Simulating Visitor Behavior

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By

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PREFACE

The dynamics of the interplay between the visitor and the exhibition environment form complex circulation patterns. As an exhibition designer, developing an understanding of those dynamics is important for improving visitor satisfaction. However, an overwhelming number of variables may transform the exhibition design process into educated guesswork. Designing through trial and error is just not feasible. As well, due to the nature of creating built environments, modifying decisions far in the design process results in significant costs. The designer has to rely on extensive experience to succeed. Accordingly, implementing a method for guidance into the design process should prove valuable for the designer.

In the context of exhibition design, one such guidance method is simulating visitor behavior. However, simulating complex behavioral patterns and displaying the outcomes in an easily comprehendible way presents a difficult challenge. Considering the inherent complexity of human behavior, the results of a simulation would merely approximate reality. However, by integrating academic knowledge into the development of the simulation, an accurate approximation is possible. Besides the integration of academic knowledge, there's another issue to consider. In a complex process such as exhibition design, the implementation of a simulation system during design progression requires not only a simple and intuitive interface but also a comprehensible output format that is meaningful for the design process.

This book elaborates on the development stages of a simulation application for visitor circulation in exhibition environments, and it presents the challenges of integrating a complex mathematical process into a visual and artistic process such as exhibition design. Those challenges include understanding individual stages of development, building a theoretical foundation, creating a simulation framework, composing individual operations, and implementing the finalized simulation into the design process. Taken together, this process sheds light on the underlying challenges of creating a functioning simulation.

The contents of this book are beneficial not only for exhibition designers and simulation developers but also anyone interested in visitor behavior and spatial design in general.

CHAPTER ONE

INTRODUCTION

Museums and galleries have long been interested in knowing their visitors. Starting from the early 20th century, many academic studies concerning visiting times and visitor behavior were conducted (Loomis 1987; Screven 1976). The research has revealed several key factors in visiting experience such as age, gender, education, income, specific interests, and previous museum experience (Bitgood and Loomis 1993; Bitgood, Patterson and Benefield 1988; Bollo and Pozzolo 2005; Gorman 2008; Loomis 1987; Screven 1976; Serrell 1996; 1997; Soren 1999). The data played a critical role in understanding visitors and their behavior patterns in exhibition environments. Besides the background and preferences of a visitor, another variable affecting visiting experience is the design and planning of the exhibition space. Researchers stated in previous studies that proper planning of an exhibition space plays a crucial role in visitor satisfaction (Bitgood Patterson and Benefield 1988; Bitgood and Loomis 1993).

Although the exhibition design process mostly relies on artistic preference and personal judgment, it also requires previously acquired knowledge of visitor needs and expectations (Dean 1994; Eckel and Beckhaus 2001). The exhibition design process is non-linear and reflective; however, throughout the progression revisions and modifications become difficult and costly (Guler 2015; Locker 2011; Schön 1984) (Figure 1). Therefore, the exhibition designer has to rely on extensive experience.

In the context of exhibition design, there are many ways to prevent false assumptions and reduce erroneous design decisions caused by inadequate knowledge of visitor needs and expectations. One such way is visually aiding the designer with sketches, cardboard models, or digital depictions of the exhibition environment (Neal 1987). However, the visual aid may still contain design deficiencies, since models and sketches can provide only limited feedback. Other methods may include providing design checklists or aiding the designer with smartphone apps (Guler 2015).
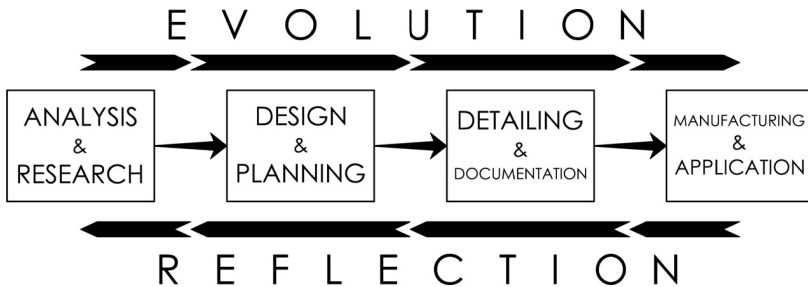
Figure 1. The exhibition design process.

Simulations have been aiding designers on different design problems for decades (Kicinger, Arciszewski and De Jong 2005). Various research projects have been conducted on simulations with a limited focus on exhibition design, usually as implementation cases (Saunders and Gero 2004; Jun, Sung and Choi 2006). However, no studies or applications have been conducted with a focus on the exhibition design process.

To fill this gap in the literature, this book elaborates on the following question: "Can simulating visitor circulation behavior in an exhibition environment help the designer during the layout planning process and how?"

Purpose of the Book

Due to the complexity of the design process many errors may be introduced as the product advances (Lawson 1997). Performing simulations is one way to detect these errors and improve the quality of the final product. Considering the available collection of statistical data and observations regarding visitor behavior in exhibition spaces, it is possible to create a simulation that can approximate visitor behavior and provide useful feedback for the designer (Serrell 1997; Bollo and Pozollo 2005).

The main purpose of this book is to elaborate the stages of development of a simulation application for visitor circulation in exhibition environments and to present the challenges of integrating a complex mathematical process into design progression. A simulation is proposed based on statistical data and observations published in previous academic research. By utilizing the proposed simulation, the designer will be able to integrate the knowledge base into his or her design process. This also book sheds light on adapting simulations into the early phases of the interior

design process by presenting both the programmers' points of view and the designers' points of view together.

Structure of the Book

This book is composed of eight chapters. The introductory chapter explains the aim of the book and briefly introduces the proposed simulation application.

In the second chapter, the exhibition design process is explained in separate phases to understand what the proposed simulation application intends to aid.

In the third and fourth chapters, visitor and exhibition dynamics are explained. The first step of conceptualizing the operation logic of a simulation is to understand the dynamics of visitor behavior and the exhibition environment. Accordingly, visitor profiles, expectations, needs, and motivations are categorized and explained as *visitor indicators* in the third chapter. Major gallery types, physical and mental plans, attraction power, and viewing times of exhibit elements are categorized and explained as *exhibition indicators* in the fourth chapter.

In the fifth chapter, the framework of the proposed simulation and the implementation of the knowledge base are explained. User interface, input and output parameters, and individual processes of the proposed simulation are explained in detail.

The sixth chapter explains the development process of the proposed simulation. The development process is elaborated through flowcharts and pseudo codes. Possible alternative solutions to singular functions and operations are also discussed.

The seventh chapter outlines an experiment based on two sample exhibition design cases. The design and simulation processes for the sample exhibition environments are explained in detail. Simulation outputs of sample exhibition environments are compared and evaluated.

The eighth chapter provides conclusions. Limitations are discussed and suggestions for future research are proposed.

CHAPTER TWO

EXHIBITION DESIGN PROCESS

Exhibition design is a process in which exhibit elements and their surroundings are organized to communicate a narrative, impart an idea, or introduce a brand. The focus of the exhibition design process is the visitor and the experience. Contemporary exhibition design is part of an increasingly complex, ubiquitous, and obsessive visual culture in which the presentation of an object or an idea is as important, and at times more important, than the object or idea itself.

A multi-layered process, exhibition design relies on artistic, intellectual, and practical skills in addition to an awareness of construction procedures. Therefore the exhibition designer is expected to provide both creative and technical solutions to planning, designing, and documenting various aspects of the exhibition space, all the while sculpting a complete visitor experience. According to Dernie (2006) the responsibilities of an exhibition designer include "exhibition fixtures, presentation and installation, presentational elements, display cases, projection facilities, media, hardware and software, exhibition engineering, exhibition graphics, information panels, exhibition labeling, drawings and depictions, map production, illustrations, photographs and reproductions, scanning/ lithography, typesetting, models and replicas, costume models, prints and paintings, enlargement production, book binding, framing, object installation/art handling, lighting design and effects lighting" (p. 111). In addition, the exhibition designer is sometimes expected to assist with bidding processes and act as an advisor during the construction and installation phases (Bogle 2013). The responsibilities of the exhibition designer may seem excessive; however, this extensive list is actually indicative of the multidisciplinary nature of the exhibition design process. Considering the whole arc of the exhibition design process, different teams of professionals interact during different periods of the process, resulting in an interdisciplinary synergy. One can imagine the exhibition designer as a film director, presenting a concept and a vision and coordinating teams of professionals to create solutions for specific problems in different phases of the exhibition design process. Usually specialists are required

from other fields, such as product design, lighting design, graphic design, interface design, engineering, conservation-restoration, and construction, not only as advisors but also as active members of an exhibition design team. Due to its multidisciplinary nature, exhibition design is pervious to ideas, concepts, and techniques from other fields, adding to the richness of the process.

The way exhibit elements need to be arranged and the context in which they will be presented require a particular design approach. The context of an exhibition can be cultural or commercial; the exhibition can be situated in museums, galleries, expo centers, malls, archaeological sites, historic buildings, or streets and parks. Among these environments, museums, galleries, and convention/expo centers are among the most commonly visited. Museums can be considered as showcases and places of conservation for cultural heritage, scientific achievements, and any evidence of human endeavor. Galleries can be considered as bastions of art where it thrives and evolves. Conventions and exhibition centers usually focus on brand, image, and consumer relationships.

Every different environment caters to a certain type of exhibition and imposes a distinct visitor profile, therefore bringing forth specific design requirements, concepts, and techniques. Considering the variety of exhibition environments and types of presentation, having an understanding of the needs, behavior, and habits of various target audiences is important for achieving improved visitor satisfaction. The exhibition designer should be aware of any such requirements or do the research before starting the project.

The exhibition designer should acknowledge that the properties of the exhibit element will also change depending on the context. In the context of an art exhibition, the exhibit element would most likely be a work of art such as a painting, a sculpture, an installation, or a video projection. On the other hand, in the context of a science exhibition the exhibit element may be several artifacts brought together in a glass enclosure or housing, with additional information presented through text, graphics, or even interactive displays.

Depending on its target audience, sought-after effect, and context, the exhibition can be permanent, temporary, or travelling. Each variable changes the design requirements, creating a profound impact on the exhibition design process. In the case of a permanent exhibition, intellectual sustainability is an important issue, and the exhibition designer should consider the evolution of the exhibition. In the case of a temporary exhibition, the exhibition designer should consider the construction and dismantling of the exhibition space. In the case of a travelling exhibition,
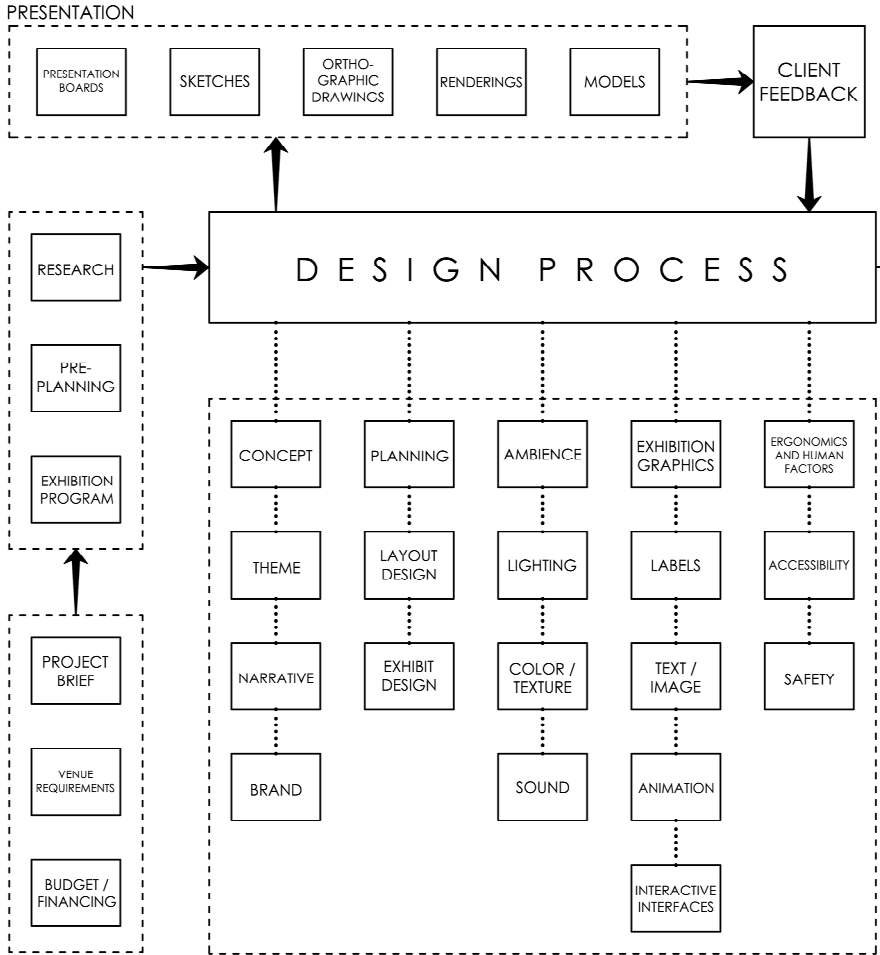
however, the socio-cultural constitution of the next exhibition location may become a primary concern.

Phases of the Exhibition Design Process

The exhibition design process can be understood in four phases: the preparation process, the design process, the realization process, and the life-cycle of the realized exhibition (Figure 2). The first phase is the preparation process. During this phase, the exhibition designer receives the project brief, venue requirements, and also budget and financing information. Following the project brief, the exhibition designer conducts research, pre-plans certain aspects of the exhibition, and creates a design program. The preparation phase is necessary to create a solid foundation for the following phases.

The second phase is the design process. The exhibition design process has several internal stages. However, due to its iterative nature these stages are not sequential and are usually intertwined; aspects of a later stage will most certainly affect a previous design decision. During the first stage, the exhibition designer is expected to create a concept and develop a visitor experience based on a theme, a narrative, or a brand. During the second stage, the exhibition designer plans the exhibition space, designing the layout and exhibit elements. Ambience is the next consideration of the exhibition designer. Lighting, color, texture, and sound all contribute to the ambience of the exhibition space. During the fourth stage, the exhibition designer focuses on the visual details of the exhibition space. Labels, texts, images, illustrations, animations, and interactive interfaces are all categorized as exhibition graphics. The fifth stage includes ergonomics and human factors. The exhibition designer should consider accessibility and safety requirements during the whole design process, and also should check them continuously throughout. Presentations are another aspect of the design process, generating input from the client by providing visual material at certain stages of the design process.

The third phase is the realization process. During this phase, the exhibition designer creates detailed drawings and documentation for the finalized design. The documentation will then be used for bidding and quotation. At the last stage of the realization process, all elements of the exhibition space are manufactured, transported, and installed.

PRESENTATION

PRESENTATION BOARDS	SKETCHES	ORTHO-GRAPHIC DRAWINGS	RENDERINGS	MODELS

CLIENT FEEDBACK

RESEARCH

PRE-PLANNING

EXHIBITION PROGRAM

DESIGN PROCESS

PROJECT BRIEF

VENUE REQUIREMENTS

BUDGET / FINANCING

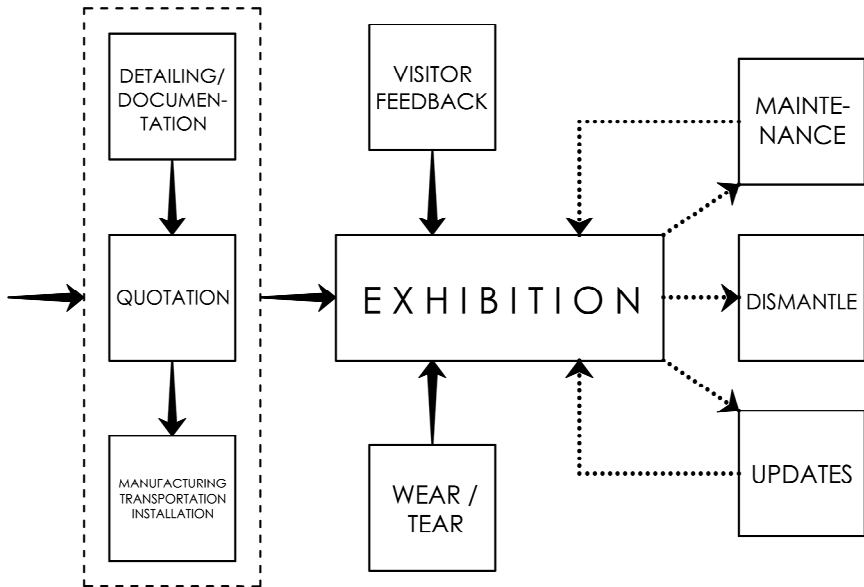| CONCEPT	PLANNING	AMBIENCE	EXHIBITION GRAPHICS	ERGONOMICS AND HUMAN FACTORS
THEME	LAYOUT DESIGN	LIGHTING	LABELS	ACCESSIBILITY
NARRATIVE	EXHIBIT DESIGN	COLOR / TEXTURE	TEXT / IMAGE	SAFETY
BRAND		SOUND	ANIMATION	
			INTERACTIVE INTERFACES	

Figure 2. The exhibition design process in detail.

The fourth phase is the life cycle of the realized exhibition. During this phase, depending on the type of the exhibition, the feedback from the visitors, and the sustained wear and tear, the exhibition will either be dismantled or updated. Maintenance is an important concern for long-term and travelling exhibitions.

The Preparation Process

A thorough understanding of the project brief is the first step in the exhibition design process. Usually important information on the client's vision, the exhibition area to be designed, the artifacts to be exhibited, the venue requirements, the available budget, the financing, the visitor profile, and any additional requirements are provided along with expected turnaround dates in the project brief. The exhibition designer should consider that the requirements, budgetary concerns, and sustainability of the final product may differ significantly compared to other design processes. For instance, working for an established institution, the exhibition designer should consider the vision, overreaching goals, social role, and public image of the client along with related guided tours,

giftshop paraphernalia, outreach programs, and advertisement campaigns (Bogle 2013; Locker 2011).

Funding for the project can be met through donations, grants, and sales; however, the most important point is to consider the size and the availability of budget as it may be a primary constraint on certain stages of the exhibition design process. Understanding the available budget and when it can be available is crucial for a healthy exhibition design process. Revisions during later stages of the exhibition design process may create a lot of strain on the budget, which is one thing the exhibition designer should always pay attention to. Additionally, conducting a feasibility study during the preparation phase is useful for understanding the financial viability of the project and utilizing the budget efficiently.

The Design Process

During the research phase, the exhibition designer completes any missing information from the knowledge base required to complete the given design task. After the research phase, a concept – sometimes with viable alternatives for the sake of discussion – must be formed. The concept will provide the foundation for all future design decisions. The departure point of the concept should relate to the context of the exhibition and image of the institution or brand. A successful concept should lend itself to visual elaboration as exhibition design is almost completely a visual process. The term concept should not be used to refer to the point of inspiration of a design but to the backbone holding together every design decision.

Even though the design process can be divided in phases, usually the process is much more fluid and no distinct moments or lines indicate where a particular process is happening. Usually the process matures in iterations where design solutions are scrutinized continuously, and feedback is received from the client and participating teams to fit all the requirements of an exhibition until the project is solid enough to develop construction drawings and technical requirements. Until this point, the process is cyclical and the design is continuously evolving and transforming, a reflective process (Schön 1984). The final phase of any design process involves resolving construction details, material selection, signage, interface design etc., usually decisions requiring an established/matured design at hand.

The most important aspect of exhibition design is determining the mode of presentation. During the exhibition design process, the exhibition designer is not actually planning a layout of individual exhibit elements

but rather creating an experience for the visitor. Consequently, the relationship between exhibit elements and the context in which the exhibit elements are presented become important concerns for the exhibition designer.

Structure of the Exhibition

When organizing the exhibit elements, either a chronological or a narrative approach can be employed. A chronological approach is when exhibit elements are ordered according to a linear chronology. A narrative approach, on the other hand, is when the layout is structured in a way to tell a story. Even though both approaches have advantages and disadvantages, an exhibition designer should always consider that the employed method dictates how the information will be imparted and should be determined according to visitor profile. A chronological approach will have a strong structure but may create monotony – it also provides less flexibility for the designer. A narrative approach provides the flexibility and interest usually needed for casual visitors; however, the structure may turn out to be weak and the exhibition may turn out to be confusing and incomprehensible as a whole. Nevertheless, an exhibition designer should understand that mixing and matching different approaches is not only possible but also mandatory for improved visitor satisfaction and breaking monotony.

Deciding between a chronological structure and a narrative structure is only part of the design problem. Considering every exhibition provides a distinct experience, determining the visitor's role in that experience is important. Usually visitors are imagined as passive receivers of information, but a more accurate depiction portrays visitors as actively engaging with exhibit elements, creating personal memories as they move through the exhibition. Therefore, any method or type of presentation, such as information walls, immersive displays, and media facades should be employed to create a unique experience (Dernie 2006). Relating information to particular experiences and receiving information in a unique context may be a more effective method of learning compared to simpler instructional approaches (Locker 2011).

Another important design decision for the exhibition designer is determining the way every individual exhibit element will be experienced. Exhibit elements can be viewed either in the open or in a display case. Both methods have advantages and disadvantages that the exhibition designer has to consider. An open presentation creates a more intimate relationship between the visitor and the exhibit element, and negative

effects such as glare and reflections are avoided. A downside is that the exhibit element is unprotected both from visitors and the environment. Exhibit elements presented in a display case are protected from the negative side effects of UV, humidity, and heat. Still, not only are cases expensive, but also utilizing them limits visitor engagement. The case will act not only as a physical barrier but also a psychological one (Locker 2011).

Ambience

Ambiance is one of the most important aspects of an exhibition space as the experience of the visitor and any memory of the exhibition will largely be affected by the perceived ambience. Form, color, material, texture, lighting, additional graphics, and even construction details of displays contribute to ambience.

Exhibition design is primarily a visual endeavor and lighting design is a vital aspect of the process. Lighting profoundly affects the atmosphere and the mood of the interior space therefore affecting how the narrative, theme, or brand will be perceived, and what kind of an experience will be arranged for the visitor. Lighting design can create a visual unity by associating different exhibit elements and spatial features, or it can create contrast for introducing variation and definition.

There are two distinct type of lighting: natural and artificial. Natural lighting refers to the daylight received through the openings of the exhibition space. Natural light provides the best color rendering, creates a familiar atmosphere, and due to its dynamic disposition, creates movement in space. On the negative side, if not controlled properly through employing reflective, obscure, and filtered solutions, natural light may cause excessive glare and may even damage artifacts. Artificial lighting provides more control useful for creating and enhancing the ambience. Also, low UV levels and heat generation properties along with the availability of photosensitive switches and dimmers provide more protection. The exhibition designer should carefully consider type, cost, electrical power, lighting pattern, and intensity drop-off of each lighting fixture. The best solution would most likely involve a mixture of both types of lighting, benefiting from the best of both worlds achieving dynamism and diversity.

Poor lighting design may cause three negative effects that the exhibition designer should watch out for: glare, color distortion, and unwanted reflections. Glare is an excessively bright area in relation to its immediate surroundings, creating an overwhelming sensation for the

observer. Color distortion is caused by certain types of artificial lighting with a poor color rendering index. Unwanted reflections are usually the result of poorly angled glass cases and unbalanced relative light levels, forming reflections on displays of both the surroundings and the visitors.

Color, material, and texture are other aspects contributing to enhancing the ambience in the exhibition space. Color can be closely associated with the concept, theme, and narrative of the exhibition environment. Color not only enhances the ambience but also provides a more memorable experience for the visitor. The use of color should be planned out in conjunction with lighting design, as both aspects are mutually dependant.

The widely accepted image of exhibition spaces with empty white, off-white, or gray walls may seem a reasonable design decision; however, color can be a useful tool for providing the required context for each individual exhibit element. Besides ambience, color is useful in establishing relationships or emphasizing contrasts between exhibit elements. Additionally, color can improve wayfinding in or in between exhibition spaces. Similar to color, material and texture improve the presentation through enhancing the ambience and narrative, elevating the definition of exhibit elements, and providing visual diversity.

Similar to lighting, sound is also an important part of ambience enhancing visitor experience, and it can be implemented through effects, atmospheres, and music. As well, sound can be useful for blocking unwanted background noise or directing visitor attention. However, sound is hard to contain and certain precautions should be taken for preventing visitor confusion and discomfort. Using directional sound sources, utilizing sound absorbent panels, and limiting the use of sound to certain areas may help achieve the proper implementation of sound in an exhibition environment.

Ergonomics and Accessibility

The exhibition designer has to consider certain ergonomic requirements, depending on how each exhibit element will be consumed by visitors. Ergonomics involve designing products compatible with human dimensions and movement. The data for the measurements and statistics can be found in government reports or reference books (Fryar, Gu, and Ogden 2012; Neufert and Neufert 2012; Panero and Zelnik 1979; Pheasant and Haslegrave 2006) Another concern for the exhibition designer is accessibility. Accessibility can be defined as enabling every user to function independently in the designed space through providing support to any user considering possible physical, visual, or aural challenges. Such

support could be in the form of ramps or wayfinding indicators for directing visitors to more comfortable routes, or hinting at incoming challenges, such as long walks (Bogle 2013). In many countries, providing accessible design is required by law. Usually the criteria is dictated through government legislation such as the Americans with Disabilities Act of 2010 in the United States and the Disability Discrimination Act of 2006 in the United Kingdom.

Though rarely a concern for small scale exhibits, wayfinding becomes a prominent issue for larger exhibition environments made up of interconnected exhibition spaces. The way visitors move in an exhibition space should be considered beforehand, and the paths provided for the visitor should be as intuitive as possible. Utilizing signs, directional indicators, and color codes is also useful for wayfinding. Additionally, providing maps and information desks with guidance staff would be useful for large-scale exhibition environments such as museums or expo centers.

Exhibition Graphics

Exhibition graphics are an important part of the presentation, usually following form, color, material, texture, and lighting. Exhibition graphics should be inspired by the visual aspects of the exhibition environment while enhancing them and adding the necessary detail. Usually the amount of information that can be attached to an exhibit element is limited. Reading the story of an artifact in a historical museum or learning how an electrical engine works at a car show requires specifically thought out ways of presentation. Usually the information is vital for providing context, clarifying any obscurities, strengthening narrative, or further engaging visitors, especially visitors who are interested. Exhibition graphics include not only labels but also any printed or projected text, images, pictograms, illustrations, animations, and digital interfaces for enhancing any exhibit element. Implementing exhibition graphics also strengthens the theme or brand, creating unity and enhancing the visitor experience.

Exhibition graphics are not limited to static two-dimensional applications, such as printed material. Multi-media displays, interactive information screens, and audio guides also support the communication of narrative, theme, and brand in the contemporary exhibition space. Such applications provide an opportunity to impart a large amount of information in a condensed area, also providing convenience in updates. The visitor can assume an active role in the exhibition environment, which creates a more effective learning process and more persistent memories of

the information. Additionally, with the advent of digital technology and public access to its extensions such as smartphones and tablets, visitor engagement can be designed in more creative ways.

There are important points to consider when designing exhibition graphics, especially when working with text. The exhibition designer should be aware of certain common mistakes: the font size being too small; the font type being too complex, illegible, or irrelevant to the narrative, theme, or brand of the exhibition; sentences being too long; spacing being too dense; and text blocks looking cluttered. A fundamental knowledge of typography would be useful for the exhibition designer to prevent any such mistakes. By using related visual elements together with text, monotony can be avoided and visitor engagement can be improved.

The contents of graphics and text are also important. They should be clear and direct and should provide information that would add to the narrative, theme, or brand rather than repeating observable features or irrelevant details. Visitors overlook text most of the time and such a presentation of information won't attract many readers. Accessibility is also a concern when designing exhibition graphics as there will be visually impaired visitors.

Presentation and Feedback

Presentations are an important part of any design process. Design processes advance in phases, and throughout the process, the client, employer, committee, or members of contributing teams will be informed about a certain phase of a project through presentations. A presentation can be in different forms and may include different types of visuals such as: concept boards, mood boards, storyboards, material boards, sketches, diagrams, floor plans, sections, elevations, detail drawings, renderings, and animations, and scale models. Presentations are useful for getting relevant feedback, steering the project in the right direction, and also keeping the team well informed about the progress of the project.

Concept boards and mood boards are useful for explaining the departure point of the design and the foundation of the visual and functional design decisions. They provide a glimpse of the ambience and atmosphere sought by the designer. Storyboards, visitor flow diagrams, and bubble diagrams can also alternatively provide information about the planned functionality and narrative of the exhibition space. Material boards can be employed in later stages of the exhibition design process as well as earlier phases to provide an in-depth perspective to the look and feel of the finished exhibition space.

Sketches are mainly a visual aid and a tool for the exhibition designer. Further, providing insight into the design progress, sketches can be employed as a useful presentation method. Sketches usually show the essence of an idea while lacking the details. The lack of precision helps the viewer to focus on the design idea being presented.

Ortographic drawings depict the exhibition environment true to its proportions, displaying a linear rendition of the space without the distortion introduced by perspective so the relative comparison of spatial elements is possible. Ortographic drawings usually employ a singular viewpoint but from different angles. Each viewpoint has a different name and presentational function: showing the space from the top, sections, and elevations and showing the space from the sides. Ortographic drawings are drawn according to technical drawing conventions and usually depict additional information such as spatial dimensions, opening locations, types, and dimensions; furniture and fixture layouts, and dimensions; and entrances, exits, emergency routes etc. One problem with ortographic drawings is that they are usually illegible to the layman, requiring explanation. Renderings and models are relatively more user friendly for the clients and team members from outside the design field. The contemporary designer uses CAD or BIM programs to create technical drawings. As a result, drawings are produced faster and alterations are done quicker. Also, the communication between different design teams and related professionals is much easier through the use of drafting technology.

Renders are colored depictions of the exhibition space from different perspectives. They provide accurate and detailed visuals of the environment complete with the ambience. Renders can be either hand-drawn or digitally created with virtual modelling and rendering software. Renders created in the digital domain are almost a standard practice in contemporary exhibition design and are requested by clients frequently. Animations are also another, more immersive way of depicting the exhibition space enabling the exhibition designer to provide walkthroughs or even real time modification of the exhibition space.

Scale physical models of the exhibition space provide a more immersive experience compared to other presentation mediums, which are usually limited to two dimensions. Physical models enable the viewer to perceive the space from different angles, providing a more tactile experience. Additionally, materials and lighting effects can be depicted on a detail model. Models can also assist the design team during the development of the project as they will help both the designer and the team understand the space and spatial decisions better. Even though

producing models is time consuming and costly, digital manufacturing is making their production easier.

The Realization Process

After the exhibition design is confirmed, the detailing and documentation phase starts. During this phase, floor plans, sections, and elevations are finalized, as well as additional drawings of construction details and tables showing brand and model number of used materials, hardware, fixtures etc. These drawings contain detailed dimensions, points of reference for specific applications, and various details. Detailed documentation is necessary for getting quotes from contractors. Providing as much detail, clarity, and precision as possible is useful as at this stage mistakes and modifications cost significantly more compared to earlier phases of the exhibition design process.

The construction phase usually involves several teams of contractors, working on different aspects of the interior of the exhibition space. Different professionals are required for different aspects of the construction such as floorings, wall surfaces, metal work, woodwork, plastic work and so on. To coordinate several teams, assigning a project manager may be helpful. Due to inaccurate documentation or inadequate construction methods, unexpected errors may occur during this phase. The exhibition designer should be aware of and watch out for any such errors further in the process, as they could spell disaster.

Transportation is an important issue during the construction phase. Parts of the exhibition may get constructed outside of the exhibition space; this is especially the case for a commercial exhibition considering the tight installation schedules dictated by convention/expo centers. Usually the designer should look for possible mistakes that may occur during installation of pre-made elements, as the dimensions of an exhibition space may not be exactly as measured at all corners and nooks. Walls usually have small angles and are not always completely flat. Correcting such small mistakes in-situ may damage the pre-made elements or may even require the items to be remade, causing extra strain on the budget. After the completion of the installation of all elements, the exhibition is complete and ready for visiting.

Life Cycle of the Exhibition

After the exhibition environment opens for visiting, maintenance and sustainability issues arise. Every exhibit element is subject to deterioration

and requires careful attention to continue functioning as intended. Particular precautionary measures should be thought out during the design process depending on the lighting, temperature, humidity, and ventilation requirements of each exhibit element. Guidelines for conserving and preserving different types of artifacts are provided throughout the literature, which should be referred to during the research phase and during the design process (Bogle 2013; Dernie 2006; Schwarz, Bertron and Frey 2006). The exhibition designer should consider how each exhibit element will be experienced, interacted, or operated by the visitor. Despite all precautionary solutions, though, exhibit elements will inevitably experience wear and tear during the lifecycle of the exhibition. Planning the maintenance of each exhibit element during the design process is an important skill to be acquired by the exhibition designer.

Although maintenance is mainly an issue for exhibitions with relatively longer life cycles, for exhibitions with shorter durations, such as commercial exhibition stands designed for expos and other ephemeral events, maintenance is less of an issue though durability should still be important. Another consideration for short-lived exhibitions is dismantling in a limited time span. Also, the designer should consider if re-installation of the exhibition will be required to provide transportability.

Sustainability is an important issue for any exhibition environment. In the context of exhibition design, however, the term sustainability should not only be interpreted as environmental impact of the methods and materials employed. An exhibition environment should also be intellectually sustainable. Considering the evolving needs of the society in general and the visitor in particular, the exhibition environment should be compatible and adaptable. Either periodically or continuously, referring to the feedback from visitors is another aspect of sustainable exhibition design. Visitors may be observed and sometimes invited to provide feedback through evaluations and interviews on their individual experience, effectiveness of the exhibition, and their opinions and expectations about planning, ambience, graphics, and usability of the exhibition environment.

Exhibition design is a complex endeavor and tied to many different variables related to a plethora of different disciplines. Factoring such complexity in a simulation application is an enormous challenge and probably won't be accomplished with simply programming algorithms. Nonetheless, providing a platform for the designer to evaluate various aspects of the exhibition environment is possible. This can be done by integrating the knowledge base through plug-ins of widely used drafting software. With this software, the designer can continue the exhibition

design process supported by the simulation through plug-in integration with 3D modelling programs. In the following chapter, this knowledge base will be elaborated, dissected, and adapted into a simulation application.

CHAPTER THREE

VISITOR INDICATORS

In an exhibition environment, visitors and exhibit elements take on different roles and display distinctive features (Bollo and Pozzolo 2005). Understanding these features is crucial for the exhibition designer. In this book, the first group of features to be examined belongs to visitors. The role of a visitor in an exhibition environment motivates him or her to explore the exhibition space. This behavior renders the visitor as the active element of the exhibition environment.

In the context of this book, the term "visitor indicators" refers to the knowledge base derived from the literature on visitor behavior, which would determine and define visitor variables of the proposed simulation. In this chapter, the elements comprising visitor indicators are explored (Figure 3).
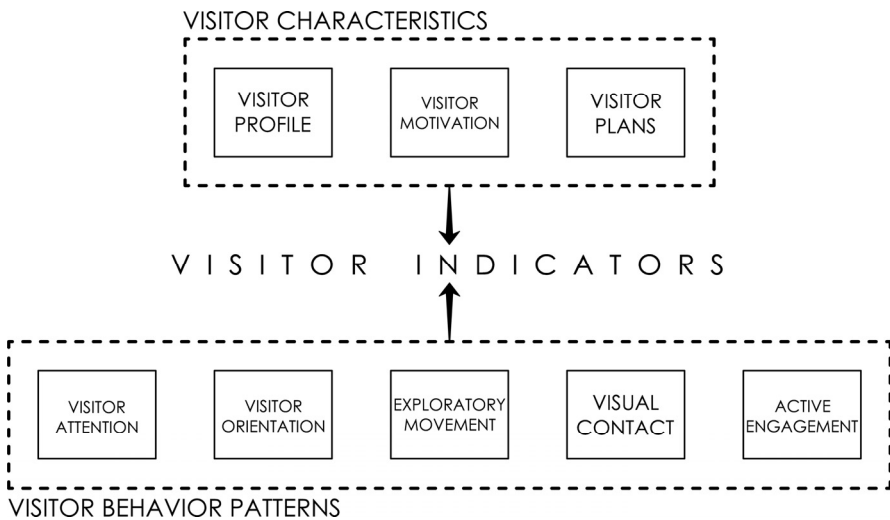

Figure 3. Sub-categories and elements of visitor indicators.

This chapter is composed of two sections: visitor characteristics and visitor behavior patterns. The "visitor characteristics," visitor profiles, the concept of identity, and the effects of identity on visitor needs and motivations are explored. In "visitor behavior patterns" the effects of visitor motivation and needs on visitor attention, orientation, movement, and viewing times are explored.

Visitor Characteristics

Various researchers stated that visitors are the actors of an exhibition and their satisfaction should be the primary goal of the exhibition designer (Bitgood and Loomis 1993; Bitgood, Patterson and Benefield 1988; Bitgood 2002; D'agostino, Loomis and Webb 1991; Kelly 2002a; Kelly 2002b; Kelly 2002c). The satisfaction level of a visitor can be assessed by the degree to which his or her expectations and needs are met. In this section, the effects of visitor profile, visitor motivation, and visit plans are explored.

Visitor Profile

Visitor expectations and needs are closely related to visitor profile. Age, gender, education level, cultural profile, and leisure preferences are all important issues in understanding a visitor's characteristics (Andrews and Asia 1979; Bitgood 2002; Davies 1994; McManus 1991; Sparacino 2002). Understanding the characteristics of a visitor is important for understanding his or her behavioral patterns.

Researchers have identified numerous ways for identifying visitor profiles according to the different characteristics of visitors. Various visitor groups are identified by Hooper-Greenhill (1999) based on visitors' physical and social characteristics. These visitor groups are families, school parties, other organized educational groups, leisure learners, tourists, the elderly, and people with visual auditory, mobility, or learning disabilities. Dean (1994) identified visitor groups under three categories according to their attention levels and viewing habits:

1- "Casual visitors" involve people who move through the exhibition space too quickly without interacting with the exhibit elements too much. Dean (1994) also defined this group as "people who rush."
2- "Cursory visitors" wander around the exhibition space; however, they are more responsive to exhibit elements, and if they target any exhibit element, a close exploration is likely to occur. Dean (1994) also defined this group as "people who stroll."