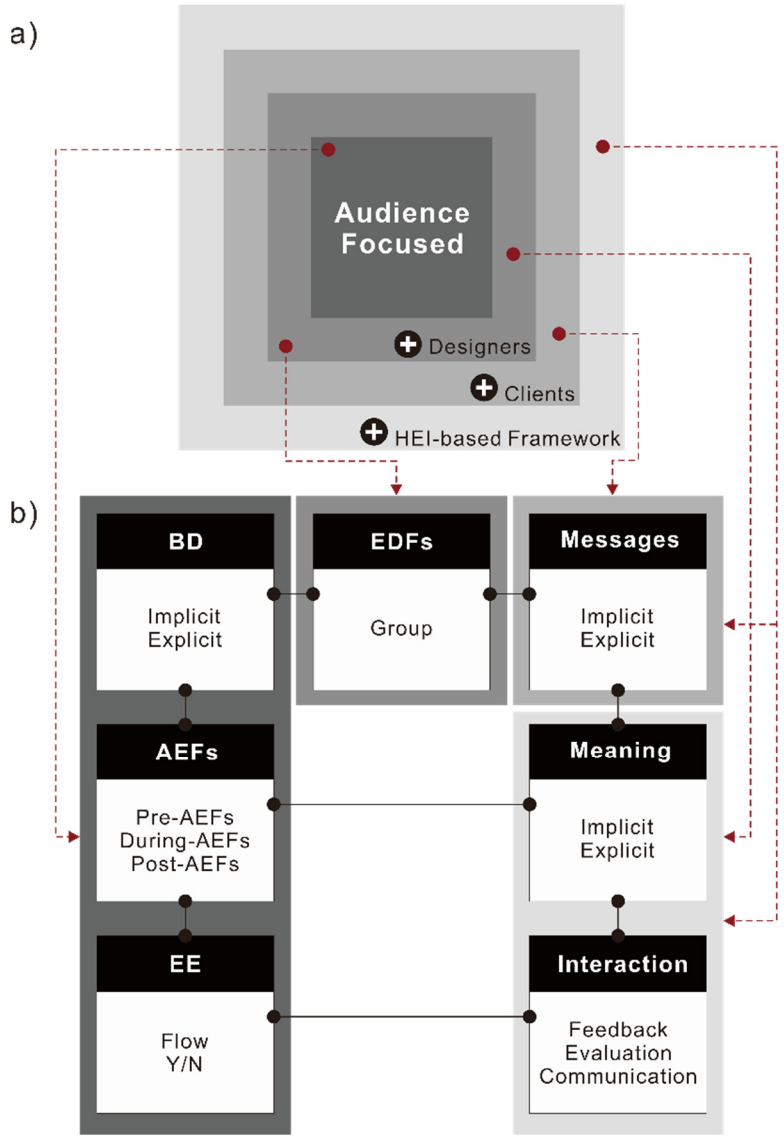


Figure 7.50. Integrated extension of HEI-based exhibition design for the conceptual framework of designing enjoyable exhibition (modified from Braun, Burwitz et al., 2015).

7.3.2 Combing narrative and enjoyment

> '*When reduced to its base elements, a narrative can be considered to comprise a linear sequence of concepts and/or emotions*' (Macleod et al., 2012, p.183)

The term '***narrative***', as '*human meaning-making tool*' (Schorch, 2013, p.193), '*a human phenomenon*' (Abbott, 2008, back cover), and/or '*the basic of all human communication*' (Griffin & McClish, 2011, p.307), is used to describe the most common and effective way to communication (Suzanne, Hourston et al. 2012), not

only for exhibition design but also with '*literature, film, and theatre*' (Abbott 2008) (Section 2.3.2). Narrative is essential because it determines what the audiences see, when they see it and how (Tan 1995). Story-telling is considered as the means to narrative, which is also one of the most fundamental approaches to structure experience (Allanwood and Beare 2014). For instance, two designer participants during the interview survey expanded his/her views:

> 'The main function of exhibition design is storytelling through a sequence of events to allow the visitors/clients to understand/interact/engage better with the topic displayed.' (Pd2, 16th August, 2016)
>
> 'The most important thing is to be able to tell a story, even if it speaks about furniture, or mechanical parts.' (Pd3, 7th September, 2016).

However, referring to communicate messages, '*the message only become a story when it is given a narrative thread with a clear beginning, middle, and end*.' (Berger et al., 2007, p.104).

The characteristics of narrative can be summarized as following: (1) A semiotic structure with time, space, (Stavroulaki and Peponis 2003, Macleod 2005, Stam 2005), and meaning (Chatman 1980, Choi 2010, Griffin and McClish 2011, Roppola 2013); (2) A dynamic process/sequence but with a beginning, a middle and an end (Berger, Lorenc et al. 2007, Griffin and McClish 2011, Mortensen 2011, Forrest 2015, Hou 2015); (3) A structured model for transforming experiences and messages by movement/path (Pine and Gilmore 1999, Dernie 2006, Bal 2007, Berger, Lorenc et al. 2007, Rohloff 2009, Pascale 2012, Suzanne, Hourston et al. 2012, McKenna-Cress and Kamien 2013, Daggubati 2016); (4) A communication among clients, exhibition, and audiences (Sparacino 2002, Dernie 2006, Suzanne, Hourston et al. 2012, Wahlin and Kahn 2015). Consequently, narrativity was proposed as a parameter for measuring '*the degree of storyness of a narrative*' (Macleod et al., 2012, p.110).

In summary, narrative through story-telling is fundamental and essential to exhibition design (Dernie 2006, Locker 2011, Hou 2015, Baker, Istvandity et al. 2016). It has the power to make connection and transformation between exhibitions and audiences (Bal 2007). Thus, Choi (2010) mentioned that narrative may directly influence audience experience '*emotionally, intellectually, and physically*' (p.215). Also, narrative combines story and discourse/performance, the two main aspects, according to Chatman (1980)'s Narrative Theory (shown in Figure 7.51). The narrative structure means structuring communication for effective message-transforming, as shown in Figure 7.52.

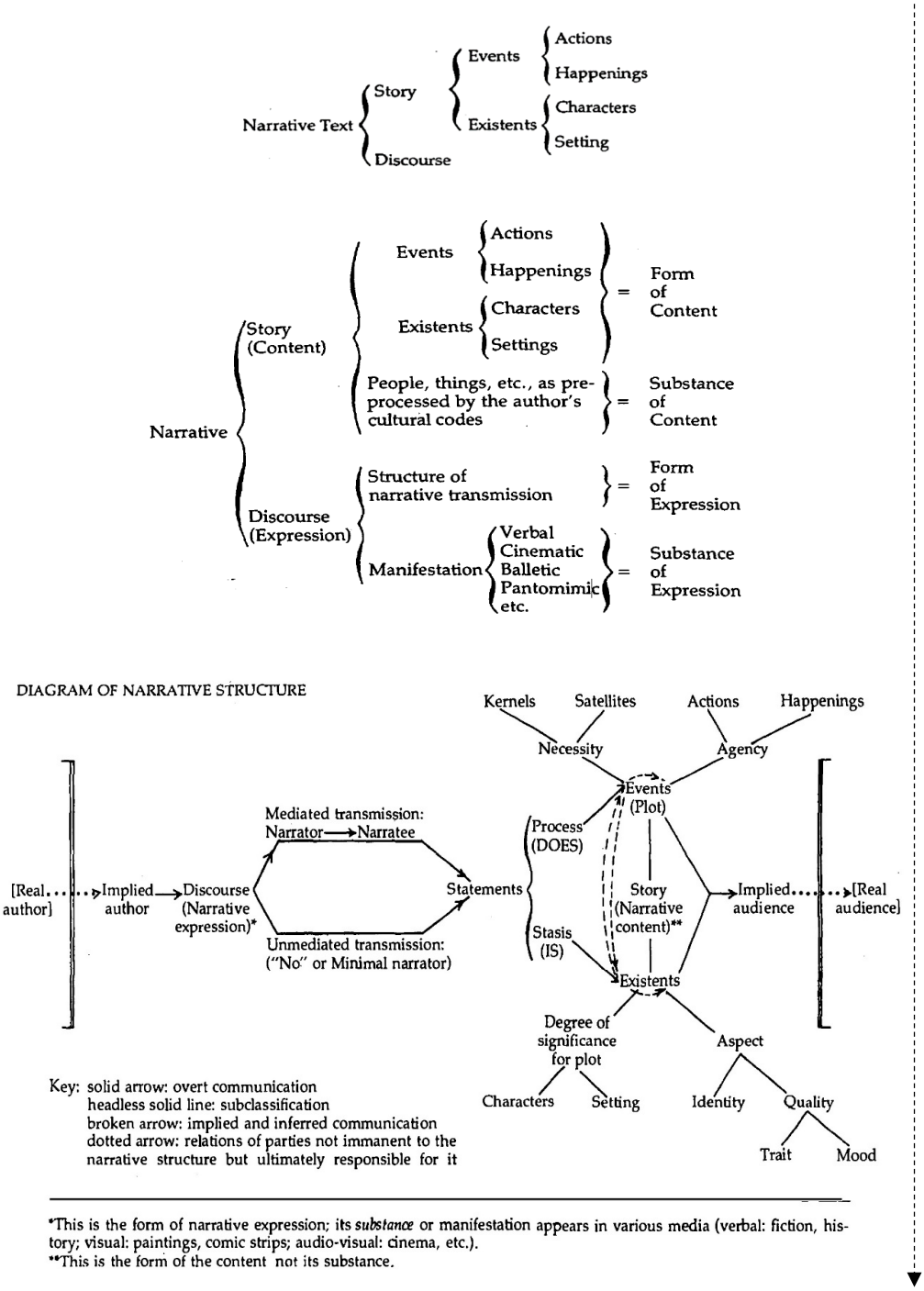
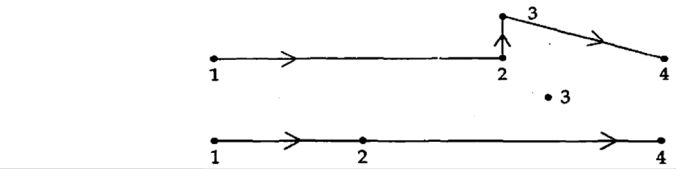
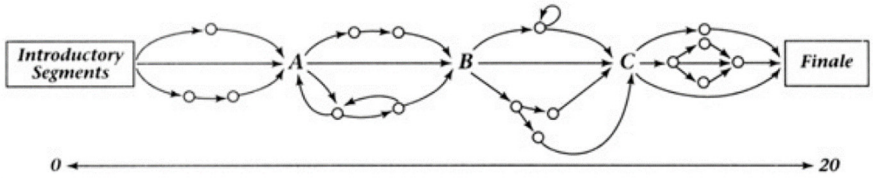


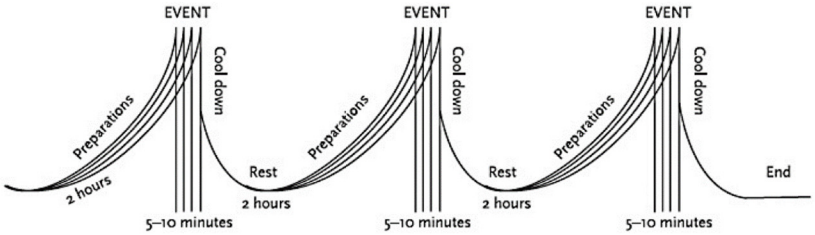
Figure 7.51. Narratvie structure through story-telling (Chatman, 1980)



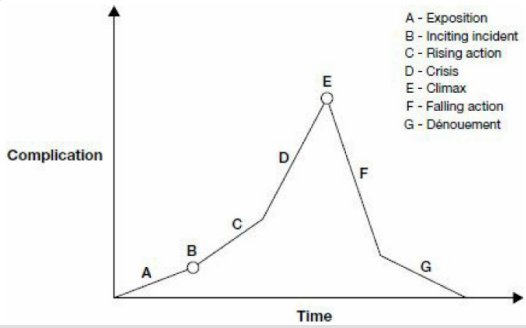
Chatman (1980), p.129



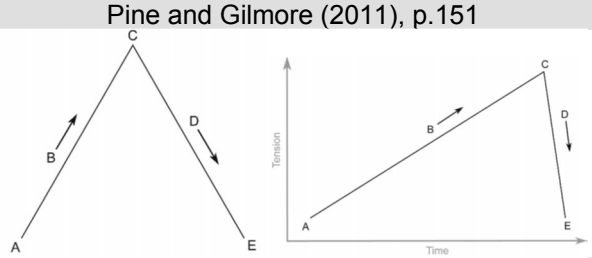
Pine and Gilmore (1999), p.135



Schechner (2004), p.115



Pine and Gilmore (2011), p.151



Suzanne, Hourston et al. (2012), P.183.184

Figure 7.52. Comparison summarized among different narrative structures.

Green, Brock et al. (2004) pointed out that there is a combination between enjoyment and narrative, because:

> '*One key element of an enjoyable media experience is that it takes individuals away from their mundane reality and into a story world*.' (p.311)

As with experience (Allanwood and Beare 2014) and narrative (Berger, Lorenc et al. 2007), enjoyment also has sequences (Green, Brock et al. 2004). Therefore, coming narrative and enjoyment tend to the discussion in this research. The FDEE (Chapter 4) has highlighted the measuring role of enjoyment. Figure 7.53, modified from Rosenblum, Yacoob et al. (1996), illustrates the enjoyment combined with narrative in depth. According to the indicated narrative structure (Suzanne, Hourston et al. 2012), exhibition subsequence can be categorized as five parts: introduction (A), rising action (B), climax (C), falling action (D), and conclusion (E). It follows a sequence motion from beginning to end. Each part involving exhibition factors (EDFs, AEFs, and BD) depends on the measurement of enjoyment emotion (EE), which of improvement (+/-) leading to the accepted enjoyable exhibition design. The sequence of exhibition factors (EDFs, AEFs, and BD) tends to keep pace with the narrative sequence of exhibition. In addition, the term '*enjoyability*' was used as a measure to evaluate the degree of enjoyment in disciplines like ambient intelligent (Bartneck 2002), HCI (Westerink, Ouwerkerk et al. 2007), Psychopathology (Bouman and Luteijn 1986, Etten, Higgins et al. 1998), and architecture (Brush, Chenoweth et al. 2000).

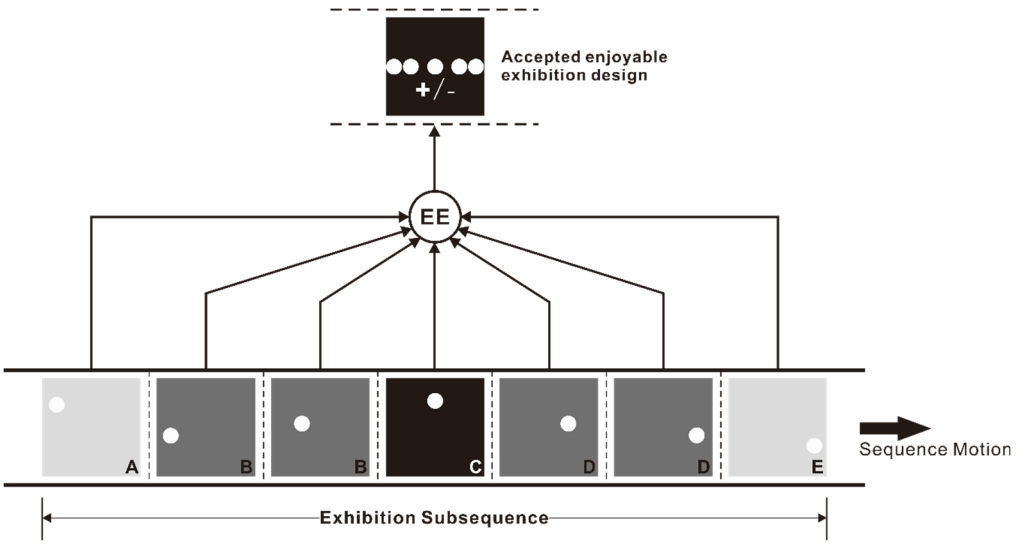


Figure 7.53. Embedding EE into narrative structure (modified from Rosenblum, et al., 1996).

7.3.3 Model discussion for exhibition design

The conceptual framework of HEI and FDEE illustrated in this thesis provides a systematic and theoretical basis for further exploring exhibition design. However, it still needs attention on the algorithm work helping for further practical development, in despite of a fact that exhibition design is still a new direction that needs to be explored.

Previous research works focusing on the algorithm of exhibition design were presented mainly in the areas of marketing (Kolter and Kolter 1998), servicescape (Cronin and Taylor 1992, Bolton and Lemon 1999), audience classification (Brida, Disegna et al. 2013), repeat visiting behaviour (Brida, Disegna et al. 2014), measuring experience (Chang and Horng 2010), visiting time (Sandifer 1997, Chiozzi and Andreotti 2001, Wu, Hu et al. 2013), decision-making (Corfman and Lehmann 1987), customer satisfaction (Fornell, Johnson et al. 1996, Pine and Gilmore 2011), management (Frey and Meier 2006), consumer emotion responses (Holbrook and Batra 1987), audience behaviour (Peponis, Conroy-Dalton et al. 2004, Bollo and Dal Pozzolo 2005, Wineman, Peponis et al. 2006, Zancanaro, Kuflik et al. 2007, Sookhanaphibarn and Thawonmas 2009, Kiriyama and Sato 2013, Martella, Miraglia et al. 2016, Zank and Kunz 2016), evaluation (Screven 1976, Miles and Alt 1988, Sandifer 2003, Yalowitz and Bronnenkant 2009), human swarm behavior (Okada, Motegi et al. 2011), path (Peponis, Conroy-Dalton et al. 2003), emotion classification (Shafieyoun 2016), and meaning (Chen 2005). Although these algorithms serviced for exhibition design to some extent, there are no studies focusing on the systematic and dynamic relationship among EDFs, AEFs, and BD with HEI or/and FDEE, as a fundamental framework.

Artificial neural networks (ANNs)[37] could be used for explaining the dynamic and interactive relationship among EDFs, AEFs, EE and BD, the key aspects for HEI and FDEE. It also provides an available direction for further research on exhibition design in terms of algorithm. Although there is no study currently focusing on ANNs for exhibition design, some research institutions have tried to carry out the relevant study and obtained some both theoretical and practical results. For example, a MIT study program '*sto(ry)chastics*' applied Bayesian network architecture with the Expectation Maximization (EM) algorithm for designing a more narrative and interactive exhibition.

[37] Artificial neural networks (ANNs) are an algorithm in the view of information processing, which is inspired by biological neural networks and constitutes the operating mechanism of animal brains. It has been widely used in various research and application fields. ANNs can be summarized as four basic characteristics: Nonlinear, nonlimitation, nonqualitative, nonconvexity (Zurada, 1992). This will answer the purpose of HEI and/or FDEE.

The brief presentation for the architecture of ANNs in terms of exhibition design is conducted in Figure 7.54. This diagram consists of two parts: the narrative structure of the exhibition with visiting time ($\mathrm{EDF} \in \mathrm{display} \in \mathrm{theme/event} \in \mathrm{exhibition}$), and four layers ($\mathrm{input\ EDFs} \rightarrow \mathrm{BD\ layer} \rightarrow \mathrm{AEFs\ layer} \rightarrow \mathrm{output\ EE}$). Meanwhile, based on the algorithm of HEI presented in Section 3.6.1, it can be summarized as:

$$HEI = f(EDFs, AEFs, BD)$$

Where,

The set of exhibition design factors integrated as $EDFs \in X_{ij}$. Each exhibition design factor is itself a set:

$EDFs = \{c_1 \dots c_8, t_1 \dots t_{11}, cu_1 \dots cu_2, s, a_1 \dots a_6, d_1 \dots d_{13}, e_1 \dots e_4, m_1 \dots m_5\}$ of a content c, technology t, social s, audience a, design language d, environment e, marketing m.

The set of audience experience factors integrated as $AEFs \in X_{ij}$. Each audience experience factor itself a set $AEFs = \{pr_1 \dots pr_6, du_1 \dots du_8, po_1 \dots po_4\}$ of a pre-experience pr, during-experience du, post-experience po.

The set of behaviour data integrated as $BD \in X_{ij}$. Each behaviour data itself a set $BD = \{p_1 \dots p_5, pi_1 \dots pi_9\}$ of a posture p, physiological index pi.

Input EDFs layer relies on the tracking and timing of EDF from each exhibition, theme/event, to display, and then to EDF itself. Tracking and timing are done using eye-tracker or traditional approaches such as observation or paper-and-pencil (Section 3.4.3). This is followed by the recognition of BD from the set of detected EDFs units. It is completed by using wearable equipment with various sensors. AEFs layer checks and reviews a set of AEFs after and with the recognition of BD. The fourth layer combines a sequence of BD and AEFs through a feature-selcetion algorithm to understand emotions. As final measurement, a feature-selcetion algorithm tends to infer enjoyment emotion based on previous three layers. However, the further in-depth discussions on the algorithm are not involved in this thesis. This is another research direction to be explored.

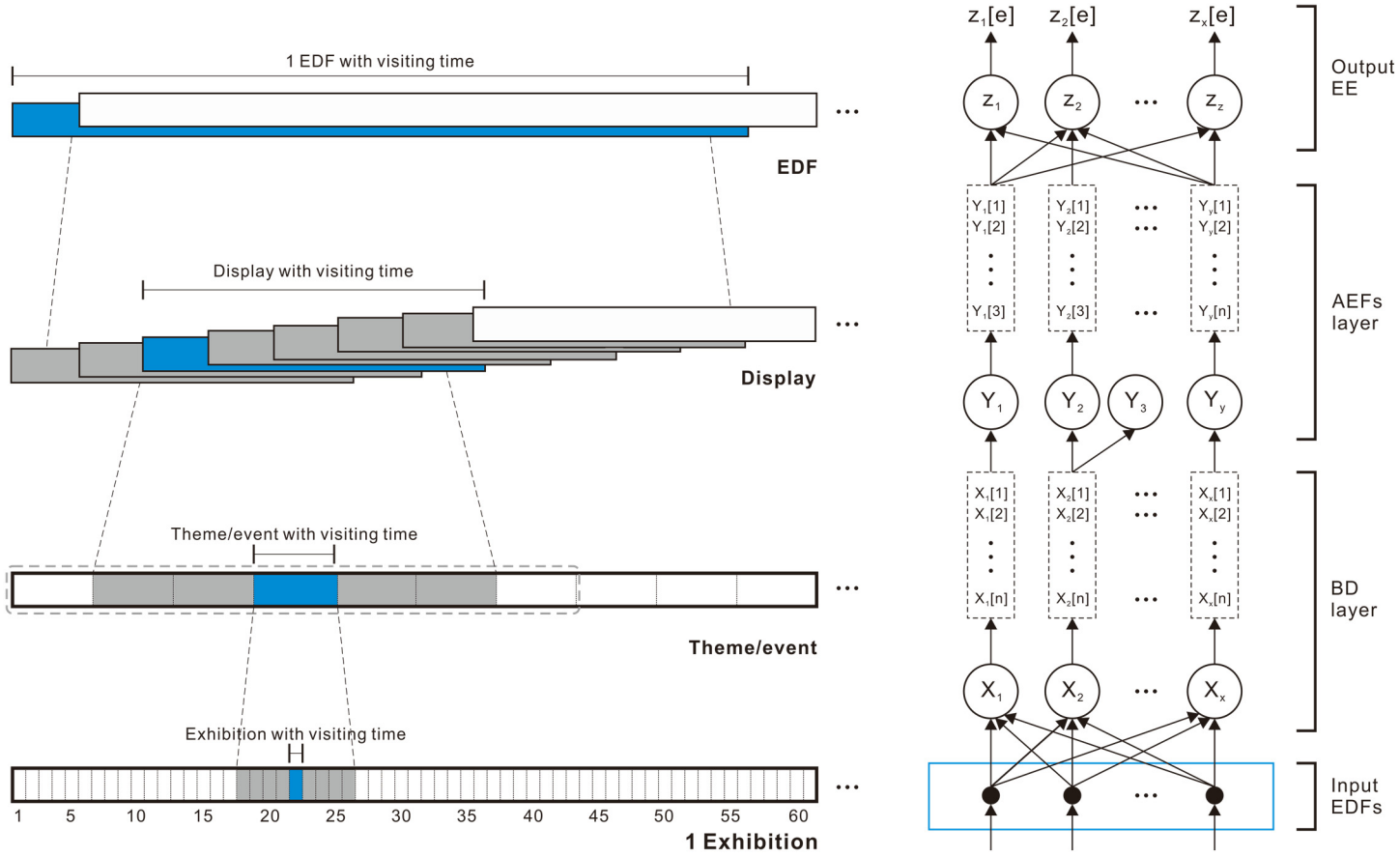


Figure 7.54. Exploring possible model for exhibition design based on ANNs.

7.4 Conclusion

7.4.1 Addressing research questions

Three research questions were proposed to explore what is the relationship among EDFs, AEFs and BD. Using findings from the research work conducted in this thesis can address these questions.

> **RQ1:** *What are the EDFs and AEFs perceived by audiences and used by designers in exhibitions?*

The first research question was aimed at identifying and analyzing EDFs and AEFs in the context of an exhibition. Throughout the thesis, we find how EDFs, AEFs and BD had been embedded into HEI. Firstly, the initial results of EDFs, AEFs and BD had been identified by using the method of grounded theory, which involving the focus group with research professionals in three countries (UK, Italy, and China), systematic literature review for around 1200 scientific articles, and personal narrative with practical exhibition design projects for around three months (Chapter 1). Secondly, the experiment 2 by using the questionnaire for surveying 500 audiences in the field of Expo Milano 2015 and semi-structured interview was conducted with 11 participants. Through them, the EDFs and AEFs perceived by audiences and used by designers and clients were investigated. Thirdly, a conceptual model of HEI was presented with the '***combination***' of EDFs, AEFs, and BD. The combination was based on the research work implemented in the thesis, but also utilized the previous scientific literature reviewed the Chapter 1.

> **RQ2:** *How can an exhibition be designed to create enjoyment?*

The second research question was aimed at defining a framework of designing enjoyable exhibitions. It included two sub-questions: '*how are enjoyable exhibition designed by using EDFs and AEFs?*', and '*how can the exhibition design framework be applied to design exhibition that creates enjoyment?*' The answers provide insight into consideration of the performance and transformation (Section 2.5.2), the conceptual framework of HEI, and the combination of EDF, AEFs, BD and enjoyment emotion. In terms of both theoretic and technique aspects, the following factors were highlighted: i) three stakeholders, ii) collaborative data for evaluation and iii) embedding enjoyable into exhibition design. Chapter 4 shows how an exhibition became enjoyable by using the FDEE framework. It describes how three stakeholders entered directly scenarios of exhibition by performing and transforming into an exhibition with collaborative data. Through these processes, audience experience (AE) was transformed and enhanced, and thus helping exhibition professionals design more effective and better exhibitions.

> **RQ3:** *How can behavioral data be used to get more reliable and valid data of enjoyment emotion in exhibitions?*

The third research question was aimed at studying what had been reviewed (Chapter 1) about the possible relationship among EDFs, AEFs, and BD. It also includes two sub-questions, '*what are the methods, approaches and tools to get reliable and valid quantitative data about enjoyment emotion in exhibitions?*', and '*how can behavioral data be used to understand the impact of EDFs in enjoyment emotion in exhibitions?*' Chapter 5 addresses the question by conducting a field study that shows the interactive and dynamic relationship among EDFs, AEFs, and BD through timing and tracking with wearable equipment, eye-tracker, and questionnaire. The dynamic relationship among EDFs, AEFs, BD and enjoyment, is illustrated through the experiment in a local university exhibition for students' design and art work. In the experiment 2, there were four types of BD recorded: EMG, HRV, SKT, and EDA. The results further supported the theoretical framework of HEI and FDEE by using quantitative data. Moreover, Chapter 6 coded selected exhibition with ten types of display in line with a visiting sequence (shown in Table 6.42), and the result of questionnaire presents that all participants indicate enjoyment during their exhibition-visiting among them. However, further study may continue to explore the impact of each of ten types of display/exhibition with EDFs on audience enjoyment based on the interactive relationship among EDFs, AEFs and BD. It tends to be another valuable PhD topic.

In summary, the framework of designing enjoyable exhibition (FDEE) had opened up a view and approach to the '*performance*' and '*transformation*', which had changed the audience experience. Audience experience (AE) in turn enacted the achievement of human-exhibition interaction (HEI). The HEI then was drawn upon more effective exhibition design. The conceptual framework suggests that there is a dynamic and loop interaction among three stakeholders with individual target by combing EDFs, AEFs, and BD. Consequently, FDEE focusing on the measuring role of enjoyment emotion with a series of transformations provides further insight into a possible approach across all HEI state for exhibition development through these transformations and collaborative data. In the following section, it tends to present three final conceptual statements servicing for these research questions and findings across the thesis.

7.4.2 Final conceptual statements

The findings of this thesis will be summarized in this section by the form of final conceptual statements. These statements offer a way to be understood in the both practical and theoretical context of the exhibition industry and exhibition design. They are not introduced to make generalizations. Instead, they tend to some extent served as a basis for further exploration that helps to design better exhibition. As a consequence, a simplified summary of the thesis findings is presented as follows:

I. Human-exhibition Interaction (HEI): HEI exists as communicative and dynamic relationship between collaborative data (EDFs, AEFs, and BD), and three stakeholders (clients, designers, and audiences).

II. Transforming process: Transforming audience experience into enjoyable exhibition states involves six performance processes: Considering audience, message-transforming between clients and designers, combining client, designers and audiences, collaborative data for evaluation, and embedding enjoyable into exhibition design.

III. Enjoyment as measurement: Enjoyment used as a tool for measuring the effectiveness of exhibition design, and hence providing a performance environment for clients, designers and audiences within the context of exhibition.

IV. Framework of designing enjoyable exhibition (FDEE): FDEE is inscribed with HEI; embed BD to make enjoyable exhibition; and loop with the interactive, and communicative network.

7.4.3 Novel contribution to knowledge

Parts of novel contributions to knowledge have been indicated in Section 3.6.5 (Chapter 3). It includes: The dimensions of exhibition, mapping exhibition design, transforming audience experience, designing enjoyment exhibition, embedding behavioral data into exhibition design, identifying EDFs, AEFs and BD, and performing evaluation in exhibition design.

A main contribution of this thesis is the **framework of human-exhibition interaction (HEI)**[38], illustrated in Section 3.6. While previous studies (Section 3.6.1) have reported a communicative interaction between exhibitions and audiences in the field of designing exhibitions (Miles and Alt 1988, Bitgood 1992, Stafford, Stafford et al. 2004, Bitgood 2006, Snibbe and Raffle 2009, Vavoula, Sharples et al. 2009, Massara, Liu et al. 2010, Deckers, Levy et al. 2012, Gilboa and Vilnai-Yavetz 2013, Roppola 2013, Lischke 2014), none illustrated as systematic framework of the interactions in detail as investigated for this study. Furthermore, the relationship among EDFs, AEFs and BD has received analysis to some extent, none of in-depth studies was been progressed with quantized and combined investigation (Bitgood and Patterson 1987, Chen and Ho 2003, Ng 2003, Macdonald 2007, Bitgood 2009, Choi 2010, Bitgood 2011, Petermans, Janssens et al. 2013, Cohen, Prayag et al. 2014). The research performed in this thesis addresses these issues through the mixed method involving grounded theory, systematic literature review, personal narrative, focus group, and real

[38] An article *Human-exhibition Interaction (HEI) in Designing Exhibition: a Systematic Literature Review* has been reviewed by the International Journal of Hospitality Management, on January 2018.

projects in practice. These research methods were selected based on consideration of the exhibition factors reported in previous scientific articles that all focused on the qualitative study instead of quantitative analysis (shown in Table 3.20 and Table 3.21, Section 3.5.4).

Another initial contribution relates to **the framework of designing enjoyable exhibition (FDEE)**[39] which combines collaborative data, enjoyment emotion and three stakeholders on the basis of HEI. It was illustrated in Figure 5.38. It speaks to the discussion about how to design an enjoyable exhibition based on the concerns of which the relationship among BD, EDFs, and AEFs is (Chapter 5). The review of previous research works in Chapter 1 showed that enjoyment emotion as evaluation and measurement has received attention in many fields (Green, Brock et al. 2004, Sweetser and Wyeth 2005, Fu, Su et al. 2009, Csikszentmihalyi 2014); however, none of the studies enabled enjoyment emotion into the academic and production area of exhibition design, though it has been mentioned for exhibition design in some previous studies (Section 3.3.3). Thus, the development of FDEE provides an original addition to knowledge.

The reported exhibition design approaches were a liner in general, with either a one-, two-, or multi-directional process (Miles and Alt 1988, Seagram, Patten et al. 1993, Lin 2002, Chuan, Kun et al. 2006, Jung and Choi 2014, Huang, Wei et al. 2016). However, across the practical projects, it tends to be unrealistic for various designers and clients by using a unified mean. Unlike previous research work, FDEE is a loop and circular form that enables exhibition professors to use it at any point during the development process.

The identification and combination of EDFs, AEFs, and BD in Section 3.4 and 3.5 are also a valuable contribution to knowledge. Although they were reported in the scientific literature and serviced in exhibition industry generally as a tool, the formal study for factor identification with scientific methods was not available in previous research work (shown in Section 3.5.4). However, this research, on the one hand, identified these key exhibition factors by using suitable research methods (Section 3.5); on the other hand is to obtain quantitative data by conducting an experiment in the field through the application of appropriate equipment. Finally, collaborative data obtained in experiment provide a supported data as the basis of HEI and FDEE. As a consequence, factor identification for exhibition design is a novel contribution, which is the foundation but can help three stakeholders design more effective and enjoyable exhibition particularly when considering better exhibition design.

[39] An introduction to the framework was published in CHI 2015: Wang, N. (2015). *Enhancing User Experience to Design Enjoyable Exhibition Events*. Paper presented at the Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems.

7.4.4 Limitations and directions for further research

The limitations of the research had been discussed in the last section of each chapter. This section interprets the limitations from an integral perspective. In addition, Table 7.44 presented in following provides recommendations to address the matters in future work.

Generally speaking, there are several limitations resulting from the weight and balance that take place during a common research journey. For example, investigating 500 audiences directly in the field of Expo Milano meant an access opportunity with a rich resource for this thesis. But it meanwhile meant accepting the limitations of the objective environment, such as only one researcher conducting overseas, quite limited research funding and time, low response rates, etc. Normally a research team tends to ensure the implementation of such work across preparation, experiment and data analysis, especially in large-size exhibition with massive crowds (Tröndle, Greenwood et al. 2012, Tröndle and Tschacher 2012, Tröndle, Wintzerith et al. 2012). These types of limitations also appear in other work conducted in this thesis.

Another limitation stems from the fact that a great deal of time was spent coding 1467 scientific articles by using the method of grounded theory with the software NVivo-11 that allows qualitative data transferred into quantitative data. This was caused by two reasons: first is due to the lack of systematic review for studying exhibition design, and thus this thesis has to try to clearly reveal its theoretical development path for following studies; another is because ground theory indicated '*all is data*' (Glaser, 2001, p.145), which increases the demand for the amount of data with reliability and validity. However, it provides a fundamental background for further investigations and studies. For instance, Chapter 3 initially identified 59 EDFs, 18 AEFs, and 14 BD by using a systematic review method. Meanwhile, considering the issue of reliability and validity of the data, the research collected triangulated data from different time, locations, or sources. Also, it follows standardized research method, research design, and data collection to obtain more validated data. Whereas during the process, it required more time for the research work.

Regarding the limitations of the adapted research method, this research selected experiment conduction based on small sample (11 participants for in-depth interview, 12 participants for investigation with eye-tracker and wearable equipment), rather than only large sample in field study of Expo (500 respondents in survey). There are three reasons for integrating small sample and large sample in the experiment. First, using eye-tracker and wearable equipment needs long time for debugging and preparing efforts. For example, there is only one day for conducting the experiment with eye-tracker and wearable equipment, but it cost

two weeks for preparation, two days for training, and around three weeks for data analysis. Meanwhile, in this study, the equipment application requires attention to avoid the damage when collecting data in the field; the innovation laboratory, the equipment owned, enacts a limited time for outside application instead of inside laboratory. At interview stage, the recruitment work was spent much time due to most of them depends on a variable and busy timetable with project development. Second, although large sample can provide of the extent of reliability and validity to data analysis that is why a survey conducted in Expo Milano, small sample instead allows the research to develop more in-depth analysis on an exploratory study. For instance, considering it would be time-consuming for an interview with qualitative data analysis by using software NVivo, and timing and tracking with quantitative data analysis by using software SPSS and ErgoLab, small sample was selected for experiment 1a, 1b and 2. Similar examples also can be observed in previous studies.

A final potential limitation relates to the confusion among '*audience experience*', '*visitor experience*', and '*user experience'*. The term '*audience experience*' and '*visitor experience*' is used in the context of exhibition study, while '*user experience*' is usually in the context of HCI, experience design, or product/industrial design. Visitor experience was mentioned in visitor studies relatively for museum context (Falk 1993, Crimm, Morris et al. 2009, Falk and Dierking 2012, Bogle 2013, Forrest 2015, MacLeod, Dodd et al. 2015). For this thesis, the term of 'audience experience' was highlighted through this research work, because it is used frequently to illustrate the conveying message of receiver by telling a story on the basis of communication theory (Taylor 1963, Miles and Alt 1988, Lin 2002, Sparacino 2002, Lin, Ma et al. 2014), similar with other multimedia such as film (shown inTable 1.1, Section 2.3). It is not easy for distinguishing the user and audience. For instance, Allanwood and Beare (2014) claimed in his book *Basics Interactive Design: User Experience Design: Creating Designs Users Really Love*, '*in different social situations, …, and the people around us are an audience*.' In general, user experience (UX) was assumed to product-oriented from a commercial perspective (Hassenzahl and Tractinsky 2006, Desmet and Hekkert 2007, Law, Bevan et al. 2008, Obrist, Tscheligi et al. 2010, Rosenzweig 2015). Compared with UX, audience experience (AE) tends to context-oriented and message-oriented from both commercial and cultural perspectives (Kolter and Kolter 1998, Berry, Carbone et al. 2002, Carù and Cova 2007, Forrest 2015, Nesbitt and Maldonado 2016).

While this study introduced the research gaps of exhibition design in this section, there remains a wide range for further research that explores the interactive communication for HEI. For the future study, the attention should be directed toward developing more comprehensive interactive models that can explain

communication among three stakeholders not only designing effective exhibitions, but also caring audience experience, a system of relationship that combines EDFs, AEFs, and BD. It tends to be achieved by evaluating exhibition design with HEI framework such as EDFs, AEFs, BD, according to the communication nature of exhibition and exhibition design. That could better explain the reason for designing enjoyable exhibition, the evaluating, and decision-making role of enjoyment emotion. In conclusion, the introduction of research gaps and further research directions is outlined in Table 7.44.

This thesis had begun with the research problem '*What is the relationship among EDFs, AEFs, and BD?*' Investigations into the research question were conducted through mixed method, including grounded theory, systematic literature review, questionnaire, semi-structure interview, and timing and tracking by using eye-tracker and wearable equipment. Both qualitative and quantitative data were collected for scientific analysis. The new frameworks, HEI and FDEE, have also been developed, in which an enjoyable exhibition may be achieved through transforming audience experience with exhibition design. The research findings provide scientific knowledge to exhibition professionals or companies for planning, designing and evaluating exhibitions, and support audiences more interacting with exhibitions.

As shown in Table 7.43 in Section 7.2, it mapped the whole thesis, moving from research questions; to an initial conceptual framework; to a series of experiment and analysis; and to a theoretical framework for enjoyable exhibition design, all outlined in the chapters in detail and depth. The review chapter summarized the gap among exhibition, exhibition design, audience experience, enjoyment emotion, and behaviour data. It provided a fundamental background for further study. In this chapter, human-exhibition interaction (HEI) framework and identification of EDFs, AEFs, and BD were explored from the literature. The experiment chapters directly investigated the research questions through the field study. The FDEE chapter then illustrated the approach by combing previous research findings. The last chapter has addressed the research questions as conclusion. However, this is just a beginning as a research exploration and direction in terms of exhibition design. Further research can be conducted with various research methods, comparison studies, or algorithm studies in depth.

Table 7.44. Research gaps and further research directions.

Research gaps	Future research directions
- Measuring audience experience objectively by using HEI and FDEE; - empirical and quantitative studies on investigating EDFs, AEFs, and BD in exhibition design; - The combined studies on the interactive relationships among EDFs, AEFs, and BD;	- HEI: How can more behavioral data be obtained for designing and evaluating exhibitions? How to design more interactive exhibition by using HEI and FDEE? How to bridge the gap between academic and practical aspects with HEI framework? How and what is the difference between HIE and traditional exhibitions from the points of three stakeholders? What is the benefits that HEI should be learned from traditional culture? What are the differences among HEI and other interactions such as HCI?
- Obtaining and extracting quantitative data for designing and evaluating exhibitions that are more effective; - Designing interactive exhibitions combining various stakeholders, such as client, audience, designer, and evaluator;	- Enjoyment: Do audiences feel they 'enjoy' exhibitions? To commercial and to cultural exhibitions? How three stakeholders (clients, designers, and audiences) consider and use the decision-making role of enjoyment emotion in exhibition design? How can exhibitions be designed to create enjoyment by using algorithm?
- Comparison study between traditional methods and FDEE to design a more attractive exhibition realizing the communication end; -Helping clients and designers to understand their audiences; getting through the loops among client, designer, and audience in HEI; considering the role of evaluator;	- Audience experience: Is there a detailed means to transform audience experience by designing more interactive exhibitions? What is the difference between previous frameworks and FDEE? - The balance between physical and virtual exhibitions with various technologies; the effect comparison between physical and virtual exhibitions; What and how physical exhibition is shaped or integrated by technologies?
- Evaluating exhibition design based on HEI framework;	- Gender and age perspectives on both commercial and cultural exhibitions are an emerging topic.
- Behaviour data can be used to understand and evaluate audience experience with algorithm;	- Evaluation: HEI framework calls for considerable evaluation in exhibition design, including both pre-and post-visiting stage of exhibitions.
- Enjoyment emotion can be used to evaluate exhibition design with algorithm; - Comprehensive reviews on the topic areas of combining exhibition design, audience experience, behaviour data, and enjoyment emotion; - Audiences respond emotionally to exhibitions and aspects of exhibition design trigger and emotional reaction based on HEI; - The integration of exhibition design between academics/research/framework and industries/ practice/ project; - The comparison study for methods of gaining and analyzing behaviour data, audience experience and enjoyment emotion; - Exploring and developing algorithms in exhibition design based on the framework of HEI and FDEE; - Methods of gaining and analyzing behavior data, audience experience and enjoyment emotion; - Considering other performance factors including cost, area, satisfaction etc.	- Initial, front-end, summative, and formative evaluations on future exhibition design should be developed - Both commercial and cultural exhibitions appear to be more blurring and interactive – Is this an important trend? And what is the influence on exhibition design? - Needs: What are the fundamental needs on the different views of three stakeholders, including clients, designers, and audiences? - How is exhibition design shaped by economic, culture, social and other various contexts? What is the difference between exhibition design and other design disciplines? And what is the difference between China and other countries in exhibition industry? What is difference between exhibition designers and designers of other design disciplines? - Technology: How technology influences both commercial and cultural exhibitions, and three stakeholders? Can it help audiences to feel enjoyable, or enable clients and designers to design attractive exhibitions? How to use technologies in line with HEI and FDEE? - Algorithm: How to develop algorithms in designing exhibitions based on the view of clients, designers and audiences? How to mine valuable data to design better enjoyable exhibitions based on the framework of HEI and FDEE? How to integrate other algorithms into exhibition design such as machine learning and deep learning?

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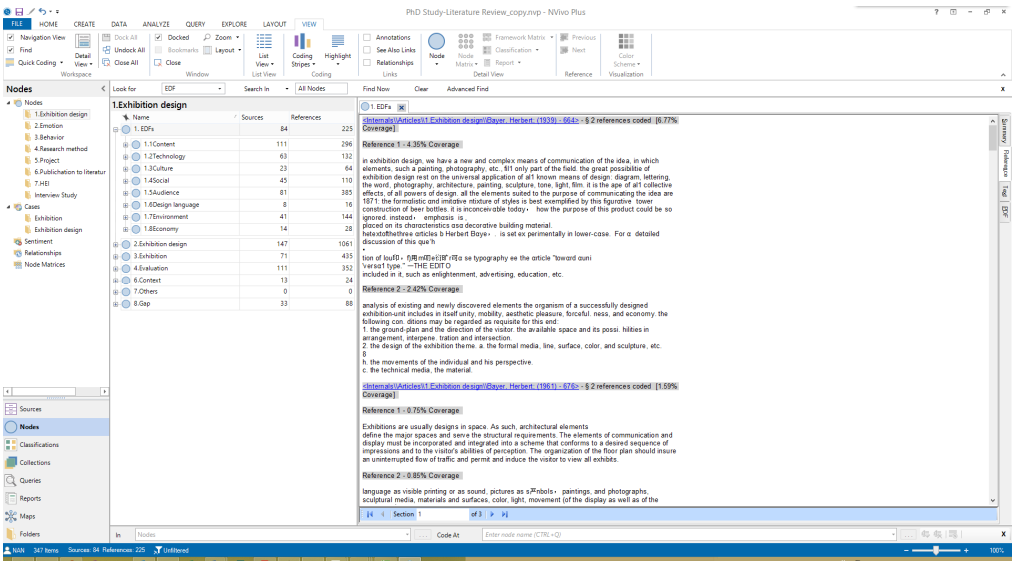
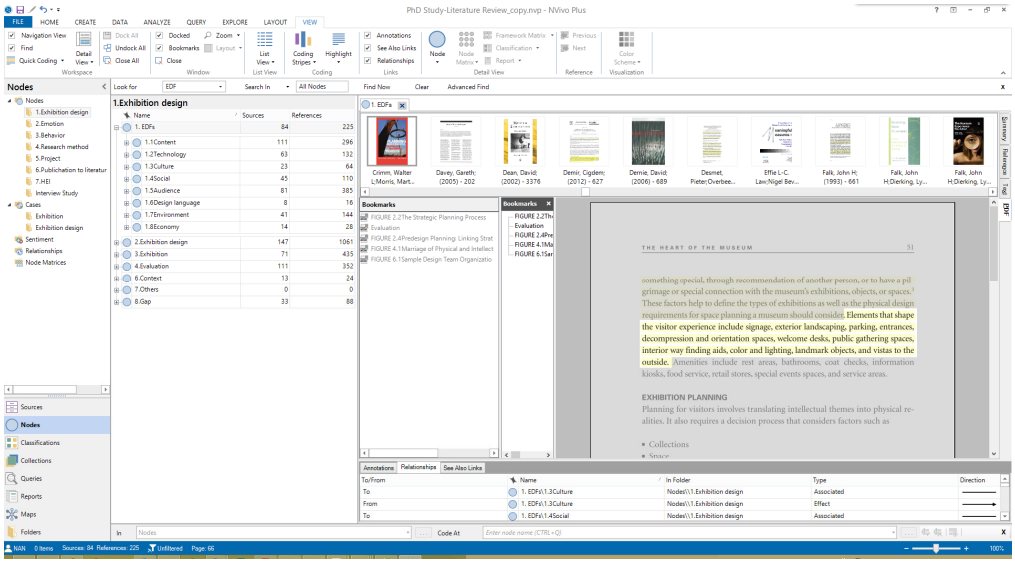
Appendix I: NVivo example '*exhibition design factors*'





Appendix II: Paticipant information and enter-/exit-questionanires used in Expo Milano 2015

Participant Information Sheet *Transforming Audience Experience to Design Enjoyable Exhibition*

Dear Participant,

Thank you for agreeing to participate in this questionnaire survey in connection with my *PhD research* at the University of Nottingham. The project is a study of what is the relationship among exhibition design factors (EDFs) ※, positive emotions (enjoyment) and behavioral data.

Your participation in the survey is voluntary. You are able to withdraw from the survey at any time and to request that the information you have provided is not used in the project. Any information provided will be confidential. Your identity will not be disclosed in any use of the information you have supplied during the survey.

The research project has been reviewed according to the ethical review processes in place in the University of Nottingham. These processes are governed by the University's Code of Research Conduct and Research Ethics. Should you have any question now or in the future, please contact me or my supervisor. Should you have concerns related to my conduct of the survey or research ethics, please contact my supervisor or the University's Ethics Committee.

Yours truly,

Nan Wang

Contact details:

Researcher: Nan Wang (zx17864@nottingha.edu.cn)

University Research Ethics Committee Coordinator, Ms Joanna Huang

(Joanna.Huang@nottingham.edu.cn)

※ Exhibition Design Factors (EDFs): Any factors used to develop exhibition design, e.g.:

- Contents i.e. Text, Image, Media, and Meaning.
- Design Language i.e. Style, Narrative, Art, Furniture, Art, Shape, Color, Texture, Material, amongst others.
- Technology i.e. Augmented Reality, Virtual Theatre, Sensors, Mixed Reality System, amongst others.

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

A PhD Study 2015101 | **2015 Tell Us Your Feelings about Exhibition Design in Milano Expo** ENT

Is this your first time visiting Expo in the world?

O Yes O No

➡ If no, where did you visit it? _____

Did you come to the Expo today specifically to see this pavilion?

O No O Yes

Are you looking forward to find if you will feel enjoyable emotions in this pavilion today?

O No O Yes

How do you think you will rate your overall experience after visiting this pavilion?

O Poor O Fair O Good O Excellent O Superior

Are you visiting this exhibition alone or with others?

[Mark one or more]

O I am alone

O One or more adults

O One or more youth under 18

Are you male or female? O Male O Female

Do you live in Italy or another country?

O Italy. Specify ZIP code: ☐☐☐☐☐

O Another country, specify: _____

What is your age? ☐☐

What do you expect to feel visiting this pavilion? [Mark one or more]

O Being moved by beauty
O Personal satisfaction
O Enriching my understanding
O Feeling a spiritual connection
O Connecting with the emotional experience
O Good service
O Attracting my attention
O Increasing my curiosity
O Encourage my creativity
O Making me feel cool
O Finding new interests
O Having fun
O Spending leisure time
O Learning a useful knowledge
O Social experience
O Sharing memories with others
O Reflecting on myself
O Authenticable experience of different cultures
O Other: _____

Help us to understand your interests. For each of this following items, please chose the activities that describes your personality better.

I like to ...				
...bring people together	O Not me at all	O A little me	O Me	O Very much me
...construct things	O Not me at all	O A little me	O Me	O Very much me
...logical games	O Not me at all	O A little me	O Me	O Very much me
...spending leisure time outside	O Not me at all	O A little me	O Me	O Very much me
...help others	O Not me at all	O A little me	O Me	O Very much me
...being trendy	O Not me at all	O A little me	O Me	O Very much me
I like to ...				
...jogging	O Not me at all	O A little me	O Me	O Very much me
...know how things are made	O Not me at all	O A little me	O Me	O Very much me
...improve knowledge	O Not me at all	O A little me	O Me	O Very much me
...play competitive sports	O Not me at all	O A little me	O Me	O Very much me
...Shopping	O Not me at all	O A little me	O Me	O Very much me
...spend my leisure time with other people	O Not me at all	O A little me	O Me	O Very much me

THANK YOU !

Time ☐☐ Period O am O pm Pavilion ☐

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

A PhD Study 2015102 | **2015 Tell Us Your Feelings about Exhibition Design in Milano Expo** | EXIT

Is this your first visit to this Expo in the world?

O Yes O No

→ If no, where did you visit it? _____

Did you come to the Expo today specifically to see the exhibition?

O No O Yes

Do you enjoy your visit at the pavillon today?

O No O Yes

Please rate your overall experience at this pavilion?

O Poor O Fair O Good O Excellent O Superior

Are you visiting this exhibition alone or with others?

[Mark one or more]

O I am alone

O One or more adults

O One or more youth under 18

Are you male or female? O Male O Female

Do you live in Italy or in another country?

O Italy. Specify ZIP code: ☐☐☐☐☐

O Another country, specify: _____

What is your age? ☐☐

Which of these status did you experience watching INSIDE the pavilion? [Mark one or more]

O I've been moved by beauty

O I considered my own needs

O I enriched my understanding

O Felt a spiritual connection

O Connection with the emotional experience

O Good service

O Caught my attention

O Increased my curiosity

O Encouraged my creativity

O Felt cool

O I found Expo interesting

O Had fun

O Spent leisure time

O Learned useful knowledge

O Social experience

O Sharing memories with others

O Reflected on myself

O Authenticable experience of different cultures

O Other: _____

Please rate your ENJOYMENT with the following factors INSIDE of the pavilion:	**1** very slightly or not at all	**2** a little	**3** moderately	**4** quite a bit	**5** extremely
Availability of information/ pamphlet	O	O	O	O	O
Photos on the walls	O	O	O	O	O
Exhibition multimedia (video, audio, interactivity)	O	O	O	O	O
Meanings of the exhibition	O	O	O	O	O
Computer interactive	O	O	O	O	O
Variety of cultures	O	O	O	O	O
Sharing experience with other people	O	O	O	O	O
Watching, walking and sitting	O	O	O	O	O
I feel happy, enjoyment, surprise, etc.	O	O	O	O	O
Style of exhibition design	O	O	O	O	O
Story-telling/narrative	O	O	O	O	O
Quality of art	O	O	O	O	O
Quality of shape	O	O	O	O	O
Color of exhibition	O	O	O	O	O
Texture of exhibition	O	O	O	O	O
Material of exhibition	O	O	O	O	O
Time of visiting exhibition in the pavilion	O	O	O	O	O
Communication with the staff	O	O	O	O	O
I can visit the exhibition very efficiently	O	O	O	O	O
Setting	O	O	O	O	O
Lighting	O	O	O	O	O
Music	O	O	O	O	O
Smell	O	O	O	O	O

THANK YOU !

Time ☐☐ Period O am O pm Pavilion ☐

Appendix III: Consent form and semi-structured interview used for designers and clients

PARTICIPANT CONSENT FORM

Project title *Transforming Audience Experience to Design Enjoyable Exhibition*
Researcher's name Nan Wang

- I have read the Participant Information Sheet and the nature and purpose of the research project has been explained to me. I understand and agree to take part.
- I understand the purpose of the research project and my involvement in it.
- I understand that I may withdraw from the research project at any stage and that this will not affect my status now or in the future.
- I understand that while information gained during the study may be published, I will not be identified and my personal results will remain confidential.
- I understand that the interview and data collection will be recorded.
- I understand that data will be stored in accordance with data protection laws.
- I understand that I may contact the researcher or supervisor if I require more information about the research, and that I may contact the Research Ethics Sub-Committee of the University of Nottingham, Ningbo if I wish to make a complaint related to my involvement in the research.

Signed …… (Participant)

Print name …… **Date** ……

Contact details

Researcher: Nan Wang (zx17864@nottingham.edu.cn)

UNNC Research Ethics Sub-Committee Coordinator:
Joanna.Huang@nottingham.edu.cn

If a thank-you postcard could be accepted by you after this interview, please provide your postal address:

☐ Tick the box , accepting the thank-you postcard.

Street and unit

Your state/province, and zip code

DESIGNER

Interview for a PhD study

PARTICIPANT INFORMATION

Name:						
Gender:	Male			Female		
Nationality:						
Country of Residency:						
Your Job Title:						
What is Your Age:	Under 20	21-35	36-50	51-65	66 +	
Academic Experience:	Less than high school	High school	Undergraduate	Master's	Doctoral	Professional
Year of Exhibition Design:	1985 or before	1986-1995	1996-2005	After 2006		
Your Recent Exhibition Design Project:						

DEFINITIONS

Exhibition Design Factors (EDFs): Factors used by designers to help design exhibitions for communication.

Audience Experience Factors (AEFs): Factors perceived by audiences that will affect their memory and decision-making before, during and after vising exhibitions.

MEME: an idea is passed from one member of society to another, not in the genes but often by people copying it.

Tools: Any instrument used to develop exhibition design, e.g.:

- Design Software i.e. 3D Max, Rhino, CAD, CorelDraw, Photoshop, Aftereffect, amongst others
- Standards i.e. National and internationals, or local laws and regulations
- Reference Literature i.e. books, journals, catalogues, amongst others.
- Database i.e. information resources that help make decision and design.

QUESTIONS

1. How do you think Commercial exhibition and Cultural exhibition? Briefly, tell me about your experience to a commercial exhibition? Tell me about your professional life and experience to exhibition design? You can illustrate your answer with examples.

LEADER/EXPERT

Interview for a PhD study

PARTICIPANT INFORMATION

Name:						
Gender:	Male				Female	
Nationality:						
City of Residency:						
Your Occupational Status:						
Your Job Title:						
What is Your Age:	Under 20	21-35	36-50	51-65	66 +	
Academic Experience:	Less than high school	High school	Undergraduate	Master's	Doctoral	Professional
Your Recent Exhibition Visiting:						
Did You Enjoy Your Exhibition Visiting?	Yes			No		

DEFINITIONS

Exhibition Design Factors (EDFs): Factors used by designers to help design exhibitions for enhancing audience experience and communication, e.g. shape, color and lighting etc..

Audience Experience Factors (AEFs): Factors perceived by audiences that will affect their satisfaction and decision-making before, during and after vising exhibitions, e.g. satisfaction, learning and curiosity etc..

MEME: an idea is passed from one member of society to another, not in the genes but often by people copying it.

Tools: Any instrument used to develop exhibition design, e.g.:

- Software i.e. Project, excel and other management software.
- Standards i.e. National and internationals, or local laws and regulations.
- Reference Literature i.e. books, journals, catalogues, amongst others.
- Database i.e. information resources that help make decision.

QUESTIONS

1. How do you think the difference between Commercial exhibition and Cultural exhibition? Briefly, tell me about your experience to a commercial exhibition? Tell me about your experience about exhibition design? You can illustrate your answer with examples.

2. Based on your company, what do you consider are the main considerations when you designing an exhibition? What are the main function of exhibition design in an exhibition? You can illustrate your answer with examples.

3. According to your experience, which are the factors that have the biggest effect on the final design of your exhibition project?

4. How do you think the future and development of exhibition design as you know?

5. Do you learn about Exhibition Design, Product Design, Interior Design and etc.? If yes, please describe the difference.

6. There is a graph about exhibition design progress, which ones are the most influential part in the process? Please mark it and provide your reason. (Modified from Paul Cobley's (1996) communication model)

7. Please rate each of the below Tools according to its daily use in your professional careers of exhibition design. 10 means USED VERY OFTEN and 1 USED NOT AT ALL, you can add other factors that you use.

1: Advice from Client	1 Used not at all	2	3	4	5	6	7	8	9	10 Used very often
2: Professional Advice from Researcher	1 Used not at all	2	3	4	5	6	7	8	9	10 Used very often
3: Feedback from Audience	1 Used not at all	2	3	4	5	6	7	8	9	10 Used very often
4: Interaction with Audience	1 Used not at all	2	3	4	5	6	7	8	9	10 Used very often
5: Standards	1 Used not at all	2	3	4	5	6	7	8	9	10 Used very often
6: Data Bases	1 Used not at all	2	3	4	5	6	7	8	9	10 Used very often
7: Literature	1 Used not at all	2	3	4	5	6	7	8	9	10 Used very often
8: Design Software: _____	1 Used not at all	2	3	4	5	6	7	8	9	10 Used very often
9: Others: _____	1 Used not at all	2	3	4	5	6	7	8	9	10 Used very often
10: Others: _____	1 Used not at all	2	3	4	5	6	7	8	9	10 Used very often
11: Others: _____	1 Used not at all	2	3	4	5	6	7	8	9	10 Used very often

8. Do you consider there are needs to understand the audience and their feedbacks during exhibition design process? Please explain your answer.

9. Do you consider that there are enough tools to understand audience or help design exhibition? Please explain your answer.

10. Do you consider Audience Experience Factors helping exhibition design? Please explain your answer.

11. Which are the most important Exhibition Design Factors that affect your design works?
    a. How will you integrate these Factors in the exhibition design project? You can describe your answer with an example.
    b. Do you use any tool to integrate, measure or verify these factors in your design projects?

12. Do you consider it important to evaluate the performance of the exhibition design as following? Please rate each of them according to its importance based on your experiences. 10 means VERY IMPORTANT and 1 UNIMPORTANT.

1: Evaluation Before Exhibition Built	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Please provide your reason										

2: Evaluation During Exhibition Built	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Please provide your reason										

3: Evaluation After Exhibition Built	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Please provide your reason										

13. Do you know tool that help to evaluate the performance of the exhibition design? Which ones? Do you use it/them?

14. Do your know tools that help you understanding audience such as their emotions, user experience or behaviors? Which ones? Do you use it/them?

15. Have your ever be involved into a commercial exhibition design in another country? If yes,
    a. Which country?
    b. What were the main considerations you had while designing it?
    c. How did you include there considerations in the stage of design?
    d. Which tools could support your design decision?

16. Below, some Exhibition Design Factors and Audience Experience Factors involved in exhibition design are presented. Please rate each of them according to its importance based on your experiences. 10 means VERY IMPORTANT and 1 UNIMPORTANT.

1: Exhibition Design Factors	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Content	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Text	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Graphic	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Label	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Multimedia	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Exhibit	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Brief (report/proposal)	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Concept	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Meaning	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Others: _____	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Technology	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Internet	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Mobile	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Label	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Touch-screen system	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Digital interaction	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Virtual reality	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Augmented reality	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Mixed reality	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Hologram	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Sensor	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important

Laser cutting	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Robot	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Others: _____	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important

Culture	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Crossing	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Collaboration	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Others: _____	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important

Social	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Communication	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Others: _____	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important

Audience	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Behavior	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Emotion	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Gender	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Sensation	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Age	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Personality	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Others: _____	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important

Design language	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Style	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Narrative	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Interaction	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Ergonomics	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important

Aesthetics	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Prop	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Shape	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Color	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Texture	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Time	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Model	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Motion	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Technical drawing	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Others: _____	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important

Environment	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Space	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Lighting	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Signage	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Temperature	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Architecture	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Others: _____	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important

Marketing	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Client	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Requirement	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Budget	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Services cape	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Rules and regulations	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Others: _____	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important

2: Audience Experience Factors	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Motivation	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Satisfaction	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Understanding	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Engagement	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Emotional	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Service	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Attention	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Curiosity	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Creativity	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Cool	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Interesting	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Fun	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Leisure	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Learning	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Participation	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
Memory	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important

	Reflection	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
	Authenticity	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important
	Others: _____	1 Unimportant	2	3	4	5	6	7	8	9	10 Very Important

Please provide comments to help us understand particularly high or low ratings. Please provide any other comments or add more topics:

_____

_____

_____

Do you agree to present your name in publishing paper based on an academic purpose?

Agree ☐ Disagree ☐

End of the Interview

Appendix IV: Participants' visitng time during Experiment 2 with wearabel devices and eye-tracker

	P1			P2			P3		
	Start time	End time	During	Start time	End time	During	Start time	End time	During
First floor	00:00:25.681	00:09:05.163	00:08:00	00:00:35.711	00:06:01.725	00:05:26	00:00:53.041	00:02:02.471	00:01:09
Second floor	00:09:20.882	00:18:03.616	00:08:00	00:06:16.946	00:08:13.917	00:01:57	00:08:32.575	00:13:27.263	00:04:55
Exhibition1	00:00:25.681	00:00:30.986	00:00:05	00:00:35.711	00:01:10.553	00:00:35	00:00:53.041	00:02:02.471	00:01:09
Exhibition2	00:00:30.986	00:00:40.434	00:00:09	00:01:10.553	00:01:46.963	00:00:36	00:02:02.471	00:03:02.887	00:01:00
Exhibition3	00:00:40.434	00:01:28.768	00:00:48	00:01:46.963	00:02:12.789	00:00:26	00:03:02.887	00:03:56.646	00:00:54
Exhibition4	00:01:44.752	00:03:04.596	00:01:20	00:02:24.366	00:03:07.410	00:00:43	00:04:07.526	00:04:58.045	00:00:51
Exhibition5	00:03:16.574	00:08:58.637	00:05:42	00:03:17.149	00:05:55.783	00:02:39	00:05:03.312	00:08:10.742	00:03:07
Exhibition6	00:09:24.329	00:16:35.120	00:07:11	00:06:20.040	00:07:19.771	00:01:00	00:08:36.513	00:12:27.632	00:03:51
Exhibition7	00:16:42.619	00:18:02.652	00:01:20	00:07:25.112	00:08:13.537	00:00:48	00:12:34.683	00:13:27.384	00:00:53
Transition1	00:01:29.248	00:01:30.632	00:00:01	00:02:12.789	00:02:24.380	00:00:12	00:03:56.646	00:04:07.345	00:00:11
Transition2	00:03:04.308	00:03:16.603	00:00:12	00:03:07.410	00:03:17.426	00:00:10	00:04:53.359	00:05:03.010	00:00:10
Transition3	00:08:58.836	00:09:24.563	00:00:26	00:05:55.757	00:06:19.986	00:00:24	00:08:10.755	00:08:36.087	00:00:25
Transition4	00:16:35.074	00:16:43.459	00:00:08	00:07:19.885	00:07:25.096	00:00:05	00:12:27.624	00:12:34.725	00:00:07
Transition5	00:18:02.689	00:18:25.935	00:00:23	00:08:13.601	00:08:35.315	00:00:22	00:13:27.624	00:13:49.106	00:00:21
Display1	00:00:25.681	00:00:30.986	00:00:05	00:00:35.711	00:01:10.553	00:00:35	00:00:53.041	00:02:02.471	00:01:09
	-	-	-	-	-	-	-	-	-
Display2	00:00:30.986	00:00:40.434	00:00:09	00:01:10.553	00:01:46.963	00:00:36	00:02:02.471	00:03:02.887	00:01:00
Display3	00:00:40.434	00:01:28.768	00:00:48	00:01:46.963	00:02:12.789	00:00:26	00:03:02.887	00:03:56.646	00:00:54
Display4a	00:09:27.962	00:09:45.737	00:00:18	00:06:19.986	00:06:53.074	00:00:33	00:08:36.087	00:09:36.610	00:01:01
	00:09:48.586	00:10:08.816	00:00:20	00:07:05.167	00:07:10.898	00:00:06	00:10:13.599	00:10:47.190	00:00:34
	00:11:41.052	00:13:37.924	00:01:57	-	-	-	00:11:40.161	00:12:01.589	00:00:21
	00:14:42.236	00:16:32.530	00:01:50	-	-	-	-	-	-
Display4b	00:01:44.327	00:01:58.609	00:00:14	00:02:24.380	00:02:27.905	00:00:04	00:04:07.345	00:04:11.488	00:00:04
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	-	-	-	-	-	-	-	-	-
Display4c	00:02:01.265	00:02:10.575	00:00:09	00:02:30.070	00:02:34.112	00:00:04	00:04:14.108	00:04:15.336	00:00:01
	00:02:18.927	00:02:25.752	00:00:07	00:02:55.215	00:02:59.293	00:00:04	00:04:25.416	00:04:29.664	00:00:04
	00:02:33.892	00:02:55.624	00:00:22				00:04:37.868	00:04:46.888	00:00:09
Display4d	00:10:13.126	00:10:41.298	00:00:28	00:06:56.676	00:06:59.988	00:00:03	00:09:40.822	00:09:48.617	00:00:08
	00:13:38.321	00:14:38.672	00:01:00	00:07:10.898	00:07:14.362	00:00:03	00:10:47.190	00:11:36.896	00:00:50
	-	-	-	-	-	-	00:12:01.589	00:12:25.259	00:00:24
	-	-	-	-	-	-	-	-	-
Display4e	00:10:41.618	00:11:39.245	00:00:58	00:06:59.988	00:07:04.028	00:00:04	00:09:48.617	00:10:11.334	00:00:23
Display5	00:03:18.231	00:03:23.787	00:00:06	00:03:18.675	00:03:40.992	00:00:22	00:05:08.950	00:05:31.257	00:00:22
	00:03:50.552	00:04:38.741	00:00:48	00:03:51.798	00:04:10.063	00:00:18	00:05:36.825	00:06:21.385	00:00:45
	00:08:33.657	00:08:41.181	00:00:08	00:04:44.101	00:05:45.582	00:01:01	00:07:44.697	00:07:58.035	00:00:13
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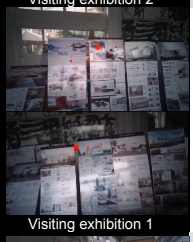
	-	-	-	-	-	-	-	-	-
Display6	00:03:30.719	00:03:50.185	00:00:19	00:04:10.063	00:04:44.101	00:00:34	00:06:21.385	00:07:44.697	00:01:23
	00:04:38.741	00:08:11.085	00:03:32	-	-	-	-	-	-
	00:08:11.085	00:08:33.657	00:00:23	-	-	-	-	-	-
Display7	00:16:43.007	00:16:49.067	00:00:06	00:07:25.096	00:07:30.407	00:00:05	00:12:34.725	00:12:37.489	00:00:03
	00:16:56.840	00:17:36.886	00:00:40	00:07:35.840	00:07:40.057	00:00:04	00:12:47.993	00:13:02.014	00:00:14
	-	-	-	00:07:42.023	00:07:54.912	00:00:13	00:13:13.675	00:13:21.063	00:00:07
Display8	00:16:49.067	00:16:56.840	00:00:08	00:07:30.407	00:07:35.840	00:00:05	00:12:38.836	00:12:46.969	00:00:08
	00:17:43.061	00:17:58.987	00:00:16	-	-	-	-	-	-
Display9	-	-	-	00:07:40.278	00:07:42.023	00:00:02	00:13:03.476	00:13:12.983	00:00:10
Display10	-	-	-	-	-	-	-	-	-

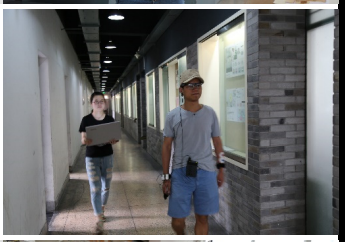
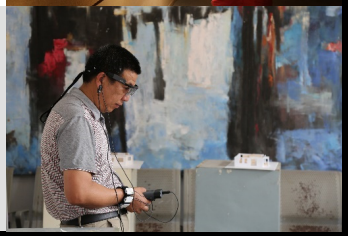
	P4			P5			P6		
	Start time	End time	During	Start time	End time	During	Start time	End time	During
First floor	00:01:21.875	00:01:52.864	00:00:31	00:01:01.914	00:04:12.417	00:03:11	00:03:16.672	00:10:35.349	00:07:19
Second floor	00:05:54.833	00:08:05.587	00:02:11	00:04:29.213	00:06:12.401	00:01:43	00:10:49.945	00:13:55.724	00:03:06
Exhibition1	00:01:21.857	00:01:52.864	00:00:31	00:01:01.914	00:01:29.172	00:00:27	00:03:16.672	00:04:00.390	00:00:44
Exhibition2	00:01:52.864	00:02:09.303	00:00:16	00:01:29.172	00:01:42.288	00:00:13	00:04:00.390	00:04:43.346	00:00:43
Exhibition3	00:02:09.308	00:02:39.994	00:00:31	00:01:42.288	00:02:04.813	00:00:23	00:04:43.346	00:05:06.060	00:00:23
Exhibition4	00:02:50.021	00:03:30.121	00:00:40	00:02:13.797	00:02:49.596	00:00:36	00:05:17.269	00:05:56.954	00:00:40
Exhibition5	00:03:41.414	00:05:34.078	00:01:53	00:03:00.483	00:04:05.678	00:01:05	00:06:07.721	00:10:29.962	00:04:22
Exhibition6	00:05:57.642	00:06:57.674	00:01:00	00:04:32.947	00:05:20.953	00:00:48	00:10:53.879	00:12:28.308	00:01:34
Exhibition7	00:07:03.160	00:08:05.226	00:01:02	00:05:26.174	00:06:12.147	00:00:46	00:12:33.412	00:13:55.269	00:01:22
Transition1	00:02:39.994	00:02:50.022	00:00:10	00:02:04.813	00:02:13.837	00:00:09	00:05:06.060	00:05:17.320	00:00:11
Transition2	00:03:30.062	00:03:41.709	00:00:12	00:02:49.563	00:03:00.417	00:00:11	00:05:56.932	00:06:07.721	00:00:11
Transition3	00:05:33.542	00:05:57.627	00:00:24	00:04:05.673	00:04:32.965	00:00:27	00:10:30.126	00:10:53.892	00:00:24
Transition4	00:06:57.627	00:07:03.169	00:00:06	00:05:20.935	00:05:26.177	00:00:05	00:12:28.237	00:12:33.483	00:00:05
Transition5	00:08:05.587	00:08:23.314	00:00:18	00:06:12.103	00:06:32.278	00:00:20	00:13:55.270	00:14:12.347	00:00:17
Display1	00:01:21.857	00:01:52.864	00:00:31	00:01:01.914	00:01:29.172	00:00:27	00:03:16.672	00:04:00.390	00:00:44
	-	-	-	-	-	-	-	-	-
Display2	00:01:52.864	00:02:09.303	00:00:16	00:01:29.172	00:01:42.288	00:00:13	00:04:00.390	00:04:43.346	00:00:43
Display3	00:02:09.308	00:02:39.994	00:00:31	00:01:42.288	00:02:04.813	00:00:23	00:04:43.346	00:05:06.060	00:00:23
Display4a	00:05:57.627	00:06:20.009	00:00:22	00:04:32.965	00:04:51.151	00:00:18	00:10:53.892	00:11:58.439	00:01:05
	00:06:35.432	00:06:45.904	00:00:10	00:05:04.652	00:05:11.884	00:00:07	00:12:14.354	00:12:20.806	00:00:06
	00:06:50.453	00:06:56.931	00:00:06	00:05:15.553	00:05:20.021	-	-	-	-
	-	-	-	-	-	-	-	-	-
Display4b	00:02:50.022	00:02:53.260	00:00:03	00:02:13.837	00:02:16.837	00:00:03	00:05:17.320	00:05:21.808	00:00:04
	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
Display4c	00:02:55.480	00:02:58.849	00:00:03	00:02:18.507	00:02:20.758	00:00:02	00:05:25.004	00:05:27.513	00:00:03
	00:03:05.404	00:03:10.022	00:00:05	00:02:27.115	00:02:31.700	00:00:05	00:05:36.956	00:05:39.065	00:00:02
	00:03:20.689	00:03:22.223	00:00:02	00:02:37.911	00:02:42.533	00:00:05	00:05:45.706	00:05:49.945	00:00:04
Display4d	00:06:24.086	00:06:30.882	00:00:07	00:04:54.809	00:05:00.340	00:00:06	00:12:01.799	00:12:07.976	00:00:06
	00:06:45.904	00:06:50.280	00:00:04	00:05:11.884	00:05:15.058	00:00:03	00:12:21.060	00:12:22.497	00:00:01
	-	-	-	00:05:37.474	00:05:48.725	00:00:11	-	-	-
	-	-	-	-	-	-	-	-	-
Display4e	00:06:30.882	00:06:33.893	00:00:03	00:05:00.577	00:05:03.445	00:00:03	00:12:08.184	00:12:10.637	00:00:02
Display5	00:03:46.911	00:04:02.191	00:00:15	00:03:16.789	00:03:22.365	00:00:06	00:06:10.514	00:06:31.603	00:00:21
	00:04:13.613	00:04:20.178	00:00:07	00:03:35.689	00:03:42.873	00:00:07	00:06:42.494	00:07:31.001	00:00:49
	00:05:05.736	00:05:12.854	00:00:07	-	-	-	00:08:40.654	00:09:49.861	00:01:09
	-	-	-	-	-	-	00:09:56.814	00:10:21.738	00:00:25
	-	-	-	-	-	-			
Display6	00:04:20.258	00:05:05.736	00:00:45	00:03:22.365	00:03:35.689	00:00:13	00:07:31.001	00:08:40.654	00:01:10
	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
Display7	00:07:13.954	00:07:33.924	00:00:20	00:05:26.177	00:05:33.432	00:00:07	00:12:49.768	00:13:13.971	00:00:24
	-	-	-	00:05:59.787	00:06:03.173	00:00:03	-	-	-
	-	-	-	-	-	-	-	-	-
Display8	-	-	-	00:05:34.428	00:05:37.474	00:00:03	00:12:41.298	00:12:49.536	00:00:08
	-	-	-	-	-	-	-	-	-
Display9	00:07:35.006	00:07:53.493	00:00:18	00:05:49.632	00:05:54.085	00:00:04	00:13:14.380	00:13:41.467	00:00:27
Display10	-	-	-	-	-	-	-	-	-

	P7			P8			P9		
	Start time	End time	During	Start time	End time	During	Start time	End time	During
First floor	00:03:29.876	00:09:50.033	00:06:20	00:00:41.457	00:06:14.270	00:05:33	00:00:35.886	00:06:02.030	00:05:26
Second floor	00:10:08.923	00:13:36.127	00:03:27	00:06:28.865	00:08:56.808	00:02:28	00:06:23.746	00:09:02.345	00:02:39
Exhibition1	00:03:29.876	00:04:47.254	00:01:17	00:00:41.457	00:01:38.189	00:00:57	00:00:35.886	00:01:16.862	00:00:41
Exhibition2	00:04:47.254	00:05:34.845	00:00:48	00:01:38.189	00:02:07.777	00:00:30	00:01:16.862	00:01:45.754	00:00:29
Exhibition3	00:05:34.845	00:06:21.122	00:00:46	00:02:07.777	00:02:43.088	00:00:35	00:01:45.754	00:02:23.969	00:00:38
Exhibition4	00:06:41.049	00:07:31.087	00:00:50	00:02:54.699	00:03:34.704	00:00:40	00:02:41.168	00:03:36.016	00:00:55
Exhibition5	00:07:41.726	00:09:43.583	00:02:02	00:03:45.498	00:06:06.811	00:02:21	00:03:51.418	00:05:52.143	00:02:01
Exhibition6	00:10:12.810	00:11:58.325	00:01:46	00:06:32.975	00:07:46.876	00:01:14	00:06:28.460	00:07:56.248	00:01:28
Exhibition7	00:12:07.420	00:13:36.153	00:01:29	00:07:52.452	00:08:56.259	00:01:04	00:08:03.343	00:09:02.509	00:00:59
Transition1	00:06:21.132	00:06:41.052	00:00:20	00:02:43.088	00:02:54.710	00:00:12	00:02:23.969	00:02:41.240	00:00:17
Transition2	00:07:31.078	00:07:41.712	00:00:11	00:03:34.704	00:03:45.487	00:00:11	00:03:36.019	00:03:51.404	00:00:15
Transition3	00:09:43.811	00:10:12.841	00:00:29	00:06:06.751	00:06:32.990	00:00:26	00:05:52.237	00:06:28.618	00:00:36
Transition4	00:11:58.324	00:12:07.448	00:00:09	00:07:46.875	00:07:52.456	00:00:06	00:07:56.204	00:08:03.331	00:00:07
Transition5	00:13:36.129	00:13:59.342	00:00:23	00:08:56.256	00:09:13.933	00:00:18	00:09:02.346	00:09:34.911	00:00:33
Display1	00:03:29.876	00:04:47.254	00:01:17	00:00:41.457	00:01:38.189	00:00:57	00:00:35.886	00:01:16.862	00:00:41
	-	-	-	-	-	-	-	-	-
Display2	00:04:47.254	00:05:34.845	00:00:48	00:01:38.189	00:02:07.777	00:00:30	00:01:16.862	00:01:45.754	00:00:29
Display3	00:05:34.845	00:06:21.122	00:00:46	00:02:07.777	00:02:43.088	00:00:35	00:01:45.754	00:02:23.969	00:00:38
Display4a	00:10:12.841	00:10:52.183	00:00:39	00:06:32.990	00:07:03.308	00:00:30	00:06:28.618	00:07:03.651	00:00:35
	00:11:15.311	00:11:44.897	00:00:30	00:07:22.630	00:07:36.174	00:00:14	00:07:20.228	00:07:30.797	00:00:11
	00:11:54.636	00:11:57.967	00:00:03	-	-	-	00:07:34.786	00:07:51.033	00:00:16
	-	-	-	-	-	-		-	-
Display4b	00:06:41.052	00:06:44.570	00:00:04	00:02:54.710	00:02:58.247	00:00:04	00:02:41.240	00:02:44.248	00:00:03
	-	-	-	-	-	-	00:02:46.343	00:02:52.225	00:00:06
	-	-	-	-	-	-	00:03:01.124	00:03:08.068	00:00:07
Display4c	00:06:46.715	00:06:55.410	00:00:09	00:02:59.182	00:03:05.348	00:00:06	00:03:19.079	00:03:25.978	00:00:07
	00:07:03.013	00:07:07.805	00:00:05	00:03:12.697	00:03:16.021	00:00:03	-	-	-
	00:07:14.373	00:07:24.510	00:00:10	00:03:23.403	00:03:27.465	00:00:04	-	-	-
Display4d	00:10:55.019	00:11:08.025	00:00:13	00:07:08.538	00:07:17.288	00:00:09	00:07:09.984	00:07:15.315	00:00:05
	00:11:45.046	00:11:52.131	00:00:07	00:07:36.469	00:07:39.929	00:00:03	00:07:30.900	00:07:34.244	00:00:03
	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
Display4e	00:11:08.025	00:11:13.343	00:00:05	00:07:17.447	00:07:21.855	00:00:04	00:07:15.315	00:07:19.553	00:00:04
Display5	00:07:43.276	00:07:47.048	00:00:04	00:03:46.274	00:04:19.913	00:00:34	00:03:53.171	00:04:01.738	00:00:09
	00:07:49.552	00:09:25.333	00:01:36	00:04:24.030	00:04:43.834	00:00:20	00:04:10.888	00:04:23.971	00:00:13
	00:09:33.682	00:09:37.758	00:00:04	00:04:57.623	00:05:08.524	00:00:11	00:05:13.827	00:05:23.498	00:00:10
	-	-	-	00:05:08.524	00:05:36.529	00:00:28	-	-	-
	-	-	-	00:05:38.986	00:05:57.476	00:00:18	-	-	-
Display6	-	-	-	00:04:43.834	00:04:57.623	00:00:14	00:04:23.971	00:05:13.827	00:00:50
	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
Display7	00:12:07.448	00:12:23.646	00:00:16	00:08:05.919	00:08:21.378	00:00:15	00:08:03.331	00:08:10.420	00:00:07
	00:12:39.293	00:13:03.717	00:00:24	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
Display8	00:12:24.065	00:12:37.994	00:00:14	-	-	-	00:08:10.420	00:08:26.928	00:00:17
	-	-	-	-	-	-	00:08:44.117	00:08:52.074	00:00:08
Display9	00:13:04.125	00:13:22.408	00:00:18	00:08:21.676	00:08:34.338	00:00:13	00:08:37.282	00:08:43.419	00:00:06
Display10	-	-	-	-	-	-	00:08:30.719	00:08:37.282	00:00:07

	P10			P11			P12		
	Start time	End time	During	Start time	End time	During	Start time	End time	During
First floor	00:00:38.574	00:07:04.189	00:06:26	00:02:03.066	00:12:54.843	00:10:52	00:01:15.451	00:09:15.557	00:08:00
Second floor	00:07:19.446	00:10:27.285	00:03:08	00:13:11.535	00:17:36.492	00:04:25	00:09:32.495	00:12:16.650	00:02:44
Exhibition1	00:00:38.574	00:01:34.644	00:00:56	00:02:03.066	00:05:20.276	00:03:17	00:01:15.451	00:02:53.498	00:01:38
Exhibition2	00:01:34.644	00:02:44.406	00:01:10	00:05:20.276	00:05:45.712	00:00:25	00:02:53.498	00:03:46.359	00:00:53
Exhibition3	00:03:28.666	00:03:59.434	00:00:31	00:05:45.712	00:06:53.860	00:01:08	00:03:46.359	00:05:13.368	00:01:27
Exhibition4	00:04:12.807	00:04:44.581	00:00:32	00:07:10.739	00:08:17.390	00:01:07	00:05:24.540	00:06:08.623	00:00:44
Exhibition5	00:04:54.203	00:06:57.169	00:02:03	00:08:29.814	00:12:48.770	00:04:19	00:06:20.906	00:09:08.238	00:02:47
Exhibition6	00:07:22.145	00:09:08.139	00:01:46	00:14:41.098	00:15:55.990	00:01:15	00:09:36.161	00:11:14.611	00:01:38
Exhibition7	00:09:15.746	00:10:27.286	00:01:12	00:16:01.987	00:17:36.488	00:01:35	00:11:22.455	00:12:16.866	00:00:54
Transition1	00:03:59.434	00:04:12.783	00:00:13	00:06:53.860	00:07:10.805	00:00:17	00:05:13.368	00:05:24.562	00:00:11
Transition2	00:04:44.579	00:04:54.197	00:00:10	00:08:17.342	00:08:29.826	00:00:12	00:06:08.467	00:06:20.889	00:00:12
Transition3	00:06:57.155	00:07:22.201	00:00:25	00:12:48.766	00:13:15.173	00:00:26	00:09:08.189	00:09:36.230	00:00:28
Transition4	00:09:08.109	00:09:15.748	00:00:08	00:15:55.952	00:16:01.984	00:00:06	00:11:14.579	00:11:22.438	00:00:08
Transition5	00:10:27.283	00:10:52.364	00:00:25	00:17:36.476	00:17:58.484	00:00:22	00:12:16.874	00:12:36.614	00:00:20
Display1	00:00:38.574	00:01:34.644	00:00:56	00:02:03.066	00:05:20.276	00:03:17	00:01:15.451	00:02:53.498	00:01:38
	00:02:44.406	00:03:28.666	00:00:44	-	-	-	-	-	-
Display2	00:01:34.644	00:02:44.406	00:01:10	00:05:20.276	00:05:45.712	00:00:25	00:02:53.498	00:03:46.359	00:00:53
Display3	00:03:28.666	00:03:59.434	00:00:31	00:05:45.712	00:06:53.860	00:01:08	00:03:46.359	00:05:13.368	00:01:27
Display4a	00:07:22.201	00:07:44.737	00:00:23	00:13:15.173	00:14:37.351	00:01:22	00:09:36.230	00:10:07.164	00:00:31
	00:07:55.847	00:08:30.190	00:00:34	00:15:30.317	00:15:43.491	00:00:13	00:10:24.289	00:10:39.112	00:00:15
	00:08:35.009	00:08:59.833	00:00:25	-	-	-	00:10:51.612	00:11:01.035	00:00:09
	-	-	-	-	-	-	-	-	-
Display4b	-	-	-	00:07:10.805	00:07:17.029	00:00:06	-	-	-
	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
Display4c	-	-	-	00:07:20.918	00:07:26.117	00:00:05	00:05:30.352	00:05:34.996	00:00:05
	-	-	-	00:07:37.438	00:07:47.149	00:00:10	00:05:05.811	00:06:00.726	00:00:55
	-	-	-	00:07:59.858	00:08:06.982	00:00:07	-	-	-
Display4d	00:07:48.913	00:07:53.319	00:00:04	00:14:46.482	00:15:19.063	00:00:33	00:10:10.834	00:10:18.548	00:00:08
				00:15:43.491	00:15:48.827	00:00:05	00:10:39.648	00:10:47.800	00:00:08
	-	-	-	-	-	-	00:11:01.035	00:11:11.262	00:00:10
	-	-	-	-	-	-	00:12:03.017	00:12:06.443	00:00:03
Display4e	00:07:53.319	00:07:55.847	00:00:03	00:15:19.063	00:15:26.233	00:00:07	00:10:18.988	00:10:22.684	00:00:04
Display5	00:04:55.452	00:05:24.627	00:00:29	00:08:32.465	00:09:07.567	00:00:35	00:06:21.828	00:07:07.848	00:00:46
	00:05:44.568	00:06:45.944	00:01:01	00:09:19.673	00:09:47.523	00:00:28	00:07:12.783	00:07:47.907	00:00:35
	-	-	-	00:11:16.635	00:11:50.966	00:00:34	00:07:58.087	00:08:19.563	00:00:21
	-	-	-	00:12:02.755	00:12:37.202	00:00:34	00:08:30.538	00:08:56.698	00:00:26
	-	-	-	-	-	-	-	-	-
Display6	00:05:24.627	00:05:44.568	00:00:20	00:09:47.523	00:11:16.635	00:01:29	00:07:47.907	00:07:58.087	00:00:10
	-	-	-	00:11:50.966	00:11:59.830	00:00:09	-	-	-
	-	-	-	-	-	-	-	-	-
Display7	00:09:36.508	00:09:49.601	00:00:13	-	-	-	00:11:22.438	00:11:33.638	00:00:11
	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
Display8	-	-	-	00:16:07.464	00:16:29.120	00:00:22	00:11:34.411	00:11:46.122	00:00:12
	-	-	-	-	-	-	-	-	-
Display9	00:09:50.040	00:10:15.032	00:00:25	-	-	-	00:11:51.707	00:11:55.162	00:00:03
Display10	-	-	-	00:16:33.919	00:16:47.088	00:00:13	-	-	-

Appendix V: Participants' visitng time during Experiment 2 with wearabel devices and eye-tracker

	Observation in field	Tracked by Tobii Glasses	EDFs perceived	AEFs perceived	Over experience	
					Before	After
P1 8:00 am		 Visiting exhibition 6	Photos Meaning Ergonomic Emotional Narrative Aesthetic Colour Material Texture	Motivation Understanding Attention Curiosity Learning	Excellent	Good
P2 13:10 pm		 Visiting exhibition 2	-	Leisure Memory	Excellent	Good
P3 9:00 am		 Visiting exhibition 1	Photos Meaning Ergonomic Emotional Narrative Aesthetic Colour Material Texture	Motivation Cool	Superior	Excellent
P4 10:00 am		 Visiting exhibition 3	Pamphlet Photos/Culture Social/Colour Ergonomic Emotional Shape/Narrative Aesthetic/ Smell Material/Time Visit efficiently Lighting/Music Environment	Satisfaction	Excellent	Excellent
P5 10:30 am		 Visiting exhibition 7	Photos	Understanding Attention Curiosity Cool Interesting Leisure Social Reflection	Excellent	Good
P6 10:40 am		 Visiting exhibition 1	Photos Multimedia Meaning Technology Culture/ Prop Ergonomic Emotional Shape/Aesthetic Colour/Material Texture/Time Communication Visit efficiently Environment	Motivation Understanding Service Attention Curiosity Creativity Cool Leisure	Superior	Superior

P7 11:05 am		 Visiting exhibition 7	Photos Meaning Culture/Social Ergonomic Emotional Shape/prop Aesthetic Colour Material/Texture Visit efficiently Lighting Environment	Satisfaction Service Cool	Excellent	Excellent
P8 12:46 pm		 Visiting exhibition 1	Photos Ergonomics Emotional Shape Aesthetic Colour Material Texture Time Prop Lighting Environment	Satisfaction Attention Curiosity Cool Fun Authenticity	Superior	Superior
P9 13:39 pm		 Visiting exhibition 6	Photos Meaning Technology Emotional Aesthetic Colour Visit efficiently	Service Attention Fun Leisure	Excellent	Superior
P10 14:07 am		 Visiting exhibition 7	Multimedia Meaning Culture Ergonomic Shape Time Visit efficiently Lighting Smell Environment	Satisfaction Engagement Emotional Attention Cool Leisure Social	Excellent	Excellent
P11 14:00 pm		 Visiting exhibition 5	Multimedia	Motivation Satisfaction Understanding Service Curiosity Interesting Fun Reflection Others	Superior	Superior
P12 15:00 pm		 Visiting exhibition 3	Multimedia Meaning Culture Emotion Visit efficiently Environment	Motivation Understanding Emotional Service Curiosity Creativity Interesting Learning Social Culture	Excellent	Excellent